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"LET KNOWLEDGE GROW FROM MORE TO MORE
AND THUS BE HUMAN LIFE ENRICHED."

A New Survey of Universal Knowledge

ENCYCLOPÆDIA BRITANNICA

Volume 10

GAME BIRDS TO GUITTONE

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GAME BIRDS *TO* GUITTONE

GAME BIRDS. In North America the term game birds includes the so-called upland game birds (native gallinaceous or chickenlike birds) such as quail, pheasant, grouse and partridge; aquatic game birds such as ducks, geese and swans; and the shore birds—woodcock, snipe and plover. In Great Britain the term applies only to grouse. pheasant and partridge.

This article deals with game bird farming, or the production of game birds under artificial conditions for restocking areas for shooting purposes and for the sale of game birds for food For description, classification, food habits, breeding. etc., of the various species of game birds see the separate articles QUAIL; PHEASANT, etc.

The propagation of these birds involves two distinct phases. The first, raising game birds in captivity, began with the desire to assist in the restoration of game in depleted areas to produce birds for hunting. Some still believe that this method of stocking game is necessary to insure good hunting Although research has indicated that in North America it is far too costly, and thus impractical, it is still an important undertaking in areas in which hunters are willing to pay the cost Specialists in game production and management agree that suitable cover and food in the wild is of first importance in supporting a natural abundance of game birds; and with intelligent supervision and frugal cropping. this situation should maintain a reasonable supply. This was the concept of game management in the second half of the 20th century (*See* also WILDLIFE CONSERVATION) The second phase, a later development that rapidly gained in magnitude, was the raising of game birds for meat It was thought that eventually pen-raised game birds nould become as common in the diet of ordinary citizens as turkey and duck

In both North America and Great Britain game farming is a long established practice, but there is a difference in the purpose of it. In North America, where it is illegal to sell wild birds the major purpose is to supply the food market nith artificially reared birds. In Great Britain the object is to restock ground where shooting takes place. The reasons for this difference are both social and climatic.

In North America the right to hunt is in theory, and largely in practice, free to all. Hunters do not expect to kill particularly large numbers of birds and conservation measures are aimed at enabling each hunting licence holder to take a fair share (say, four to ten birds) in a day. In Great Britain game birds are the property of the owner of the land on which they exist and as such they form. part of the crop. Since game-bearing land carries an extra revenue assessment which the landlord must pay, it follows that he must make this crop as large as possible. The British climate militates against this to a greater extent than the American climate does. since in Britain the nesting and hatching period of the year is likely to be afflicted by storms which. if the whole process of game reproduction were left to nature. might decimate the stock in any particular year. Therefore. while America relies on carefully fostered natural reproduction for all purposes, except to supply the food trade, Britain relies to a great extent on artificial rearing in order to make the game crop pay its way.

Game farming was a 20th-century introduction both in North America and Great Britain, though in Britain its roots went farther back. probably to the mid-19th century when the substitution of the breech-loading for the muzzle-loading shotgun and the improvement of the cartridge made it possible to kill large numbers of birds and thus supply a poultry market. Probably the first game farmers were keepers (wardens) who set up on their own account to supply fertile eggs, chicks and grown young birds to estates in the vicinity. Changes in farming practice in the early years of the 20th century induced them to specialize in game farming as opposed to gamekeeping. and 22 established game farms in Great Britain were in business on a very considerable scale at the end of the 1950s.

The farming change which had the greatest effect was the introduction of fall plowing on arable land. The effect of this was to bury the stubbles on which game birds used to feed throughout the winter months and to replace it with equivalent areas of plowed land which contained no grain or seed for the birds to live on. Thus there was a marked change in the game-carrying capacity of a good area of land before and after plowing. A heavy stock had to be heavily shot to save it from starvation and then artificially replenished the following summer when food again became available.

Species Raised.—Quail and pheasant are raised in every section of the United States and in parts of Canada. The bobwhite quail is the most numerous, most popular and best kno n of the upland game birds. In the northern United States it is called "quail," but in the south it is commonly referred to as "partridge." California and valley quail are also produced in captivity. In addition, there are gambel, mountain and scaled quail and the Texas, Mexican, masked and mearns bobwhite quail.

More ring-necked pheasants are raised in pens than any other species of game bird The true pheasant has no white ring around the neck, a common characteristic of the Chinese and Mongolian species which have been mixed considerably in breeding. The ordinary wild pheasant, so abundant in the United States, is in reality a hybrid. There are also golden, amherst and silver pheasants. Other upland game birds raised successfully include the partridge. The chukar (Alectoris graeca) from India and the Hungarian or European partridge (Perdix *perdix*) are the more important species. Some attempts have been made to raise grouse and the prairie chicken. or pinnated grouse. but with little success.

Aquatic game bird production (wild ducks and geese) was a small but growing industry in the second half of the 20th century. The market for mallard ducks and the Canadian goose as food was increasing. Other species were produced only in small numbers.

Licences and Permits. — In the United States a state licence is required to raise game birds in captivity. Such a licence and copies of laws pertaining to game bird production may be obtained from the state game or conservation commission. In most states, usually under certain restrictions, game birds raised in pens may be sold for food. Over 30 states allowed the sales of all kinds of pen-raised game birds for meat; three states restricted sales to pheasant exclusively, and one state limited sales to exotic species.

The canning of pheasant was carried on in several states and quick-freezing was used in others. To buy or sell migratory waterfowl, including wild ducks, geese or swans raised in captivity, a federal permit is required from the U.S. department of the interior's fish and wildlife service.

Developments. — Raising game birds often has been a profitable undertaking, if operated as a business. In the suburbs, persons sometimes have raised birds in back yards and on adjacent land, rented for the purpose. In this manner, the overhead was kept at a minimum and the cost of experience was low. Poultry dealers in the United States and Canada showed more interest in raising and selling game birds and the public was developing a taste for game bird meat.

In the United States, pheasants were raised more extensively in the east, north central, middle Atlantic and Pacific coast states. Bob hites were produced more extensively in the south Atlantic and east north central states. California quail were confined to the Pacific coast. In the second half of the 20th century 1 game bird was raised for every 38 domestic turkeys produced; 1 for every 16 ducks; 1 for every 2 pigeons; 1 for every 1.5 geese and 1 for every 1.3 guineas.

Most of the British game farms were established in their present form in the first decade of the 20th century. They received a considerable stimulus after the end of World War I when many estates, from which the keepers had gone to war, needed to re-establish a breeding stock on short notice. From that date on the idea of replenishing breeding stock from game farms spread to other countries outside Great Britain, of which Denmark and Hungary perhaps deserve special mention.

A considerable export trade had been built up and this, though sometimes limited by restrictions imposed by agricultural departments, was increasing in the second half of the 20th century. British game farms were exporting great numbers of birds to the countries of western Europe and Scandinavia and to some countries in South America, where high-density game production was becoming better understood and appreciated. Before World War II a considerable export trade had been carried on with countries in eastern Europe and with some of the Arab countries in the middle east.

Techniques. — In North America, feeding, breeding, management and marketing are similar to those of poultry production. The problems involved in game bird farming were greatly simplified, because of research conducted by federal and state experiment stations and by commercial feed companies.

Those raising game birds found that the completely mixed and balanced rations developed by the feed companies were quite satisfactory.

The cost of producing game birds in the second half of the 20th century was largely a labour cost. Practically all the equipment required to raise upland game birds could be built at home. Metal equipment (purchased from manufacturers and dealers) proved to be more durable than that made of wood and wire netting; it was also easier to clean and disinfect.

Birds adapted to small-scale production are quail, chukar and Hungarian partridge. It makes little difference whether a beginner starts with the bird or the egg. Eggs may be purchased for incubation by a hen or in an incubator. A small number of day-old chicks is also an inexpensive way to start raising game birds. Quite a few new game breeders begin operations with mature birds. The best location for pens is on high ground, sloping toward the east, nith no net places nearby where mosquitoes might breed. It was found that game birds should not be raised on ground previously occupied by poultry or other domesticated birds because of the danger of contracting their diseases; that the area about the pens should be kept free of manure piles, garbage heaps and other sources of contamination; and that the bird area should be enclosed nith a 6-ft. chicken wire fence to keep out stray dogs, cats and other animals.

Marketing. — Game birds may be sold alive as breeders, for restocking purposes and for meat. Those for food purposes are sold in feather or oven-dressed. The meat may be marketed fresh. quick-frozen or canned. In the second half of the 20th century clubs. restaurants and hotels offering game birds on their menus were increasing in the United States and Canada. Some larger and older game farms developed a lucrative business especially featuring game bird gift packages. The leading food magazines carried advertisements offering birds in feather or oven-dressed, attractively wrapped and boxed.

In addition to marketing native game birds, several of the larger farms imported and sold birds such as Scotch grouse and English red-leg partridge.

See also POULTRY AND POULTRY FARMING.

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(F. G. A.)

GAMELIN, MAURICE GUSTAVE (1872–1958), French army officer. was born in Paris on Sept. 20, 1872. Commissioned from St. Cyr in 1893. he served in World War I, first on Gen. Joseph Joffre's staff, then as division commander. After that war he headed a military mission to Brazil until 192j, when he assumed command of French forces in the Levant. He became army chief of staff in 1931, vice-president of the Conseil Supérieur de la Guerre and army inspector general in 1935, and finally chief of staff of national defense in 1938.

In World War II Gamelin commanded the Allied forces on the western front until May 1940, when his armies fell before the German offensive.

Relieved of his command, he was subsequently arrested, placed on trial to answer for the defeat and then, in 1943, interned in Germany, where he remained until May 1945. He died in Paris on April 18, 1958.

Gamelin's memoirs were published under the title *Servir*, 3 vol. (1946–47). (M. V.)

GAMELINE (? –1271), lord chancellor of Scotland and bishop of St. Andrews, was named lord chancellor in 1250 and was made one of Pope Innocent IV's chaplains in 1254. In the following year he was elected bishop of St. Andrews by the prior and canons, and the selection was subsequently confirmed by the king and council.

On St. Stephen's day of the same year he was consecrated by the bishop of Glasgow, upon a warrant from the pope. During the course of a political upheaval Gameline fell into disfavour at court and was forced to leave the country. His enemies accused him on several charges, but when he submitted his case to the pope in Rome he was acquitted and later returned to his see in Scotiand.

In 1267 he was again involved in a controversy with the court. He died on April 29, 1271, and was buried in his cathedral at St. Andrews.

GAMELYN, THE TALE OF, a verse romance written about the middle of the 14th century and once ascribed to Geoffrey Chaucer because the only existing version was found in the manuscript of his *Canterbury Tales.* It is generally believed that Chaucer planned to develop it as one of the *Tales.*

The tale, about 900 lines in length, concerns the youngest of three brothers who is robbed of his inheritance and persecuted by the eldest brother and finally triumphs with the aid of a band of outlaws. The story was used by Thomas Lodge in his novel *Rosalynde* which was later to provide the basis for Shakespeare's comedy *As You Like It.* The original story has no "love interest" as embodied in the Rosalind and Celia of Shakespeare's version, but is simply an account of the young brother's adventures and his eventual return to property and respectability after the defeat of his enemy.

GAMES, CLASSICAL. Public Games.—The public games of Greece (ἀγῶνες) and Rome *(ludi)* consisted in athletic contests and spectacles of various kinds, generally connected with and forming a part of a religious observance. Probably no institution exercised a greater influence in moulding the national character and producing that unique type of physical and intellectual beauty which is seen reflected in Greek art and literature than the public contests of Greece *(see* ATHLETE; ATHLETIC SPORTS; GLADIATORS).

For them each youth was trained in the gymnasium; they were the central mart where poet, artist and merchant each brought his wares and the common ground of union for every member of the Hellenic race. It is in Greece, therefore, that the earliest form and the fullest development of ancient games is to be found. The shows of the Roman circus and amphitheatre were at best a shadow, and in the later days of the empire a travesty, of the Olympia and Pythia, and require only a cursory notice.

The earliest games of which there is any record are those at the funeral of Patroclus, which form the subject of the 23rd *Iliad.* They are noteworthy as shouing that Greek games were in their origin clearly connected with religion; either, as here, a part of the funeral rites, or else instituted in honour of a god, or as a thank offering for a victory gained or a calamity averted, or in expiation of some crime. Each of the great contests was held near some shrine or sacred place and each is associated with some deity or mythical hero It was not before the 4th century B.C. that this honour was paid to a living man *(see* Plutarch, *Lysander,* 18).

The games of the *Iliad* and those of the *Odyssey* at the court of Alcinous show at what an early date the distinctive forms of Greek athletics—boxing, wrestling. putting the weight, the foot and the chariot race—were determined.

The Olympian games were the earliest, and to the last they remained the most celebrated, of the four national festivals. Olympia was a naturally enclosed spot in the plain of Elis. It was bounded on the north by the rocky heights of Cronion and on the south and west by the Alpheus and its tributary, the Cladeus. There was the grove of Altis, in which were ranged the statues of the victorious athletes, and the temple of Olympian Zeus with the chryselephantine statue of the god. the masterpiece of Pheidias. There Heracles (so ran the legend which Pindar has introduced in one of his finest odes), when he had conquered Elis and slain its king Augeas, consecrated a temenos and instituted games in honour of his victory. A later legend, which probably embodies historical fact, tells how, when Greece was torn by dissensions and ravaged by pestilence, Iphitus inquired of the oracle for help and was bidden restore the games which had fallen into desuetude; and there was, in the time of Pausanias, suspended in the temple of Hera at Olympia, a bronze disk whereon were inscribed, with the regulations of the games, the names of Iphitus and Lycurgus. From this it may be safely inferred that the games were a primitive observance of the Eleians and Pisans, and first acquired their celebrity from the powerful concurrence of Sparta. The sacred armistice, or cessation of all hostilities during the month in which the games were to be held, is also credited to Iphitus.

In 776 B.C. the Eleians engraved the name of their countryman, Coroebus, as victor in the foot race, and thenceforward there is an almost unbroken list of the victors in each succeeding Olympiad or fourth recurrent year.

For the next 50 years no names occur but those of Eleians or their next neighbours. After 720 B.C. Corinthians and Megareans are found, and later still, Athenians and extra-Peloponnesians. Thus what at first was nothing more than a village feast became a bond of union for all the branches of the Doric race, and grew in time to be the high festival to which every Greek gathered, from the mountain fastnesses of Thessaly to the remotest colonies of Cyrene and Marseilles. It survived even the extinction of Greek liberty, and had nearly completed 12 centuries when it was abolished by the decree of the Christian emperor, Theodosius, in the tenth year of his reign.

Let us attempt to call up the scene which Olympia in its prosperous days must have presented as the great festival approached. Heralds had proclaimed throughout Greece the "truce of God." So religiously was this observed that the Spartans chose to risk the liberties of Greece, when the Persians were at the gates of Pylae, rather than march during the holy days. Those white tents belong to the Hellanodicae, or ten judges of the games, chosen one for each tribe of the Eleians. They have been already here ten months, receiving instruction in their duties. All. too, or most of the athletes must have arrived, for they have been undergoing the indispensable training in the gymnasium of the Altis. But along the "holy road" from the town of Elis a motley throng is crowding. Conspicuous in the long train are the θεωροί or sacred deputies, clad in their robes of office and bearing with them, in their carriages of state, offerings to the shrine of the god.

There is no lack of noted visitors. It may be Alcibiades, who, they say, has entered no less than seven chariots; or Gorgias, who has written a famous ἐπίδειξις for the occasion; or the sophist Hippias, who boasts that all he bears about him, from the sandals on his feet to the dithyrambs he carries in his hand, are his own manufacture; or Aetion, who will exhibit his picture of the marriage of Alexander and Roxana—the picture which gained him no less a prize than the daughter of the Hellanodices Praxonides; or, in an earlier age, the poet laureate of the Olympians, Pindar himself.

A feature of the mediaeval tournament and the modern racecourse, however, is wanting. Women might indeed compete and win prizes as the owners of teams, but all except the priestesses of Demeter were forbidden, matrons on pain of death, to enter the enclosure.

At daybreak the athletes presented themselves in the bouleuterion, where the judges were sitting, and proved by witnesses that they were of pure Hellenic descent and had no stain, religious or civil, on their character. Laying their hands on the bleeding victim, they swore that they had duly qualified themselves by ten months' continuous training in the gymnasium, and that they would use no fraud or guile in the sacred contests. Thence they proceeded to the stadium, where they stripped to the skin and anointed themselves. A herald proclaimed, "Let the runners put their feet to the line," and called on the spectators to challenge any disqualified by blood or character. If no objection was made, they were started by the note of the trumpet, running in heats of four, ranged in places assigned by lot. The presidents seated near the goal adjudged the victory.

The foot race was only one of 24 Olympian contests which Pausanias enumerates, though it must not be supposed that these were all exhibited at any one festival. Till the 77th Olympiad all was concluded in one day, but afterward the feast was extended to **five.**

The order of the games is for the most part a matter of conjecture, but, roughly speaking, the historical order of their institution was followed. The most important are described below in this order.

1. The Foot Race.—For the first 13 Olympiads the δρόμος, or single lap of the stadium, which was 200 yd. long, was the only contest. The δίαυλος, in which the course was traversed twice, was added in the 14th Olympiad, and in the 15th the δόλιχος, or long race, of 7, 12 or, according to the highest computation, 24 laps, about 2 5 mi. in length. It is said that the Spartan Ladas, after winning this race, dropped down dead at the goal. There was also, for a short time, a race in heavy armour, which Plato highly commends as a preparation for active service.

2. Wrestling was introduced in the 18th Olympiad. The importance attached to this exercise is shown by the very word "palaestra," and Plutarch calls it the most artistic and cunning of athletic games. The practice differed little from that of modem times, save that the wrestler's limbs were anointed with oil and sprinkled with sand. The third throw, which decided the victory, passed into a proverb, and struggling on the ground was not allowed in the upright wrestling of the Olympic pentathlon, though it was permitted in the *pancratium* (see below).

3. In the same year was introduced the πένταθλον (pentathlon), a combination of the five games enumerated in the well-known pentameter ascribed to Simonides: ἅλμα, ποδωκείην, δίσκον, ἄκοντα, πάλην. Only the first of these calls for any comment. The only leap practised seems to have been the long jump. The leapers increased their momentum by means of ἁλτῆρες or dumbbells. which they swung in the act of leaping. The take-off may have been slightly raised, and some commentators with very little warrant have stated that springboards were used. The record jump with which Phayllus of Croton is credited, 55 ft, is incredible with or without a springboard. It is disputed whether a victory in all five contests, or in three at least, was required to win the πένταθλον.

4. The rules for boxing (q v.) did not differ greatly from those of the modern ring, and the chief difference was in the use of the caestus. This device. in Greek times, consisted of leather thongs bound round the boxer's fists and wrists The weighting with lead or iron or metal studs, which made the caestus more like a "knuckle duster" than a modern boxing glove, mas a later Roman development. The killing of an antagonist, unless it was proved to be accidental, not only disqualified for a prize, but was severely punished. The use of earguards and the comic allusions to broken ears rather than noses suggest that the Greek boxer did not hit out straight from the shoulder, but fought windmill fashion. In the *pancratium*, in which the only recognized fouls were biting and gouging. hitting uith the fists and wrestling were combined.

5. The chariot race had its origin in the 23rd Olympiad. Of the hippodrome, or racecourse, no traces remain, but from the description of Pausanias it may be inferred that the dimensions were approximately 1,600 ft. by 400 ft. Down the centre there ran a bank of earth, and at each end of this bank was a turning post around which the chariots had to pass. "To shun the goal with rapid nheels" required both nerve and skill, and the charioteer played a more important part in the race than even the modern jockey. Pausanias says that horses would shy as they passed the fatal spots. The places of the chariots were determined by lot, and there were elaborate arrangements for giving the drivers a fair start. The number of chariots that might appear on the course at once is uncertain. Pindar (Pyth. v, 46) praises Arcesilaus of Cyrene for having brought off his chariot uninjured in a contest where no fewer than 40 took part. The large outlay involved excluded all but rich competitors, and even kings and tyrants eagerly contested for the victory. Thus in the list of victors is found the names of Cylon. the would-be tyrant of Athens, Pausanias the Spartan king, Archelaus of Macedon, Gelon and Hiero of Syracuse and Theron of Agrigentum.

Chariot races with mules, with mares and with two horses in place of four were successively introduced. Races on horseback date from the 33rd Olympiad.

Lastly, there were athletic contests of a similar kind for boys, and a competition of heralds and trumpeters, introduced in the 93rd Olympiad.

The prizes were at first, as in the Homeric times, of some intrinsic value, but after the 6th Olympiad the only prize for each contest was a garland of wild olive, which was cut with a golden sickle from the *kallistephanos,* the sacred tree brought by Hercules "from the dark fountains of Ister in the land of the Hyperborean~to be shelter common to all men and a crown of noble deeds" (Pindar. 01. iii. 18).

Greek writers from Herodotus to Plutarch dwell with complacency on the magnanimity of a people who cared for nothing but honour and were content to struggle for a corruptible crown. But though the Greek games present in this respect a favourable contrast to the greed and gambling of the modern racecourse, yet to represent men like Milon and Damoxenus as actuated by pure love of glory is a pleasing fiction of the moralists. The successful athlete received, in addition to the honours, very substantial rewards. A herald proclaimed his name, his parentage and his country; the Hellanodicae took from a table of ivory and gold the olive crown and placed it on his head, and in his hand a branch of palm; as he marched in the sacred revel to the temple of Zeus, his friends and admirers showered in his path flowers and costly gifts, singing the old song of Archilochus, τήνελλα καλλίνικε, and his name was canonized in the Greek calendar. Fresh honours and rewards awaited him on his return home. If he was an Athenian he received, according to the law of Solon, 500 drachmas and free rations for life in the Prytaneum; if a Spartan, he had as his prerogative the post of honour in battle. Poets like Pindar. Simonides and Euripides sang his praises, and sculptors like Pheidias and Praxiteles were engaged by the state to carve his statue. And there were well-attested instances of altars being built and sacrifices offered to a successful athlete. An Olympian prize was regarded as the crown of human happiness. Cicero, with a Roman's contempt for Greek frivolity, observes with a sneer that an Olympian victor receives more honours than a triumphant general at Rome, and tells the story of the Rhodian Diagoras who, having himself won the prize at Olympia and seen his two sons crowned on the same day. was addressed by a Laconian in these words: "Die. Diagoras, for thou hast nothing short of divinity to desire."

Alcibiades, when setting forth his services to the state, puts first his victory at Olympia and the prestige he had won for Athens by his magnificent display. But perhaps the most remarkable evidence of the exaggerated value which the Greeks attached to athletic prowess is a casual expression which Thucydides employs when describing the enthusiastic reception of Brasidas at Scione. The state. he says, voted him a crown of gold. and the multitude flocked around him and decked him with garlands, as though he were an athlete.

The Pythian games originated in a local festival held at Delphi, anciently called Pytho in honour of the Pythian Apollo, and were especially devoted to musical competitions. The date at which they became a Panhellenic ἀγών (so Demosthenes calls them) cannot be determined, but the Pythiads as a chronological era date from 527 B.C., by which time music had been added to all the Panhellenic contests. Now, too, these were held at the end of every fourth year; previously there had been an interval of eight years. The prize was a chaplet of laurel.

The Nemean games uere biennial and date from 516 B.C. They were by origin an Argive festival in honour of Nemean Zeus, but in historical times were open to all Greece and provided the established round of contests, except that no mention is made of a chariot race. A wreath of wild celery was the prize.

The Isthmian games, which were held on the Isthmus of Corinth in the first and third years of each Olympiad, date, according to Eusebius, from 523 B.C. They are variously reported to have been founded by Poseidon or Sisyphus in honour of hlelicertes. or by Theseus to celebrate his victory over the robbers Sinis and Sciron. Their early importance is attested by the law of Solon which bestowed a reward of 100 drachmas on every Athenian who gained a victory. The festival was managed by the Corinthians; and after the city was destroyed by Mummius (146 B.C.) the presidency passed to the Sicyonians until Julius Caesar rebuilt Corinth

(46 B.C.). They probably continued to exist till Christianity became the religion of the Roman empire. The Athenians were closely connected with the festival, and had the privilege of *proedria,* the foremost seats at the games, while the Eleians were absolutely excluded from participation. The games included gymnastic, equestrian and musical contests. The prize was a crown, at one time of parsley (or wild celery) and later of pine. The importance of the Isthmian games in later times is shown by the fact that Flamininus chose the occasion for proclaiming the liberation of Greece. 196 B.C. That at a later anniversary (A.D. 67) Nero repeated the proclamation of Flamininus, and coupled with it the announcement of his own infamous victory at Olympia, shows alike the hollowness of the first gift and the degradation which had befallen the Greek games, the last faint relic of Greek nationality.

The *ludi publici* of the Romans included feasts and theatrical exhibitions as well as the public games with which alone this article is concerned. As in Greece, they were intimately connected with religion. At the beginning of each civil year it was the duty of the consuls to vow to the gods games for the safety of the commonwealth, and the expenses were defrayed by the treasury. Thus, at no cost to themselves. the Roman public were enabled to indulge at the same time their religious feelings and their love of amusement. Their taste for games naturally grew till it became a passion, and under the empire games were looked upon by the mob as one of the two necessaries of life. The aediles who succeeded to this duty of the consuls were expected to supplement the state allowance from their private purse. Political adventurers were not slow to discover so ready a road to popularity, and what at first had been exclusively a state charge was taken up by men of wealth and ambition. A victory over some barbarian horde or the death of a relation served as the pretext for a magnificent display.

The worst extravagance of private citizens was eclipsed by the reckless prodigality of the Caesars, who squandered the revenues of whole provinces in catering to the mob of idle sightseers on whose favour their throne depended.

Though public games played as important a part in Roman as in Greek history, and must be studied by the Roman historian as an integral factor in social and political life. yet. regarded solely as exhibitions, they are comparatively devoid of interest, and one might well sympathize with Pliny. who asks his friend how any man of sense can go day after day to view the same dreary round of fights and races.

It is easy to explain the different feelings which the games of Greece and of Rome excite. The Greeks, at their best; were actors; the Romans, from first to last. were spectators. It is true that even in Greek games the professional element played a large and ever-increasing part. As early as the 6th century B.C. Xenophanes complains that the wrestler's strength is preferred to the wisdom of the philosopher, and Euripides, in a well-known fragment, holds up to scorn the brawny, swaggering athlete. But, what in Greece was a perversion and acknowledged to be such, the Romans not only practised but held up as their ideal. No Greek, however high in birth. was ashamed to compete in person for the Olympic crown. The Roman, though little inferior in gymnastic exercises, kept strictly to the privacy of the palaestra; and for a patrician to appear in public as a charioteer is stigmatized by the satirist as a mark of shameless effrontery.

Roman games are generally classified as fixed: extraordinary and votive; but they may be more conveniently grouped according to the place where they were held, viz., the circus or the amphitheatre.

For the Roman world, the circus was at once a political club, a fashionable lounge. a rendezvous of gallantry, a betting ring and a playground for the million. Juvenal, speaking loosely, says that in his day it held the whole of Rome: but there is no reason to doubt the precise statement of P. Victor, that in the Circus Maximus there were seats for 350,000 spectators.

Of the various *ludi circenses* it may be enough here to give a short account of the most important, the *Ludi Magni* or *Maximi*.

Initiated, according to legend, by Tarquinius Priscus, the **Ludi** *Magni* were originally a votive feast to Capitoline Jupiter, promised by the general when he took the field and performed on his return from the annual campaign. They thus presented the appearance of a military spectacle, or rather a review of the whole burgess force, which marched in solemn procession from the capitol to the forum and thence to the circus, which lay between the Palatine and Aventine. First came the sons of patricians, mounted on horseback, next the rest of the burghers ranged according to their military classes, after them the athletes. naked save for the girdle round their loins, then the company of dancers with the harp and flute players, next the priestly colleges bearing censers and other sacred instruments and lastly the simulacra of the gods, carried aloft or drawn in cars.

The games themselves were fourfold: (1) the chariot race; (2) the *ludus Troiae;* (3) the military review; and (4) the various gymnastic contests. Of these only the first two call for any comment.

1. The chariot employed in the circus was the two-wheeled war car, at first drawn by two, afterward by four and more rarely by three horses. Originally only two chariots started for the prize, but under Caligula reference is made to as many as 24 heats run in the day, each of four chariots. The distance traversed was 14 times the length of the circus or nearly 5 mi. The charioteers were apparently from the first professionals, though the stigma under which the gladiator lay never attached to their calling. Indeed a successful driver may compare in popularity and fortune with a modern jockey. The drivers were divided into companies, distinguished by colours, whence arose the factions of the circus which assumed such importance under the later emperors. In republican times there were two factions, the white and the red; two more, the green and the blue, were added under the empire, and for a short time in Domitian's reign there were also the gold and the purple. Even in Juvenal's day party spirit ran so high that a defeat of the green was looked upon as a second Cannae. After the seat of empire had been transferred to Constantinople these factions of the circus were made the basis of political cabals, which frequently resulted in sanguinary tumults, such as the famous Nika revolt (A.D. 532), in which 30.000 citizens lost their lives.

2. The *ludus Troiae* was a sham fight on horseback, in which the actors were patrician youths. A description of it will be found in the fifth *Aeneid*. *(See* also CIRCUS.)

The two exhibitions which are next considered, though occasionally given in the circus, belong more properly to the amphitheatre. *Venatio* was the baiting of wild animals, who were pitted against one another or against men—captives, criminals or trained hunters called *bestiarii*. The first certain instance on record of this amusement is in 186 B.c., when M. Fulvius exhibited lions and tigers in the arena. The taste for these brutalizing spectacles grew apace, and the most distant provinces were ransacked by generals and proconsuls to supply the arena with rare animals—giraffes, tigers and crocodiles. Sulla provided for a single show 100 lions. and Pompey 600 lions. besides elephants, which were matched with Gaetulian hunters. Julius Caesar enjoys the doubtful honour of inventing the bullfight. At the inauguration of the Colosseum 5,000 wild and 4,000 tame beasts were killed, and to commemorate Trajan's Dacian victories there was a butchery of 11,000 beasts.

The *naumachia,* was a sea fight, either in the arena, which was flooded for the occasion by a system of pipes and sluices, or on an artificial lake. The rival fleets were manned by prisoners of war or criminals, who often fought till one side was exterminated. In the sea fight on Lake Fucinus, arranged by the emperor Claudius, 100 ships and 19,000 men were engaged.

But the special exhibition of the amphitheatre was the *munus gladiatorium*, which dates from the funeral games of Marcus and Decimus Brutus, given in honour of their father. 264 B.C. It was probably borrowed from Etruria. and was a refinement on the common savage custom of slaughtering slaves or captives on the grave of a warrior or chieftain. Nothing so clearly demonstrates the vein of coarseness and inhumanity running through the character of the Roman as his passion for gladiatorial shows. One can imagine how Pericles, or even Alcibiades, would have loathed a spectacle that Augustus tolerated and Trajan patronized. Only after the conquest of Greece is there evidence of their introduction into Athens, and they were then admitted rather out of compliment to the conquerors than from any love of the sport. In spite of numerous prohibitions from Constantine downward, they continued to flourish even as late as St. Augustine. To a Christian martyr, if the story told by Theodoret and Cassiodorus may be credited. belongs the honour of their final abolition. In the year 404 Telemachus. a monk who had travelled from the east on this sacred mission, rushed into the arena and endeavoured to separate the combatants but he was instantly dispatched by the praetor's orders.

The emperor Honorius. on hearing the report. however, issued an edict abolishing the games, which were never afterward revived. *(See* GLADIATORS.)

Of the other Roman games the briefest description must suffice. The *Ludi Apollinares* were established in *212* B.c.. and were annual after *211* B.c., consisting mainly of theatrical performances.

The *Megalenses* were in honour of the great goddess, Cybele, instituted 204 B.C., and from 191 B.C. celebrated annually. A procession of Galli, or priests of Cybele, was a leading feature. Under the empire the festival assumed a more orgiastic character. Four of Terence's plays were produced at these games. The *Ludi Saeculares* were celebrated at the beginning or end of each *saeculum,* a period variously interpreted by the Romans themselves as 100 or 110 years.

The celebration by Augustus in 17 B.C. is famous by reason of the ode composed by Horace for the occasion. They were solemnized by the emperor Philip A.D. *248* to commemorate the millennium of the city.

Private Games.—These may be classified as outdoor and indoor games. There is quite naturally a much closer resemblance between the pursuits and amusements of children than of adults. Homer's children built castles in the sand, and Greek and Roman children alike had their dolls, their hoops. their skipping ropes, their hobbyhorses, their kites and their knucklebones and played at hopscotch, tug of war. pitch and toss, blindman's buff. hide-and-seek and kiss in the ring, or at closely analogous games. Games of ball were popular in Greece from the days of Nausicaa, and at Rome there were five distinct kinds of ball, and more ways of playing with them. For particulars the dictionary of antiquities must be consulted. It is strange that there is found in classical literature no analogy to cricket, tennis, golf or polo. and though the *follis* resembled modern football. it was played with the hand and arm, not with the leg. Cockfighting was popular both at Athens and Rome, and quails were kept and put to various tests to prove their pluck.

Under indoor games may be distinguished games of chance and games of skill, though in some of them the two elements were combined.

Tesserne, marked with pips like modern dice, were evolved from the *tali,* knucklebones with only four flat sides. The old Roman threw a hazard and called a main, just as did Charles Fox. The vice of gambling was lashed by Juvenal no less vigorously than by Pope. The Latin name for a dicebox survived in the fritillary butterfly and flower.

The primitive game of guessing the number of fingers simultaneously held up by the player and his opponent was still popular in modern times in Italy, where it became known as *morra.* The proverbial phrase for an honest man was *quicum* in *tenebris mices,* one you would trust to play at *morra* in the dark.

Athena found the suitors of Penelope seated upon cowhides and playing at *πεσσοί,* which was a form of draughts, an invention ascribed to Palamedes. In its earliest form it was played on a board with five lines and with five pieces. Later there were 11 lines: and a further development was the division of the board into squares. In the Roman *latrunculi* (soldiers), the men were distinguished as common soldiers and "rovers," the equivalent of crowned pieces.

Duodecim scripta, as the name implies, was played on a board with 12 double lines and approximated very closely to modern backgammon. There were 15 pieces on each side, and the moves were determined by a throw of the dice; 'iblots" might be taken, and the object of the player was to clear off all his own men. Lastly must be mentioned the *cottabus,* a game peculiar to the Greeks, and with them the usual accompaniment of a wine party. In its simplest form each guest threw what was left in his cup into a metal basin, and the success of the throw, determined partly by the sound of the wine in falling, was reckoned a divination of love.

For the various elaborations of the game, Athenaeus and Pollux must be consulted.

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GAMES, THEORY OF, is a branch of mathematics that aims to analyze various problems of conflict by abstracting common strategic features for study in theoretical "models"—termed "games" because they are patterned on actual games such as bridge and poker. By stressing strategic aspects *(i.e.,* aspects controlled by the participants). it goes beyond the classical theory of probability. in which the treatment of games is limited to aspects of pure chance. A theory of games of strategy. broached in 1921 by Emile Borel. was established in 1928 by John von Neumann. who went on. with Oskar Morgenstern, to develop it as a means of dealing with competitive economic behaviour. Their joint work (published in 1944) stemmed from the presence, both in actual games and in economic situations. of several common factors. such as conflicting interests. incomplete information and the interplay of free rational decision and chance. Although most actual games elude full-scale analysis because of the amount of intricate cataloguing and computing that would be required, many can be analyzed in miniature or simplified form. Of greater consequence. perhaps. is the opening to mathematical attack of a wide range of gamelike problems, not only in economics but also in sociology, psychology, politics and war.

CLASSIFICATION OF GAMES

The theory identifies a game, for analysis, as: (1) singular. dual or plural; *(2)* extensive or normalized: (3) finite or infinite. This three-way classification highlights strategic likenesses and differences in games, reflecting results of the theory and divisions within it.

Singular, Dual and Plural Games.—In classifying games by the number of players, the significant figure is not the number of individuals involved but rather the number of parties with distinct interests actively represented in the play. It is assumed specifically that these interests are measured in terms of money or some other numerical scale of utility. The presence of only one such interest, though there may be more than one participant, characterizes a game as singular. Typical are solitaire card games, many types of puzzles and problems of an isolated economic unit with a single goal *(e.g.,* Robinson Crusoej. Such games are distinguished by the absence of conflict; with no opponent to thwart his plans, the single player need only, in theory. list all his possible courses of action and then select the best, as measured on his scale of utility. Conflict enters with dual games (called zero-sum two-person games by von Neumann and Morgenstern), played by two parties in diametric opposition—what one wins, the other loses. Each party, in seeking an optimal course of action. must reckon with the possible actions of an opponent with contrary aims. This direct conflict of interests is exemplified by two-person board games such as chess, two-handed card games such as cribbage and two-team card games such as bridge. In contrast, the presence of active interests that are not diametrically opposed stamps a game as plural. All games having more than two active interests fall in this class; so do two-party bargaining situations in which the parties stand to gain by reaching an agreement.

Extensive and Normalized Forms.—From the rules of any game. two abstract forms can be obtained. The extensive form of a game eliminates all features which refer specifically to the means of playing it—all those features which characterize it as a card game, a dice game or an economic conflict. Thus the extensive form amounts to a literal translation of the rules into the technical terms of a formal system designed to describe all games. The normalized form is a more condensed version of the game, stripped of all features but the choice of over-all strategies.

The raw material for the extensive form comes from the common elements of strategic games, such as the interrelations between the players' choices, the variety and character of information available to them and the effect of chance on the play. The object of a systematic description of these features is to isolate those junctures at which a player is called upon to make a choice and the states of information on which his choices are based. From this analysis emerges a precise definition of the first key concept on uhich the theory of games has been built. This is the notion of a pure strategy for a player; namely, a complete set of advance instructions that specifies a definite choice for every conceivable situation in which the player may be required to act. Such a set of instructions represents a total plan that covers all contingencies the player may face during any playing of the game, whether these are attributable to choices of other players or to events governed by chance: its execution could be delegated perfectly well to an agent without discretionary power. The complexity imposed on a single pure strategy by its completeness. and the enormous number of pure strategies that may need cataloguing. explain the failure of the theory to analyze most common parlour games. However, the practical difficulties do not prevent the enumeration in theory of all the pure strategies of a game.

While the extensive form of a game may have a large number of moves. or junctures at which a player must make a choice, in the normalized form each player makes only one move, which consists of a single choice irom his set of pure strategies. As a result, the game is replaced by the following prototype: Each player chooses a pure strategy. making his choice in absolute ignorance of the choices of the other players. After all strategies have been chosen, they are submitted to an umpire who charts the course of the play, making chance moves in accordance with the probabilities dictated by the rules and otherwise using the choices given by the players' pure strategies. In this way there is determined for each player a set of outcomes with associated probabilities, the "expected" value of which constitutes the player's payoff.

Finite and Infinite Games.—In most games the number of pure strategies available to the players is finite because the rules ordinarily make the game terminate after a finite number of occasions for choice by the players, and because, at each occasion, a player is usually confronted by a finite number of alternatives.

Games with an infinite number of strategies often arise as idealizations of situations that are too complicated to handle in their original form (such as replacing the full, but finite, range of poker hands by a continuum of numbers). It has proved possible in this way to treat problems of many sorts as normalized dual games in which the pure strategies for each player are represented by the real numbers from zero to one (called games on a square). Infinite games have also provided a fertile source of pathological examples that offer a contrast to the regular properties found in the finite case. In a different direction, Abraham Wald's theory of statistical decision has shown that the general problem of statistical inference may be regarded as an infinite dual game in which the statistician is pitted against nature.

NORMALIZED DUAL GAMES

Matrix Games; **Saddlepoints.**—A finite dual game, when normalized, has a very simple conceptual scheme. Each of the players. A and B, chooses a pure strategy irom a finite list, without knowing the other's choice. The outcome thus determined can be specified by a single number P, the payoff *A* stands to receive: positive, negative or zero according as A wins from B, loses or draws. By the diametric opposition characteristic of a dual game, B then stands to win —P. In this way the game is described by a rectangular array of numbers, in which each horizontal row corresponds to a pure strategy for A and each vertical column to a pure strategy for B; the entry P common to the row and column is the payoff *to* A from B that these pure strategies produce. The array of numbers is called the payoff matrix; normalized finite dual games presented in such form are called matrix games. (Examples appear in Tables I and II; in each case the payoff matrix is the central box of arabic numbers.) Since the matrix entries represent gains to A and losses to B, A's aim is to maximize and B's to minimize the result that comes out of the matrix.

As A weighs the consequences of various courses of action open to him in a dual game, the theory of games counsels him to gauge each by the gain it assures him, regardless of what B does. In effect, this is equivalent to the pessimistic assumption by A that B knows his plan and will counter it to limit his gain to a bare minimum. So. to maximize his assured gain, A is led to seek a maximum of minima, abbreviated "max-min"; he should act so as to make as great as possible the least gain to which B can limit him. The antithetical aim of B is to choose a course of action that will hold to a minimum the greatest loss *A* may inflict. Thus, B's goal is a minimum of maxima, abbreviated "min-max." The clear fact that A cannot establish a floor under his possible gains that is higher than the ceiling B succeeds in placing over his possible losses is expressed by the formula:

$$A\text{'s gain-floor} = \text{max-min} \leqq \text{min-max} = \text{B's loss-ceiling.}$$

With evaluation limited to pure strategies only, this is the most precise statement that can be made for the entire class of dual games. (The effect of further restrictions is considered below under Extensive Games—A Poker Example.) The highest gain-floor for *A*, using a single pure strategy, is obtained by choosing the strategy row in which the least entry is greatest: the lowest loss-ceiling for B, using a single pure strategy, is obtained by choosing the strategy column in which the greatest entry is least. These two values are equal only when there is an entry in the payoff matrix which is, at the same time, the least in its row and the greatest in its column. Such an entry is called a saddlepoint; *e.g.*, see Table I. case (3), where the entry 3 is a saddlepoint.

Mixed Strategies; Minimax Theorem.—To close the gap between max-min and min-max in the general case in which the payoff matrix contains no saddlepoint. it is necessary to broaden the concept of strategy. Von Neumann (as well as Borel and R. A. Fisher) took the decisive step of introducing weighted averages of pure strategies. In the broadened concept the frequencies with which a player uses his pure strategies in the long run are specified by weights (some but not all of which may be zero). Operationally, the selection of the pure strategy to be used in a particular playing of the game is left to a suitable chance mechanism, which selects in a random manner from among the pure strategies in accordance with the weights the player has chosen (*e.g.*, in matching pennies. as ordinarily played, the pure strategy of showing "heads" uniformly and that of showing "tails" uniformly are randomized with equal weights by tossing the coin before showing it). This randomization by a chance mechanism avoids a mixture pattern from which the opponent might profit in the long run (*e.g.*, to alternate uniformly between heads and tails in matching pennies would weight them equally but be quite unwise in repeated play). Such a mixture of pure strategies, randomized in fixed proportions, is called a mixed strategy It is clear that neither player's position is worsened by using mixed strategies since any pure strategy is still tenable as a mixed strategy by assigning nonzero weight only to it.

When A's gain-floor and B's loss-ceiling are re-evaluated in terms of mixed strategies, it turns out that in any matrix game

$$\text{max-min} = \text{min-max.}$$

This minimax theorem of von Neumann (1928) is the main theorem of normalized finite dual games and the keystone of the whole theory. It shows that any such game has a solution consisting of (1) a "minimax" value (the common max-min and min-max), (2) an "optimal" mixed strategy for A that assures him a gain of at least the minimax value on the average and (3) an "optimal" mixed strategy for B that insures him against a loss on the average of more than the minimax value.

Examples of Matrix Games.—A and B choose whole numbers independently; A wins if the sum is odd. B wins if the sum is even. Roman numerals are used throughout to denote the numbers from which A and B make their choices. The first case shown in Table I is a very rudimentary dual game; it is the same as matching pennies. with B winning if head (I) matches head (I) or tail (II) matches tail (II), and A winning otherwise. The other four cases are variants which suggest the range of possibilities that arise even in small-scale dual games. Directly to the right of an A choice and below a B choice there appears the resulting payoff, positive if A wins (and B loses), negative if A loses (and B wins). In the rudimentary first case the amount of the payoff is simply one unit, but throughout the other four cases in Table I the amount of the payoff is the sum of the numbers chosen by A and B; *e.g.,* if A chooses I while B chooses III, as in cases (3), (4) and (j), the payoff entry is -4 because $1+3=4$, an even number, lost by A, won by B. The vertical column of weights listed for A in each case combines with a parallel column of payoffs to form the weighted payoff sum shown at the foot of that column; *e.g.,* in case (j), column I, $0(-2)+15(-4)+13(5)=5$ is the weighted payoff sum. The horizontal row of weights listed for B combines with a parallel row of payoffs to form the weighted payoff sum shown at the right end of that row. These weighted

TABLE *I.—Games* of Odd *and* ***Even***

wt.	no.	I	II	
1	II			
A		0	0	÷2

(1) minimax—0

wt.		7	5	B
	no.	I	II	
7	I	−2	3	1
5	II	3	−4	1
A		1	1	÷12

(2) minimax $= \frac{1}{12}$

wt.		1	0	B
	no.	I	III	
0	I	−2	−4	−2
1	II	3	5	3
A		3	5	÷1

(3) minimax = 3

wt.		1	2	1	B
	no.	I	II	III	
1	I	−2	3	−4	0
2	II	3	−4	5	0
1	III	−4	5	−6	0
A		0	0	0	÷4

(4) minimax = 0

wt.		0	17	0	0	11	B
	no.	I	II	III	IV	V	
0	I	−2	3	−4	5	−6	−15
15	III	−4	5	−6	7	−8	−3
13	IV	5	−6	7	−8	9	−3
A		5	−3	1	1	−3	÷28

(5) minimax $= -\frac{3}{28}$

sums become weighted averages when divided by the sum of the weights, written (with ÷) at the lower right. By randomizing their choices with the particular weights listed, A and B achieve "optimal" strategies; on the average, *A* is assured of winning at least the "minimax value" shown and B against losing more than this value. To verify the solution in each case shown in Table I, observe that the minimax value is both the minimum of the *A*-weighted average payoffs and the maximum of the B-weighted average payoffs. Note that in case (3) the payoff matrix has a saddlepoint; viz., the entry 3.

Symmetric Games.—A and B each show one or two fingers and at the same time call "two," "three" or "four," attempting to guess the total number of fingers shown; a right call wins from a wrong call—otherwise it is a draw. This is a two-finger form of an ancient game known as morra (see GAMES, CLASSICAL). In the rudimentary first version shown in Table II, the amount of the payoff is simply one unit for a win and zero for a draw; in the somewhat more sophisticated second version the amount of a winning payoff equals the total number of fingers shown by *A* and B (*e.g.,* if *A* shows I and calls II while B shows II and calls III, the payoff entry in the second version is -3, because the total number of fingers shown by A and B is $1+2=3$ and hence A's call is wrong and B's right). In either version the game is fully symmetric: both players face identical choices and rewards. This is partly disguised by the tabulation, which presents the payoffs from the viewpoint of A. To interchange *A* with B, not only must horizontal payoff rows be transposed into vertical columns. but also the sign of each payoff must be changed (to B's viewpoint). The net result of such a twofold shift leaves the payoff arrays in Table II just as they are—which is the characteristic property of

TABLE 11.—Two Games of Morra

wt.			0	1	1	0	
	show		I		II		B
		call	II	III	III	IV	
1	I	II	0	1	−1	0	0
0	I	III	−1	0	0	1	0
0	II	III	1	0	0	−1	0
1	II	IV	0	−1	1	0	0
A			0	0	0	0	÷2

wt.			0	20	15	0	
	show		I		II		B
		call	II	III	III	IV	
0	I	II	0	2	−3	0	−5
21	I	III	−2	0	0	3	0
14	II	III	3	0	0	−4	0
0	II	IV	0	−3	4	0	0
A			0	0	0	7	÷35

the tabulation of a fully symmetric dual game. As a result of the symmetry, any optimal strategy for one player must also be optimal for the other and the minimax value must be zero. Consequently. in each of the above versions of morra, the listings of weights for *A* and B which achieve the zero minimax could be reversed and this shows that both players have more than one optimal strategy. Actually, in the first version any weights *p*, q, q, *p* yield an optimal strategy; and in the second version any weights o, *p*, q, o yield an optimal strategy, provided $p/(p+q)$ is a fraction between 20/3j and 21/35.

Computation of Solutions.—The solution of a matrix game with m columns and *n* rows of payoff entries amounts to the solution of a system of linear inequalities in $m+n+1$ unknowns, A's *m* weights, *B*'s *n* weights and the minimax value. The system comprises *n* inequalities which express the A-weighted average payoffs as equal to or greater than the minimax value and *m* inequalities which express the B-weighted average payoffs as equal to or less than the minimax value; in addition, the m+n weights must be non-negative, reduced usually to fractional form with unit sum for each set, so that the weighted payoff sums become weighted averages without division. L. S. Shapley and R. N. Snow have shown that any basic solution of such a system is characterized as the unique solution of a suitably chosen subsystem of linear equations. As a result, the solution (if unique) or the full set of solutions (if more than one exist) can be determined by at most a finite number of arithmetic operations, but this number increases so rapidly, as the numbers *m* and *n* of rows and columns increase, that the solution of a large-scale matrix game by this method is formidable or impracticable.

The solution of a pair of dual linear programs, which call for maximizing and minimizing linear functions of several variables subject to constraints given by linear inequalities or equations, is equivalent to the solution of a matrix game, and vice versa, as was shown by George B. Dantzig and by David Gale, H. W. Kuhn and A. W. Tucker (see T. C. Koopmans and others [eds.], Activity Analysis of Production.and Allocation). Hence, the "simplex" method devised by Dantzig for linear programming can be applied to solve reasonably sized matrix games. Iterative procedures for approximating game solutions were formulated by George W. Brown and John von Neumann to exploit high-speed automatic electronic computers.

Games on a Square.—Imagine the finite array of payoffs of a matrix game replaced by an infinite array of payoffs, one for each point of a square *OMLN* (see fig. *1*). Let *A* choose a point X in the edge *OM* and, independently, B a point Y in the edge ON; then have A get from B the payoff attached to the point of intersection of the lines XX' and YY' perpendicular to *OM* and *ON*. This is an infinite dual game "on a square." Fig. 2 presents an example: A and B divide the area *OMJLKN*, formed by the square *OMLN* and two isosceles right triangles *MJL* and *LKN*, by means of the lines XX" and YY" based on independent choices by *A* and B of X in *OM* and Y in *ON;* A gets the unshaded area, B the shaded area. By direct calculation, taking OM $=ON=$ one unit and OX $=x$, OY $=$ y, the net payoff (A's area minus B's area) is found to be

$$P=4x+2y+y^2-x^2-4xy-2.$$

A wishes to maximize P, B to minimize P (*i.e.*, to maximize $-P$).

By analogy with a matrix game. a saddlepoint for a game on a square is at the intersection of a line XX' and a line YY', for which the payoff at the point of intersection is equal to or less than every other payoff on XX', and is equal to or greater than every other payoff on YY' (see fig 1) (A saddlepoint is so called because it appears as an actual surface-saddlepoint in the three-dimensional graph of the payoff over the square.) In the area-division game (fig. 2) $x=0.8$, y $=0.6$ give a saddlepoint having payoff 0.2, since the net payoff can be rearranged as:

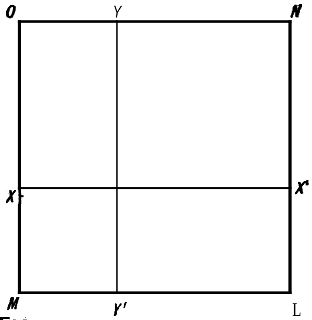

FIG 1.—GAME ON A SQUARE (see TEXT FOR FURTHER EXPLANATION)

$$P=0.2+(y-0.6)^2 \text{ if } x=0.8 \text{ and } P=0.2-(x-0.8)^2 \text{ if } y=0.6.$$

By choosing $x=0.8$, A assures himself at least 0.2, since $(y-0.6)^2$ is never less than zero; while, by choosing y $=0.6$, B guards against losing more than 0.2, since $-(x-0.8)^2$ is never greater than zero. The claim that this point is a saddlepoint can also be verified by geometric reasoning. based on the fact that it is the critical position at which XX" and YY'' bisect one another (in fig. 2).

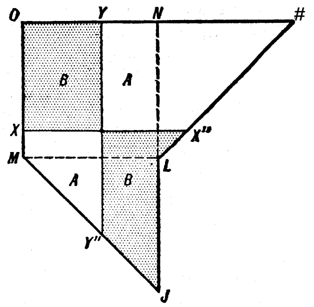

FIG. 2.—AREA-DIVISION GAME. SHOWING SADDLEPOINT DIVISION (see TEXT FOR FURTHER EXPLANATION)

The solution in pure strategies possessed by the area-division game is exceptional. because games on a square. like matrix games. do not usually possess saddlepoints. In general. each player must "weight" the points in his interval. OM or ON, if he is to do the best he can for himself. Such distributions of weights over an interval are known as probability distributions; they play a role analogous to that of mixed strategies in matrix games. Yet, even when both players employ probability distributions. the minimax theorem does not hold without some mild restriction on how the payoffs vary over the square. For the continuous case of payoffs without abrupt jumps, the equality of max-min and min-max was established by Jean Ville in 1938.

EXTENSIVE GAMES—A POKER EXAMPLE

Pure Strategies.—The primary objective of the study of a game in extensive form is the analysis of the combinatorial structure defined by the rules and its influence on the subsequent definition of strategies. This structure can be presented in the form of a branching diagram (of the sort exhibited in Table III) in which the junctures represent occasions at which a player or a chance mechanism (specified by the rules, such as cards. dice, etc.) is called upon to decide upon one of the several branches that continue the course of the play. These branches contain the state of information of the next player to act. If the branching ceases at any stage, the play is over and the payments specified by the rules are listed.

Several junctures in the diagram may be prefixed with the same information for a single player (e g., in a card game. these may be situations that differ only in the unrevealed cards held by his opponents). For strategical purposes, a player must consider such junctures to be the same. since he cannot distinguish between two such junctures and hence cannot decide in advance to make distinct choices should one or the other occur in the course of play. This means that the problem of formulating a pure strategy for a player is solved by listing all his junctures with distinct states of information and making a definite choice of a branch for each. Such a plan fulfils the requirements for a pure strategy set forth previously.

Historically, the first result on games in extensive form was stated (for the game of chess) by E. Zermelo and given a complete proof by von Neumann. It applies to games with perfect information; that is, games in which a player is always informed of the complete previous history of the play. The theorem asserts that finite dual games with perfect information can always be solved by pure strategies without randomization. In other n-ords, there is always a saddlepoint in the payoff matrix of such games. As regards chess, in particular, this means that exactly one of the following three alternatives is valid: (1) White has a pure strategy that wins, no matter what Black does; (2) both players have pure strategies that ensure at least a draw, no matter what the other does; (3) Black has a pure strategy that wins, no matter what White does. However, the theory gives no practical method for deciding which assertion is true.

Behaviour Strategies.—The lack of a solution in pure strategies for a general finite dual game means that a player must randomize his actions in some manner to obtain the amount due him (as measured by the minimax value) In the extensive form of a game, it is possible to introduce a method. alternative to that of mixed strategies, for varying his choices from contest to contest of the game in an undecipherable pattern. This method specifies by weights the long-run frequencies with which a player chooses the various alternatives presented to him in a given state of information. Rather than using a chance mechanism to select a complete plan prior to the playing of a game. a player employs such a device throughout the play, at each occasion for choice, to select an alternative in accordance with weights he has chosen. Such a decentralized system of play, randomizing the choices for each distinct state of information in fixed proportions, is called a behaviour strategy, since these weights are the statistics of a player's behaviour that an external observer could gather from a long series of contests.

Since the number of weights needed to specify a behaviour strategy is. in general. much smaller than the number of weights in a mixed strategy, it is useful to know when they produce the same results. H. W. Kuhn showed that a player can use either with equal success in any game with perfect recall; *i.e.*, any game in which a player's state of information always includes everything he has done or known previously. Poker is a game with perfect recall and hence can be played effectively with behaviour strategies. Bridge, on the other hand, does not have perfect recall since each player is a pair of persons, neither of whom is informed of the other's hand. Since there can be no correlation between the selections made by the chance devices for different states of information when a player employs a behaviour strategy. it is possible that bridge players must use mixed strategies to achieve the minimax value.

Simplified Poker.—A simplified version of poker is played by A and B with a deck containing a large number of cards marked "high" (H) and "low" (L). First. each player "antes" four chips and is dealt a single card; the four possible deals are assumed to be equally likely. Then A has two options: to "see," or to "raise" by adding two chips to the pot. If A decides to see. the higher hand wins the pot and equal hands split the pot equally. If A decides to raise. B has three options: to "fold," to see by adding two chips to the pot or to raise by adding three chips to the pot. If B folds, A wins the pot (with no hands revealed). If B sees, the higher hand wins the pot and equal hands split the pot equally. If B raises, A has two options: to fold, or to see by adding one chip to the pot. If A folds, B wins the pot (with no hands revealed). If A' sees, the higher hand wins the pot and equal hands split the pot equally. (This simplified poker adds the possibility of a raise by B to the tno-handed case [S=2] of a simplified poker treated in von Neumann and Morgenstern, Theory of Games and Economic Behavior, pp. 211–219.)

The possible sequences of choices by the players, independent

TABLE III.—*Simplified Poker in Extensive Form*

Deal	→	A to	see	→ ±4, 0					
			raise	→ B to	fold	→ 4			
					see	→ ±6, 0			
					raise	→ A to	fold	→ −6	
							see	→ ±7, 0	

1st stage		2nd stage		3rd stage		4th stage	
*H*4?4 (*H*) → *A*	→	*H*4*H*4	→ 0*				
		? 6*H*4 (*H*)	→ *B* →	*X*6*X*4	→ 4*		
				*H*6*H*6	→ 0*		
				*H*6?7 (*H*)	→ *A* →	*X*6*X*7	→ −6*
						*H*7*H*7	→ 0
*H*4?4 (*L*) → *A*	→	*H*4*L*4	→ 4*				
		? 6*L*4 (H)	→ *B* →	*X*6*X*4	→ 4		
				*H*6*L*6	→ 6		
				*H*6?7 (*L*)	→ *A* →	*X*6*X*7	→ −6*
						*H*7*L*7	→ 7
*L*4?4 (*H*) → *A*	→	*L*4*H*4	→ −4				
		? 6*H*4 (L)	→ *B* →	*X*6*X*4	→ 4*		
				*L*6*H*6	→ −6*		
				*L*6?7 (H)	→ A →	*X*6*X*7	→ −6
						*L*7*H*7	→ −7
*L*4?4 (*L*) → *A*	→	*L*4*L*4	→ 0				
		? 6*L*4 (*L*)	→ *B* →	*X*6*X*4	→ 4		
				*L*6*L*6	→ 0		
				*L*6?7 (*L*)	→ *A* →	*X*6*X*7	→ −6
						*L*7*L*7	→ 0

Equally likely

of the actual cards held. are shown at the top of Table III. The player to act precedes, and his alternatives follow. each juncture. The possible payoffs (listed as *A*'s gain, since this is a dual game) are given when the play is over. The precise payoff that occurs is determined by the cards held. In the body of Table III appears the complete branching diagram. taking account of the deal. Four-place symbols present the states of information. The first two symbols give the hand and current bet of A, the last two symbols give the hand and current bet of *B*. All are given as known to the player who is next to act; *e.g.*, the symbol ?6*L*4 preceding *B* means that *B* is to act, not knowing *A*'s card, but knowing that A has bet six chips. and B holds a low card and has bet four chips. For ready reference, the actual card held is listed below each question mark. Whenever the play ends, the payoff to A is listed; if either player has folded. the symbol X is used to indicate that neither hand need be revealed.

Certain terminal situations (starred in the table) will never occur in rational play; *e.g.*, player *A* mill never see in the second stage while holding a high card since he stands to win at least as much (and sometimes more) by raising. Similar arguments advise both players to bet the limit at every juncture where they hold a high card. Reduced in this manner. a pure strategy for either player consists merely of how high he should carry his bet on a low card. These pure strategies are listed as two-place symbols to the left and above the payoff matrix in the left half of Table IV. The first number (7) gives the limit a player will bet on a high card, the second (4. 6 or 7) gives the limit on a low card. To compute the payoff to **A** when two of these strategies are

TABLE IV.—*Simplified* Poker

(Optimal mixed strategies and optimal behaviour strategies)

wt.		9	1	2	*B*
	HL	74	76	77	
6	74				2
2	76				2
4	77	$\frac{1}{4}$	$-\frac{1}{4}$	0	2
A		2	2	2	÷12
minimax = $\frac{1}{6}$					

Player	Information	Option	Weight
A	*L*4?4	see	6
		raise	6
	*L*6?7	fold	2
		see	4
B	?6*L*4	fold	9
		see	1
		raise	2

played. an average is taken over the four terminal situations that can follow the four possible deals; *e.g.*, when A plays 76 against 74 for B, the play ends in *H*7*H*7, *X*6*X*4, *X*6*X*7 or *X*6*X*4 and the corresponding entry is $\frac{1}{4}(0)+\frac{1}{4}(4)+\$(-6)+\frac{1}{4}(4)=\frac{2}{4}$. (The unreduced payoff matrix would consist of nine rows and nine columns, labelled 44, 46, 47, 64, 66, 67, 74, 76. 77.)

The weights listed are the only weights that achieve the minimax value. Player A must play "bluffing strategies" (either 76 or 77) one-half of the time, while B must decide to bluff one-fourth of the time.

The average behaviour imposed by these optimal mixed strategies upon a player with a given state of information constitutes an optimal behaviour strategy. The optimal weights, so defined, are given in the right half of Table IV (*e.g.*, with information L4?4, player *A* assigns the "seeing" pure strategy 74 the, weight 6 and assigns the "raising" pure strategies 76 and 77 the weights 2+4= 6; in common parlance this means that, in the long run, A sees as often as he raises upon being dealt a low card).

PLURAL GAMES

Economic Example: Non-Co-operative Solutions.—Two basically different approaches to the behaviour of parties to plural games have been proposed. The solutions that they suggest are contrasted in the following (highly simplified) problem from economics: Two sellers. A and B, in competition with each other. are contemplating a price cut of the same amount. Each knows that if they both sell at the same price they will divide the market evenly. while if one cuts his price and the other does not, then the former will capture the entire market. If the total profits at the higher and lower prices are known. this situation gives rise to a symmetric two-party plural game. The top part of Table V lists the payoffs for four of these games; in all cases, six units of profit are available at the higher price, while the lower price, in the four cases, yields four, two, zero and minus two units of profit respectively (negative profit is positive loss). The profits of *A* and *B* in each of the four games are shown to the right of each pair of prices (*i.e.*, pure strategies).

As a solution to the sellers' problem, the non-co-operative theory of John Nash suggests and proves the existence of a pattern of independent action in which there is no incentive for deviation by any player alone. As such, it is an extension of the minimax theory for dual games. A price cut by each seller is a Nash equilibrium point in each of the first three games, and if both keep the higher price, the result is an equilibrium point in the last three

TABLE V.—*Price* Cut *Example*

Prices		Profits (1)		(2)		(3)		(4)	
A	B	*A*	*B*	A	*B*	A	*B*	A	*B*
	high	3	3	3*	3*	3*	3*	3*	3*
	low	0	4	0	2	0	0	0	−2
low	high	4	0	2	0	0	0	−2	0
low	low	2*	2*	1*	1*	0*	0*	−1	−1
Coalition		Maximum assured profit							
A with *B*		6		6		6		6	
A alone		2		1		0		0	
B alone		2		1		0		0	

games. These solutions (starred in the top part of Table V) can be checked by verifying that unilateral changes in strategy are not rewarded. In the first game. the stability of the solution derives from the fact that a lone decision by either party to sell high would decrease his profit from two units to nothing. Although it is clear in this case that both sellers would benefit from an agreement binding each other to the higher price. this pattern is considered unstable since either seller could increase his profit by unilateral action. In like manner, a cut by a single seller can be considered a (fictitious) coalition between that seller and the buyers of the market, but can be upset by lone action by the other seller to his advantage. Indeed, the dilemma posed by the first game consists of the instability. with respect to unilateral defections. of each of the three possible two-party coalitions that may form among the two sellers and the market.

Co-operative Solutions.—The co-operative theory of von Neumann and Morgenstern for plural games (their general n-person games) is built upon these coalitions and introduces the possibility that the parties to an agreement may distribute their payments so as to maintain the coalition. The bottom part of Table V continues the analysis of the sellers' problem from this point of view. It lists for each of the four games the maximum assured profit for A and B acting together, for *A* alone and for B alone (*e.g.*, the greatest profit *A* can assure himself in the fourth game is zero; to do this he holds to the higher price). The co-operative theory suggests, for all four games, that (1) the sellers agree to hold to the higher price; (2) that each receive at least as much from the coalition as by independent action; (3) that the remainder be distributed in some manner between them (*e.g.*, in the second game, each seller surely receives one unit and the four additional units are divided in an unspecified manner). No mode of distribution is singled out, because even though one seller may prefer one division to another, he cannot enforce it by a unilateral change of his strategy or his allegiance. On the other hand. every other distribution of the profits is less advantageous to the collective interest of the two active parties, the sellers. In general. the stability of a co-operative solution derives from these two sources: internal consistency and external domination.

In 1953 D. B. Gillies showed that a sizable swath of plural games possess co-operative solutions.

Simple Games; A Power Index.—The co-operative theory has a political aspect when the only prospects of a coalition are to win or lose; this is the case in voting systems, such as legislatures, committees and voting stockholders. Such games are called simple, and the only tao possible outcomes, win or lose, for the coalitions are indicated numerically by one and zero. L. S. Shapley proposed an a *priori* numerical indicator of the relative equities of the players of any co-operative game, which is easily calculated for such a situation. This power index measures the average contribution of a player to the coalitions to which he might belong. taking account of the order in which the members join the coalition; *e.g.*, a participant in a simple game contributes to a coalition only if his entrance changes it from a losing to a winning coalition

As representative of this class, consider a four-man committee composed of a chairman, with three votes, and three other members, with one vote each. A simple majority of votes wins, while ties are considered as a loss for both sides. The 24 possible sequences in which the members might vote are listed in Table VI; the chairman is denoted by *A* and the three ordinary members by b, c and d. The pivotal player, the first to complete a majority in each voting order, is starred in each column. Since the chairman is pivotal three-fourths of the time, his power index is 75%. The ordinary members share the remaining fourth equally and have as indices $8\frac{1}{3}$%. Thus the voting ratio of 3:1 results in a power ratio of 9:1 in this simple game.

Table VI.—*Committee Voting Example*

Voting	24 possible orders																							
First	A	A	A	A	A	A	b	b	c	c	d	d	b	b	c	c	d	d	b	b	c	c	d	d
Second	b*	b*	c*	c*	d*	d*	A*	A*	A*	A*	A*	A*	c	d	b	d	b	c	c	d	b	d	b	c
Third	c	d	b	d	b	c	c	d	b	d	b	c	A*	A*	A*	A*	A*	A*	d	c	d	b	c	b
Fourth	d	c	d	b	c	b	d	c	d	b	c	b	d	c	d	b	c	b	A*	A*	A*	A*	A*	A*

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GAMETE, in biology the name given to the special cells set apart in most plants and animals for sexual reproductive purposes. (See Sex.)

They are usually of two kinds: (1) the ovum, which is large, stationary and heavily laden with food materials (yolk); and (2) the spermatozoon or (in plants) spermatozoid, which is small, actively motile and, in all animals except the Arthropoda (insects, spiders, crabs, etc.) and nematode worms, consisting of a head of nuclear material (see Cytology) and a long vibratile tail. In the higher plants (conifers and flowering plants) and in many fungi this element is much modified (see Plants and Plant Science), but in most of the lower plants the spermatozoid closely resembles the animal spermatozoon.

In some Algae (*q.v.*), both gametes are spermatozoonlike; and in certain Algae and Protozoa the whole organism acts as a gamete. The two gametes, in all the above cases, fuse to form a zygote, which develops into the adult organism.

An organism producing ova is said to be female; one producing spermatozoa, male; one producing both. hermaphrodite. (See Sex; Heredity; Cytology; Hermaphrodite; Embryology).

GAMETOGENESIS, in embryology the name given to an abnormal form of egg fertilization caused by the entrance of a number of spermatozoa into the ovum instead of one as in normal fertilization. A corresponding number of male pronuclei are formed, and the subsequent development, if it takes place at all, is abnormal.

The spermatozoa and ova are called the gametes. In the Arthropoda, selachians. amphibians and mammals the reproductive organs can admit of several spermatozoa normally entering the ovum. but of these only one forms a male pronucleus, the rest being absorbed.

(See Embryology; Heredity; Sex.)

GAMING AND WAGERING: see Gambling and Betting; Horse Racing and Breeding.

GAMMA-RAYS (written γ-rays) are electromagnetic radiations of very high frequency emitted by radioactive bodies (see Radioactivity. Artificial; Radioactivity. Natural). These radiations have wave lengths from 3Å to 0.005 Å (1 Å = 1 angstrom unit = 1×10^{-8} cm.). They are the shortest waves of the electromagnetic wave spectrum. They are similar to and have the same general properties as X-rays, except that they are of higher frequency and more penetrating (see X-rays, Nature of).

(J. D. Sn.)

See Eastman Kodak Co., *Radiography of Materials* (1943).

GAMUT, a term in music used to mean generally the whole compass or range of notes possessed by an instrument or voice (from the Greek letter *gamma,* used as a musical symbol, and ut, the first syllable of the mediaeval hymn. *Sanctus* Johannes). Historically, however, the sense has developed from its stricter musical meaning of a scale (the recognized musical scale of any period), originating in the mediaeval "great scale," of which the invention has usually been ascribed to Guido of Arezzo (*q.v.*) in the 11th century. The whole question is somewhat obscure, but, in the evolution of musical notation out of the classical alphabetical system, the invention of the mediaeval gamut is more properly assigned to Hucbald (d. 930). In his system of scales the semitone was always between the and and 3rd of a tetrachord, as G, A, ♭B, C, so the ♮ B and ♯ F of the second octave were in false relation to the ♭ B and the ♮ F of the first two tetrachords. To this scale of four notes G. A, ♭ B, C were subsequently added a note below and a note above which made the hexachord with the semitone between the 3rd and 4th both up and down, as F, G, A. ♭ B, C, D. It was at a much later date that the 7th, the leading note in modern music, was admitted into a key, and for this the first two letters of the last line of the above-named hymn. *Sanctus Johannes,* would have been used, save for the notion that as the note Mi was a semitone below Fa, the same vowel should be heard at a semitone below the upper Ut, and the syllable Si was substituted for Sa. Long afterward the syllable Ut was replaced by Do in Italy. but it was retained in France; and in these two countries, with whatever others employ their nomenclature, the original Ut and the substituted Do stand for the sound defined by the letter C in English and German terminology. The literal musical alphabet thus accords with the syllabic:

A	B	C	D	E	F	G
La,	Si,	Ut or Do,	Re,	Mi,	Fa,	Sol.

In Germany a remnant of Greek use survives. A was originally followed in the scale by the semitone above, as the classical Mesē was followed by Paramesē, and this note. namely ♭ B, is still called B in German. English ♮ B (French and Italian Si) being represented by the letter H. The gamut which, whenever instituted, did not pass out of use until the 19th century, regarded the hexachord and not the octachord, employed both letters and syllables. made the former invariable while changing the latter according to key relationship and acknowledged only the three keys of G, C and F.

(*See* also MUSICAL NOTATION.)

GANDA, a Bantu tribe of east equatorial Africa. The Hamitic invaders. while remaining the light-skinned aristocracy. were much more absorbed by the local Bantu who form the peasantry. Apart from this distinction of skin colour there is not much to distinguish the aristocracy from the peasantry (*bakopi*) in physical appearance. though there is in speech, and class distinction is no longer an ethnic one.

The hair of the Ganda people is thick and woolly and is kept short. and the Ganda alone among the surrounding Bantu tribes do not mutilate their persons in any way. Bracelets of iron, copper and ivory are worn but otherwise the people are not addicted to personal adornment. They cover the whole body from chest to ankles with robes of bark cloth, the manufacture of which is an important industry.

They live in large circular huts, divided by many partitions and thatched with unusual care and skill. The walls and partitions are covered with a characteristic reed work. and every home of importance has attached to it a series of neatly kept courtyards surrounded by high fences of reed work. A number of these residences surrounded by luxuriant gardens go to form a loose settlement. of which the market place is the conspicuous feature. The houses of the peasantry are simpler. of smaller dimensions and of ruder structure. Broad roads. carried over swamps by solid causeways. radiate from the capital to the villages of chiefs.

The Ganda are skilled watermen and maintain a large flotilla of war canoes. Their canoes are in remarkable contrast to the dugouts of most of their neighbours. their keel, false prow and sewn boards suggesting an Indonesian origin.

Their weapons consist of thrusting spears. a club which is used for war and executions, an oval shield of wickerwork with a central boss of wood or iron. Children use bows and arrows. They manufacture good pottery and artistic mats. and have a variety of musical instruments including the xylophone, flutes. harps, horns and drums. The drums of the *kabaka* or king are a tribal property and each is individually named. special drummers being detailed by chiefs for monthly duty.

Though they keep the usual domestic animals (their cattle being mostly of the short-horned. humped variety), they are essentially agriculturalists. the banana and sweet potato being the staple crop though a few cereals are also raised. All land except the clan burial grounds is the property of the *knbaka,* and individual holdings which are cultivated by a man's wife are granted him by his chief or directly by the *kabaka.*

The clans are totemic and exogamous, have each certain social and political functions and are graduated in social status and prestige by various factors which are not constant. Certain clans are debarred from presenting a prince as candidate to the throne. Clans and their subdivisions have their separate estates (*butaka*) which are the clan burial grounds in charge of clan functionaries called *bataka*, who among other duties have to select the male and female life servants of the *kabaka.*

Inheritance is patrilineal and the heir is one of the sons of the deceased. who is selected after the funeral by his brothers and sisters. Wives are not inherited but live as widows (with considerable licence) in separate huts built for them by the heir. Polygyny is usual. and blood brotherhood is a widely practised institution.

Society is elaborately organized on a feudal system. at the centre of which is the *kabaka* who exercises direct and absolute rule. He is assisted by three ministers, the *katikiro* or chief executive, the *mulamuzi* or chief justice and *muwanika* or treasurer, and a variety of lesser officials including his naval and military commanders in chief. These ministers are also members of the *lukiko* or council, which consists of the chiefs of the 20 *saza* or counties into which the country is divided. together with three notables for each county and six additional men of importance for the kingdom—all nominated by the *kabaka.* The functions of the *lukiko* are judicial. administrative and advisory. Each county is in charge of a chief appointed by the *kabaka* who assigns him estates on appointment, but neither these nor the chieftainship are hereditable and are held solely at the *kabaka's* pleasure. The counties are subdivided into approximately ten districts each called *gombolola* under district chiefs subordinate to the county chiefs. and these district chiefs have a varying number of petty headmen or *miruka* under them. The peasants are tenants at will of the landholders, to whom they owe allegiance and service, including the maintenance of roads, personal labour, taxes and military obligations.

Through all the hierarchy of chieftainship the same state and similar functionaries are maintained as at the royal court. and judicial procedure prescribes that with certain exceptions trials shall start at the lowest court and reach the *lukiko* by a series of appeals or commitments.

The *kabaka's* mother has a very important position in the constitution.

Their religion combines ancestor worship with the worship of a number of natural phenomena. such as Kiwanuka the lightning, Musisi the earthquake. Kazoba the firmament was the nearest approach to a high god, but such a conception is probably subsequent to Mohammedan and Christian influence and is not earlier than the comparatively modern deity Katonda. There is a caste of priests and diviners called *Bamandwa,* and virgins were dedicated as brides to the nature deities.

See E. Hornell, "Indonesian Culture in East Africa," *Man,* i (1928); Sir H. H. Johnston, *The Uganda Protectorate* (1902); J. Roscoe, *The* Baganda (1911). (J. H. D.)

GANDAK, a river of northern India. It is formed in the Nepal Himalayas by the union of the waters of the Kali Gandak, Buria Gandak, Trisuli, etc. The united stream, at first called Trisulganga. flows southwest until it reaches Indian territory, where it turns southeast across the Gorakhpur district of Uttar Pradesh, and then between the Champaran and Saran districts of Bihar. It falls into the Ganges opposite Patna, after a 475-mi. course. It is a snow-fed stream, its floods endangering the surrounding plains.

The LITTLE GANDAK rises in the Nepal hills, enters Gorakhpur district about 8 mi. W. of the Gandak and joins the Gogra just within the Saran district of Bihar.

The BURHI (or old) GANDAK also rises in the Nepal hills, and runs roughly parallel to and east of the Gandak, of which it represents an old channel, passing Muzaffarpur and joining the Ganges nearly opposite to Monghyr. Its principal tributary, the Baghmati, rises in the hills north of Kathmandu, flows southward through Tirhut and joins the Burhi Gandak close to Rusera.

GANDAMAK, a village of Afghanistan, west-southwest of Jalalabad. on the road to Kabul.

On the retreat from Kabul of Gen. William Elphinstone's army in 1842, a hill near Gandamak was the scene of the massacre of the last survivors of the British force by the Afghans.

A treaty was signed there in 1879 with Yakub Khan, recognized by the people of Kabul as amir. He ceded to Great Britain the Kurram valley and the Pishin and Sibi areas, and the control of the Khyber and Michni passes was also assumed by the British.

(See AFGHANISTAN: *History.)*

GANDHARA, a region of ancient India. now in northwestern Pakistan. corresponding to the vale of Peshawar, with extensions into the lower valleys of the Kabul and Swat rivers, and the eastern plain of the Indus northwest of Taxila.

Gandhara appears in the inscriptions of the Achaemenid rulers of Persia. The region probably came under their influence during the reign of Cyrus the Great (559–530 B.C.), although records only exist from the time of Darius I (522–486 B.C.). Herodotus confirms the inscriptions and mentions the presence of Gandharans in the army of Xerxes.

In Indian sources references to Gandhara and its inhabitants go back to the Rigveda and Brahmana literature; the early Buddhist texts also contain many references. Taxila is mentioned as the capital and as a great centre of learning. Pushkalavati (modern Charsadda) is also sometimes mentioned as the capital. The ruler of Taxila submitted (327 B.C.) to Alexander the Great. Later Gandhara became a province of the Mauryas and thereafter was ruled successively by Indo-Greeks. Sakas and Parthians. The monuments of Gandhara have been famous for more than a century; excavations were carried out by the archaeological survey of India at Taxila and in the vale of Peshawar.

From the 1st century A.D. Gandhara became the centre of a flourishing school of sculpture and architecture. The origins of this school have been much disputed, but it contained both Indian and Hellenistic (or Roman) elements. The former were largely associated with the spread of Mahayana Buddhism. while the latter owed their introduction to the extensive trade of the Parthians with the Mediterranean: and their development to the Kushans. The earlier view that the art style arose from the Greek dynasties in Bactria and northwest India appears to be incorrect. The Gandhara school lasted, at least locally, until the Muslim invasions in the 7th and 8th centuries. The architecture is mainly of stone, frequently adorned with sculpture in either schist or stucco. The monuments take the form of Buddhist stupas and monasteries, often of locally developed varieties. The sculptures are almost entirely Buddhist: many of the details and motifs find close parallels in the contemporary art of Rome. See INDIAN ART: *Gandhara (Greco-Buddhist) Sculpture.*

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GANDHARVA, (1) in Vedic Hindu mythology a celestial spirit of the highest sky. though in the Avesta he was a dragonlike monster. Gandarewa, dwelling in the sea. the abode of the white Haoma *(see* SOMA). But he was soon multiplied into a class of minor deities with various collective functions. Gandharva's union with the Apsaras *(q.v.)* typifies marriage. and they are parents of the first men. He is also a herbalist. Later, the Gandharvas preside over battles, the most popular being Tumburu, the "tambour" who leads them to watch those of men.

Gandharvas have their own breed of horses, their own land, located on both sides of the Indus, suggesting Gandhara. while Takshila and Pushkalavata were in Gandharva-desa and Gandhara-desa respectively. But Gandharva-nagara— "town"–is sometimes spoken of as a real city and sometimes as only a mirage. (2) In Hindu law a *gandharva* marriage is informal, based on mutual consent.

See A. A. Macdonell, *Vedic Mythology* (Strasbourg, 1897); E. W. Hopkins, *Epic Mythology* (Strashourg. 1915).

GANDHI, MOHANDAS KARAMCHAND (1869–1948), Hindu nationalist leader, was born on Oct. 2. 1869. at Porbandar in western India of a Hindu family with official traditions. His father was chief minister of one of the Gujarat states. When 18 years old Mohan was sent by his family to study law in London. and there he remained for more than three years, being called to the bar in 1891.

It is significant that on the voyage to England he nearly starved himself, having promised his mother that he would eat no meat. Though refusing to break his promise in spite of the inconvenience. he was not then a convinced vegetarian: but he read vegetarian writings in London and became an active member of the Vegetarian society. This led to a lifelong study of diet and personal hygiene, on which he wrote books. There can be no doubt that his careful personal regimen was largely responsible for the vigour of mind and body which he retained! in spite of a poor physique, to the end of his life.

When he returned to India, although professionally qualified) he was self-distrustful and made little headway as a lawyer until he was called to South Africa in 1893 by an Indian firm in that country.

In South Africa he became aware at once of the disabilities under which the Indians were suffering. Within a few years he was drawn so completely into the struggle far political rights that he gave up what had become a lucrative legal practice and undertook a drastic course in *brahmacharya,* or self-discipline. in order to devote his whole energies to public work. From the time of the formation of the Natal Indian congress in 1894 the agitation grew stronger year by year. At one stage in the struggle Gandhi and his friends. including several non-Indians. started a self-supporting colony. called Tolstoy farm, in order to free themselves for disciplined public activity without dependence on the ordinary life of the community.

In the forming of his social convictions Gandhi mas powerfully influenced by the writings of John Ruskin and Leo Tolstoy and also by an Indian poet. Raychandbhai. though the deepest influences of all were from the *Bhagavadgita* and the New Testament. He became convinced that the good life was life lived near the soil. with a minimum of dependence on machines. He himself learned the arts of farming. cooking, nursing. sanitation and teaching. He taught his own four sons.

In the course of the fight with the South African government, he and his wife and companions suffered arrest and imprisonment, and he was assaulted on one occasion by Europeans upon landing after a visit to India and on another by Indians. some of whom could not understand his insistence on always thinking the best of the "enemy." Once. at least. he refused to proceed with the movement of resistance to the government. when he saw that it had other peculiar difficulties to face. Moreover. both during the South African War of 1899–1902 and the so-called Zulu rebellion of 1906 he organized ambulance corps; for at that time he believed that the British empire was essentially beneficent, and he considered it his duty to assist to the utmost in times of stress.

The climax of the South African struggle came in 1913. A series of repressive measures. culminating in a demand that every Indian seeking to live in the Transvaal register himself. was met by repeated crossings of the Transvaal border by groups of Indians. Finally. a body of more than 2.000 Indians. many of them unlettered coolie labourers. followed Gandhi over the frontier. The unfailing forbearance, courtesy and restraint of leaders and followers was too much for public opinion. and a commission was appointed which reported in favour of the repeal of most of the obnoxious acts.

Gandhi also won the respect of Gen. Jan Smuts. who at the beginning had done his utmost to crush the movement. In 1914, feeling that he was no longer needed by the Indian community in South Africa. he returned to India.

Gandhi was already convinced that India was ripe for home rule. or *Swaraj* (self-rule) as it was usually called at that time. As soon as he had allowed himself a year's probation. enjoined by his mentor, the Indian statesman G. K. Gokhale. Gandhi threw himself actively into the work of the Indian National Congress party.

In South Africa he had organized nonviolent resistance to the government and had formed the conviction that war or revolution is always wrong and that when changes cannot be achieved by persuasion and constitutional agitation alone, nonviolent forms of direct action must be attempted. So. too. during the first few years of his residence in India, he and his friends organized corporate *Satyagraha,* or soul force, as a remedy for social and political injustices in various parts of the country. Finally. after the promulgation of the Rowlatt acts in the spring of 1919. which gave the government extraordinary powers to suppress the unrest that at the time nas widespread in the Punjab, he called on his followers to withdraw from all government appointments and institutions. even from schools and colleges. and to undertake mass civil disobedience against the government.

Not all his followers. however. understood his insistence on nonviolence; and when outbreaks of violence occurred he called off the movement and underwent personal penances. When hundreds of people who had gathered in Amritsar to attend a prohibited political demonstration were shot down in April 1919. Gandhi called the government "satanic"; but he confessed that he himself had committed a "Himalayan blunder" in failing to perceive that the people were not yet sufficiently disciplined to remain nonviolent in the face of severe provocations a-hen the policy of nonviolence was once launched. On three separate occasions the movement broke into violence and each time he called it off. to the exasperation of many of his associates. Finally. in 1922. he was arrested and sentenced to six years' imprisonment. The bearing of both judge and prisoner at the trial created a profound impression.

At the beginning of 1924, following an operation for appendicitis. he was released.

Between 1918 and 1922 Gandhi had done his utmost to produce an accord between the Hindu and Moslem communities; in furtherance of this purpose he actively supported the Moslem agitation for preserving the Turkish *Khilafut*, as the symbol of the unity of Islam. While he was in prison, relations between the two communities deteriorated and there were communal riots in a number of towns.

Accordingly, in Sept. 1924, he undertook a three weeks' fast at Delhi, hoping thereby to induce Hindus and Moslems to come to a better understanding. For a time the fast seemed to have achieved its object but before long conflict broke out again.

In 1925, being out of sympathy with the desire of most Congress leaders to enter the new legislatures set up under the Montagu-Chelmsford reforms of 1919, Gandhi retired from active politics and announced his intention of observing a year's political silence. In fact he did not return to full political leadership for three or four years. During this period he was constantly at work in the villages of India urging the people to take up hand-spinning in order to break free from their dire poverty and dependence on shoddy. town-made goods. and also urging them to abolish the evil of untouchability. At every village meeting that he addressed, if he found that the organizers had divided it into two sections, one for caste people, the other for untouchables, he would always sit among the untouchables to speak; and he had welcomed untouchables to his *ashram* or settlement at Sabarmati soon after his return to India.

He also fought against the drink and drug-taking habits of the people; he urged them to tend their cattle properly; he constantly taught good will between the religious communities and in other ways sought to promote the well-being of the myriad villages in which 90% of the people of India live. Throughout his public life in India. whenever he saw a barrier in the way of immediate political action, he turned to what he called "the constructive program" in faith that he was thereby preparing the country better for the next struggle for freedom.

In 1927 the British government appointed a parliamentary commission to consider whether India was ready for another instalment of self-government. This commission, led by Sir John Simon, was met in India by a widespread boycott, and an attempt was made to organize an all-parties reply to the commission in the form of an Indian-drafted dominion constitution. But the younger generation, led by Jawaharlal Nehru (*q.v.*) and Subhas Chandra Bose. had made up their minds for full independence. One section, impatient with the slow progress of the government and with the frustrations and persecutions arising from alien rule, broke loose from the Congress methods of action and started a campaign of violence. This brought Gandhi back into political activity. The Congress resolved that, as the government would make no promise of immediate dominion status; a new campaign of civil disobedience must be launched, and Gandhi was put in charge. He resolved to defy the government's salt monopoly. Accordingly, in April 1930, he walked all the way from his *ashram* near Ahmedabad to the sea at Dandi. and there he and his followers made salt from the sea. This salt march had an extraordinary effect in the country and before long many thousands of his followers were in jail for breaking various laws; finally Gandhi was himself imprisoned again.

During this imprisonment the government called a round-table conference in London, which was attended by a number of Indian moderates. It took such long strides toward self-government that, on their return to India. the chief delegates persuaded Gandhi, who had been set free, to meet the viceroy, Lord Irwin; and after prolonged talks between Gandhi and Irwin the Delhi pact was signed on March 5, 1931.

A few months later Gandhi attended the second round-table conference. but the British government had changed and this conference achieved nothing. On Gandhi's return to India he and his followers were arrested. During 1932 once again all the Congress leaders were behind prison bars.

Before the end of that year, when the MacDonald communal award was published, giving the untouchables or depressed classes separate political representation, Gandhi, in jail, started a fast unto death. He could not tolerate the idea of the perpetual separation of the untouchables from the rest of the people. Hindu and depressed-class leaders gathered round his bedside, and in a few days a compromise was accepted which for a period of years reserved many places for the depressed classes in the legislatures, but voting was to be in joint constituencies.

The next year Gandhi was released and he gave his main energies to work for the untouchables, for whom he coined the new name of *Harijans* or children of God. His weekly paper was published under this name for the rest of his life. During the next few years he undertook several more fasts in the interests of communal tolerance and the rights of the depressed classes. For Gandhi a fast signified his willingness to suffer for the cause that was close to his heart and at the same time was undertaken as an act of self-purification.

When World War II broke out, Gandhi was prepared to offer moral support to Great Britain. but he fell into line with his Congress colleagues in insisting that there could only be full co-operation from India if they were assured that one of the fruits of a British victory would be full freedom for India; and no such promise was forthcoming.

By 1940 the Congress had become completely estranged, and Gandhi started an individual civil disobedience movement, asserting the right of Indians to declare themselves in opposition to the war. He declared, however, that he did not wish to embarrass the British in their struggle. In 1942 Sir Stafford Cripps, on behalf of the government, made an effort to break the deadlock; but his proposals, although they assured freedom when the war was over, no longer met the Congress demand and Gandhi described them as a "postdated cheaue."

In Aug. 1942 the Congress leaders endorsed a demand made in July for an immediate transfer of responsibility and were thereupon arrested uith thousands of their followers. Gandhi held the British government responsible for the turmoil that followed in the early autumn of 1942 and. being unable to induce the government to change its policy, he fasted for three weeks while he was being held in detention in the spring of 1943. The government, however. was unmoved. In Feb. 1944 Mrs. Gandhi died in detention and Gandhi, after a serious illness, was released a few months later.

After his release Gandhi's first effort was to come to an understanding with Mohammed Ali Jinnah. the leader of the Moslem league, who was demanding, in the name of the 90.000 000 Moslems of India, the establishment of an independent Moslem state, to be called Pakistan. But the Gandhi-Jinnah talks proved unfruitful. When the Congress leaders were released, after the conclusion of the war, Congress and the Moslem league continued to drift apart.

With the advent of the Labour government in Britain. Indian nationalism entered its last phase. After a cautious beginning the new government indicated its willingness to transfer power in India completely, and three cabinet ministers visited India to negotiate a final settlement.

The question still remained: was it to be one free India or two? Gandhi withstood division to the end, insisting that Hindus and Moslems were one people. But the tide at the moment was flowing the other way. In the summer of 1946 terrible killings between the communities broke out in Calcutta and quickly spread to East Bengal, then to Bihar and later to other areas. especially the Punjab. Gandhi spent months during the winter of 1946–47, at the age of 77, tramping barefoot from village to village in Bengal, and later visiting the affected districts of Bihar and the Punjab, reminding the people that the God whom they worshipped under various names was the same God, that their real interests were identical. and urging the minority community to cast out its fears and the majority to win back the minority by rebuilding their ruined homes. He and his helpers had a large measure of success but a section of the political leaders of both the Hindu and Moslem communities opposed them.

In the spring of 1947 the Congress leaders agreed to the division of India. though Gandhi himself still disapproved. The date for independence and for the division was fixed for Aug. 15. Two days before that date Gandhi. having reached Calcutta. entered into a pact with H. S. Suhrawardy, who was the prime minister of Bengal until its partition. an active member of the Moslem league and one of Gandhi's most outspoken critics a few months previous. He was deeply distrusted by the Hindus of Bengal: but the determination of the two men to act together for the peace of Calcutta and Bengal had an almost miraculous effect. Instead of bringing fresh massacres to Calcutta. as had been widely anticipated. Aug. 1 j was a day of general rejoicing and fraternization all over the city. throughout eastern India and also in Delhi and elsewhere.

A few disappointed Hindus tried to break the peace a fortnight later: Gandhi immediately began a fast and within five days all parties in Calcutta promised to work together for peace.

As soon as he had recovered from his fast. Gandhi hurried to Delhi. for in the northwest the division of the Punjab had caused fresh outbreaks of violence. Unspeakable horrors were committed against the minority communities on both sides of the new frontier. and millions of people were fleeing in terror to the safety they hoped to find beyond the frontier. Delhi itself was swept into the flames of hatred and terror.

For four months Gandhi, living in Delhi and sometimes visiting the adjacent districts of the Punjab, did his utmost to fight against the violence and fury that surrounded him. Many Hindus and Sikhs. who had lost their relatives and their property in the western Punjab, were bent on revenge and resolved to turn all Moslems out of India.

Gandhi confessed that his lifelong teaching of nonviolence had not affected the people as he had believed; but he fought on dauntlessly. still insisting that, whatever might be happening in Pakistan. in India all communities must have equal rights—it must be a land for all.

In the middle of Jan. 1938. seeing that even the capital city of Delhi nas still unsafe for Moslems, he once again undertook a fast, and within a fen. days all the Delhi leaders had entered into a solemn agreement that they would welcome their Moslem neighbours back to their homes. But a small fringe of Hindus was not to be convinced. They saw that. so long as Gandhi lived. India could never become a Hindu-dominated state. Accordingly. on Jan. 30, 1948, ten days after his fast. as he was walking to his daily prayer meeting in the garden of Birla house. Delhi. he was fatally shot by a Hindu extremist.

Gandhi's Teaching.— Gandhi may be remembered, first and foremost, as a prophet of nonviolence in an age that saw two world wars: as a man who identified himself at all times with the poor and the disinherited. never abandoning his exacting standards of personal self-discipline even when he was the acknonledged leader of the nation and the idol of millions; or perhaps most of all as a man who asserted the validity of moral principles (especially the principle of truth) and their application to public life in all circumstances. even when the application of principle was manifestly against the immediate interest of his party or nation. He would not allow that any plea of expediency could justify a deviation from truth.

It is significant that he called his own autobiography *The* Story of *My Experiments With Truth;* and. indeed. it is no ordinary biography at ail, for it omits many important incidents and concentrates on those experiences which had led him to some fresh insight into truth.

It was often said that Gandhi was a religious man. a saint who had strayed into politics. But he himself said that he was a politician who was trying to become a saint. Yet it is true that he was fundamentally a religious man. Nothing would induce him to abandon his two regular times of open prayer, held about 3:30 A.M. and 5 or 6 P.M. He might add to them but he would not excuse himself from them. In addition. whenever he was alone (except during sleep the amount of such times was very small) he spent much time in meditation and prayer. Although to the end of his life he used certain Hindu forms of prayer and had great faith in the efficacy of repeating certain set forms. yet the essence of his religion was universal. God, he declared in *Harijan* (from which the quotations here and below are taken with the permission of the Navajivan trust). was to him identical with truth. "God is. even though the World deny him. Truth stands. even though there be no public support. It is self-sustained. Truth is perhaps the most important name of God. In fact it is more correct to say that Truth is God than to say that God is truth." "Let then our first act every morning be to make the following resolve for the day: 'I shall not fear anyone on earth. I shall fear only God. I shall not bear ill-will towards anyone. I shall not submit to injustice from anyone. I shall conquer untruth by truth and in resisting untruth I shall put up with all suffering.' "

This last quotation suggests the link in his mind between truth and nonviolence. two principles which, in later life especially, he constantly linked together. Every resort to violence. he believed, showed a failure to hold on to the matchless weapon of truth. A man n-ho resorts to angry argument against an opponent does so because he has no faith that truth alone will convict or convert. Sometimes. indeed. it is necessary to appeal not only to the head but to the heart. That means that a man must be prepared not only to be tireless in seeking to persuade his opponent by patient argument but also to undergo suffering for the truth that he declares. Such suffering, cheerfully undergone. may induce those who have not yielded to persuasion to re-examine their fundamental motives. It may lead to a change of heart. Here can be seen the mainspring to Gandhi's fasts.

Nonviolence, though negative in form. was to Gandhi a positive principle. It is a literal translation of the word *ahimsa*. But Gandhi himself coined a special word. *Satyagraha,* meaning soul force or truth force. in order to show that the man who renounces violent weapons. and even violent speech and thought. is still a fighter. He need not be. he must not be. passive when faced with evil. His weapons are to be truth and love or good will. "*Ahimsa,*" he wrote. "is not merely a negative state of harmlessness but it is a positive state of love. of doing good even to the evil-doer. But it does not mean helping the evil-doer to continue to wrong or tolerating it by passive acquiescence. On the contrary. love. the active state of *Ahimsa,* requires you to resist the wrongdoer by dissociating yourself from him even though it may offend him or injure him physically." "Complete non-violence is complete absence of ill-will against all that lives. It therefore embraces even subhuman life, not excluding noxious insects or beasts. They have not been created to feed our destructive propensities. If we only knew the mind of the Creator we should find their proper place in his creation. Non-violence is therefore in its active form good-will towards all life. It is pure Love. I read it in the Hindu scriptures. in the Bible. in the Koran." "When a person claims to be non-violent. he is expected not to be angry with one who has injured him. He will not wish him harm; he will wish him well."

Gandhi achieved this ideal to an extraordinary degree. He was often attacked and vilified; yet it may be doubted whether even his intimate friends ever heard him speak angrily or contemptuously of his critics. On the contrary, he was constantly contriving means for repaying evil with good. He nas the most charitable of men. and the most tolerant. If he thought a man were doing evil, he would say so: but he would welcome opportunities for meeting such a man and inducing him to do good.

Gandhi's determination to revive hand-spinning and weaving and other village crafts has been interpreted as a complete rejection of machinery. This is a misapprehension. Primarily, he urged these things as the first and simplest steps in the fight against the abysmal poverty of the Indian villages. "The spinning-wheel itself." he pointed out. "is a machine. What I object to is the craze for machinery, not machinery as such. The craze is for what they call labour-saving machinery. Men go on saving labour till thousands are without work and thrown on the open streets to die of starvation." "Scientific truths and discoveries should first of all cease to be the mere instruments of greed. Then labourers will not be over-worked and machinery, instead of being a hindrance, will be a help." "The supreme consideration is man. The machine should not tend to make atrophied the limbs of men." "Replace greed by love and everything will be right."

Similarly, his strong criticisms of medical science have suggested that he rejected all scientific treatment of disease. Again, it is largely a matter of emphasis. He believed that strict adherence to the rules of hygiene and the laws of health ("overworking the body is a form of violence," he once said) would lead to the avoidance of nearly all illness. When they did occur, he believed that most illnesses could be best treated by "nature cure" rather than by drugs.

In politics he called himself a democrat and a socialist. but he had his own explanation of these terms. "The truest test of democracy is in the ability of anyone to act as he likes, so long as he does not injure the life or property of anyone else." "If the whole of India were to say that even peaceful public meetings may not be held without permission, that peaceful volunteer associations may not be formed without permission and that newspapers cannot be published without permission, that prohibition cannot be accepted. For a man may not be expected to ask for another's leave to breathe or eat or drink. The three things I have mentioned are the breath. the food and the drink of public life." "Liberty of speech means that it is unassailed, even when it hurts."

His socialism certainly was not state socialism. for he wanted the state to wither away. nor was it connected with the teachings of Karl Marx or other western socialists. It was a deduction from his principle of nonstealing. Anyone who took for his own use more than he needed was, in Gandhi's view, robbing the poor. He did not object to employers of labour or to capitalists or landowners as such: but he called on them to abandon their riches, to share their wealth with the community, to be trustees for those who were dependent on them. He was less concerned with changing the social structure than with changing human motives. By these principles he himself lived. He was constantly trying to get rid of his dependence on possessions, even the possession of any home of his own, or dependence on secretarial help. He strove to make himself dependent on God alone.

Thousands of men were his friends; the circle was ever-widening. But none was his intimate; or rather, all were. With all his friends and visitors he was courteous, patient. tolerant. sometimes playful and ever ready to be merry, even when his lifework was threatened with destruction. His spirit was unconquerable.

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(H. G. AR.)

GANDÍA, a seaport of eastern Spain in the province of Valencia; on the Gandía-Alcoy and Alcira-Denia railways. Pop. (1950) 20.205 (mun.). The town is on the left bank of the Alcoy or Serpis river, which drains a rich and densely populated plain. The river enters the Mediterranean sea at the small harbour of Gandia (El Grao). 3 mi. N.E.

Among the ancient buildings are the Gothic church, the college founded by the director-general of the Jesuits (1510–1572) and the palace of the dukes of Gandia. The town manufactures leather. silk, velvet and ribbons, and exports fruit and imports coal, timber and flour.

GANDO, a former amirate of west Africa, in the northwest part of the Federation of Nigeria, and west of the Niger river. The state was established, about 1819, on the death of Othman Dan Fodio, the founder of the Fula empire. and its area and importance varied considerably during the 19th century. several of the Fula amirates being regarded as tributaries. while Gando itself was more or less dependent on Sokoto. Gando in the middle of the century included both banks of the Niger at least as far northwest as Say.

The districts outside the British protectorate now belong to France. Treaty relations with the British were entered into in 1884 and in 1903 the part assigned to the British sphere by agreement with France came definitely under the control of the administration in Nigeria.

Gando is included in the province of Sokoto. The chief town is Gando, on the Sokoto. the first considerable affluent of the Niger from the east, about 60 mi. S.W. of the town of Sokoto.

GANESHA or GANESH, in the post-Epic Hindu mythology. eldest son of Siva and Parvati. His name means leader of (Siva's) attendants; he is a creator of obstacles and as such came to be placated for their removal.

Depicted with an elephant's head, to symbolize his sagacity, he is the god of worldly wisdom; and is invoked on the first page of every book, especially in ledgers, as he bestows prosperity in trade.

He is worshipped all over India, especially in the south. and is affected by six sects, under his six titles. Maha-Ganapati, etc. These hold him, not Siva, to be the real first cause and the Hairamba Ganapatiyas are taxed with unedifying rites.

See "Ganapatiyas" in J. Hastings, *Encyclopaedia of Religion and Ethics*, vol. vi (Edinburgh, 1913).

GANESH DATTA SHASTRI, SHRI JAGADGURU (1861–1940), Indian philosopher who published several works on Sanskrit. was born on July 12, 1861, son of Pandit Upendra Datta Shastri. astronomer and Sanskritist. He was educated at the Oriental college, Lahore, and Punjab university, and in 1882 became a teacher. He held professorships of Sanskrit at Forman Christian college (1886- go;), Government college and of Vedanta philosophy at Oriental college (1908–17). In 1917 he was appointed senior professor of Sanskrit and theology at Sanatan Dharam college, Lahore. In 1926 he was invested by the government of India with the highest Sanskrit title of *Mahāmahopādhyāya;* he was the first Punjabi on whom this title was conferred. He died at Lahore in 1940. He trained a large band of scholars who made considerable contributions to Sanskrit scholarship. Shastri's works are still used.

His publications include: *The Students' Practical Sanskrit-English-Hindi Dictionary* (Lahore, 1905); *The Etymological Sanskrit-Hindi Dictionary*, called *Padmachandrakosh* (1898); *Shāstriyasiddhānta* (Lahore, 1909); and a commentary on the *Bhagavadgita* (1926).

GANGES (Hindi GANGA), a great river of northern India, formed by the drainage of the southern Himalayas. Its lower reaches focus the river system of Bengal and it falls into the Bay of Bengal after a course of 1.540 mi. The greater of its two main headstreams, the Xlaknanda, rises in the neighbourhood of the Garhwal-Tibet border. about 30 mi. N. of Nanda Devi; the lesser, the Bhagirathi, issues from an ice cave at the foot of a Himalayan snow bed near Gangotri. in Tehri-Garhwal district. Uttar Pradesh, 10,300 ft. above sea level. Devaprayag, the point of junction of the Alaknanda and Bhagirathi streams, is a celebrated place of pilgrimage, as is also Gangotri. At Sukhi it pierces the Himalayas and turns southwest to Hardwar. also a place of great sanctity. It proceeds by a tortuous course along the eastern boundaries of Dehra Dun. Saharanpur, Muzaffarnagar. Meerut, Bulandshahr. Aligarh and Etah districts. and into Farrukhabad. in which last district it receives the Ramganga. Thus far the Ganges has been little more than a series of broad shoals, long deep pools and rapids, except during the melting of the snows and throughout the rainy season. At Xllahabad. however, it receives the Jumna. a large river. which also rises in the Himalayas farther west. The combined river winds east by southeast through Uttar Pradesh. receiving the Gumti and the Gogra at consecrated spots. But the tongue of land at Allahabad (*q.v.*), where the Jumna and the Ganges join, is the true Prayag, or place of pilgrimage. to which hundreds of thousands of devout Hindus repair to wash away their sins in the sacred river. The great festival called the Magh Mela is held there.

Shortly after passing the holy city of Benares the Ganges enters Bihar and. after receiving the Sone from the south, passes Patna and is joined by the Gandak, which rises in Nepal. Farther east it receives the Kosi. and then. skirting the Rajmahal hills. turns sharply southward, passing near the ruined city of Gaur. Between Murshidabad and Rajshahi districts, down to where the Matabhanga branches off, the Ganges is the frontier between India and East Pakistan. The delta begins 220 mi. in a straight line. or 300 mi. by the windings of the river. from the Bay of Bengal. The main channel, which is in Pakistan, takes the name of the Padma or Padda. and proceeds in a southeasterly direction past Pabna to Goalanda. above which it is joined by the Jamuna or main stream of the Brahmaputra. The vast confluence receives further additions from the hill country to the east, and forms a broad estuary known as the Meghna. which enters the Bay of Bengal near Noakhali. This estuary. however, is only the largest and most easterly of a great number of mouths or channels. The most westerly is the Hooghly. which receives the waters of a number of distributary channels that start from the parent Ganges above Murshidabad.

Between the Hooghly on the west (in India) and the Meghna on the east (in Pakistan) lies the delta. Its northern angle consists of rich and fertile districts. such as Murshidabad and Twenty-four Parganas, Nadia in India and Jessore in Pakistan. But toward its southern base. resting on the sea. the country sinks into a series of swamps, intersected by a network of channels. This waste is known as the Sundarbans. from the sundari tree, which grows in abundance in the seaboard tracts.

The most important channel of the Ganges for commerce is the Hooghly (*q.v.*), on which stands Calcutta, about go mi. from the mouth. Above this city navigation is undertaken by native craft and is practicable as far as Garhmuktesar. 100 mi. below Hardwar. Below Calcutta important boat routes through the delta connect the Hooghly with the eastern branches of the river.

The catchment basin of the Ganges is bounded north by a length of about 700 mi. of the Himalayan range, south by the Vindhya mountains and east by the ranges which separate East Bengal from Burma; its area is nearly 450,000 sq.mi. and it forms one of the most densely populated river plains in Asia. The average fall from Allahabad to Benares is six inches per mile; from Benares to Calcutta. between four and five inches: from Calcutta to the sea, one to two inches.

Great changes take place from time to time in the river bed. Extensive islands are thrown up and attach themselves to the mainland, while the river deserts its old bed and seeks a new channel. perhaps many miles away. Many decayed or ruined cities attest such changes in ancient times.

The Ganges is crossed by six railway bridges on its course as far as Benares; by another at Mokameh. 60 mi. E. of Patna; and another at Sara in East Bengal. The Cpper Ganges canal and the Lower Ganges canal. with headworks at Hardwar, are the two principal systems of perennial irrigation in Uttar Pradesh.

GANGOTRI, a celebrated place of Hindu pilgrimage in the Himalayas. It is in Tehri-Garhwal district in Uttar Pradesh, India, on the Bhagirathi, one of the two chief headstreams of the Ganges. Gangotri contains a small temple about 20 ft. high, in which there are images representing Ganga, Bhagirathi and various other figures of mythology.

The bed of the river adjoining the temple is divided off by the Brahmans into three basins, where the pilgrims bathe. One of these basins is dedicated to Brahma. another to Vishnu and the third to Siva. The pilgrimage to Gangotri is considered efficacious in washing away sin and ensuring eternal happiness. The water taken from this sacred spot is exported by pilgrims to other parts of India. The temple is 10,319 ft. above sea level.

GANGPUR, a former feudatory state, geographically within Orissa, but administered under British paramountcy through the Eastern States agency.

The state had an area of 2,477 sq.mi. and a population (1941) of 398,171. Its capital was Suadi. After India became independent Gangpur was merged into Sundergarh district, Orissa (Jan. 1, 1948). and made into two subdivisions.

GANGRENE, a synonym in medicine for mortification or death of tissues of varying extent. There may be gangrene of an appendix, an extremity or of the whole body after death. It may result from injury. infection as in gas gangrene and from diseases of the blood vessels. There are various diseases in which it is prone to occur such as diabetes and arteriosclerosis. It is likely to occur after severe burns and freezing. Treatment varies with the cause but the recovery depends largely upon factors which prevent continuation or extension of the cause and the re-establishment of circulation. *See* also NECROSIS. (*F.* L. A.)

GANIVET, ANGEL (1865–1898), Spanish essayist and novelist, was born at Granada. He entered the diplomatic profession and was appointed consul at Antwerp, Helsingfors (where he published in 1896 his first book *Granada la bella)* and Riga. Ganivet shows a brilliant power of evocation in the novels *La Conquista del reino de Maya . . .* (1897) and *Los Trabajos del infatigable creador Pio Cid* (1898).

His best work lies, however: in the field of the essay—in the *Idearium español* (189; ; Eng. trans., *Spain: an Interpretation,* 1946), where, as in the *Epistolario* (1904), his original thought on Spanish problems has free play.

GANJA (KIROVABAD), a town in the Azerbaijan A.S.S.R., in 40° 43' N. and 46° 20' E., altitude 1,446 ft., on a northern spur of the Armenian plateau above the valley of the Kura river. Pop. (1956 est.) 111,000, mainly Tatars and Armenians.

The position of Ganja on the railway facilitated the production of wine and liquorice and textile manufactures, including wool. cotton and silk. It became the outlet for the copper mines of Kedabek and the sulphur pyrites of Chigari-dzor. Manganese is found in this district, where cotton plantations, vineyards, fruit gardens and a silkworm-breeding industry were also established. Beekeeping is profitable.

The town is very old, and changed hands between Persians, Khazars and Arabs even in the 7th century. Later it was captured by Mongols, Persians, Georgians and Turks. In 1904 it became Russian and was known as Elisavetpol until the formation of the Azerbaijan S.S.R., when it resumed its original name. In 1935 it was renamed Kirovabad.

In 1926 the Russians under Ivan Paskevich defeated a Persian attack on the town. Amid the ruins of old Ganja, 4 mi. distant, is the Green mosque, and the beautiful mosque of the Persian Shah Abbas (1620) is in the modern town. The Persian poet. Shah Nizam (Nizami), was probably born there about 1141 and his grave is said to be in the vicinity.

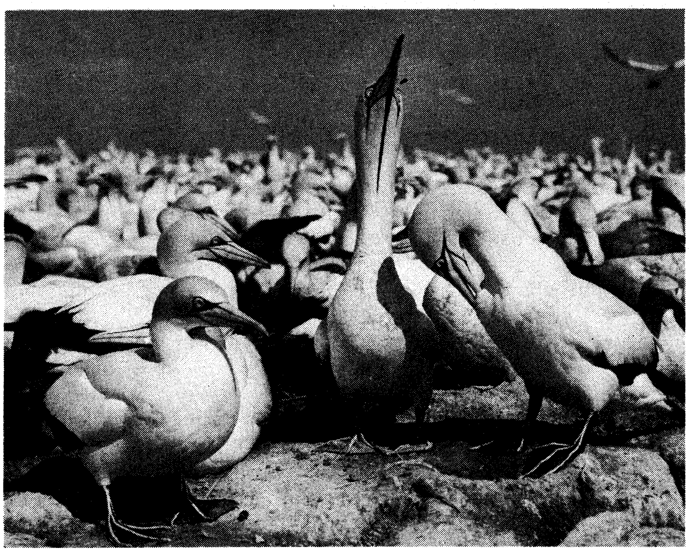
There is a marked contrast between the newer quarters and the winding, narrow! unhealthy ancient streets with their low-roofed, windowless huts.

GANJAM, a district of Orissa state, India; before 1936 in Madras. Area 4.828 sq.mi.; pop. (1951) 1,624,829. It is largely mountainous. rocky and afforested. The Maliahs. a chain of the Eastern Ghats. have an average height of about 2,000 ft. The chief rivers are the Rushikulya, the Vamsadhara and the Nagavali.

Ganjam formed part of the ancient kingdom of Kalinga. The inaccessible country long kept the rising Mohammedan power at hay; and it was not till nearly a century after the first invasion of Orissa that a Mohammedan governor was sent to govern the Chicacole Circar. including the present district of Ganjam. In 1753 the Northern Circars, including Chicacole. were made over to the French. In 1759 Masulipatam was taken by an English force, and the French had to abandon Ganjam and their other factories in the north. In 1765 the Northern Circars were granted to the English by imperial firman. and in Aug. 1768 an English factory was founded at Ganjam. protected by a fort. In 1816 Ganjam was overrun by the Pindaris; and in 1836 occurred the Gumsur campaign. when the British first came into contact with the aboriginal Kondhs and suppressed their practice of human sacrifice.

The district's principal crops are rice, other food grains, pulses and oilseeds; half the cultivated land is under irrigation. Many people are occupied with river and sea fishing and curing. Salt is evaporated. as a government monopoly, along the coast. Sugar is refined at Aska. The busy ports of Gopalpur and Calingapatam are only open roadsteads. The district is traversed throughout by the east coast line of the Eastern railway. The district headquarters are at Berhampur.

GANNET, any of several large gull-like sea birds which with the boobies constitute the family Sulidae, order Pelicaniformes, particularly three larger species (Morus) inhabiting cooler temperate seas. The North Atlantic gannet or solan goose (M. *bassana*) is 36 in. long, white tinged with pale yellowish straw on head and neck, and has a cigar-shaped body with stout pointed beak, pointed tail and long slender black-tipped wings. It breeds locally in large colonies on steep island cliffs and offshore rocks, principally about the British Isles but also at the Faeroes, Iceland, Labrador and islands in the Gulf of St. Lawrence, ranging south in winter to northwest Africa and the Gulf of Mexico. The most famous gannetry is located on Bass Rock, off the coast of Scotland.



AUTHENTICATED NEWS

SOUTH AFRICAN GANNET (MORUS CAPENSIS)

When in full plumage, at three years of age, the birds breed once a year after mutual courtship performances. A crude nest of seaweed and grasses is built on a ledge; one egg, rarely t o, of pale blue, hidden by thick chalk and nest stained, is incubated by both birds in turn for about 44 days. The young are hatched naked and blind, but soon become covered by white down, which is replaced by brown feathers speckled with white. The bird waddles on land, but is an expert flyer, moving in single file 30 to 40 ft. up over the sea, alternating rapid wing beats with gliding. With half-closed wings it plunges into the sea for fish, which it swallows whole.

While diving, the gannet is cushioned by subcutaneous air spaces connected with the lungs; the nostrils are closed. The bird floats high while sitting on the water. Young at the nest take regurgitated food from the wide-opened mouth of the parent.

There are two slightly smaller southern species: the South African or cape gannet (*M.* capensis), breeding on islands off the Cape of Good Hope; and the Australian gannet (M. serrator), middle tail feathers dark, breeding on islands about Tasmania and North Island, New Zealand.

The six smaller species, the booby gannets or boobies (Sula), so called because of their stupid appearance and reaction to man, breed on tropical and subtropical islands, ranging far over the sea. Three are cosmopolitan: the white-bellied brown booby (*S.* leucogaster); and two white species, the red-faced or red-footed booby (S. Sula), which usually nests in low trees, and the masked or blue-faced booby (S. dactylatra).

Two are important guano birds along the northwest coast of South America; the blue-footed booby or camanay (S. nebouxii), brown and white streaked in colour, found from western Mexico to northern Peru and the Galapagos Islands; and the Peruvian booby or piquero (S. variegata) of islands off the coast of Peru and northern Chile. It fishes in the cold Humboldt current offshore, has a white head and body and variegated brown and white back, wings and tail. S. *abbotti* breeds on Assumption and Christmas Islands in the Indian ocean. Boobies usually lay two eggs, in a slight depression in the sand or rock, with the exception of the red-footed booby which builds a nest of twigs in low bushes. They are preyed on by the frigate bird (*q.v.*). (G. F. Ss.)

GANODONTA, or TAENIODONTA, an extinct group of clawed mammals of the North American Palaeocene and Eocene. Seven genera are known, distributed in two subfamilies of the family Stylinodontidae. The more primitive Conoryctinae, confined to the Palaeocene, are rather generalized and insectivorelike. The Stylinodontinae, forming a progressive series throughout the Palaeocene and Eocene, culminate in large animals with high-crowned, rootless, columnar teeth, superficially slothlike. The skull is short faced. deep jawed and small brained. The tail is massive and the limbs are strong and heavy, of digging type, with large, compressed claws. Some students have maintained that the taeniodonts were edentates, related to the ground sloths, but more recent studies suggest that the resemblance is probably due to similar habits and not to common ancestry. The taeniodonts probably represent an independent and isolated offshoot of the earliest Insectivora. (G. G. Si.)

GANOID, any fish having ganoid scales, rhombic bony scales covered on the outer surface with a layer of ganoin, an enamellike shiny substance. It is now known that ganoid scales differ considerably in structure, and that the ganoids are not a natural taxonomic group. Most fish with ganoid scales are extinct. but the gar (Lepisosteus), sturgeon, paddlefish or spoonbill and bowfin survive in the fresh waters of North America and elsewhere, and the Polypteridae in the rivers of Africa. See FISHES.

GANYMEDE, son of Tros (or Laomedon), king of Troy. Because of his surpassing beauty, he was carried off by the gods, or Zeus or, according to a later myth, the eagle of Zeus or the god himself in eagle shape, to serve as cupbearer. In compensation, Zeus gave his father a stud of immortal horses (or a golden vine). From fairly early times (Theognis. 6th century B.C.), and perhaps especially among Dorians, his kidnapper was supposed to have a homosexual passion for him, hence the connotation which Catamitus, the popular Latin form of his name, had and has. A Cretan variant of the legend makes Minos, the island's primitive ruler, Ganymede's ravisher. He was later identified with the constellation Aquarius.

GAON, a Hebrew word (plural Geonim) meaning "excellency," describing the head of a talmudic academy. The Geonim were the spiritual leaders of post-talmudic and early medieval Jewry, and they functioned, with occasional lengthy interruptions, from the middle of the 7th century to the end of the 13th. Gaon is the fourth of a series of titles—Sofer, Tanna, Amora and Gaon—of Jewish postbiblical teachers. The geonic academies—which were engaged in the interpretation and development of the talmudic law, and thus served also as high courts adjudicating controversies over the law—arose first in Babylonia, and later appeared also in Palestine. The teaching of the Geonim, like that of their predecessors. safeguarded tradition, and their advice or decisions on points in the law (responsa) were often invoked far beyond the limits of their schools or communities. The responsa are of special importance for Jewish history and theology.

Among the great Geonim may be mentioned Sherira ben Hanina (d. 1000) of the academy at Pumbeditha, author of the famous letter addressed to Jacob ben Nissim of Kairwan in which the history of the talmudic and geonic periods is set forth; Amram ben Sheshna of the Sura academy, the first authority to arrange a complete domestic and synagogal liturgy; Saadia ben Joseph (*q.v.*) of Sura. who fought Karaism, translated the Scriptures into Arabic, compiled a dictionary and was a pioneer in the fields of theology and philosophy; and his contemporary and adversary, Aaron ben Meir of Jerusalem. The last great Geonim were Samuel ben Hofni (d. 1034), Hai ben Sherira (*q.v.*) and Samuel ben Ali, Gaon of Baghdad, contemporary and adversary of Maimonides (*q.v.*).

Jewish scholars usually differentiate between the Babylonian and Palestinian Geonim. There existed a constant rivalry between the two Gaonates, a rivalry which broke out in open struggle at the time of Saadia. Ben Meir lost the battle for supremacy, and thereafter the superior authority of the Babylonian Gaonate was rarely questioned.

The spread of talmudic studies during the geonic period to many Jewish communities in other countries brought about the establishment of talmudic academies outside Babylonia. There thus occurred a gradual weakening of the Babylonian Gaonate, which by the end of the 13th century had disappeared altogether. The age of codifiers succeeded, and their codes exercised great unifying influence over scattered world Jewry. The codes, especially Joseph Qaro's (*q.v.*) *Shulhan Arukh,* became the halakic authority in Jewry, and later activity in the field of Halakah centred in them.

After the end of the geonic period the word "Gaon" was used in Jewry merely as a title of honour, to describe excellence in learning. In later centuries one outstanding halakic authority, Elijah ben Solomon (*q.v.*), was called the Vilna Gaon or the Gaon. *See* also TALMUD.

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(J. M. RL.)

GAP, the capital of an *arrondissement* in the French *département* of Hautes-Alpes, 122 mi. by rail from Marseille. Pop. (1954) 13,338. It is the *Vapincum* of the Romans founded by Augustus about 14 B.C. In 1232 most of the region passed from Provence by marriage to the dauphins of Viennois. The town itself, however, remained under the rule of the bishops until 1512, when it was annexed to the crown of France. The town was sacked by the Huguenots in 1567 and 1577, and by the duke of Savoy in 1692. It was the birthplace of the reformer Guillaume Farel (1489–1565), who first preached his doctrines there about 1561–62.

Gap is built at a height of 2,418 ft. on the right bank of the Luye (an affluent of the Durance). The 17th-century cathedral was entirely reconstructed (1866–1905). The prefecture contains scientific and archaeological collections, as well as the archives. which include many manuscripts from the monastery of Durbon. etc. The episcopal see of Gap, in the ecclesiastical province of Aix-en-Provence, first mentioned in the 6th century, was in 1791 enlarged by the annexation of that of Embrun.

GARAMOND (GARAMONT), **CLAUDE** (c. 1480–1561), French type designer and publisher, one of the first punch cutters to work independently of printers, who perfected the design of roman type faces and so assisted the roman letter to oust the gothic from European typography outside Germany, was born in Paris about 1480. He mas apprenticed about 1510 to A. Augerau and by 1520 was working with Geoffroy Tory. His first romans, and his *grecs du roi,* were cut for the great firm of Estienne. In 1545 he began to publish books, with P. Gaultier as his printer. He died in poverty in Paris in 1561. His roman fonts, cut from 1531 onward. surpassed the best Aldine romans in grace and clarity. and influenced European punch cutters for 150 years. His Greek set the pattern for Greek printing until the early 19th century; cut for Francis I in the 1540s, the *grecs du roi* displayed larger and more emphatic capitals than the Aldine Greek, but retained a larger number of ligatures and contractions. Garamond may have cut no italics until 1545, and then perhaps only two fonts; these followed the Aldine style in general, with a reduced number of ligatures, but were the most influential early italics to be designed with sloped and flourished capitals. Eighty years after his death. his types were copied and adapted by J. Jannon; revived forms of these copies bear Garamond's name today, but do not bear witness to his skill. (H. A. F. W.)

GARASHANIN, ILIYA (1812–1874), Serbian statesman. was born on Jan. 28. 1812. at Garasha (Kragujewac). In 1836 Prince Milosh appointed him a colonel and commander of the then just organized regular army of Serbia. In 1842 he was called to the position of assistant to the home minister, and from that time until his retirement from public life in 1867 he was repeatedly minister of home affairs. He rendered great services to his country as minister for foreign affairs. He sought to replace the Russian protectorate over Serbia by the joint protectorate of all the great powers of Europe. In 1853 he opposed co-operation with Russia against Turkey and the western powers. His anti-Russian views led Prince Menshikov, while on his mission in Constantinople, 1853, peremptorily to demand his dismissal. Nevertheless his personal influence in the country secured the neutrality of Serbia during the Crimean War. It was due to Garashanin that France proposed to the peace conference of Paris (1856) that the old constitution. granted to Serbia by Turkey as suzerain and Russia as protector in 1839. should be replaced by a more modern and liberal constitution, framed by a European international commission. But the agreement of the powers was not secured. Garashanin induced Prince Alexander Karageorgevich to convoke a national assembly. which had not been called to meet for ten years. The assembly was convoked for St. Andrew's Day 1858. but its first act was to dethrone Prince Alexander and to recall the old prince Milosh Obrenovich.

When after the death of his father Milosh (in 1860) Prince Michael ascended the throne, he entrusted the premiership and foreign affairs to Iliya Garashanin. The result of their policy was that Serbia was given a new, although somewhat conservative, constitution, and that she obtained, without mar, the evacuation of all the fortresses garrisoned by the Turkish troops on the Serbian territory, including the fortress of Belgrade (1867). Garashanin was preparing a general rising of the Balkan nations against the Turkish rule, and had entered into confidential arrangements with the Rumanians, Bosnians, Albanians. Bulgarians and Greeks, and more especially with Montenegro. But the execution of his plans was frustrated by his sudden resignation (at the end of 1867), and by the assassination of Prince Michael a few months later (June 10, 1868).

Although he was a Conservative in politics, and as such often in conflict with the leader of the Liberal movement. Yovan Ristich. Garashanin certainly was one of the ablest statesmen whom Serbia had in the 19th century.

His son, NILUTIN GARASHANIN (1843–1898), entered parliament in 1874. He was minister of the interior (1880–83), and prime minister (1884–87). In 1894 he became ambassador in Paris, where he died on March 7, 1898.

GARAT, DOMINIQUE JOSEPH (1749–1833), French writer who played a prominent part in political life between 1789 and 181j, was born at Bayonne (Basses-Pyrénées), Sept. 8. 1749. He was a deputy to the states-general and achieved notoriety for his accounts of its proceedings published in the *Journal de Paris.* Garat's assiduity in following the fluctuations of public opinion, however, made his role in politics undignified and ridiculous. He had the duty, as minister of justice, of informing Louis XVI of his death sentence and, after March 1793 when he became minister of the interior, of maintaining public order. Having failed conspicuously in this latter task, he resigned (Aug. 1j) and was arrested on Oct. 2, 1793. Although he owed his prompt release and freedom from interference during the Terror to friendship with Robespierre, this debt did not prevent his turning against the dictator on 9th Thermidor. After the revolution of 18th Brumaire, he quickly became a supporter of Napoleon who rewarded Garat's adulation with the titles of senator (1800) and count (1808), while from 1803 he was also a member of the Institute of France. Garat was unsuccessful in his attempt to change sides yet again in 1814 and 1815, and during the Bourbon restoration he went into retirement. He was, horn-ever, recalled to his place in the Institute in 1832.

Garat died near Ustaritz (Basses-Pyrénées), Dec. 9, 1833.

GARAT, PIERRE-JEAN (1764–1823), French singer, nephew of Dominique Joseph Garat, was born in Bordeaux on April 25, 1764. Gifted with a voice of exceptional timbre and compass he was the favourite singer of Marie Antoinette. to whom he gave lessons. At the beginning of the Revolution he accompanied Rode to England, where the two musicians appeared together in concerts. He returned to Paris in 1794 but fell under suspicion, was imprisoned for a short time, and then left Paris for Hamburg. He gained a great reputation in all the capitals of Europe, and retained his voice for a long period. He was a keen partisan of Gluck in opposition to Handel. On the institution of the Paris conservatory he became its first professor of singing and had many famous pupils.

See Bernard Miall, *Pierre Garat* (1913).

GARBORG, ARNE EVENSEN (1851–1924), Norwegian writer, was born on Jan. 25, 1851, at Thime. He joined the movement for the creation of a Norwegian literary language based on the *landsmaal* or peasant dialect derived from old Norsk, in place of the Dano-Norwegian literary medium. He wrote a series of novels deeply penetrated by religious feeling. In 189j he wrote a cycle of lyric poems in the *landsmaal, Haugtussa* (1895), which describe a young girl's belief in the supernatural. He also translated the *Odyssey* (1918) and a selection from the *Mahabharata* (1921), and, for representation at the *landsmaal* theatre, which he and his wife had founded, Holberg's classical comedy, *Jeppe paa Berget* (1921). His collected works, *Skrifter i samling,* began to appear in 1908. Garborg died on Jan. 14, 1924, at Asker.

GARÇÃO, PEDRO ANTÓNIO CORREIA (1724–1772), one of the principal neoclassical Portuguese poets. Born in Lisbon on April 29, 1724, he was the son of a foreign office official; his mother was of French descent. He studied law at Coimbra but does not appear to have taken his degree. In 1751 his marriage brought him a rich dowry and he had a moderately lucrative post in the *Casa da Índia,* but later a lawsuit reduced him to poverty. From 1760 to 1762 he edited the *Lisbon Gazette.* In 1756 he became a member of the *Arcádia Lusitana,* a literary society founded to rid Portuguese poetry of the still-persisting 17th-century liking for conceits, windy words and rhetorical phrases. For reasons which are still obscure Garção was arrested in April 1771 and imprisoned, but he was never brought to trial. He died in Lisbon on the day of his release, Nov. 10, 1772.

Taking Horace as his model, and aided by sound judgment, scholarship and wide reading, Garção adopted a classical simplicity of form and expression. His sonnets and epistles reveal him as a man of good taste and good sense, devoted to his friends and possessing high ideals of conduct and of art. His verse comedies, the *Teatro Novo* (1766) and the *Assemble'ia ou Partida* satirize respectively the theatre and the social life of Lisbon. In the "Cantata de Dido," included in the latter play, he combined the spirit of classical art with perfection of form to produce one of the most celebrated 18th-century Portuguese poems.

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GARCÍA (DEL POPOLO VICENTE), MANUEL (1775–1832), Spanish tenor singer and composer, was born in Seville on Jan. 22, 177j. At 17 he made his début on the stage at Cádiz, in an operetta which included songs of his own composition. He had already a considerable reputation as a composer of light operas and as an operatic singer when he appeared in Paris in 1808, in Paer's opera *Griselda.* At Naples later he created some famous rôles in Rossini's operas, and sang them until 1816 when he visited London and Paris. Between 1819 and 1823 he lived in Paris, singing in *Il Barbière, Otello, Don Giovanni,* etc., and producing some operas of his own—he wrote about 100 in all—of mhich *La Morte* di *Tasso* mas the most important. But his greatest work was done as a teacher of singing in London and Paris. Of his principles and method he left an account in his *Metado di Canto,* the substance of which was subsequently incorporated by his son Manuel in his admirable *Traité complet de l'art du chant* (1847). He died in Paris on June 2, 1832.

His son, MANUEL GARCÍA (1805–1906), who celebrated his hundredth birthday in London on March 17, 1905, was born at Madrid, and as a teacher became no less famous than his father. He was a professor at the Paris Conservatoire (1830–48), at the Royal Academy of Music, London (1848–95), and will be remembered, it is safe to say, so long as the art of singing is studied, as the inventor of the laryngoscope.

See M. Sterling Mackinlay, *Garcia the Centenarian and his Times* (1908).

GARCÍA DE LA HUERTA Y MUÑOZ, VICENTE ANTONIO (1734–1787), Spanish playwright, poet and critic, achieved success with *Raquel* (1778), a drama of national history, but of modern outlook, and the only actable Spanish tragedy of his era. He was born at Zafra, March g, 1734, and died at Madrid on March 12, 1787. His translations from Sophocles and Voltaire and his affection for the traditional Spanish stage indicate a breadth of interest which sometimes confused his critical judgment; *e.g.,* in his eccentric collection *Teatro Hespañol* (1785–86). As a polemist, defending Spanish literature, he was inefficient, but as a poet he had lyrical moments which are unjustly forgotten.

(I. L. Mc C.)

GARCÍA LORCA, FEDERICO: *see* LORCA, FEDERICO GARCÍA.

GARD, a department in the south of France, part of the old province of Languedoc. Pop. (1954) 396,742. Area 2,271 sq.mi. It is bounded N. by the departments of Lozbre and Ardbche, E. by the Rhône, which separates it from Vaucluse and Bouches-du-Rhône, S. by the Mediterranean, S.W. by Hérault and W. by Aveyron. Gard is divided into three sharply-defined regions. The tree-clad Cévennes, with their deep and fruitful valleys, occupy the northwest, reaching a height of 5,120 ft. on the frontier of Lozbre. The Garrigues, a dry, hilly limestone region stretches south from the Cévennes over about half the department, and grows cereals, grapes and olives. The southern coastal plain is unhealthful because it has numerous lagoons and marshes, but it comprises the best arable land and vineyards in Gard.

Besides the Rhône and the Ardkche, the principal rivers are the Ckze. Gard, Vidourle and Hérault. They all rise in the Cévennes, and the Ckze and the Gard feed the Rhône, the lower Vidourle forming the southwest boundary of the department. The Hérault rises, and flows for a short part of its course, in the west of Gard. The upper course of the river Gard is in mountain gorges, and melting snows often cause disastrous floods. Near Remoulins it is crossed by a celebrated Roman aqueduct — the Pont du Gard. The canal de Beaucaire extends from the Rhône at Beaucaire to Aigues-Mortes. which communicates with the Mediterranean at Grau-du-Roi by means of the Grand-Roubine canal.

The climate is narm in the southeast. colder in the northwest; it is rather changeable, and rain storms are common. The cold and violent northwest wind known as the mistral is its worst drawback. Les Fumades (near Allkgre) and Euzet have mineral springs. The chief grain crops are wheat and oats. Rye, barley and potatoes are also grown. Gard is famed for its cattle. its breed of small horses and its sheep, which yield very fine wool. In the rearing of silkworms it ranks first among French departments. The principal fruit trees are olive, mulberry and chestnut. The vine is extensively cultivated and yields excellent red and white wines. The department is rich in minerals namely coal, iron, lime, lignite, asphalt. zinc, lead and copper, for the most part situated in the neighbourhoods of Alès and La Grand' Combe and Le Vigan. Much salt is obtained from the coastal marshes. The fisheries are productive. Manufactures include silk, of which Alès is the chief centre, cotton and woolen fabrics, hosiery, carpets, ironware, hats (Anduze), gloves, paper, leather, earthenware and glass. There are important metallurgical works, the chief of which are those of Besskges. The exports of Gard include coal, lignite, coke, asphalt, building stone, iron, steel. silk. hosiery, mine, olives. grapes and truffles.

The department is served by the P.L.M. railway. It is divided into the three arrondissements of Nîmes, Alks and Le Vigan, with 40 cantons and 353 communes. The chief town is Nimes, the seat of a bishopric of the province of Avignon and of a court of appeal. Gard belongs to the 15th military region (Marseilles), and to the académie (educational division) of Montpellier. Nîmes, Alks, Uzès, Aigues-Mortes, Beaucaire, Saint-Gilles, Bessèges, La Grand' Combe and Villeneuve-lès-Avignon are the principal towns. Opposite the manufacturing town of Pont-St.-Esprit the Rhône is crossed by a fine medieval bridge more than 1,000 yd. long built by the Pontiff brethren. Le Vigan, an ancient town with several old houses, carries on silk spinning.

GARDA, LAKE OF, Italy, the most easterly and the most extensive of the Lombard lakes (the *Lacus Benacus* of the Romans), surpassed in the Alpine region only by those of Geneva and Constance. The lake is now divided between the provinces of Verona, Brescia and Trento. Its broad basin orographically represents the southern portion of the valley of the Adige, though that river now flows through a narrow trench which is separated from the lake by the long narrow ridge of the Monte Baldo (7,277 ft.). The lake is fed by the Sarca at its north end, while at the southern extremity of the lake the Mincio flows out, on its way to join the Po. The area is 143 sq.mi., length $32\frac{1}{4}$ mi., greatest breadth about 10 mi., height of surface above sea-level 213 ft. and the greatest depth 1,135 ft. Its upper northern end is narrow, but between Garda (east) and Salo (west) the lake expands gradually into a nearly circular basin. Because of this conformation the lake is much exposed to sudden and violent winds. The steep grey limestone crags of Monte Baldo, on the eastern side of the lake, contrast strongly with the rich vegetation on the western and southern shores. The portion of the western shore that extends from Gargnano to Salo is the most sheltered and warmest part of the region, so that not merely does it resemble one continuous garden (producing lemons, figs, mulberries and olives) but is frequented in winter. The lovely promontory of Sermione (anc. Sirmio) at the southern end of the lake, has also an extremely luxuriant vegetation. It was a favourite residence of Catullus; but the large ruins of a Roman villa on the promontory belong to the imperial period, while there are also remains of the Lombard period, and a fine castle of the Scaligers.

At the south end of the lake are the towns of Peschiera ($14\frac{1}{4}$ mi. by rail from Verona on the east) and of Desenzano ($17\frac{1}{2}$ mi. by rail from Brescia on the west), which are $8\frac{3}{4}$ mi. distant from each other. There is a regular steamer service from these two towns. On the west shore of the lake are Salò, Maderno, Toscolano (a place important in the early history of the printing press), Gargnano and Limone, while the rugged east shore can boast only of Bardolino and Garda. At the northern end of the lake is Riva.

GARDELEGEN, a town in the district of Magdeburg, Germany, on the main Berlin-Hanover railway. Pop. (1950) 13,385. Gardelegen was founded in the 10th century, and on the neighbouring heath Margrave Louis I of Brandenburg gained, in 1343, a victory over Otto of Brunswick. It has a Romanesque church, and a hospital founded in 1285. There are considerable manufactures, notably agricultural machinery and buttons, and its beer has a great repute.

GARDEN, MARY (1877–), U.S. operatic singer, was born at Aberdeen, Scot., on Feb. 20, 1877. At the age of six she was taken to the United States. In 1888 her family settled in Chicago, where her early musical training was received. She went to Paris in 1896, and studied under Trabadello, Chevallier and Fougère. She made her debut at the Opéra Comique, Paris, April 3, 1900, in the title rôle of *Louise.*

Miss Garden's first appearance in the United States was in New York city in the title role of *Thais,* Nov. 25, 1907. In 1910 she became a member of the Chicago Civic Opera company, assuming, among others, the parts of Salomé, Thai's, Mélisande and Louise. She was general director of the Chicago Opera Association in 1921–22. In 1927 she sang in *Pelléas et Mélisande* in Geneva, Switzerland; also in Paris in the opera *Resurrection.*

She retired in 1934.

GARDEN: *see* HORTICULTURE; LANDSCAPE ARCHITECTURE.

GARDENA, a city of California, U.S., on the southern plain of Los Angeles county, 9 mi. S. of Los Angeles. Founded in 1883 as a farming community, it was known as a garden spot in a semi-arid region. Its growth was very slow for more than 25 years. In 1909, the town moved farther west to avoid being included in the "shoestring strip" connecting Los Angeles with San Pedro harbour. It was incorporated in 1930 with less than 3,000 residents.

Following World War II, Gardena changed rapidly into a commercial and residential city. Its citizens include a broad cross section of economic, cultural and religious groups. Manufacturing and oil production in neighbouring areas provide the principal means of employment. Local schools have been a part of the Los Angeles school district since 1907.

For comparative population figures *see* table in CALIFORNIA: *Population.* (R. C. GM.)

GARDEN CITIES. This term, first used in 1869 by A. T. Stewart in connection with the development of an estate on Long Island, N.Y., was adopted by Ebenezer Howard in writing *To-morrow: A Peaceful Path to Real Reform* (London, 1898), in which he outlined a scheme for building a new model town to be called "Garden City." Apart from the name and the fact that Howard's proposal included the idea of houses with gardens in a planned area there was nothing in common between Stewart's scheme and his. In fact Howard owed much to Edward Gibbon Wakefield's A *View of the Art of Colonization* (London, 1849). The publication of Howard's book led to the formation of the Garden Cities association in 1899 and to the establishment of Letchworth, the first garden city, in 1903, and Welwyn, the second, in 1920. The main features of Howard's scheme were (1) purchase of a large area of agricultural land within a ring fence; (2) planning of a compact town surrounded by a wide rural belt; (3) accommodation of residents, industry and agriculture; (4) limitation of the extent of the town and prevention of encroachment upon the rural belt; (5) the rise in land values to be secured for the town itself.

Howard based his scheme upon the urgent need for remedying the congestion of towns and the depopulation of the countryside. He suggested that, since towns grew because people were attracted to them from country districts which they did not like, the country must be made attractive by establishing there the qualities of town life. The new town could be limited in extent because it is possible, he considered, to get everything that is required in a town of about 30,000, while a group of such towns would between them provide all the advantages of a big city; and because the inhabitants of the rural belt would be kept in close touch with town life and rural interests would form part of the town's economy. Such towns scattered over the country would, he believed, check rural depopulation and the overgrowth of the great towns.

The garden city was to be created by a private corporation and would raise money on loan, lay out the town, construct the roads, drainage, public services, etc., and let the land on revisable leases, rents increasing with the growth of population. How-ard showed that reasonable rents would be amply sufficient to pay a return on the expenditure, leaving a considerable surplus. The rents, moreover, were to be "rate-rents," that is to sap they were to include such charges on property as were normally required to meet the expenditure of the local authority. Howard contended that his scheme was practicable for two main reasons: (1) if land were purchased at agricultural value and a large population brought to it, the increment in land value would be sufficient to provide a substantial economic foundation; (2) as manufacturers were establishing works on the outskirts of towns and in country villages because they found the costs and conditions of working in the cities too onerous, a concerted movement of industry could be organized from the over-burdened cities to the garden cities.

Howard's proposals attracted many people interested in the question of industrial housing: in the garden cities good houses could be cheaply provided ior the working classes. When Howard put forward his scheme there was no public interest in England in town planning, but the advantages of planning a town before building it were appreciated and gave additional point to his contentions. The housing and town-planning movements of the 20th century were thus profoundly influenced by the garden city movement, but the specific proposals for garden cities and the general ideas on which they were based were by no means expressed in the housing and town-planning activities that reached their heights in England in the years immediately after World War I. In particular the development of "garden suburbs" was contrary to Howard's idea, which was concerned with a town as a whole.

Letchworth.—In 1903 the first garden city was established on Howard's plan. An area of 3,822 ac. (afterward increased to 4,552) was purchased, 35 mi. from London and within $2\frac{1}{2}$ mi. of the old market town of Hitchin in Hertfordshire. A joint stock company, First Garden City Ltd., was formed to carry out the enterprise, with an authorized capital of £300,000, the dividend limited to 5% per annum. A plan was prepared for a town of 32,000 inhabitants (afterward increased to 35,000), with areas for houses, schools, etc., shops and factories and a rural belt. Development started in 1904. The company constructed the roads, drainage system, water, gas and electricity supplies. By 1951 the town had a population of 20,322, occupied with engineering, corset making, printing and bookbinding. Industrial growth continued. London county council proposed building houses ior London's overspill, which would virtually complete the scheme. In 1956 the company surrendered the limited-dividend principle.

Welwyn Garden City.—The second garden city was started in

1920 by a joint stock company (an authorized share capital £250,000, dividends not to exceed 7%). Welwyn, 20 mi. from London, north of Hatfield, consisted of 2,383 ac. (afterward increased to 5,071), on which a town of 50,000 with a rural belt was planned. The estate purchased was completely rural, and the company constructed roads, drainage, water, electricity and other supplies. By 1951 the town had a population of 18,314 with engineering, breakfast food and radio iactories, printing and other industries.

Although the Welwyn scheme at its inception aroused great interest the company experienced difficulties owing to shortness of capital and underwent two financial reconstructions, at the end oi which it abandoned the limited-dividend principle. The scheme made slower progress than was expected; but it demonstrated the economic advantages of a town site held in a single hand. The features of Welwyn are its consistent architectural development, site planning, public gardens, and large central departmental stores owned by the company, with other individual shops. As at Letchworth, land was let on building lease (but for 999 years).

Planning After World War 11.—World War II had a very adverse effect on the two garden cities: virtually no houses, factories or other buildings could be erected except for war purposes; both towns became overcrowded as evacuation areas; and there was some change in industry and population. Furthermore, the effect of the Town and Country Planning act, 1947, was to remove for nearly five years the economic basis upon which the garden cities were established, for the unearned increment (or improved value) of land was appropriated by the state in "development charges" (abolished in Nov. 1952). Moreover, although Sir Patrick Abercrombie's *Greater London Plan* (1944) showed the value of the two garden cities' contribution, the minister of town and country planning reduced the ultimate population of Letchworth to 32,000 and that of Welwyn Garden City to 36,500.

Under the New Towns act, 1946, however, Welwyn Garden City was expropriated, its building and development organization scrapped and the completion of the town entrusted to a new development corporation financed by the British treasury. The Garden City company was thus forced into liquidation. But even though the basis of compensation did not permit recognition of the full value of the property, total compensation of £3,550,000 in cash was paid for the land and building expropriated, a sum far in excess oi all that the company had spent. If the town had been completed as projected so that the economic results could have been fully realized and preserved for the town, Howard's idea of rate-rents might well have been proved right, at least in part. At Letchworth the minister was content to lay down conditions for development and to put a representative on the board of directors; otherwise the company was allowed to continue, but as mentioned above it has departed from its basic principle.

Letchworth and Welwyn Garden City were the only garden cities in Great Britain, or indeed in the world, but now exist as such only in name. While the new towns sponsored by the British government, as well as building development schemes in the U.S. and on the continent of Europe, borrowed certain characteristic and important features of the garden city idea, their economic structure was not the same, and in particular the principle of the rural belt as an integral part of town structure was not observed.

BIBLIOGRAPHY.—Ebenezer Howard, *Garden Cities of Tomorrow* (1902); Sir Patrick Abercrombie, *Greater London Plan* (1944); C. B. Purdom, *The Building of Satellite Towns,* rev. ed., (1949). (C. B. P.)

United States.—In the U.S., there was a long tradition in the development of industrial communities by private corporations, sometimes well-planned but more often lacking in spaciousness or attractiveness. The stigma of the "company town" frequently detracted from those which were built to high standards of design and construction, and no attempt was made in the early years of the 20th century to follow the conception of the garden city developed in the writings of Ebenezer Howard. Among better examples of well-planned industrial communities were Chicopee, Ga.; Kingsport, Tenn.; Kohler, Wis.; and Longview, Wash.

Planning of new communities in the United States along lines similar to those of the English garden cities of Letchworth and Welwyn came during World War I. New housing communities were designed for the United States Shipping board by teams of town planners, architects and engineers, some of the best of them having many oi the features of the English garden city. The plans for these-communities were also influenced by the examples of Forest Hills Gardens, N.Y., planned in 1911 by Frederick Law Olmsted, Jr., in collaboration with Grosvenor Atterbury as architect, and of Kingsport, Tenn., designed by John Nolen in 1915.

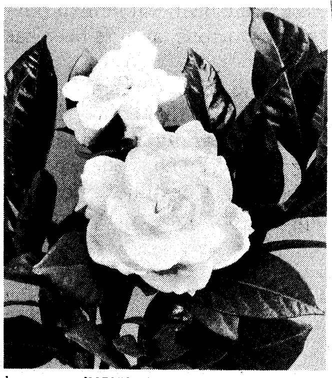
However, the nearest approach to the development in the United States of garden cities which followed the principles laid down by Ebenezer Howard was exemplified by Radburn, N.J.—the "Town for the Motor Age," designed by Clarence Stein and Henry Wright ior the City Housing corporation in 1928—and the various Greenbelt towns built by the Suburban Resettlement Division of the U.S. Resettlement administration during the late 1930s. While these communities had many of the features of the garden city such as comprehensive planning, low residential densities and controls over the extent and type of future development, none was self-sufficient industrially or was surrounded by a permanent belt of rural land. While the Greenbelt towns were originally owned by the federal government, they were later sold in whole or in part to private individuals or co-operatives.

During World War II a number of new communities were built by agencies of the federal government, such as Oak Ridge, Tenn., constructed by the Atomic Energy commission. The privately sponsored "new town" of Park Forest, Ill., in suburban Chicago, designed by Elbert Peets for American Community Builders, Inc.. was an excellent example of a well-planned residential community. It lacked diversity in its social structure and was dependent on the larger city ior its economic base, but it provided a low density residential development surrounded largely by publicly owned reservations giving the community many of the advantages of the English garden city. Another postwar example of a large-scale residential community which was planned and completed in its entirety by private interests was Levittown, Pa. It mas developed primarily to serve the needs of employees of a new steel plant built at a considerable distance from established population centres. (F. J. A.)

GARDEN CITY, a village of Nassau county, on west Long Island, 18 mi. E. of New York city, in southeastern New York, U.S., is one of the few communities in the United States that was planned as a model town from its beginning. In 1869 Alexander T. Stewart, one of New York's leading merchants, bought a tract of over 7,000 ac. of the Hempstead plain with the idea of creating a "garden city," a term adopted later by the pioneer English city planner Sir Ebenezer Howard. (See GARDEN CITIES) Stewart envisioned parks and tree-lined avenues not less than 80 ft. wide. His heirs founded The Garden City company, which guided the affairs of the community until its incorporation as an independent village in 1919.

Garden City is distinguished for its handsome residential areas and for the beautiful Cathedral of the Incarnation, the see of the Episcopal diocese of Long Island. Industries include publishing and printing. Points of interest are Adelphi college, founded in Brooklyn in 1896 (moved to Garden City in 1929) as the first degree-granting liberal arts college on Long Island, and Roosevelt field, named for Theodore Roosevelt's son Quentin, a World War I aviator, and noted as the airport where Charles A. Lindbergh began his transatlantic flight in 1927. (The field was closed to flying in 1951 and became the site of a large shopping centre, dedicated as the Roosevelt Field Development International Flight mall in 1956.) For comparative population figures see table in NEW YORK: Population. (WI. M. D.)

GARDENIA, a genus of evergreen shrubs and trees of the madder family (Rubiaceae; *q.v.*), containing about 60 species, natives of subtropical parts of the old world. Several are grown in greenhouses for their handsome, sweet-scented white flowers, which are developed singly at the end of a branch or in the leaf axils and are funnel- or salver-shaped, with a long tube.



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GARDENIA (G JASMINOIDES)

The double forms of Gardenia *jasminoides* (China), the Cape jasmine, or gardenia of the florists are among the most beautiful and highly perfumed of any in cultivation. Gardenias are readily propagated by cuttings.

The outdoor culture of a more hardy form than the gardenia of the florists is common in the warmer parts of the United States. The shrub, usually called *Gardenia* jasminoides fortuniana (or G. veitchii), is 6–8 ft. high and produces its very fragrant white flowers in midsummer.

This particular gardenia mill not stand severe frosts and requires a rich, acid soil. No other plant of outdoor culture is so spicily fragrant.

A form of it, known as G. radicans, is perhaps only a low, more or less prostrate variety of the Cape jasmine and is widely grown along the Gulf coast and in California. (N. TR.)

GARDENING: see HORTICULTURE.

GARDINER, SAMUEL RAWSON (1829–1902), English historian, son of Rawson Boddam Gardiner, was born near Alresford, Hants. He was educated at Winchester and Christ Church, Oxford, where he took a first class in *literae humaniores,* and became a fellow of All Souls (1884) and Merton (1892). For some years he was professor of modern history at King's college, London. Gardiner, who was himself a descendant of Cromwell and Ireton, is the historian of the Puritan revolution, and has written its history in a *History of England from the Accession of James I to the Outbreak of the Civil War, 1603–1642*, 10 vol. (1863–82); *History of the Great Civil War, 1642–1649*, 4 vol. (1886); and *History of the Commonwealth and Protectorate, 1649–1660*, 3 vol. (1894–1903). His researches in public and private collections of manuscripts at home, and in the archives of Simancas, Venice, Rome, Brussels and Paris, were indefatigable. In his judgments of men and their actions he is unbiassed, and his appreciations of character exhibit a remarkable fineness of perception and a broad sympathy. Throughout his work he gives a prominent place to everything which illustrates human progress in moral and religious as well as political conceptions, and specially to the rise and development of the idea of religious toleration, finding his authorities not only in the words and actions of men of mark, but in the writings of obscure pamphleteers, whose essays indicate currents in the tide of public opinion.

Gardiner's style is clear and unadorned; he appeals constantly to the intellect rather than to the emotions, and is seldom picturesque, though in describing a few famous scenes, such as the execution of Charles I., he writes with pathos and dignity. Among the most noteworthy of his separate works are: *Prince Charles and the Spanish Marriage* (2 vols., 1869); *Outline of English History* (1st. ed. 1887, later ed. 1919); *Constitutional Documents of the Puritan Revolution, 1625–1660* (1st ed., 1889; 3rd ed., 1906); *Student's History of England* (2 vols., 1st ed. 1890–91; later ed. 1920); *What Gunpowder Plot Was* (1897); *Oliver Cromwell* (1901). He edited collections of papers for the Camden Society, and from 1891 was editor of the *English Historical Review.*

See H. B. Learned, *Samuel Rawson Gardiner* (1902); R. G. Usher, "Critical study of the historical method of S. R. Gardiner," in *Washington University Studies,* vol. iii., part ii., no. i. (1915).

GARDINER, STEPHEN (1493?–1555), English bishop and lord chancellor, was born at Bury St. Edmunds, the son of a cloth merchant. He was educated at Trinity Hall, Cambridge, and became doctor of civil law in 1520, and of canon law in the following year. About 1525 he was made secretary to Cardinal Wolsey whom he accompanied on his important diplomatic mission to France in 1527. Next year Gardiner was sent by Wolsey to Italy with Edward Fox, provost of King's college, Cambridge, to promote the business of Henry's divorce from Catherine of Aragon. Though he failed to procure the desired decretal commission, Gardiner by his great intrepidity, won from Clement his consent to a general commission for Campeggio and Wolsey to try the cause in England. This, as Wolsey saw, was quite inadequate and he again instructed Gardiner to press the pope to send the desired decretal on, even if the latter was only to be shown to the king and himself and then destroyed. At last the pope gave what was desired on the express conditions that Campeggio was to show it to the king and Wolsey and no one else, and then destroy it, the two legates holding their court under the general commission. In 1529 Gardiner was sent again to Italy, but this time the pope would make no further concessions, or promise not to revoke the cause to Rome.

Gardiner's services, however, were fully appreciated. He was appointed the king's secretary. He had been already some years archdeacon of Taunton, and the archdeaconry of Norfolk was added to it in March 1529, which two years later he resigned for that of Leicester. In 1530 he was sent to Cambridge to procure the decision of the university as to the unlawfulness of marriage with a deceased brother's wife, in accordance with the new plan for settling the question without the pope's intervention. In this he succeeded, though not without a good deal of artifice. In Nov. 1531 the king rewarded him with the bishopric of Winchester, vacant by Wolsey's death. In 1532, nevertheless, he displeased the king by the part he took in the preparation of the famous "Answer of the Ordinaries" to the complaints brought against them in the House of Commons.

His next important action was not so creditable; for he was "assistant" to Cranmer as counsel for the king, when the archbishop, in the absence of Catherine, pronounced her marriage with Henry null and void on May 23, 1533. Immediately afterwards he was sent to Marseilles, where an interview between the pope and Francis I. took place in September, of which event Henry stood in great suspicion, as Francis had hitherto maintained the justice of his cause. At this interview Bonner intimated the appeal of Henry VIII. to a general council in case the pope should proceed to sentence against him. This appeal, and also one on behalf of Cranmer presented with it, were drawn up by Gardiner. In 1535 he and other bishops were called upon to vindicate the king's new title of "Supreme Head of the Church of England." The result was his celebrated *De vera obedientia,* the ablest of all the vindications of royal supremacy, reprinted in 1537 by the Swiss reformers. In the same year he had a dispute with Cranmer about the visitation of his diocese. He was also employed to answer the pope's brief threatening to deprive Henry of his kingdom. During the next few years he was engaged in various embassies in France and Germany until 1538 when, owing to Cromwell's mistrust, he was replaced as ambassador in Paris by Bonner. In 1539 he took part in the enactment of the severe statute of the Six Articles, which led to the resignation of bishops Latimer and Shaxton and the persecution of the Protestant party. In 1540, on the death of Cromwell he was elected chancellor of the University of Cambridge. A few years later he attempted to fasten a charge of heresy upon Archbishop Cranmer in connection with the Act of the Six Articles; and but for the intervention of the king would probably have succeeded. Though he had supported the royal supremacy, Gardiner objected to the religious doctrines of the Reformation. He had to contend with frequent storms of royal indignation; but the king had need of him quite as much as he had of Cranmer; for Gardiner, even under royal supremacy, was anxious to prove that England had not fallen away from the faith, while Cranmer's authority as primate was necessary to upholding that supremacy. Thus Gardiner and the archbishop maintained opposite sides of the king's church policy; and though Gardiner was encouraged by the king to put up articles against the archbishop for heresy, the archbishop could always rely on the king's protection.

Under Eduard VI. Gardiner was completely opposed to the policy of the dominant party both in ecclesiastical and in civil matters. The religious changes he objected to both on principle and on the ground of their being moved during the king's minority, and he resisted Cranmer's project of a general visitation. His remonstrances, however, were met by his committal to the Fleet, and the visitation of his diocese was held during his imprisonment. Though soon released, it was not long before he was called before the council, and, refusing to give them satisfaction, was thrown into the Tower, where he remained for over five years. His bishopric was given to Poynet, a chaplain of Cranmer's and bishop of Rochester. On Mary's accession, Gardiner was restored to his bishopric, and as lord chancellor, set the crown on the queen's head at her coronation. He also opened her first parliament and for some time was her leading councillor.

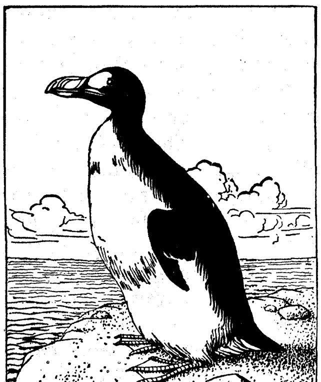
He was now called upon, in advanced life, to undo not a little of his early work—to vindicate the legitimacy of the queen's birth and the lawfulness of her mother's marriage, to restore the old religion, and to recant what he had written touching the royal supremacy. It is said that he wrote a formal retraction of his *De vera obedientia* which is no longer extant. As chancellor he negotiated the queen's marriage treaty with Philip, to which he shared the general repugnance, though he could not oppose her will. In executing it, however, he provided that the Spaniards should in nowise interfere in the government of the country. After the coming of Cardinal Pole, and the reconciliation of the realm to the see of Rome, he still remained in high favour. He no doubt approved of the act, which passed the House of Lords while he presided there as chancellor, for the revival of the heresy laws. Neither is there any doubt that he sat in judgment on Bishop Hooper, and on several other preachers whom he condemned to be degraded from the priesthood. But he endeavoured to save the lives of Cranmer and Northumberland, and much as he was maligned by opponents, there are strong evidences that his natural disposition was humane and generous. In May 1553 he went to Calais as one of the English commissioners to promote peace with France; but their efforts were ineffectual. In Oct. 1555 he again opened parliament as lord chancellor, but soon fell ill and died at Whitehall on Nov. 12. He was buried in Winchester cathedral.

Besides his conspicuous statesmanship and legal ability, Gardiner possessed a learning in divinity far from commonplace. His part in the drawing up of doctrinal formularies in Henry VIII.'s time is not clear; but at a later date he wrote tracts in defence of the Real Presence against Cranmer, some of which, being written in prison, were published abroad under a feigned name. Controversial writings also passed between him and Bucer, with whom he had several interviews in Germany. when he was there as Henry VIII.'s ambassador. A friend of learning he took great interest in promoting the study of Greek at Cambridge. He was, however, opposed to the new method of pronouncing the language introduced by Sir John Cheke, and wrote letters to him and Sir Thomas Smith upon the subject, in which, according to Ascham, his opponents showed themselves the better critics, but he the superior genius. His house was spoken of by Leland as the seat of eloquence and the special abode of the muses.

GARDNER, PERCY (1846–1937), English classical archaeologist, was born in London, and was educated at the City of London school and Christ's college, Cambridge (fellow, 1872). He was Disney professor of archaeology at Cambridge (1880–87), and professor of classicdl archaeology at Oxford (1887–1925). Gardner was a fellow of the British Academy and of other learned societies in many foreign countries. Among his works are: *Types of Greek Coins* (1883); *A Numismatic Commentary on Pausanias* (with F. Imhoof-Blumer, 1887); *New Chapters in Greek History* (1892), an account of excavations in Greece and Asia Minor; *Manual of Greek Antiquities* (with F. B. Jevons, 2nd ed. 1898); *Grammar of Greek Art* (1905); *Principles of Greek Art* (1913); *New Chapters in Greek Art* (1926); and a number of works on theological and ecclesiastical subjects.

His brother, ERNEST ARTHUR GARDNER (1862–1939), educated at the City of London school and Caius college, Cambridge (fellow, 1885), was director (1887–95) of the British School at Athens, and later became professor of archaeology at University college, London, and dean of the university. His publications include: *Introduction to Greek Epigraphy* (1887); *Catalogue of the Vases in the Fitzwilliam Museum, Cambridge* (1897); *Ancient Athens* (1902); *Handbook of Greek Sculpture* (1905); new and enlarged ed. (1915); *The Art of Greece* (1925), etc.

GARDNER, a city among the hills of northern Worcester county in north-central Massachusetts, U.S., 59 mi. N.W. of Boston, was organized as a town on June 27, 1785, on the petition of John Glazer of Westminster and was incorporated as a city on March 15, 1921. It was named after Col. Thomas Gardner, who was killed in the battle of Bunker Hill. Gardner has been called the chair city of the world; the first chair factory was started there by James M. Comee in 1805. Major products include baby carriages and walkers, fabricated structural products, furniture, office machinery, sporting and athletic goods, and toys. A wooden chair near the Boston and Maine railroad station is a landmark that is reputed to be the largest chair ever constructed. For comparative population figures *see* table in MASSACHUSETTS: *Population.* (J. F. Z.)



GREAT AUK (PINGUINUS IMPENNIS), KNOWN ALSO IN THE HEBRIDES, WHICH IT FREQUENTED, AS THE GAREFOWL

GAREFOWL, also known as great auk (*Pinguinus impennis*), a large flightless sea bird, now extinct. Slightly smaller than a tame goose, it resembled its relative the razorbill (*Alca torda*) in appearance, but a large patch of white occupied nearly all the space between the bill and the eye, while the bill itself bore eight or more transverse grooves. Because of the small size of the wings the bird was unable to fly. The great auk was 30 in. long, with a wing less than 6 in.; the razor-billed auk (*q.v*), 17 in. long, has an 8-in. wing. It bred at St. Kilda, the Faeroes, Iceland and Funk Island off Newfoundland, where the French fishermen used both the bird and its eggs for food. Enormous numbers were killed, the birds being driven up a plank into the hold of the vessel (*see* Ritchie, *Animal Life in Scotland*). It became extinct about 1844, when the last pair, with an egg, was killed at Eldey, Iceland, in June. The egg resembled that of the razorbill in shape and colour, but was larger, measuring nearly 5 by 3 in. (*See* AUKS.) (G. F. Ss.)

GARFIELD, JAMES ABRAM (1831–1881), 20th president of the United States, was born on Nov. 19, 1831, in a log cabin in the little frontier town of Orange, Cuyahoga county, Ohio. His early years were spent in the performance of such labour as fell to the lot of every farmer's son in the new states, and in the acquisition of such education as could be had in the district schools held for a few weeks each winter. But life on a farm was not to his liking, and at 16 he left home and tramping across the country to Cleveland, Ohio, sought employment from the captain of a lake schooner. But the captain drove him from the deck, and, wandering on in search of work, he fell in with a canal boatman who engaged him. During some months young Garfield served as bowsman, deck-hand and driver of a canal boat. An attack of the ague sent him home, and on recovery, having resolved to attend a high school and fit himself to become a teacher, he passed the next four years in a hard struggle with poverty and in an earnest effort to acquire an education; worked as a teacher, a carpenter and a farmer; studied for a time at the Western Reserve Eclectic Institute at Hiram, Ohio, and finally entered Williams College. On graduation, in 1856, Garfield became professor of ancient languages and literature in the Eclectic Institute at Hiram, and within a year rose to be its principal.

Soon afterwards he entered political life. In the early days of the Republican party, when the shameful scenes of the Kansas struggle were exciting the whole country, and during the campaigns of 1857 and 1858, he became known as an effective speaker and ardent anti-slavery man. His reward for his services was election in 1859 to the Ohio senate as the member from Portage and Summit counties. When the "cotton States" seceded, Garfield appeared as a warm supporter of vigorous measures, and when the call came for 75,000 troops, at once offered his services to the governor, and became lieutenant-colonel and then colonel of the 42nd Ohio Volunteers, recruited largely from among his former students He served in Kentucky, was promoted to the rank of brigadier-general of volunteers early in 1862; took part in the second day's fighting at the battle of Shiloh, served as chief of staff under Rosecrans in the Army of the Cumberland in 1863, fought at Chickamauga, and was made a major-general of volunteers for gallantry in that battle. In 1862 he was elected a member of Congress from the Ashtabula district of Ohio, and, resigning his military commission, took his seat in the House of Representatives in Dec. 1863. In Congress he 'joined the radical wing of the Republican party, advocated the confiscation of Confederate property, approved and defended the Wade-Davis manifesto, and was soon recognized as a hard worker and ready speaker. Capacity for work brought him places on important committees and his ability as a speaker enabled him to achieve distinction on the floor of the House and to rise to leadership. The year 1874 was one of disaster to the Republican party. The greenback issue, the troubles growing out of reconstruction in the South, the Crédit Mobilier and the "Salary Grab," disgusted thousands of independent voters and sent a wave of democracy over the country. Garfield himself was accused of corruption in connection with the Crédit Mobilier scandal, but the charge was never proved. A Republican convention in his district demanded his resignation, and re-election seemed impossible; but he defended himself in two pamphlets, "Increase of Salaries" and "Review of the Transactions of the Crédit Mobilier Company," made a village-to-village canvass, and was victorious. In 1876 Garfield for the eighth time was chosen to represent his district; and afterwards as one of the two representatives of the Republicans in the House, he was a member of the Electoral Commission which decided the dispute regarding the presidential election of 1876. When, in 1877, James G. Blaine was made a senator from Maine, the leadership of the House of Representatives passed to Garfield. and he became the Republican candidate for speaker. But the Democrats had a majority in the House, and he was defeated. Hayes, the new president, having chosen John Sherman to be his secretary of the treasury, an effort was made to send Garfield to the United States Senate in Sherman's place. But the President needed his services in the House, and he was not elected to the Senate until 1880.

The time had now come (1880) when the Republican party must nominate a candidate for the presidency. Gen. U. S. Grant had served two terms (1869–77) and the unwritten law of custom condemned his being given another. But the "bosses" of the Republican party in three great states — New York, Pennsylvania and Illinois — were determined that he should be renominated. These men and their followers were known as the "stalwarts." Opposed to them were two other factions, one supporting James G. Blaine, of Maine, and the other John Sherman, of Ohio. When the convention met and the balloting began, the contest along these factional lines started in earnest. For 28 ballots no change of any consequence was noticeable. Though votes were often cast for ten names, there were but two real candidates before the convention, Grant and Blaine. That the partisans of neither would yield in favour of the other was certain. That the choice therefore rested with the supporters of the minor candidates was manifest, and with the cry "Anything to beat Grant!" an effort was made to find some man on whom the opposition could unite. Such a man was Garfield. His long term of service in the House, his leadership of his party on its floor, his candidacy for the speakership and his recent election to the United States Senate marked him as the available man. Between the casting of the 1st and the 33rd ballot, Garfield, who was the leader of Sherman's adherents in the convention, had sometimes received one or two votes and at other times none. On the 34th he received 17, on the next 50 and on the next almost the entire vote hitherto cast for Blaine and Sherman, and was declared nominated. During the campaign Garfield was subject to violent personal abuse; the fact that he was alleged to have received $329 from the Crédit Mobilier as a dividend on stock led his opponents to raise the campaign cry of "329," and this number was placarded in the streets of the cities and printed in flaring type in partisan newspapers. The forged "Morey letter," in which he was made to appear as opposed to the exclusion of the Chinese, was widely circulated and injured his candidacy in the west. That the charges against Garfield were not generally credited, however, is shown by the fact that he received 214 electoral votes to his opponent's 155. He was inaugurated on March 4, 1881.

On July 2, while on his way to attend the commencement exercises at Williams college, Williamstown, Mass., the new president was shot in a Washington railway station by a disappointed office seeker named Charles J. Guiteau, and on Sept. 19, 1881, he died at Elberon, N.J., where he had been moved on Sept. 6. He was buried in Cleveland, O., where in 1890 a monument was erected by popular subscription to his memory.

President Garfield's writings, edited by Burke A. Hinsdale, were published in 1882. *See* also Theodore Clarke Smith, *The Life* and *Letters* of *James A. Garfield (1925).*

GARFIELD, a city of Bergen county, in northeastern New Jersey, U.S., at the juncture of the Passaic and Saddle rivers, is 12 mi. W. of New York city and 10 mi. N.W. of Newark. Founded in 1679 by the Dutch after purchase of the land from the Hackensack clan of the Delaware tribe of the Algonkin Indians of the Lenni Lenape nation, the city was originally known as Cadmus Melon Patch and later as East Passaic. It was renamed Garfield in 1881 after Pres. James Garfield and incorporated as a borough in 1898 and as a city in 1917. Garfield is an industrial city, whose chief industries include the manufacture of textiles, chemicals, aircraft parts, nonferrous metals, paperboard, machinery and rubber products. For comparative population figures see table in NEW JERSEY: Population. (D. N. A.; M. P. M.)

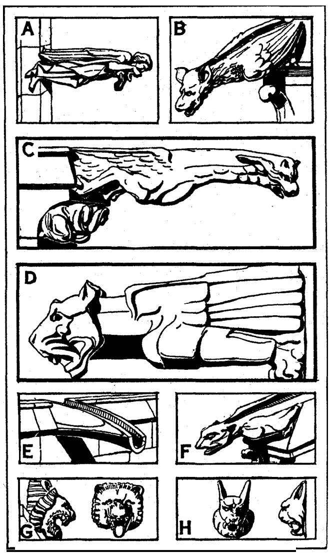
GARFIELD HEIGHTS, a suburban city of Cuyahoga county, in northern Ohio, U.S., is immediately southeast of Cleveland. Named for Pres. James Garfield, whose parents had once lived nearby, Garfield Heights did not receive village status until 1919. The area was part of the original township of Newburgh, organized in 1814, and underwent a gradual process of contraction as sections were annexed to Cleveland. The village of South Newburgh uas established in 1904 and 15 years later became Garfield Heights. By 1932 the village qualified for designation as a city. In a rapidly expanding residential area, the city encouraged limited industrial activity, including the manufacture of women's apparel, tools and dies, abrasives and metal products.

After World War II, Garfield Heights experienced a sharp increase in population; for comparative population figures see table in OHIO: Population. (W. G. K.)

GARFISH, a family of fishes (Belonidae) found in most temperate and tropical seas, also called needlefish, and recognized by their long, slender, compressed and silvery bodies, and by their jaws being produced into long, pointed, bony and sharply toothed beaks. About 50 species are known, some attaining a length of four or five feet. One species is common on the British coasts, and is well known by the name of "long-nose." The green bones deter many people from eating this wholesome food.

The skipper (Scomberesox) and halfbeak (*Hemirhamphus*), in which the lower jaw only is prolonged, are akin to the garfishes.

GARGANEY, or SUMMER TEAL, *Anas* querquedula, is one of the smallest of the ducks and is a summer visitant to England, where it breeds in the east Norfolk Broads. Slightly larger than the common teal (A. crecca), the male has a nutmeg-brown beard and a uhite line behind the eyes. The female resembles the hen teal, but possesses no wing spot. In Ireland and Scotland the garganey is rare. It has not a high northern range, and its appearance in Norway and Sweden is casual. It is nowhere common in Europe, but ranges far to the eastward in Asia and yearly visits India in winter in enormous numbers. It nests very frequently in reed beds. It is related to the blue-winged teal or summer teal (A. discors) of Canada and the United States.



A, 8, C, E, F, FROM VIOLLET-LE-DUC; D, "THE AMERICAN ARCHITECT,,; G, FROM FLETCHER, "HISTORY OF ARCHITECTURE ON THE COMPARATIVE METHOD (BATSFORD)

GARGOYLES

Ancient: G, Greek, H, Roman; Gothic: E, French undecorated, C and F, Notre Dame, Paris (*c.* 1225), B, the Ste. Chapelle, Paris (*c.* 1250), A, st. Urbain, Troyes (*c.* 1290); Modern: D, Farmers Loan and Trust build'''', 'lew York city (Starrett and van Vleck, architects)

GARGANO, MONTE (anc. Garganus *Mons*), a massive mountainous peninsula projecting eastward from the north coast of Apulia, Italy, and belonging geologically to the opposite Dalmatian coast; it was indeed separated from the rest of Italy by an arm of the sea as late as the Tertiary period. It is of the same character as the Carso, being composed of fractured calcareous rock, and has numerous superficial and subterranean cavities. The highest point (Monte Calvo) is 3,465 ft. above sea level. The oak forests for which it was renowned in Roman times have entirely disappeared except in three sections, and have left the soil dry and stony. Monte Sant' Angelo (*q.v.*) is the principal town.

GARGOYLE, in architecture, a decorated waterspout. Although technically speaking the term applies to the carved lions of classic cornices, or to the terra-cotta spout, such as those found frequently in Pompeii, in general usage the word has become restricted to the grotesque, carved spouts of the middle ages, and is even, incorrectly, applied to other grotesque beasts, such as the *chimères* that decorate the parapets of Notre Dame at Paris. The gargoyle of the developed Gothic period is usually a grotesque bird or beast sitting on its haunches on the back of a cornice molding and, in order to throw the water far from the building, projecting for several feet.

GARHWAL is a mountainous district in the Kumaon division of Uttar Pradesh, India. Pop. (1951) 639,625; area 5,631 sq.mi. Administrative headquarters are at Pauri (pop., 1951, 5,250). The celebrated temple of Badrinath, set high among the mountains, is a favourite resort for pilgrims. The district consists almost entirely of rugged mountain ranges separated by narrow valleys which in some cases become deep gorges or ravines. The only level portion of the district is a narrow strip of waterless forest between the southern slopes of the hills and the fertile plains of Rohilkhand. The Alaknanda, the source of the Ganges, receives with its affluents the whole drainage of the district. At Devaprayag it unites with the Bhagirathi to become the Ganges. Cultivation is principally confined to the immediate vicinity of the rivers.

Main exports are grain and coarse cloth; imports are salt, borax, livestock and wool.

GARIBALDI, GIUSEPPE (1807–1882). Italian patriot, was born at Nice on July 4, 1807. He entered the Sardinian naw, and, with companions on board the frigate "Euridice," plotted to seize the vessel and occupy the arsenal of Genoa at the moment when Mazzini's Savoy expedition entered Piedmont. The plot being discovered, Garibaldi fled, but was condemned to death by default on June 3, 1834. Escaping to South America in 1836, he was given letters of marque by the state of Rio Grande do Sul, which had revolted against Brazil, and after a series of victorious engagements passed into the service of Uruguay. In Montevideo, he formed the Italian legion, with which he won the battles of Cerro and Sant' Antonio in 1846 and assured the freedom of Uruguay. He returned to Italy upon receiving news of the incipient revolutionary movement, and landing at Nice on June 24, 1848, placed his sword at the disposal of Charles Albert. He formed a volunteer army 3,000 strong, but shortly after the defeat of Custozza had to flee to Switzerland. Proceeding thence to Rome, he was entrusted by the Roman republic with the defense of San Pancrazio against the French. where he gained the victory of April 30, 1849. During May he dispersed the Bourbon troops at Palestrina, Velletri and elsewhere, and after the fall of Rome started on his wonderful retreat through central Italy pursued by the armies of France, Austria, Spain and Naples. He escaped to Ravenna, then to Piedmont and ultimately to America, from whence he returned to Italy in 1854 and purchased the island of Caprera. on which he built his home. On the outbreak of war in 1859 he was in command of the Alpine infantry, defeating the Austrians at Casale on May 8, crossing the Ticino on May 23, and, after a series of victorious fights: liberating Alpine territory as far as the frontier of Tirol.

Returning to Como to wed the Countess Raimondi, by whom he had been aided during the campaign, he was apprised, immediately after the wedding, of circumstances which caused him to abandon his wife and start for central Italy. Forbidden to invade the Romagna, he returned to Caprera, where with Crispi and Bertani he planned the invasion of Sicily. Assured by Sir James Hudson of English sympathy, he began preparations for the process which ended in the making of Italy. He reached Marsala on May 11, 1860, landed under the protection of the British vessels "Intrepid" and "Argus," and on the following day his dictatorship was proclaimed at Salemi. On May 1j the Keapolitan troops were routed at Calatafimi, on May 25 Palermo was taken, on June 6, 20.000 Keapolitan regulars capitulated, on July 20 Messina fell and on Aug. 21 the battle of Reggio was won. On Sept. 7 Garibaldi entered Naples. and a month later routed the remnant of the Bourbon army on the Yolturno. On Nov. 7 he accompanied Yictor Emmanuel during his entry into Naples, and next day returned to Caprera.

Indignant at the cession of Nice to France and at the neglect of his followers by the government, he returned to political life. Elected deputy in 1861, his anger against Cavour found violent expression, until Cavour's successor. Ricasoli. enrolled the Garibaldians in the regular army. Marching on Rome in the following year, he was taken prisoner at Aspromonte on Aug. 27. Liberated by an amnesty, Garibaldi returned once more to Caprera amid general sympathy, and in 1864 was enthusiastically received in London. On the outbreak of war in 1866 he assumed command of a volunteer army! and on July 3 he defeated the Austrians at Monte Saello. on the ;th at Lodrone. on the 10th at Darso, on the 16th at Condino, on the 19th at Ampola, on the 21st at Bezzecca; when on the point of attacking Trent, he was ordered by General Lamarmora to retire. His famous reply, *"Obbedisco"* ("I obey"), has often been cited as a classical example of military obedience to a command destructive of a successful leader's hopes, but documents later published (cf. *Corriere della sera,* Aug. 9, 1906) prove that Garibaldi had for several days known that the order to evacuate the Trentino would shortly reach him. As early as July 16 Crispi had been sent to warn Garibaldi that. because of Prussian opposition. Austria would not cede the Trentino to Italy and that the evacuation was inevitable. He returned to Caprera to mature his designs against Rome, which had been evacuated by the French in pursuance of the Franco-Italian convention of Sept. 1864. In 1867 he prepared to enter papal territory. but was arrested at Sinalunga by the government and conducted to Caprera. He escaped to Florence and, with the complicity of the second Rattazzi cabinet, entered Roman territory at Passo Corese on Oct. 23. Two days later he took Monterotondo, but on Kov. 2 his forces were dispersed at Mentana by French and papal troops. Recrossing the Italian frontier, he was arrested at Figline and taken back to Caprera. In 1870 he formed a fresh volunteer corps and went to the aid of France. defeating the German troops at Chatillon, Autun and Dijon. Elected a member of the Versailles assembly, he resigned his mandate in anger at French insults and withdrew to Caprera until, in 1874, he was elected deputy for Rome. Popular enthusiasm induced the Conservative Minghetti cabinet to propose that £40,000 with an annual pension of £2,000 be conferred upon him, but the proposal was refused by Garibaldi. Upon the advent of the left to power. however, he accepted both gift and pension. He died at Caprera on June 2, 1882, one of the greatest masters of revolutionary war.

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GARLAND, HAMLIN (1860–1940), U.S. author, perhaps best remembered for his autobiographical "Middle Border" series, was born at West Salem! Wis., on Sept. 14, 1860. As his family moved progressively westward. Garland rebelled against the vicissitudes of pioneering and turned to Boston for a literary career. A follower of William Dean Howells, Garland far exceeded his mentor in the bitterness of his realism as he resentfully recorded the frustrations of rural life. The short stories of *Main-Travelled Roads* (1891), *Prairie Folks* (1893) and *Wayside Courtships* (1897), and the novel *Rose of Dutcher's Cooley* (1895) raised a storm of protest.

Garland's critical theories of "veritism," set out in *Crumbling Idols* (1894), were largely derivative but well in advance of contemporary popular acceptance. Garland next turned to the "high country" of the American west and to the occult for materials, producing a series of mediocre novels which were serialized in the burgeoning "slick magazines." His Indian stories, however. written during this period (though uncollected until 1923 in *The Rook of the American Indian),* remain one of the earliest accurate and sympathetic appraisals of this minority group. Garland grew increasingly critical of the "excesses" of the naturalists. and in 1917 in mellow autobiographical mood wrote *A Son of the Middle Border*, apostrophizing the vanishing frontier. The book won immediate and deserved acclaim. A somewhat unsuccessful sequel, *A Daughter of the Middle Border* (1921), was the Pulitzer choice for biography. *Trail-Makers of the Middle Border* (1926) nostalgically described the epic sweep of migrations which settled the American continent. In his later years Garland compiled from his journals *Roadside Meetings of a Literary Nomad* (1930) and successive reminiscent volumes.

An indefatigable lecturer and promoter of literary organizations as well as a fecund writer, Garland in his lifetime was a force in literary affairs. In youth the spokesman of the "local color school" of realists, he came in time to be the *bête noire* of the naturalistic critics. Later critical opinion was sharply divided as to the extent of his influence upon American letters.

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GARLAND, JOHN (JOHANNES DE GARLANDIA) (*c.* 1195–*c.* 1272), English grammarian and poet, whose works were important in the development of medieval Latin, was born in England of a noble family. He studied at Oxford under a certain John of London, and about 1202 went to Paris where Alain de Lille was his teacher. Garland taught at Paris until 1229 when he went to the new University of Toulouse. In 1232 or 1233 he had to flee Toulouse because of religious troubles with the Albigensians. Among his grammatical works were *Compendium grammatice* and *Liber de constructionibus*. His *Dictionarius*, a Latin vocabulary, was edited in 1857 by T. Wright, who also published fragments of the *Poetria* (1841), since edited in full by G. Mari (1892 and 1902).

The best known of Garland's poems are *De triumphis ecclesiae* (ed, by Wright, 1856), books iv–vi giving a detailed account of the Albigensian crusade in the south, and *Epithalamium beatae Mariae Virginum*. *De mysteriis ecclesiae* was edited by B. W. Otto (1812) and the *Morale scolarium*, which covers such topics as general behaviour. table manners, virtue and the defense of the pope against simony, by L. J. Paetow (1927) who in his introduction gives an account of the life and works of Garland.

GARLAND, a city of Dallas county, in northeastern Texas, U.S., is 14 mi. N.E. of Dallas. Known in the 1880s as Duck Creek and later as Embree, it was named in honour of A. H. Garland, U.S. attorney general under Pres. Grover Cleveland. It was long an agrarian town, with a population of only 2,233 as late as 1940. After World War II industrial expansion increased the population. (For comparative population figures *see* table in TEXAS: *Population.*) More than 50 industrial firms were established in Garland between 1940 and 1960.

In 1951 Garland adopted the council-manager form of government. (E. C. BE.)

GARLIC (*Allium sativum*), a bulbous perennial plant of the family Liliaceae (lily family), used for flavouring. It is native to middle Asia west of the Himalayas. The membranous skin of the bulb encloses up to 20 small edible bulbils called cloves. which are quite unrelated to the spice of that name. These bulbils are borne in the axils of the inner leaves of the bulb. The 15 to 20 leaves are long, flat and solid with a ridge on the under side of each. Flower stalks sometimes arise to one foot or more. bearing tiny bulblets and sterile flowers but no seeds. Garlic is propagated by planting either cloves or top bulblets and is grown as an annual crop by methods similar to those used in the growing of onions. It is little grown in the United States except in California.

(V. R. B.)

GARLIC MUSTARD (*Alliaria officinalis*), a plant of hedgebanks, low woods and waste grounds, called also hedge garlic, Jack-by-the-hedge and sauce-alone. It is an erect: somewhat branching. biennial or perennial herb, 2 ft. to 3 ft. high, of the mustard family (Cruciferae), native to Europe and temperate Asia and naturalized in North America from Quebec and Ontario to Virginia. The long-stalked, coarsely toothed leaves emit, when crushed. a garliclike odour. The plant bears white flowers.

GARMISCH-PARTENKIRCHEN, a resort town in Bavaria, Ger., on the edge of the Bavarian Alps and under the shadow of the Zugspitze, the highest mountain in Germany. It lies southwest of Munich in one of the valley highways leading to the Brenner pass to Italy and is on the railway from Augsburg to Innsbruck. Pop. (1950) 25,142.

GARNEAU, FRANÇOIS XAVIER (1809–1866), Canadian historian, whose *Histoire du Canada* established scientific method there, was born June 15, 1809, in Quebec, the son of a carriage maker. Leaving school at 14, he entered the court clerk's office and two years later a notary's firm, becoming himself a notary in 1830. He was in London from 1831 to 1833 as secretary to D. B. Viger, a Canadian political delegate. Back in Quebec, he wrote poetry, started a short-lived paper and dabbled in history. In 1837 he turned bank cashier and became somewhat active in politics He was appointed translator to the legislative assembly (1843) and was Quebec city clerk (1844–64). His *Histoire du Canada* (1845–48) met with great success and was translated into English. *Voyage en Angleterre et en France* appeared in 1855. Scarcely touching economics. he concentrates on war and politics, being invariably impartial. His inspiration is based on the conservation of Quebec's religion, language and laws. Revitalizing ethnic pride and aspirations, he ranks as the national historian of French-Canada. He died at Quebec, Feb. 3, 1866.

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(G. LT.)

GARNER, JOHN NANCE (1868–). U.S. vice-president during Pres Franklin D. Roosevelt's first two terms was born in a log cabin in Red River county, Tex., Nov. 22, 1868. After limited schooling, he studied law and was admitted to the Texas bar in 1890. He served two terms in the Texas legislature. 1898–1902. He was elected a Democratic representative in the U.S. congress in 1902 and continued as such for 30 years. After being successively Democratic whip and leader in the house, he was elected speaker in 1931. In 1932 he was a candidate for the Democratic nomination for president, but released his delegates in favour of Roosevelt. Garner was then nominated for rice-president and was elected; four years later he was re-elected with Roosevelt. Garner opposed a number of New Deal measures during his second term. He retired in Uvalde, Tex.

GARNET (GARNETT), **HENRY** (1555–1606), English Jesuit. was born at Heanor, Derbyshire, educated at Winchester and afterwards studied law in London. Having become a Roman Catholic. he joined the Jesuits in Italy in 1575, and in 1587 was made superior of the English province. Fearless and indefatigable in carrying on his propaganda and in ministering to the scattered Catholics, even in their prisons, Garnet is remembered for his connection with the Gunpowder plot, for which he suffered death. On June 9, 1605, Garnet was asked by Robert Catesby whether any undertaking which should involve the destruction of the innocent together with the guilty was lawful. Garnet answered in the affirmative, giving as an illustration the fate of persons besieged in time of war. Afterwards, however, he admonished Catesby against intending the death of "not only innocents but friends and necessary persons for a commonwealth," and showed him a letter from the pope forbidding rebellion. According to Sir Everard Digby, Garnet. when asked the meaning of the brief, replied "that they (meaning the priests) mere not to undertake or procure stirs, but yet they would not hinder any, neither was it the pope's mind they should. that should be undertaken for Catholic good. . . . This answer, with Mr. Catesby's proceedings with him and me, gave me absolute belief that the matter in general was approved, though every particular was not known." A few days later, according to Garnet, the Jesuit. Oswald Tesimond, known as Greenway, informed him of the whole plot "by way of confession," but he urged Greenway to do his utmost to prevent its execution. Garnet's conduct in keeping the plot a secret has been a matter of considerable controversy not only between Roman Catholics and Protestants, but among Roman Catholic writers. He appears to have taken no decisive steps to prevent the crime, and his movements immediately prior to the attempt were certainly suspicious. In

September, shortly before the expected meeting of parliament on Oct. 3, Garnet organized a pilgrimage to St. Winifred's Well in Flintshire, which included Sir Everard Digby, Ambrose Rokewood, John Grant and Robert Winter. During the pilgrimage Garnet asked for prayers "for some good success for the Catholic cause at the beginning of parliament." After his return he went to Coughton where it had been settled the conspirators were to assemble after the explosion. On Nov. 6, Bates, Catesby's servant and one of the conspirators, brought him a letter with the news of the failure of the plot. On the 30th Garnet addressed a letter to the government in which he protested his innocence. On Dec. 4, Garnet and Greenway were, by the confession of Bates, implicated in the plot. In company with another priest, Oldcorne, alias Hall. Garnet hid himself, but at last on Jan. 30, 1606, surrendered and was taken up to London. Examined by the council on Feb. 13, he refused to incriminate himself. Subsequently, Garnet and Oldcorne having been placed in adjoining rooms and enabled to communicate with one another, their conversations were overheard on several separate occasions and considerable information obtained. Garnet at first denied all speech with Oldcorne, but later on March 8, confessed his connection with the plot. He was tried at the Guildhall on the 28th.

His trial, like many others, was influenced by the political situation. the case against him being supported by general political accusations against the Jesuits as a body, and with evidence of their complicity in former plots. The prisoner himself prejudiced his cause by his numerous false statements, and by adhering to the doctrine of equivocation. He was declared guilty. and executed on May 3, 1606. He acknowledged himself justly condemned for his concealment of the plot, but maintained to the last that he had never approved it. Garnet was the author of a letter on the martyrdom of Godfrey Maurice, alias John Jones, in Diego Yepres's *Historia particular de la persecucion de Inglaterra* (1599); a *Treatise of Schism;* a translation of Canisius' *Summa of Christian Doctrine* (1622); a treatise on the Rosary; a Treatise of Christian Renovation (1616).

AUTHORITIES.—On the question of Garnet's guilt, see *A True and Perfect Relation of the whole Proceedings against . . . Garnet a Jesuit and his Confederates* (1606, repr. 1679), the official account, but incomplete and inaccurate; *Apologia pro Henrico Garneto* (1610), by the Jesuit L'Heureux, under the pseudonym Eudaemon-Joannes, and R. Abbot's reply, *Antilogia versus Apologiam Eudaemon-Joannes; H.* More, *Hist. Provinciae Anglicanae Societatis* (1660); *D.* Jardine, *Gunpowder Plot* (1857); J. Morris, S.J., *Condition of the Catholics under James I* (1872); J. H. Pollen, *Father Henry Garnet and the Gunpowder Plot* (1888); S. R. Gardiner, *What Gunpowder Plot Was* (1897), in reply to John Gerard, S.J., *What was the Gunpowder Plot?* (1897); *J.* Gerard, *Contributions Towards a Life of Garnet* (1898). *See* also *State Trials II,* and *Cal. of State Papers Dom.* (1603–10). The original documents are preserved in the *Gunpowder Plot Book* at the Record Office. *See* also GUNPOWDER PLOT.

GARNET is a general name applied to a group of specific silicate minerals having similar crystal structures. The name is from Lat. *granatum,* "pomegranate." and alludes to the resemblance of some red varieties to the seeds of this fruit. Garnets typically occur in metamorphic rocks, but also in certain types of igneous rocks and, usually in minor amounts! in clastic sediments as detrital grains. Excepting bluish tints, garnets show great diversity of colour, including colourless and black, in addition to various shades of red. Garnets are frequently employed commercially in the form of semiprecious gems, jewel bearings in watches and abrasive materials.

Gem Uses.—Use of garnets as gems began with the ancient Egyptians, if not earlier. During the latter part of the 19th century, preparation of garnets for jewelry employed many persons in Czechoslovakia, and garnet jewelry in the form of bracelets and brooches was popular. Tastes in jewelry change according to whims, however, and Bohemian jewelry declined in popularity with an apparent decline in the use of dark-coloured stones that took place during the 20th century. Most familiar during the peak of popularity were varieties of pyrope, cut both *en cabochon* and in faceted forms. Because of the dark colour, larger stones cut *en cabochon* frequently were cut concave on the reverse. Many varietal names have been applied, some of the commonest of which are mentioned below under the specific names. As is true of other gem minerals, garnet varieties have become known by misleading names. frequently consisting of a locality name used as an adjective before the name of another mineral variety, such as emerald or ruby. Although possibly the most attractive in appearance, uvarovite occurs in such small crystals as to be unusable as a gem; otherwise it might rival the emerald in popularity. Except for some of the darker varieties, the hardness of garnets is somewhat less than what would be desirable for mounting in finger rings. Garnet is considered the birthstone for those persons born during January according to an American association of jewelers. As is true of many other gems. mystical significance was attached to the wearing of garnets; they were supposed to ward off accidents during travel. In diabolical apposition is their use as bullets in ancient firearms. *See* also GEM; JEWELLERY.

Industrial Uses.—The hardness of garnets and their sharp fracture make them suitable as abrasives for wood, leather and plastics, and for lens grinding and metal and glass polishing. For discussion of these uses *see* ABRASIVES.

Heating to about 800° C.. followed by quenching, improves the toughness and fracture characteristics of iron-bearing garnets, and such a process is used by several manufacturers of garnet-coated abrasive papers and cloths. Fracture is also dependent to a considerable extent on the impurities within the crystals. At Gore mountain, in Warren county. N.Y., garnet crystals averaging five inches. but reaching a maximum of a few feet in size, are produced from a complex metamorphic rock which consists principally of hornblende and garnet. Other commercial deposits are in Benewah county. Idaho. In New Hampshire, almandite has been produced from schistose rocks. Production, sometimes as a by-product of other mining operations, has occurred in Florida, North Carolina and California. Intermittently, notable quantities of garnet have been produced for abrasive use in Canada, Czechoslovakia, India. Madagascar, Spain and South Africa.

Crystallography and Physical Characters.—In their crystallization. garnets are cubic, or apparently pseudocubic for some compositions, and commonly exhibit either dodecahedra1 or trapezohedral forms or both. The hexoctahedron, trisoctahedrbn, octahedron and cube are rare. Crystals commonly attain an inch or more in size as isolated individuals, but massive examples, consisting essentially of granular textures of very small crystals. occur also. Within a garnet crystal may be included many small grains of other mineral species.

The smallest symmetrical unit of the crystal structure contains 96 oxygen atoms arranged in tetrahedral co-ordination about 24 silicon atoms. Combined with the silicon and oxygen, garnets contain calcium, magnesium, iron and aluminum. Interstitially divalent and trivalent atoms occur in the proportions 3 to 2, leading to a general formula $R''_3R'''_2(SiO_4)_3$, where the bivalent element, R''. may be calcium, magnesium, ferrous iron or manganese, and the trivalent element, R''', may be aluminum, ferric iron, chromium or manganese. On analysis. garnets may be found to contain other metallic atoms in minor amounts as well as nonmetallic constituents other than silicon. (For discussion of type formulas and the replacement of one element by another *see* MINERALOGY: *Chemical Characters.)*

Garnetoids are essentially isostructural substances which contain a nonmetallic atom in isomorphous substitution for silicon. Both an arsenate and a phosphate mineral, berzeliite and griphite, fall in this group, as well as hydrogrossularite. The synthetic laboratory analogue of the last is tricalcium aluminate hexahydrate $(Ca_3Al_2[O_4H_4]_3)$. In this compound the structure appears to be essentially similar to that of the garnets except for the absence of the silicon atoms and the occurrence of four hydrogen atoms for each silicon atom. Expectably such a hydrated compound decomposes at a considerably lower temperature than does the analogous silicate, the garnet grossularite, $Ca_3Al_2(SiO_4)_3$.

Without taking into account such isomorphous substitutions as sodium for calcium, it is possible to account for the equivalence of the number of structural positions by the formula $X_3Y_2(ZO_4)_{3-m}(OH)_{4m}$. Z is a pentavalent atom for berzeliite and thus requires commensurate substitutions for either X or Y in order to preserve the electrical neutrality of the structure.

The common, silicate species denoted by garnet can be written as pure compounds, although the natural substances are isomorphous intermediates consisting of combinations of two or more end members, thus:

Grossularite	$Ca_3Al_2(SiO_4)_3$
Pyrope	$Mg_3Al_2(SiO_4)_3$
Almandite	$Fe_3Al_2(SiO_4)_3$
Spessartite	$Mn_3Al_2(SiO_4)_3$
Andradite	$Ca_3Fe_2(SiO_4)_3$
Uvarovite	$Ca_3Cr_2(SiO_4)_3$

Other combinations, such as ferrous-ferric and manganous-manganic end members, have been suggested and named (skiagite and blythite, respectively) but the mere introduction of additional names does not contribute toward a better understanding of the crystal chemistry involved. Varieties containing titanium (T) and the rare-earth yttrium (Y) also occur. Indeed, inasmuch as some otherwise normal garnets contain small amounts of phosphorus pentoxide, the supposed failure of some garnets to yield precise stoichiometric proportions may be attributable to the inadequacy of the analyses rather than inherent structural imperfections of the crystals. This is emphasized by the possible occurrence of aluminum atoms in tetrahedral co-ordination instead of silicon, as is true of the synthetic garnetoid $Y_3Al_2(AlO_4)_3$.

The physical properties of the garnets are variable, depending upon the composition. Grossularite has a hardness of about 6.5, whereas other varieties may be as high as 7.5 or 8 (in the case of a New Hampshire almandite). The specific gravity ranges from slightly above 3.5 (pyrope) to 4.3 (almandite). For a nearly pure end member, the lowest refractive index has been measured for grossularite (1.735) and the greatest for andradite (above 1.88). Depending upon the titanium content, the refractive index may be appreciably higher. A schorlomite variety from Kuusamo, Fin., has a refractive index above 2. Although the refractive index of pyrope has been calculated to be 1.705, specimens containing more than 60% of this end member are extremely rare.

Garnets of some compositions, particularly grossularite, andradite, spessartite and uvarovite, are not strictly isotropic at ordinary temperatures, but are composed of anisotropic sectors. On heating the anisotropism is said to disappear, suggesting that passage through an inversion temperature has brought the crystal to a truly cubic condition which is not stable at lower temperatures. Many observations on the anisotropism indicate that the individual sectors commonly have orthorhombic or lower symmetry. An anisotropic garnet from Nevada displays spectacular iridescence

The thermal behaviour and synthesis of garnets have been studied extensively. Most garnets melt incongruently, *i.e.*, decompose on or before melting and form pyroxenes, anorthite, spinels and other minerals on solidification. Grossularite. spessartite and almandite fuse at far lower temperatures than uvarovite. Utilizing high pressures and water vapour, garnets of various coinpositions can be synthesized, but only uvarovite, spessartite and possibly melanite have been produced at atmospheric pressure and possibly only the first two from a dry melt. On fusion most garnets form melts having appreciably lower specific gravities. Ferriferous varieties yield a magnetic material on cooling.

Varieties.— *Almandzte* or so-called precious garnet is usually deep red and slightly purple in colour. It occurs typically in schistose rocks formed by regional or dynamic metamorphism of argillaceous sediments, in gneisses and in granulites. Its presence is used as a criterion to indicate the grade of metamorphism by dynamic processes. Well-known localities include Gore mountain, N.P.; Salida, Colo.; Minas Gerais. Braz.; Fort Wrangell, Alsk.; Nordland, Nor.; southern Greenland; Ceylon and India. Gem quality garnet is produced mostly in Brazil, Ceylon and India. Almandite may display asterism in the form of a four-rayed cross but this phenomenon is nearly always less spectacular than that of the star ruby or sapphire.

Pyrope also is frequently deep red, owing its colour to the presence of the almandite end member with which it occurs isomorphously combined, but there is reason to believe that pure pyrope would be very nearly colourless. A rose red variety found at Macon county, N.C., is called rhodolite. The common garnet of the jewelry trade, variously called Cape ruby or Bohemian garnet, contains appreciable quantities of pyrope. Pyrope of gem quality occurs in alluvial deposits near Prague. The characteristic occurrences of pyrope are basic igneous rock, such as peridotites, and the serpentinites derived from their alteration.

Grossularite, called the gooseberry garnet because its rounded shape and greenish colour may produce a close resemblance to the fruit, when pure is completely colourless, or white because of numerous internal fractures. White, dodecahedra1 crystals from Mexico are well known, as is a pink variety called rosolite. Reddish-brown varieties include so-called cinnamon stone and hessonite (or essonite) that are occasionally seen in jewelry. A massive variety is called South African or Transvaal jade from the locality and its jadelike colour. Grossularite occurs typically in impure limestones that have been thermally metamorphosed in proximity to an intrusive igneous rock. A typical mineralogical assemblage in addition to grossularite would include several or all of these: coarsely crystalline calcite, wollastonite, idocrase, diopside and scapolite. Many such contact metamorphic zones are known throughout the world so that grossularite is a common garnet, particularly when isomorphously combined with andradite.

Andradite is similar in its occurrence to grossularite, except that availability of ferric iron is essential, and related thermally metamorphosed rocks are more likely to contain ore deposits. Andradite also occurs in igneous rocks that have assimilated other rock fragments during emplacement. Titaniferous varieties may be black by reflected light but appear dark brown by light transmitted through thin slices. Schorlomite, a highly titaniferous variety, is found in nepheline syenite at Magnet Cove, Ark. Melanites, so called because of their dark colour, are varieties containing titanium that likewise occur in association with alkaline igneous rocks, particularly in Norway, the Kola peninsula, U.S.S.R., Tasmania and the Kaiserstuhl, Ger.

The crystal chemistry of the titanium-bearing garnets has not been thoroughly investigated. but it has been supposed that schorlomite contains Ti_2O_3 in addition to the TiO_2 contained in the melanites. Green gem varieties of andradite are called demantoid because of the high index of refraction and dispersion. The deceptive name Uralian emerald has sometimes been applied to such gems inasmuch as this material occurs in the Ural mountains, as well as Saxony and Hungary. Pure andradite is probably yellow, but the colour is influenced by the presence of other isomorphous constituents. Topazolite, resembling topaz in colour, is a variety from the Piedmont region of Italy.

Spessartite, the manganese-aluminum garnet, is yellow when pure but red or orange when combined with almandite. It occurs in granites, their associated pegmatite veins, in acidic lavas and in thermal metamorphic rocks if manganese is available. Garnet predominantly of spessartite composition is found in association with metamorphic manganese ores in central India. It is found in cavities in rhyolite with topaz at Silver Cliff, Colo., and near Nathrop, Utah. In the Spessart district of Bavaria, whence the name, it occurs in granite. Other noteworthy localities include the Piedmont of Italy, Alba, It., and Madagascar.

Uvarovite, the chromium-containing garnet, is comparatively rare. It is emerald green in colour and typically occurs as small, brilliant, euhedral crystals in veins in chromite. Also it is reported from metamorphosed limestones in Tasmania and from serpentinites. First reported from the northern Urals, it is found also in California, Canada, Finland and Silesia.

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GARNETT, RICHARD (1835–1906), English librarian and author, son of the learned philologist the Rev. Richard Garnett (1789–1850), priest-vicar of Lichfield cathedral and afterward keeper of printed books at the British Museum, was born at Lichfield. He was educated at home and at a private school, and in 1851, just after his father's death, entered the British Museum as an assistant in the library. In 1875 he rose to be superintendent of the reading room, and from 1890 to 1899, when he retired, he was keeper of the printed books. In 1895 he was made a C.B. In the history of the British Museum library his place is second only to that of Panizzi. Besides introducing the "sliding press" in 1887 he was responsible for reviving the publication of the general catalogue, the printing of which, interrupted in 1841, was resumed under him in 1880, and gradually completed. He married (1863) an Irish wife, Olivia Narney Singleton (d. 1903); his son Edward (1868–1937), a well-known author, married Constance Black, known under her married name as the translator of the works of Turgenev, Tolstoy and other Russian authors.

Garnett's chief publications in book form were: in verse, *Primula* (1858), *Io in Egypt* (1859), *Idylls and Epigrams* (1869, republished in 1892 as *A Chaplet From the Greek Anthology*), *The Queen and Other Poems* (1902), *Collected Poems* (1893); in prose, biographies of Carlyle (1887), Emerson (1887), Milton (1890), Edward Gibbon Wakefield (1898); a volume of remarkably original and fanciful tales, *The Twilight of the Gods* (1888); a tragedy, *Iphigenia in Delphi* (1890); *A Short History of Italian Literature* (1898); *Essays in Librarianship and Bibliophily* (1899); *Essays of an Ex-librarian* (1901).

GARNIER, (JEAN LOUIS) CHARLES (1825–1898), French architect, creator of the Paris Opera house, was born in Paris on Nov. 6, 1825, and died there on Aug. 3, 1898. The son of a wheelwright, he studied at the Petite École de Dessin and entered the atelier of L. H. Lebas in preparation for the École des Beaux Arts. Admitted in 1842, he won the Grand Prix de Rome in 1848 and went to the Villa Medici. He entered and won the competition for the new Opéra de Paris, in 1860. One of the most famous buildings of the century, the Opera house followed an eclectic style with lavish ornamentation which was intended as a foil to the pageantry of a glittering court and a suitable palace of the arts of the second empire. Started in 1861, this vast undertaking, interrupted by the war of 1870, was completed in 1875. Garnier's other works included the small theatre for the casino of Monte Carlo, the casino and baths at Vittel. the observatory at Nice, an apartment house and the Hôtel du Cercle de la Librairie in Paris, as well as villas in Bordighera. For the Paris exposition of 1889 he conceived the Exposition des Habitations Humaines, which became the subject of his book *L'Habitation Humaine* (with A. Ammann, 1892). He also published, in 1871, *Le Théâtre*, and in 1878–81, *Le Nouvel Opéra de Paris*, a monumental description and defense of the work with which his name is irrevocably linked. (Jn. P. C.)

GARNIER, MARIE JOSEPH FRANÇOIS [Francis] (1839–1873), French officer and explorer, was born at St. Étienne on July 25, 1839. He entered the navy, and after voyaging in Brazilian waters and the Pacific he obtained a post on the staff of Admiral Charner, who from 1860 to 1862 was campaigning in Cochin-China. After some time spent in France he returned to the East, and in 1862 he was appointed inspector of the natives in Cochin-China, and entrusted with the administration of Cholon, a suburb of Saigon. At his suggestion the marquis de Chasseloup-Laubat sent a mission to explore the valley of the Mekong. Garnier accompanied Captain Doudart de Lagrée on this expedition. From Kratie in Cambodia to Shanghai 5,392 mi. were traversed, and of these 3,625 mi. were of country largely unknown to European geography. The area was surveyed with care and positions fixed by astronomical methods. most of the observations being taken by Garnier himself. Volunteering to lead a detachment to Talifu, the capital of Sultan Suleiman. the sovereign of the Mohammedan rebels in Yunnan, he successfully carried out the dangerous enterprise. When shortly afterwards Lagrée died. Garnier conducted the expedition in safety to the Tang-tsze-Kiang, and thus to the Chinese coast The preparation of his narrative, after his return to France. was interrupted by the Franco-German War, and during the siege of Paris he served as principal staff officer to the admiral in command of the eighth "sector." Returning to Cochin-China he found the political circumstances of the country unfavourable to further exploration, turned to China, and in 1873 followed the upper course of the Yang-tsze-Kiang to the waterfalls. He was next commissioned by Admiral Dupré, governor of Cochin-China, to found a French protectorate or a new colony in Tongking. On Nov. 20, 1873 he took Hanoi the capital of Tongking. and on the 21st of December he was slain in fight with the Black Flags. His chief fame rests on the fact that he originated the idea of exploring the Mekong, and carried out the larger portion of the work.

The narrative of the principal expedition appeared in 1873, as *Voyage d'exploration en Indo-Chine effectué pendant les années 1866, 1867 et 1868, publié sous la direction de M. Francis Garnier, avec le concours de M. Delaporte et de M. M. Joubert et Thorel* (2 vols). An account of the Yang-tsze-Kiang from Garnier's pen is given in the *Bulletin de la Soc. de Géog.* (1877) His *Chronique royale du Cambodje*, was reprinted from the *Journal Asiatique* in 1872 See *Ocean Highways* (1874) for a memoir by Colonel Yule; Petit. *Francis Garnier* (1885) and Hugh Clifford, *Further India*, in the Story of Exploration series (1904).

GARNIER, ROBERT (c. 1545–c. 1600), French tragic poet, was born at Ferté Bernard (Le Maine). He published his first work while still a law-student at Toulouse, where he won a prize (1565) in the *jeux floraux*. It was a collection of lyrical pieces, now lost, entitled *Plaintes amoureuses de Robert Garnier* (1565). After some practice at the Parisian bar, he became *conseiller du roi* in his native district, and later *lieutenant-général criminel*.

In his early plays Garnier was a close follower of the Senecan school. His pieces in this rhetorical manner are *Porcie* (published 1568, acted at the hôtel de Bourgogne in 1573), *Cornélie* and *Hippolyte* (both acted in 1573 and printed in 1574). His next group of tragedies—*Marc-Antoine* (1578), *La Troade* (1579), *Antigone* (acted and printed 1580)—shows an advance on the theatre of Etienne Jodelle and Jacques Grévin, and on his own early plays, since the rhetoric is accompanied by some action.

In 1582 and 1583 he produced his two masterpieces *Bradamante* and *Les Juives*. In *Bradamante*, which alone of his plays has no chorus, he cut himself adrift from Senecan models, and sought his subject in Ariosto, the result being what came to be known later as a tragi-comedy. The dramatic and romantic story becomes a real drama in Garnier's hands, though even there the lovers. Bradamante and Roger, never meet on the stage. The contest in the mind of Roger supplies a genuine dramatic interest. *Les Juives* has for its theme the story of the barbarous vengeance of Nebuchadrezzar on the Jewish king Zedekiah and his children. This tragedy, although almost entirely elegiac in conception, gains unity by the personality of the prophet. Emile Faguet says that of all French tragedies of the 16th and 17th centuries it is, with *Athalie*, the best constructed with regard to the requirements of the stage. Actual representation is continually in the mind of the author; his drama is, in fact, visually conceived.

The best edition of his works is by Wendelin Foerster, 4 vol. (Heilbronn, 1882–83). A detailed criticism of his works is to be found in Emile Faguet, *La Tragédie française au XVI^e siècle*, pp. 183–307 (1883).

GARNIER, TONY (1869–), a precursor, with August Perret, of 20th-century French architecture, was born at Lyon in 1869. Both Garnier and Perret explored the means of expression inherent in the new material, reinforced concrete. Most of the works of Garnier were executed in Lyon, under the aegis of the mayor, Édouard Herriot. The large complex of the stockyards (1909), the stadium (1915), the Granges-Blanches hospital with its 22 pavilions (started in 1915), as well as his planned housing schemes (*see* T. Garnier, *Grands travaux de la ville de Lyon*, 1919), developed out of the farsighted planning of his *Cite' In-*

dustrielle ("industrial city"), which secured Garnier's place in the history of architecture. On his Grand Prix de Rome grant he developed (beginning in 1898, exhibited in 1904 and published in 1917) plans for an entire city, embracing new concepts of city planning far more advanced than the garden city idea: long narrow lots running east-west, buildings separated by wide open spaces, separate levels provided for pedestrians and houses with roof gardens. The detailed ground plans for the houses were decades in advance of their time. The plasticity and strength of Garnier's chief material, concrete reinforced with steel, was employed to reach unexpected solutions for his schools, railway stations and sanatoriums. (S. GN.)

GARNIER-PAGÈS, LOUIS ANTOINE (1803–1878), French republican leader, was born at Marseilles on Feb. 16. His brother Étienne (1801–1841) was active as a republican leader under the restored Bourbons, supported the revolution of 1830 and after 1831 sat in the chamber of deputies as a leader of the republican opposition. Louis Antoine likewise supported the revolution of 1830 and after his brother's death was elected to the chamber. He took a leading part in the revolution of 1848, became a member of the provisional government in that year and was acclaimed mayor of Paris. In March he was made minister of finance and incurred great unpopularity by his imposition of additional taxes. He was a member of the constituent assembly and the executive commission. Under the second empire he became a leader of the republican opposition and opposed the war with Prussia. After the fall of Napoleon III he served as a member of the government of national defense. Failing to secure election to the national assembly of 1871, he retired into private life and died in Paris on Oct. 31, 1878. His writings include *Histoire de la révolution de 1848,* 10 vol. (1861–72), and *L'Opposition et l'Empire,* 2 vol. (1873). (D. TN.)

GARNISH: *see* ATTACHMENT; PRACTICE AND PROCEDURE; BANKRUPTCY.

GAROFALO, BENVENUTO DA (BENVENUTO TISI or TISIO) (1481–1559). Italian painter, was the most prolific 16th-century painter of the Ferrarese school. Modern knowledge of his early life and training is due entirely to Giorgio Vasari, who records Garofalo's apprenticeship with Domenico Panetti, his association with the Cremonese Boccaccio Boccaccino and his two visits to Rome in the first and second decades of the century. The style of his early works confirms Vasari's account but shows in addition the strong influence of Dosso Dossi, especially in the treatment of landscape backgrounds. This is clearest in several pictures of the Nativity painted before 1520; it is also apparent in the fine "Sacrifice to Ceres" (1526) in the National gallery, London. North Italian influences, particularly from Andrea Mantegna's "Camera degli Sposi," also dominate the ceiling paintings in the Seminario at Ferrara (1519).

The influence of Raphael and Michelangelo made itself increasingly felt from about 1520 onward, however, and Garofalo, though he seems never to have left Ferrara at this time, kept pace with the developments of Michelangelesque mannerism in Florence and Rome, for example, in the "Baptist Taking Leave of His Father" (1542) in S. Salvatore, Bologna. Garofalo died in his native Ferrara on Sept. 6, 1559. The history of his development well illustrates the derivative status of the Ferrarese school after its great period in the second half of the 15th century.

See E. G. Gardner, *The Painters of the School of Ferrara* (1911). (*M. W. L.* K.)

GARO HILLS, a district in the Assam Valley division of Assam, India. Area 3,149 sq.mi. Pop. (1951) 242,075. It takes its name from the Garos, a tribe of Tibeto-Burmese origin, by whom it is almost entirely inhabited. The Garos are probably a section of the great Bodo tribe, which at one time occupied a large part of Assam. In the 18th century they were a terror to the inhabitants of the plains below their hills. The early period of British rule is a record mainly of raids by the Garos, followed by blockades of the hills. At last in 1866 a British officer was posted among the hills with a small police force. This step was effective in putting a stop to raids till 1871–72, when further outrages were committed by some independent Garos. It was decided to annex their territory. A police force marched through the hills and there were no further disturbances.

The district consists of the westernmost spurs of the Assam hills, which run down almost to the bank of the Brahmaputra where it emerges upon the plain of Bengal and takes its great sweep to the south. The district headquarters are at Tura. Coal in large quantities and petroleum are known to exist in the hills. Nomadic cultivation is practised; *i.e.,* patches of forest are burnt and cleared with the axe and crops are grown among the ashes. These patches are cultivated for a few years and then left, fresh areas being cleared in the same way. Nearly half of the cotton grown in Assam is raised by the Garos; it is remarkable for a short staple and wooly fibre, which has led to its being mixed with wool for carpet making.

The Garos are an Assam tribe of the Bodo group which seems to have migrated from the direction of Bhutan, but probably absorbed some pre-existing local stock (wavy and even curly hair is frequent); the existing culture suggests Indonesian affinities. A Tibeto-Burmese language is spoken; the tribe is related to the Rabhas, Kacharis and Tipperas.

Villages are built on river banks, the houses raised on piles; land is communal and cultivation shifting, rice and cotton being grown. Garos are good fishermen but indifferent hunters. Distension of the ear is practised. There are a dozen subtribes with varying customs and dialects, but all are divided into matrilineal clans. Marriage is exogamous and polygamous and the proposal comes from the woman, who, if accepted, lives for a time in the bridegroom's house on probation, but this system is subject to compulsory cross-cousin marriage coupled with a rule by which a man must marry his wife's father's widow, who is in such cases the husband's father's sister, actual or classificatory. Such a wife takes precedence of her daughter married before her. A man's sister's son, called his *nokrom,* stands therefore in intimate relationship to him, as the husband of one of the daughters and ultimately of his widow and the vehicle through which his family's interest in the property of his wife is secured for the next generation, for no male can inherit property.

The dead are buried, followed by various forms of secondary disposal including urn burial, burial by water and sometimes by special treatment of the frontal bone. Head-hunting (*q.v.*) used to be practised, enemy skulls being kept in the latrines, and there are faint traces of cannibalism and human sacrifice in the past. Religion is generally animistic, but provides a benevolent creator and a sort of vague ancestor worship with soul figures of wood or stone, probably phallic, and a fertility cult which involves the sacrifice of an imitation horse. They believe in the reincarnation of the soul. *See* also HEAD-HUNTING; LYCANTHROPY; METEMPSYCHOSIS.

See A. Playfair, *The Garos* (1909).

GARONNE (Lat. *Garumna*), a river of southwestern France, rising in the Maladetta group of the Pyrenees and flowing in a wide curve to the Atlantic ocean. It is formed by two torrents, one of which has a subterranean course of $2\frac{1}{2}$ mi., disappearing in the sink known as the Trou du Taureau ("bull's hole") and reappearing at the Goueil de Jouéou. After a course of 30 mi. in Spanish territory, during which it flows through a fine gorge, the Vallée d'Aran, the Garonne enters France in the *département* of Haute-Garonne through the narrow defile of the Pont du Roi, and at once becomes navigable for rafts. At Montréjeau it receives on the left the Neste, and encountering at this point the vast plateau of Lannemezan, turns abruptly east, flowing in a wide curve to Toulouse. At Saint Martory it gives off the irrigation canal of that name. At that point the Garonne enters a fertile plain and supplies the motive power to several mills. It is joined on the right by various streams fed by the snows of the Pyrenees. Such are the Salat, at whose confluence river navigation begins, and the Arize and the Ariège (both names signifying "river").

From Toulouse the Garonne flows to the northwest, skirting the northern border of the plateau of Lannemezan which there drains into it by the Save, Gers and Baïse. On its right the Garonne receives its two chief tributaries, the Tarn, near Moissac, and the Lot, below Agen; afterward it is joined by the Drot (or

Dropt) and on the left by the Ciron. Between Toulouse and Castets, 333 mi. above Bordeaux, the river is accompanied at a distance of from $\frac{1}{2}$ mi. to 3 mi. by the so-called "lateral canal" of the Garonne, constructed in 1838–56. This canal is about 120 mi. long. From Toulouse to Agen the main canal follows the right bank of the Garonne, crossing the Tarn on an aqueduct at Moissac, while another aqueduct carries it across the Garonne at Agen. It has a fall of 420 ft. and more than 50 locks. The carrying trade upon it is chiefly in agricultural produce and provisions, building materials, wood and industrial products. At Toulouse the canal connects with the Canal du Midi, which runs to the Mediterranean.

After passing Castets the Garonne begins to widen out considerably to about 650 yd. at Bordeaux, its great commercial port. From there it flows between two flat shores to the Bec d'Ambès ($15\frac{1}{2}$ mi.), where, after a course of 357 mi., it unites with the Dordogne to form the vast estuary known as the Gironde. The peninsula lying between these two great tidal rivers, the Entre-deux-Mers ("between two seas"), is famous for its wines. The drainage area of the Garonne is 22,079 sq.mi. Floods are of common occurrence and descend very suddenly. The most disastrous occurred in 1875, 1856 and in 1770, when the flood level at Castets was the record height of $42\frac{1}{2}$ ft. above low-water mark.

GAR PIKE (Lepisosteus), a genus of fishes with four, or perhaps more, species in the rivers of North and Central America, with elongate body covered with hard rhombic scales, with the jaws produced and with strong conical teeth. Fishes with ganoid scales of the same structure were abundant in Mesozoic times, but Lepisosteus is not known before the Eocene. In the billfish or long-nosed gar (L. osseus) the jaws are exceedingly long and slender, in other species shorter and broader. The alligator gar of Cuba, Mexico and the southern United States, reaches a length of 10 ft. These are piscivorous fishes, of sluggish habits, but very voracious. The name gar or garfish is also given to the Belonidae, fishes of warm seas, slender and with long jaws, but with thin cycloid scales, and not related to the gar pikes.

GARRET, properly a small lookout tower built on a wall, and hence the name given to a room on the top story of a building, the sloping ceiling of which is formed by the roof.

GARRETT, JOÃO BAPTISTA DA SILVA LEITÃO DE ALMEIDA, VISCONDE DE ALMEIDA GARRETT (1799–1854), one of Portugal's finest prose writers, the most important playwright since Gil Vicente and chief of the romantic poets. He was born on Feb. 4, 1799, in Oporto, but the French invasion of Portugal drove the family to the Azores where he lived for a time. In 1816 he went to the University of Coimbra where he soon earned notoriety by the precocity of his talents and his fervent liberalism. His tragedy *Lucrécia* was played at Coimbra in Feb. 1819, and there also he wrote *Mérope* and a great part of *Catão*. All these plays, which are of little merit, belong to the so-called classical school. After taking a degree in law, he went to Lisbon, and on Nov. 11, 1822, married Dona Luisa Midosi, but the marriage proved unhappy, and a formal separation was granted in 1839.

The reactionary movement against the liberal revolution of 1820 reached its height in 1823, and Garrett, forced to leave Portugal by order of the absolutist ministry, went to England where he read and was impressed by the work of the English romantics. Imbued with the spirit of patriotism, he published in 1825 the poem, *Camões,* which, together with his Dona Branca of 1826, undermined the influence of the worn-out classical and Arcadian poets. He was permitted to return to Portugal in 1826, and thereupon devoted himself to journalism. His defense of liberal principles led to three months' imprisonment and when Dom Miguel was proclaimed king on May 3. 1828, Garrett again had to leave the country. He spent the next three years in and about Birmingham, Warwick and London. Returning in Feb. 1832, he disembarked at the island of Terceira, whence he proceeded to São Miguel, then the seat of the liberal government. There he co-operated with the statesman Mousinho da Silveira, assisting him in drafting the laws which were to revolutionize the framework of Portuguese society. In his spare time he wrote some of the lyrics later collected in *Flores* sem Fruto (1845). He took part in the expedition that landed on the Portuguese mainland at Mindelo on July 8, 1832, and in the subsequent occupation of Oporto by the liberal forces. In Oporto, influenced by the works of Walter Scott, he sketched out his historical romance *O* Arco de *Sant'Ana,* the first part of which was published much later, in 1845.

During 1834–35 Garrett served as consul general and chargé d'affaires in Brussels. Entering parliament in 1837, he soon made his mark as an orator, and was asked by the government to draw up proposals for the formation of a national theatre. Thus a school of actors and playwrights arose under his influence. To give them models he wrote a series of prose dramas, choosing his subjects from Portuguese history. He began in 1838 with the Auto de Gil Vicente and followed this with Dona *Filipa* de Vilhena (1840), *O* Alfngeme de *Santarém* (1841) and Frei *Luís* de Sousa (1843), one of the greatest of 19th-century Portuguese plays.

An excursion to Santarém in July 1843 resulted in a prose masterpiece describing his journey. *Viagens na* minha terra (1846). He took no part in the intermittent civil war which raged in Portugal about this time. He spent much of 1850 in completing his Romanceiro, a collection of traditional poems; he was the first to perceive the value of this type of poetry. In June 1851 he was created a viscount, and in 1852 was for a short time minister of foreign affairs. In 1853 he brought out Folhas *Caídas,* a collection of short love poems exquisite in form—the best Portuguese lyric poems of the romantic period. He died in Lisbon on Dec. 9, 1854. Poet, dramatist, novelist, journalist and orator, he deserves the comment of Rebelo da Silva: "Garrett was not a man of letters only but an entire literature in himself."

Garrett was endowed with a deep sensibility, a creative imagination and a fine control of language. He was first and always an artist. His artistic temperament is revealed in his many-sided activity, his expansive kindliness, his seductive charm, especially for women, his ardent patriotism, his aristocratic pretensions, his vanity and dandyism and the ingenuousness that made forgivable the many faults of his irregular life. His sincere, sensual and melancholy lyrics, his eloquence, the truth of his comedy and the elegance of his lighter compositions are all expressions of his richly endowed personality.

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(E. P.; A. B.; N. J. L.)

GARRICK, DAVID (1717–1779), perhaps the greatest English actor and theatrical manager, was of French Huguenot descent. His grandparents. probably surnamed Garrigues, escaped to England from Bordeaux on the revocation of the Edict of Nantes, anglicized their name and, in due course, purchased a commission in the English army for their elder son, Peter. After Peter had married Arabella Clough, the daughter of a lay singer of Lichfield cathedral, he made Lichfield his home, bringing up a large family on modest means. His famous second son was born, however, at Hereford on Feb. 19, 1717, during a recruiting campaign. David, like Samuel Johnson before him, was educated at Lichfield grammar school under that stern disciplinarian John Hunter. In 1731 Captain Garrick, after some years on half pay, rejoined his regiment at Gibraltar, relying on "Davy" as the eldest son at home to send him regular reports on the doings at Lichfield during his absence. On his return in 1736 he sent David to be coached at Samuel Johnson's newly opened academy at Edial. But the seminary closed down six months later, and master and pupil decided to seek their fortunes in London. On March 2, 1737, Johnson, aged 27, and Garrick, aged 20, left Lichfield together on horseback for London—Johnson, as he later recalled, "with twopence halfpenny in his pocket" and Garrick "with three-halfpence in his." Intended by his father for the bar, David dutifully betook himself to Rochester to read law under the tutelage of John Colson, but Captain Garrick's death and a legacy of £1,000 from an uncle released him from studies profoundly uncongenial to him. In 1738 he and his elder brother, Peter, who had abandoned his career in the navy, set up in partnership as vintners in Lichfield and London, David managing the London branch.

Garrick had been stagestruck since childhood, and on the pretext of seeking custom, frequented the coffee houses of Covent Garden, where he made many theatrical friends, including Charles Macklin, whose theories on the reform of acting he assimilated, and Charles Fleetwood, manager of Drury Lane. Henceforth Garrick haunted the theatres, studying every branch of the art from tragedy to pantomime. On April 15, 1740, Fleetwood presented Garrick's first comic sketch, *Lethe,* which entered on a long period of popularity. In March 1741 Garrick appeared incognito as Harlequin in Henry Giffard's small unlicensed theatre at Goodman's Fields. In the summer Giffard's company opened at Ipswich, and there, under the name of Lyddal, Garrick made his first appearance as an actor as Aboan in T. Southerne's tragedy, *Oroonoko.* On Oct. 19, 1741, he appeared anonymously as Richard III at Goodman's Fields with resounding success. His daringly naturalistic style discredited forever the singsong elocution and formalized movements of the older tragedians—a style introduced into England from France after the Restoration. Among those who applauded him was Macklin, whose novel interpretation of Shylock earlier that year had prepared the way for Garrick's greater break with tradition. Londoners flocked to Goodman's Fields. Alexander Pope saw him three times and declared "that young man never had his equal and he never will have a rival." Having made his name as a tragedian, Garrick turned to comedy and after the hunchback king came a coxcomb, an aged madman, a tragic young lover, a foolish old husband and many more in a dazzling display of versatility, until it became an open question whether he excelled in comedy or tragedy. On Dec. 2, 1741, he used his own name for the first time as Lothario in N. Rowe's *The Fair Penitent.* Within the first seven months of his career he acted 18 characters.

Garrick's decision to go on the stage deeply offended his family, and they were slow to forgive him. On the day after his initial triumph in 1741, he wrote to Peter proposing to break their partnership. He had, he said, already lost £400 of his capital, whereas as an actor his future was assured. Neither his arguments nor the success of his farce, *The Lying Valet,* mollified his brother. Nevertheless, Garrick's fortune was indeed made, and Fleetwood engaged him for Drury Lane for the nine month season opening in Sept. 1742 at the record salary of 500 guineas. In preparation for his debut, Garrick acted at Drury Lane on three benefit nights in May. In June he went to Dublin and played opposite the fascinating Irish actress Peg Woffington at Smock Alley theatre. Their liaison, which lasted three years, began that summer. From Sept. 1742 to April 1745 he played at Drury Lane. After this he went again to Dublin and, jointly with Thomas Sheridan, managed Smock Alley theatre for the whole of the ensuing winter season. On his return in 1747 he accepted a short engagement with John Rich at Covent Garden and gave his last performances under a management not his own. At the close of the 1746–47 season, Fleetwood's patent for the management of Drury Lane expired, and Garrick, in partnership with James Lacy, purchased its renewal. Garrick contributed two-thirds of the money; *i.e.,* £8,000. The partners agreed to draw £500 a year each as managers, and Garrick, in addition, his actor's salary of 500 guineas with a clear benefit. On April 8, 1747, the agreement was signed, and in the autumn Garrick began his career as a manager.

The theatre reopened on Sept. 15, 1747, with Macklin's Shylock. Johnson's famous prologue was spoken by Garrick, whose policy as a manager it may be taken to express, while the latter's epilogue was spoken by Mrs. Woffington. The company included, besides Garrick himself, Mrs. Cibber, Mrs. Pritchard, Mrs. Clive, Mrs. Woffington, Spranger Barry, Macklin, Richard Yates and Edward Shuter. Henry Woodward joined them a year later. Fulfilling most of the functions of a modern producer, Garrick brought discipline to a slipshod stage and with judicious casting and strict rehearsing achieved a unity of style and an all-round excellence of performance new to its history. His own acting continued to astonish and delight. He chose his parts wisely, preferring those with energetic action and rapid changes of mood to suit his flamboyant style. Although his short stature made failure in such parts as Othello and Hotspur inevitable, his supremacy was never challenged. In tragedy, Barry most nearly approached him; in comedy, Woodward.

As a manager, Garrick's aim was to restore Shakespeare to favour and to discredit the Restoration plays, whose obscenity and false sentiment had, he thought, vitiated taste. Every season he presented at least ten plays popularly accepted as Shakespeare's, although most of them were in fact adaptations. He gave Nahum Tate's *King Lear,* without the Fool and with a happy ending; Colley Cibber's *Richard 111,* in which only half the lines were Shakespeare's; and John Dryden's *The Tempest,* in which Miranda has a sister and the love interest is doubled. Among his own versions are *Catherine and Petruchio, Florizel and Perdita* and *Cymbeline.* No copy of his ridiculed *Hamlet,* omitting the gravediggers and with a sentimentalized ending, survives, and the manuscript is said to have been buried with him. Like his audiences, he valued Shakespeare's dramatic situations rather than his poetry, but by popularizing certain roles he aroused fresh interest in Shakespeare's then unfamiliar text.

In considering new plays Garrick was ready to encourage talent and during his 29 years' management presented 75 new plays, exclusive of afterpieces. Nevertheless, disappointed authors accused him of malice and self-interest and involved him in many paper wars. Even Johnson, whose turgid play, *Irene,* he presented in 1749 with painstaking care, showed little gratitude. Among his few sins of omission are his refusals of R. Dodsley's *Cleone* and J. Home's *Douglas.* More reprehensibly, he failed to recognize Oliver Goldsmith's dramatic gifts and missed the opportunity of presenting *She Stoops to Conquer.* He did little to bring greater historical'accuracy to stage costume, excelling rather in spectacle, thus preparing the way for melodrama. In Philippe de Loutherbourg, he discovered a stage designer of genius.

Garrick had married in 1749 Eva Maria Veigel, a Viennese dancer professionally known as Mlle. Violette, the ward of Lord and Lady Burlington. Little is known of her prior to her arrival in England in 1746, and her adoption by the Burlingtons has inspired many legends as to her parentage. The Garricks' marriage, though childless, was ideally happy. When in London they lived in Southampton street until 1772, when they removed to Adelphi terrace. Their real home was, however, by the Thames at Hampton, where in 1754 Garrick bought a villa. In 1763 fatigue suggested the need for a holiday. Leaving his younger brother, George, in charge of his personal interests, he and Mrs. Garrick went abroad for 18 months. In Naples they basked in the flattering attentions of the English aristocracy; elsewhere in Italy they were also cordially received. In Munich, Garrick suffered a serious abdominal illness, which left him with a weakness he never wholly overcame. In Paris, where they broke their outward and homeward journeys, Garrick made many friends among the actors and among the *Philosophes,* to whom as Shakespeare's champion he was especially interesting. His private performances of Shakespearean scenes in dumbshow started a vogue for naturalism in the English manner, and Denis Diderot's *Paradoxe sur le comédien* was the outcome of their meeting.

In Nov. 1765 Garrick reappeared at Drury Lane as Benedick in *Much Ado About Nothing.* Henceforth he acted less frequently and never again in a new role. His refusal to play Lord Ogleby in his own and G. Colman's *The Ctandestine Marriage* led to a quarrel between them, but Thomas King's brilliant rendering of the part contributed to the comedy's success in Feb. 1766. In 1769 Garrick organized the Shakespeare jubilee at Stratford-on-Avon, thus bringing that town into prominence as the poet's birthplace. In 1773 he was elected to the Literary club and, as a member of the Johnson circle, makes many appearances in the pages of James Boswell's *Life of Johnson.* In 1776 he sold his share of the Drury Lane patent for £35,000 and gave a series of last performances in his favourite roles. They included Hamlet, Lear, Richard III and Benedick, Lusignan in A. Hill's *Zara,* Drugger in Ben Jonson's *The Alchemist,* Sir John Brute in Sir John Vanbrugh's *The Provoked Wife,* Archer in Thomas Farquhar's *The Beaux' Stratagem,* Leon in John Fletcher's *Rule a Wife and Have a Wife* and Ranger in John Hoadly's *The Suspicious Husband.* Finally, on June 10, he bade farewell to the stage as the youthful Don Felix in Mrs. Centlivre's *The Wonder!* In the course of his career he had played 96 roles. He died in London on Jan. 20, 1779, and was buried in the Poets' corner of Westminster abbey. He left a fortune of over £100,000. Mrs. Garrick survived him until 1822.

Garrick was under medium height and in later years inclined to stoutness. His large, well-marked features and compelling black eyes served him as an actor in a theatre lit by candlelight better than conventional good looks. The extraordinary mobility of his whole person, which enabled him to transform himself, as it were, at will, are attested by many anecdotes. His charm and culture gained him many friends among the aristocracy, but his vanity, touchiness and snobbishness alienated his fellow actors. His reputation for meanness was ill-deserved. According to Johnson, Garrick had given away more money than any man in England. Goldsmith's poem *Retaliation* is a portrait of penetrating truth. Garrick's own work has proved ephemeral. "A fellow-feeling makes one wond'rous kind" is one of the few lines remembered from his 80 prologues and epilogues. Of his songs, the best-known is "Heart of Oak."

Portraits and engravings of Garrick are numerous. Sir Joshua Reynolds painted him many times. Hogarth, Zoffany and Sir Nathaniel Dance-Holland depicted him in character. Mrs. Garrick's favourite likeness of him by Gainsborough perished in the fire at Stratford in 1946. L. Roubillac's statue of Shakespeare, for which Garrick sat, is in the British museum.

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GARRISON, LINDLEY MILLER (1864–1932), U.S. lawyer and secretary of war, was born at Camden, N.J., on Nov. 28, 1864. He attended Phillips Exeter academy, Harvard (for one year) and graduated from the University of Pennsylvania law school in 1886. In the same year he was admitted to the Pennsylvania bar and began law practice in Philadelphia. In 1888 he was admitted to the New Jersey bar and practised law in Camden until 1898 when he founded a law firm in Jersey City. He was appointed to the office of vice-chancellor of the state in June 1904, and, at the end of his first term in 1911, was reappointed and remained in office until 1913 when President Wilson named him for a post in his cabinet as secretary of war.

During his term of office, Garrison initiated a system of summer training camps to provide for a reserve of commissioned army officers. Originally designed for college students, the plan was extended in 1915, after the beginning of World War I, to include camps for business men. He instituted reforms in the administration of the insular possessions and was credited with writing a bill which, among other things, established a legislature for the Philippines. At the president's request, Garrison, aided by the general staff, developed a plan for increasing the military forces of the country but resigned on Feb. 10, 1916, when the president did not support his proposals as fully as he had expected. He resumed the practice of law, and died at Sea Bright, N.J., Oct. 19, 1932.

GARRISON, WILLIAM LLOYD (1805–1879), the American antislavery leader, was born in Newburyport, Mass., on Dec. 10, 1805. His parents were from the British province of New Brunswick. The father, Abijah, a sea captain, drank heavily and deserted his home when William was a child, and it is not known whether he died at sea or on land. The mother, whose maiden name was Lloyd, is said to have been a woman of high character, charming in person and eminent for piety. She died in 1823. William had little education but made the most of his opportunities. He was set to learn the trade of a shoemaker, first at Newburyport, and then, after 1815, at Baltimore, Md. Then he was apprenticed to a cabinet-maker at Haverhill, Mass., but ran away. In Oct. 1818, when he was 14, he was indentured to Ephraim W. Allen, proprietor of the Newburyport *Herald*, to learn the trade of a printer. He soon became an expert compositor, and after a time began to write anonymously for the *Herald*. His communications won the commendation of the editor, who had not at first the slightest suspicion that he was the author. He also wrote for other papers with equal success. His skill as a printer won for him the position of foreman, while his ability as a writer was so marked that the editor of the *Herald*, when temporarily called away from his post, left the paper in his charge.

The printing office afforded him an opportunity to increase his meagre education. He was enthusiastic about liberty; the struggle of the Greeks to throw off the Turkish yoke enlisted his sympathy; and at one time he seriously thought of entering the West Point academy and fitting himself for a soldier's career. His apprenticeship ended in 1826, when he beqan the publication of a new paper (actually the old one under a new name), the *Free Press*, in his native place. The paper, whose motto was "Our Country, our Whole Country, and nothing but our Country," was an intellectual force, but was too radical for Newburyport, and the enterprise failed.

Garrison then went to Boston, where, after working for a time as a journeyman printer, he became the editor of the *National Philanthropist*, the first journal established in America to promote the cause of total abstinence from intoxicating liquors; but a change in the proprietorship led to his withdrawal before the end of the year. In 1828 he established the *Journal of the Times* at Bennington, Vt., to support the re-election of John Quincy Adams to the presidency of the United States. This paper also died within a year. In Boston he had met Benjamin Lundy (*q.v.*), who had for years been preaching the abolition of slavery. Garrison had been deeply moved by Lundy's appeals, and after going to Vermont he showed the deepest interest in the slavery question. Lundy was then publishing in Baltimore a small monthly paper, *The Genius of Universal Emancipation*, and he went to Bennington and invited Garrison to join him in the editorship. His mission was successful.

Garrison first accepted Lundy's views of gradual emancipation, but soon changed to total and immediate freedom for slaves when he joined Lundy in Baltimore in 1829. Lundy believed that the Negroes, on being emancipated, must be colonized somewhere beyond the limits of the United States; Garrison held that they should be emancipated on the soil of the country, with all the rights of freemen. Garrison saw that it would be idle to expose and denounce the evils of slavery, while responsibility for the system was placed upon former generations, and the duty of abolishing it transferred to an indefinite future. His demand for immediate emancipation fell like a tocsin upon the ears of slaveholders. The *Genius*, when it became a vehicle for this dangerous doctrine, was feared and hated. Baltimore was then one of the centres of the domestic slave trade, and upon this trafficGarrison heaped the strongest denunciations. He was prosecuted for libel by the owner of a slave-carrying vessel, was fined $50, and, in default of payment, committed to jail.

John G. Whittier interceded with Henry Clay to pay Garrison's fine and thus release him from prison. Clay responded favourably, but before he could act Arthur Tappan, a philanthropic merchant of New York, contributed the necessary sum and set the prisoner free after an incarceration of seven weeks. The partnership between Garrison and Lundy was then dissolved by mutual consent, and Garrison resolved to establish a paper of his own, in which he could advocate the doctrine of immediate emancipation and oppose the scheme of African colonization. He first proposed to establish his paper at Washington, in the midst of slavery, but on returning to New England and observing the state of public opinion there, he came to the conclusion that little could be done in the south while the non-slaveholding north was lending her influence for the sustenance of slavery. He determined, therefore, to publish his paper in Boston, and set himself to the task of awakening an interest in the subject by lectures in some of the principal cities and towns of the north. In Boston, then a great cotton mart, he tried in vain to procure a church or vestry for the delivery of his lectures, until a body of infidels under the leadership of Abner Kneeland (1774–1844), proffered him the use of their small hall. He accepted it gratefully, and delivered in Oct. 1830 three lectures, in which he unfolded his principles and plans.

On Jan. 1, 1831, without capital and without a subscriber, he and his partner, Isaac Knapp (1804–43), issued the first number of the *Liberator,* avowing their "determination to print it as long as they could subsist on bread and water, or their hands obtain employment." Its motto "Our country is the world—our countrymen are mankind," shows his changed viewpoint. The paper in addition to favouring abolition, attacked war, alcoholic liquors and tobacco, and assailed freemasonry, capital punishment, and imprisonment for debt. The editor, in his address to the public, uttered the words which have become memorable as embodying the whole purpose and spirit of his life: "I am in earnest—I will not equivocate—I will not excuse—I will not retreat a single inch—and I will be heard." For many months Garrison and his partner made their bed on the floor of the room in which they printed their paper, and where Mayor Harrison Gray Otis of Boston, in compliance with the request of Governor Robert Y. Hayne of South Carolina, "ferreted them out." Otis decided, however, that the paper could not be suspended. In the same year (1831), $5,000 reward was offered for Garrison's arrest and conviction under the laws of Georgia. The *Liberator,* though in constant financial difficulties, exerted a mighty influence, and lived to record not only President Lincoln's proclamation of emancipation, but the adoption of an amendment to the constitution of the United States forever prohibiting slavery.

Garrison was a pacifist, and sought the abolition of slavery by moral means alone. He knew that the national government had no power over the system in any state, though he thought it should bring its moral influence to bear in favour of abolition. His idea was to combine the moral influence of the north, and pour it through every open channel upon the south. To this end he made his appeal to the northern churches and pulpits, beseeching them to bring the power of Christianity to bear against the slave system, and to advocate the rights of the slaves to immediate and unconditional freedom. When they did not respond, he denounced them, and by 1840 had become very unorthodox. The first society organized under Garrison's auspices, and in accordance with his principles, was the New England antislavery society in Jan. 1832. The same spring Garrison issued his *Thoughts on African Colonization,* in which he showed from official documents that the American colonization society was organized in the interest of slavery, and that in offering itself as a practical remedy for that system it was guilty of deception. Garrison was deputed by the New England antislavery society to visit England for the purpose of counteracting the influence there of agents of the colonization society. He went in the spring of 1833, and was received with great cordiality by British abolitionists. He took home with him a "protest" against the American colonization society signed by Wilberforce, Zachary Macaulay, Samuel Gurney, William Evans, S. Lushington, T. Fowell Buxton, James Cropper, Daniel O'Connell and others.

Garrison's visit to England enraged the pro-slavery people, and when he returned in September with the "protest" against the colonization society, and announced that he had engaged the services of George Thompson as a lecturer against American slavery, there were fresh outbursts. The American antislavery society was organized in December of that year (1833), the declaration of its principles coming from Garrison's pen. The activities of this society and Thompson's lectures aroused such fury that, in the autumn of 1835, Thompson was compelled to return secretly to England. He had announced that he would address the women's antislavery society in Boston, and a mob gathered. Not finding him, it seized Garrison and dragged him through the streets until he was rescued, and protected in the jail until he could leave the city in safety.

The abolitionists of the United States were a united body until 1839–40 when division occurred. Garrison countenanced the activity of women in the cause, even appointing them as lecturing agents; moreover, he believed in the political equality of the sexes, to which a strong party was opposed upon social and religious grounds. His attack on the churches caused dissent. Many believed that Garrison injured abolitionism by causing it to be associated in men's minds with these unpopular views on other subjects. These differences led to the organization of a new national antislavery society in 1840, and to the formation of the "Liberty Party" (*q.v.*) in politics (*see* BIRNEY, JAMES *G.*). The two societies sent their delegates to the world's antislavery convention in London in 1840, and Garrison refused to take his seat in that body, because the women delegates from the United States were excluded. The discussions of the next few years served to make clearer than before that the constitution of the United States supported slavery; and Garrison came to the conclusion that its pro-slavery clauses were immoral, and that it was therefore wrong to take an oath for its support. Because of this, Garrison burned the constitution, denouncing it as "a covenant with death and an agreement with hell." He chose as his motto, "No union with slaveholders," and thereafter worked for peaceful disunion. When in 1861 the southern states seceded from the union and took up arms against it, he saw clearly that slavery would perish in the struggle and that the constitution would be purged of its pro-slavery clauses. He therefore ceased to advocate disunion, and devoted himself to hastening the inevitable event. His services at this period were recognized and honoured by President Lincoln and others in authority, and the whole country knew that the agitation which resulted in the abolition of slavery was largely due to his uncompromising spirit and indomitable courage.

In 1865 at the close of the war, he declared that, slavery being abolished, his career as an abolitionist was ended. He counselled a dissolution of the American antislavery society, insisting that it had become *functus officiis,* and that whatever needed to be done for the protection of the freedmen could best be accomplished by new associations formed for that purpose. The *Liberator* was discontinued at the end of the same year, after an existence of 35 years. He visited England for the second time in 1846, and again in 1867, when he was received with distinguished honours, public as well as private. In 1869 he became president of the Free Trade league, advocating the abolition of custom houses throughout the world. In 1877, he again visited England, and declined every form of public recognition. He died in New York on May 24, 1879, at the age of 74, and was buried in Boston, after a most impressive funeral service, four days later. In 1843 a small volume of his *Sonnets and other Poems* was published, and in 1852 appeared a volume of *Selections from his Writings and Speeches.*

Garrison's son, WILLIAM LLOYD GARRISON (1838–1909), was a prominent advocate of the single tax, free trade, woman's suffrage, and of the repeal of the Chinese Exclusion act, and an opponent of imperialism. Another son, WENDELL PHILLIPS GARRISON (1840–1907), was literary editor of the New York *Nation* from 1865 to 1906.

BIBLIOGRAPHY.—The great authority on the life of Garrison is the thorough and candid work of his sons, W. P. and F. J. Garrison, *William Lloyd Garrison, 1805–1879; The Story of his Life told by his Children* (4 vols., 1885–89). See *Garrison: an Outline of his Life* (1879), and *William Lloyd Garrison and his Times* (1880) by Oliver Johnson, a prominent abolitionist and intimate friend of Garrison. Goldwin Smith's *The Moral Crusader; a Biographical Essay on William Lloyd Garrison* (1892) is a brilliant sketch. J. J. Chapman's *Garrison* (1913) is valuable for its picture of the abolition movement; Lindsay Swift, *William Lloyd Garrison* (1911), is a reliable biography though it is too eulogistic; Edward Channing, *A History of the United States* (vol. v and vi, 1905–25), and Ellis Paxson Oberholtzer, *A History of the United States since the Civil War* (1917–26) give the relation of Garrison to the history of his time.

GARROTTE (Spanish for "cudgel"), an appliance used in Spain and Portugal for the execution of condemned criminals (*see* CAPITAL PUNISHMENT). The execution was performed originally by twisting a cord or bandage on the criminal's neck until strangulation occurred but later a mechanically operated metal collar was adopted. "Garrotting" is the name given in England to a form of robbery with violence which became rather common in the winter of 1862–63. An act of 1863, imposing the penalty of flogging in addition to penal servitude for this offense, had the effect of stopping it almost entirely.

GARRYA, the single genus of attractive, broad-leaved, evergreen, treelike shrubs of the family Garryaceae consisting of several Californian, Mexican and Central American species closely related to the dogwood family, Cornaceae. Their male and female flower-bearing catkins occur on separate plants, are pendulous, several inches long and somewhat woolly—hence the common name "Silk Tassel Bush." Hypogynous, pulpy berries develop in the female catkins.

The leaves of different species vary from light to dark green on top. are hairy or downy on the lower surface, and have smooth to wavy margins. Two California species, *Garrya elliptica* and *G. fremontii,* have been horticulturally adapted.

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GARSHIN, VSEVOLOD MIKHAILOVICH (1855–1888), Russian author. was born in the government of Ekaterinoslav (Dnepropetrovsk) in Feb. 1855, the son of a retired army officer. From his childhood he had a nervous temperament, and in 1872 he was put under restraint for a year. In 1874 he entered the High School of Mines at St. Petersburg (now Leningrad), but on the outbreak of the Russo-Turkish War (1877) he enlisted as a private in an infantry regiment. Wounded in hug. 1878 he was invalided home; from that time he suffered from frequent attacks of melancholia. He died on March 24, 1888. Many of his best known stories, *The Signal* (1912); *The Coward, Mad Love,* or *An Artist's Dream* (1889); *The Red Flower* (1883); *Attalea Princeps* and *That which was Not* have been translated into English. His *Four Days,* written while he was lying wounded at Kharkov. created a great sensation.

GARSTANG, JOHN (1876–1956), British archaeologist whose unusually wide experience of sites in the middle east culminated in his work at Mersin, Turkey, during 1937–47, was born in Blackburn. Lancashire, May 5, 1876. In 1897, while a mathematical scholar at Jesus college, Oxford, he began the excavation of Roman sites in England and in 1902 was made honorary reader in Egyptian archaeology at Liverpool university. He became professor of archaeological methods and practice there in 1907, and retained this position until his retirement in 1941. During 1900–08 he excavated sites in Egypt, Nubia and Asia Minor, becoming an authority on the Hittite civilization, on which he published a standard work, *The Land of the Hittites* (1910), revised as *The Hittite Empire* in 1929. His excavations of the ancient Ethiopian capital, Meroë, 1909–14, revealed evidence of its occupation by Roman troops.

During World War I Garstang served with the Red Cross in France. In 1919 he was made director of the British School of Archaeology in Jerusalem and in 1920 was also made first director of the Palestine department of antiquities. He retired from both posts in 1926 In 1930 he began work at Jericho, where important discoveries were made about the city's history in the Bronze Age. His work at hfersin began in 1937; he published his conclusions in 1953 (*Prehistoric Mersin)*; and although some features of his method and presentation were criticized, its importance was recognized by his appointment as first director of the British Institute of Archaeology at Ankara. 1947–48, and president from 1949 until his death at Beirut, Lebanon, Sept. 12, 1956. His books included *The Foundations of Bible History: Joshua, Judges* (1931).

GARSTIN, SIR WILLIAM EDMUND (1849–1925), British engineer, was born in India on Jan. 29, 1849. He was educated at Cheltenham and King's college, London, and in 1872 entered the Indian public works department. In 1885 he was transferred to Egypt, and in 1892 became inspector general of irrigation and under secretary of state for public works. He proved himself an indefatigable worker, and by his efforts extensive areas were reclaimed in Egypt and the Sudan. Among his greatest works were the Asyut barrage and the Aswan reservoir. In addition, it was due to him that the White Nile was cleared of sudd, thus rendering possible free navigation between Khartoum and Gondokoro. In 1907 he was appointed British government director of the Suez Canal company. During World War I he devoted himself to Red Cross work in England, being created G.B.E. in 1918.

He died in London on Jan. 8, 1925.

GARTH, SIR SAMUEL (1661–1719), English physician and poet, entered Peterhouse, Cambridge, in 1676, graduating B.A. In 1679, and M.A. in 1684. He took his M.D. and became a member of the College of Physicians in 1691. In 1699 he published a mock-heroic poem, *The Dispensary,* in six cantos, which had an instant success, passing through three editions within a year. The poem is a record of the first attempt to establish the outpatient rooms which later became common in England, and ridicules the apothecaries and their allies among the physicians. Garth was a member of the Kit-Kat club, and became the leading physician of the Whigs, as Radcliffe was of the Tories. In 1714 he was knighted by George I and was made physician-in-ordinary to the king and physician-general to the army. He died on Jan. 18. 1719.

GARTOK (GARYARSA) is the capital of Ngari (Ari) district in the western Tibetan highland. Ngari was the birthplace of the native pre-Buddhic Tibetan religion, Bon Po, a mixture of exorcism and primitive worship, and was also the scene of the Buddhist renaissance in the 11th century. Gartok, on the upstream of the Indus, is the western gateway to Tibet. A caravan route leading to Leh and Simla in India through the Shipki pass has existed for centuries. Gartok is joined to Ngachuka via Zhikatse, and to Polur and Khotan in Sinkiang by modern highways. The Taklakot or Taklakhar highway, 157 mi. long, links Gartok with Pulanchung (Puran Tzong), a rich agricultural region on the south.

Gartok, once a desolate town in winter, was considerably built up after the Chinese Communist occupation of Tibet. A large garrison force is stationed in the region. New banks, post offices, schools, general stores and hospitals have been constructed along the Gar river.

During the warm season, a brisk barter trade is carried on between the nomads from the northern plain, the Zhikatse merchants and the traders from India and Nepal. Regular fairs are held throughout the summer, attracting as many as 2,000 people daily, with hundreds of tents littering the bare plain and hillside during the night. (T.-L. S.)

GARUT, a regency in Java, Indonesia. It has a population of 847,758, and is the centre of a well-cultivated region, noted for its tea, rubber and cinchona plantations, but is better known as one of the most beautiful health resorts of Java. Situated at a height of 2,300 ft. above sea level, the town (pop. 55,850) is very charmingly laid out. The regency forms a plateau, around which are grouped magnificent mountains, some volcanoes, with mountain lakes, hot springs and other wonders of nature. Among the most interesting excursions are the crater of the Papandayan, a volcano still active, which blew out the greater part of one side of a mountain in 1772, killing thousands of people and destroying much of the surrounding countryside; the Kawah Kamodyan, a most interesting collection of pools of boiling mud, geysers and fumaroles; the Telega Bodas, or White lake, situated amid charming forest scenery; the Kawah Manut, or Bird's Crater; the lakes of Bagendit and Leles, and the hot springs of Chipanas; the lake of Pendjalu; and Mount Chikorai. The regency was occupied by the Japanese from March 1942 to the end of World War II.

(E. E. L.; X.)

GARY, ELBERT HENRY (1846–1927), U.S. jurist and chief organizer of the United States Steel corporation, was born on Oct. 8, 1846, near Wheaton, Ill. He studied law first in the office of his uncle, Col. Henry Vallette, and then at the Union College of Law in Chicago, from which he was graduated in 1867. In 1869 he began his law practice in Chicago. He was elected judge of Du Page county in 1882 and again in 1886. During this period he also frequently held court in Chicago and Cook county and occasionally presided over important cases in other counties throughout the state of Illinois. He was three times elected president of the town of Wheaton and, on its becoming a city in 1890, served as mayor for two terms.

A leader and authority in corporation law and insurance matters, he became general counsel and a director in a number of large railroads, banks and industrial corporations, including steel and wire companies. In 1891 he was one of the organizers of the Consolidated Steel and Wire company. In 1898. upon the organization of the Federal Steel company, with the financial backing of J. P. Morgan and Company, he became its first president and retired from legal practice. This company was merged in 1901 with the U.S. Steel corporation, which was then organized with a capital stock exceeding $1,000,000,000, then by far the largest industrial corporation in the world. Gary was elected chairman of the executive committee and later chairman of the board of directors and of the finance committee, and continued to be chief executive officer during 26 years of remarkable development of the steel industry and growth of the corporation.

The steel mills and town of Gary, Ind., were laid out in 1906 by the U.S. Steel corporation and later named in his honour. By the time of Gary's death, the town had grown to be a city of more than 100,000, with enormous and varied mills for the manufacture of iron and steel products. As chairman of U.S. Steel, he advocated and established many measures for the welfare of the employees of industrial corporations, including stock ownership by them and participation in profits, high wages and safe, sanitary and pleasing surroundings. He was always a strong advocate and a firm upholder of the open shop. During his chairmanship the 7-day week and the 12-hour day for labour in the steel mills were abolished. He died in New York city, Aug. 15, 1927.

(J. A. FA.; X.)

GARY, one of the largest cities in Indiana. is located at the southern end of Lake Michigan. The city's history began in 1906 with the construction of the huge steel mills and various subsidiary plants of the United States Steel corporation. Since the building of the municipality was included in the plans of the steel company, Gary was a "city by decree." Gary was incorporated as a town in 1906 and became a city in 1909. It was named for Judge Elbert H. Gary, chairman of the board of directors of United States Steel.

In 1905 and 1906 the steel company purchased 9,000 ac. of sand ridges and swamps which included a frontage of more than seven miles on Lake Michigan. The location was selected because of its position midway between the iron ore beds of the north, accessible by water, and the coal region of the south. The steel works were constructed along the lake shore and the city was located to the south. The Gary Land company, a subsidiary of the steel corporation. platted and laid out its part of the city, constructed the streets and sidenalks, installed the sewage system and built the water works and electric plant. In Dec. 1908 the first blast furnace was fired, and the production of steel began early the following year. Subsidiary plants of the United States Steel corporation, American Bridge, American Sheet and Tin Plate and National Tube mills were located in the vicinity, and a large manufactory of portland cement was established. Manufacturers of screws and bolts, steel springs, automobile bodies and chemicals also established plants in the course of the years. However, Gary is essentially a one industry city; it has periodically suffered economic hardship when steel production has declined and when the huge mills have been shut down by strikes, as during the 116-day strike in the fall of 1959, which was finally settled in Jan. 1960.

Culturally, Gary was the scene of the establishment by William A. Wirt of the work-study-play school, more popularly known as the platoon school, a significant development in the history of public-school education. The city is served by an extension centre of Indiana university. The park system includes a public beach on Lake Michigan. The population soared, reaching 178,320 in 1960; for comparative population figures *see* table in ISDIANA: *Population.* In the 1950 census Gary was treated as a part of the Chicago metropolitan area; in 1960 it was designated a central city of the Gary-Hammond-East Chicago standard metropolitan statistical area, comprising Lake and Porter counties, pop. 573,548, a part of the Chicago standard consolidated area. *See* CHICAGO: *Population: Metropolitan Area.* (P. ME.)

GAS, a general term for one of the three states of aggregation of matter; also more specifically applied to coal gas. *See* ANESTHESIA AND ANESTHETICS; CHEMISTRY: *Physical Chemistry*; GAS INDUSTRY; CHEMICAL WARFARE.

GAS CHAMBER, a method of execution used in the United States, introduced in an effort to provide a more humane way of killing condemned criminals; it was first used in Nevada in 1924. It consists of a sealed chamber into which poisonous fumes are injected. The condemned man is strapped in a chair in the lethal chamber and is killed by inhaling the fumes. If the prisoner breathes deeply, his death is almost instantaneous and painless, but many resist by holding their breath or by taking short, slow breaths, and some observers claim that these prisoners suffer very much By the second half of the 20th century nearly one-fourth of the states prescribed the gas chamber as the method of execution

See also CONCENTRATION CAMPS: *Nazi Germany.*

(R. G. CL.)

GASCOIGNE, GEORGE (c. 1530–1577), English poet: was one of the most talented of the writers who flourished during the early Elizabethan period, before Edmund Spenser's *Shepheardes Calender* (1579) gave a new direction and impetus to English poetry. The son of Sir John Gascoigne of Cardington, Bedfordshire, he attended Trinity college, Cambridge, began the study of law at Gray's Inn in 1555, and thereafter pursued careers as a politician, country gentleman, courtier, soldier of fortane and man of letters, achieving moderate distinction in each. He was M.P. for Bedford in the parliaments of 1557–58 and 1558–59. In 1561 he married Elizabeth Breton, a widow, and thus became stepfather to the poet Nicholas Breton. On his paternal estate be became involved in litigation, mainly because of his extravagance and debts. was once imprisoned in Bedford jail and gained a reputation for disorderly living. From 1572 to 1574 he served with English troops in the Low Countries and obtained a captain's commission, ending his military career as a repatriated prisoner of war. In 1575 he helped to arrange the celebrated entertainments provided for Queen Elizabeth I at Kenilworth and Woodstock, and in 1576 went to Holland as an agent in the royal service. Gascoigne died at Bernack, near Stamford; on Oct. 7, 1577, and was buried at Stamford. Among his personal friends were many of the leading poets, courtiers and court ladies of his day, notably the poets George Whetstone, George Turberville and Edmund Spenser and the literary patron Lord Grey of Wilton.

Gascoigne was a skilled literary craftsman, and his work is memorable for its versatility and vividness of expression and for his treatment of events based on his own experience; but his chief importance is as a pioneer of the English Renaissance, with a remarkable aptitude for domesticating ioreign literary genres. He foreshadowed the English sonnet sequences with groups of linked sonnets in his first published work, *A Hundreth Sundrie Flowres* (1573), a collection of verse and prose. In *The Posies* (1575), an authorized revision of the earlier work which had been published anonymously, he included also "Certain Notes of Instruction," the first treatise on prosody in English. In *The Steel Glass* (1576), one of the earliest formal satires in English, he wrote the first original nondramatic English blank verse. In subject, however, *The Steel Glass* is traditional; it is an attack, in the spirit of *Piers Plowman,* on the worldliness, corruption and Italianate manners of the aristocracy, and a defense of native feudal virtues. In two amatory poems, the autobiographical "Dan Bartholomeu of Bath" (published in *A Hundreth Sundrie Flowres)* and *The Complaint of Pkilomene* (1576), Gascoigne developed Ovidian verse narrative, the form used by Shakespeare in *Venus and Adonis* and *Lucrece.*

"The Adventures of Master F. J.", published in *A Hundreth Sundrie Flowres,* was the first original prose narrative of the English Renaissance. Probably because of embarrassment caused by the factual elements in this tale of love intrigue in an English country house, Gascoigne revised the work; and it appeared in *The Posies* as "The Pleasant Fable of Ferdinando Jeronimi and Leonora de Valasco," purportedly a translation from the Italian with the more libidinous passages removed. Another prose work. *The Spoil of Antwerp* (1576), is an early example of war journalism, characterized by objective and graphic reporting.

Gascoigne's *Jocasta* (performed in 1566) was the first Greek tragedy to be presented on the English stage. Translated into blank verse, with the collaboration of Francis Kinwelmersh, from Lodovico Dolce's *Giocasta,* it derives ultimately from Euripides' *Phoenissae.* In comedy, Gascoigne's *Supposes* (1566?), a prose translation and adaptation of Ariosto's *I Suppositi,* was the first prose comedy to be translated from Italian into English. A dramatically effective work, it provided the subplot for Shakespeare's *The Taming of the Shrew.* A third play, *The Glass of Government* (1575), is a didactic drama on the prodigal son theme. Together with several moralistic works in traditional forms of verse and prose on such commonplace themes as the vanity of human life, the sinfulness of man and the evils of drunkenness, it rounds out the picture of Gascoigne as a typical literary man of the early Renaissance, who never lost contact with native tradition as he made his periodic excursions into foreign literature to bring back new forms and themes.

The standard edition is *The Complete Works of George Gascoigae,* edited by J. W. Cunliffe, published in two volumes (1907–10). The original version of his first published work was reprinted in *George Gascoigne's "A Hundreth Sundrie Flowres,"* edited by C. T. Prouty (1942).

See C. T. Prouty, *George Gascoigne, Elizabethan Courtier, Soldier, and Poet* (1942); S. A. Tannenbaum, *George Gascoigne, a Concise Bibliography* (1942). (L. A. SK.)

GASCOIGNE, SIR WILLIAM (c. 1350–1419), chief justice of England in the reign of Henry IV. Gascoigne practised as an advocate in the reigns of Edward III and Richard II. On the banishment of Henry of Lancaster, Gascoigne was appointed one of his attorneys, and soon after Henry's accession to the throne was made chief justice of the court of king's bench. After the suppression of the rising in the north in 1405, Henry eagerly pressed the chief justice to pronounce sentence upon Scrope, the archbishop of York, and the earl marshal Thomas Mowbray, who had been implicated in the revolt. This he absolutely refused to do, asserting the right of the prisoners to be tried by their peers. Although both were afterward executed, the chief justice had no part in the transaction. The oft-told tale of his committing the prince of Wales to prison is unauthentic, though it is characteristic of Gascoigne's independence. Gascoigne appears to have been removed from his post or to have resigned soon after the accession of Henry V. He died in 1419, and was buried in the parish church of Harewood in Yorkshire.

GASCONY (WASCONIA; Fr. *Gascogne),* an old province in southwest France. It takes its name from the Vascones, people of Iberian origin settled in the north of Spain who, between 561 and 602, crossed the Pyrenees and invaded the district known to the Romans as Novempopulana or Aquitania Tertia. Basque, the national language of the Vascones, took root only in a few of the high valleys of the Pyrenees, such as Soule and Labourd; in the plains Latin dialects prevailed, Gascon being a Romance language. In the 7th century the name of Vasconia was substituted for that of Novempopulana. The Vascones readily recognized the sovereignty of the Merovingian kings, but in reality they remained independent. They even appointed national dukes, against whom Charlemagne had to fight at the beginning of his reign. Finally, during the second half of the 9th century, the Carolingians were able to establish Frankish dukes in the country. But it must be admitted that, at that time and in the 10th century, the history of Gascony falls into the profoundest obscurity. In the feudal period Gascony comprised a great number of countships (including Armagnac, Bigorre, Fezensac, Gaure and Pardiac), viscountships (including Béarn, Lomagne, Dax, Juliac, Soule, Marsan, Tartas, Labourd and Maremne) and seigneuries (Albret, etc.).

During the Hundred Years' War Gascony was a battlefield for the forces of England and of France. The French seized the duchy, but, aided by the rivalry between the powerful houses of Foix and Armagnac, Edward III was able to recover it; and by the treaty of Brétigny in 1360 John II recognized the absolute sovereignty of England therein. Handed over as a principality by Edward to his son, the Black Prince, it was used by its new ruler as a base during his expedition into Spain, in which he received substantial help from the Gascon nobles. The renewal of the war between England and France, which took place in 1369, was due in part to a dispute over the sovereignty of Gascony, and during its course the whole of the duchy save a few towns and fortresses was lost; but the victories of Henry V in northern France postponed for a time the total expulsion of the foreigner. This was reserved for the final stage of the war and was one result of the efforts of Joan of Arc, the year 1451 witnessing the capture of Bayonne and the year 1453 the final retreat of the English troops from southwestern France.

The French kings, especially Louis XI, managed to restore the royal authority in the duchy, although this was not really accomplished until the close of the 15th century when the house of Armagnac was overthrown. It was by means of administrative measures that these kings attained their object. Gascony was governed on the same lines as other parts of France; and from the time of Henry IV, who was prince of Béarn and who united his hereditary lands with the crown, its history differs only slightly from that of the rest of the country. The Renaissance inspired the foundation of educational institutions and the Reformation was largely accepted in BCarn, but not in other parts of Gascony. The wars of religion swept over the land, which was the scene of some of the military exploits of Henry IV; and Louis XIV made some slight changes in its government. As may be surmised, the boundaries of Gascony varied from time to time, but just before the outbreak of the Revolution they were the Atlantic ocean, Guienne, Languedoc and the Pyrenees; and from east to west the duchy at its greatest extent measured 170 mi.

At the end of the *ancien régime* Gascony was united with Guienne to form a great military government. After the division of France into *de'partements,* Gascony, together with Béarn, French Navarre and the Basque country, formed the *de'partements* of Basses-Pyrénées, Landes, Hautes-Pyrénées and Gers. Parts of Gascony also now form *arrondissements* and cantons of the *départements* of Lot-et-Garonne, Haute-Garonne, Ariège and Tarn-et-Garonne.

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GAS ENGINE: *see* INTERNAL-COMBUSTION ENGINE.

GASHOLDERS. Since the manufacture of gas must be maintained at an approximately even rate throughout the 24 hrs., while the rate of consumption varies considerably at the different hours of the day, it is necessary to provide storage for the gas produced during the periods of minimum demand, and also to provide against any temporary breakdown in the manufacturing plant. In the early days of the gas industry the vessel in which the gas was stored was known as a "gasometer," since this vessel had to serve the dual purpose of storing and measuring the amount of gas made. With the advent of the station meter in the year 1820 for measuring the volume of gas, the name of "gasholder" was adopted, but even now in Great Britain journalists and others invariably use the technically obsolete word "gasometer."

The capacity of the gasholder should be equal to at least 75% of the maximum daily output. There are now four distinctive types of gasholders: (1) frame guided; (2) spirally guided; (3) dry or tankless; (4) spherical. The frame guided and spirally guided holders may have one or more lifts, the one lift type being known as a single lift holder, and the other as a telescopic gasholder, the latter type being generally adopted for economic reasons. The movable vessel in which the gas is stored is known as the floating gasholder. The steel structure which guides the floating holder as it ascends or descends is termed the guide framing, and is erected round the circumference of the steel or brick tank which contains the water for sealing the sides of the floating gasholder, thus preventing the escape of gas. Gas is admitted into the holder by means of an inlet pipe which passes through the bottom of the tank, and extends to a height of about 6 in. above the water level; another similar pipe is provided as an outlet for the gas to the district mains; both pipes being controlled by slide valves.

The telescopic form of holder (fig. 1) consists of two or more lifts, which work or slide inside one another, much in the same way as an ordinary telescope. The inner or first lift is constructed to a certain diameter, according to the capacity required, and the diameter of each succeeding lift is increased by about 2 ft., whilst the depth of each lift would be constant, and equal to about one-fifth the diameter. In order to secure a gas-tight joint between

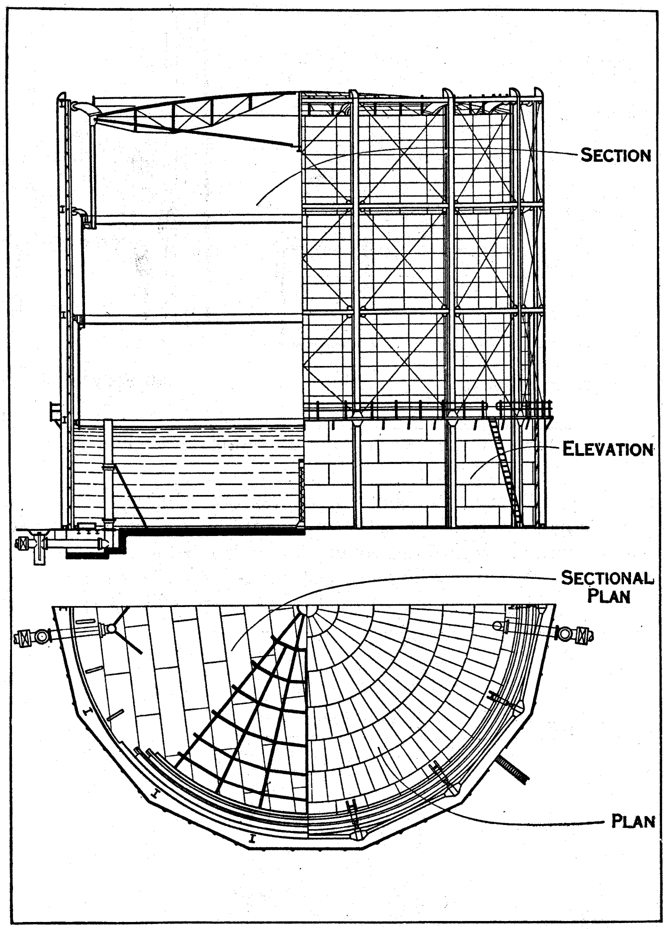


FIG. 1.—ELEVATION AND SECTIONAL PLAN OF TELESCOPIC GASHOLDERS
This type consists of two or more lifts working into each other on the telescopic principle. The diameters of the lifts decrease by 2 ft., the depths remaining constant

the lifts as they leave the tank, the bottom row of sheeting of the inner lift is prepared with a channel cup about 18 in. deep, whilst the top row of sheeting of the adjoining lift is fitted with an inverted channel cup, usually termed the "dip" (fig. 2). As the inner lift rises out of the water in the tank, the channel cup engages with the dip, thus making a gas-tight water-sealed joint between the lifts. Each succeeding lift is fitted with a dip at the top, and a cup at the bottom, with the exception of the final or outer lift, which is provided with a dip at the top only, and a strong angle steel curb at the bottom. The crown of the holder is dome-shaped, and when at rest in the tank, is either supported by a trussed steel roof forming part of the inner lift, or upon a permanent steel or timber framing erected in the tank. The sheeting of the sides and crown of the holder is about $\frac{1}{8}$ in. thick, with the exception of the rows of sheets adjoining the cup and dip, and also the junction between the crown and sides of the inner lift, which are much thicker, in order to allow for extra wear and strain at these points. The tank may be constructed in brick, concrete or steel. Brick and concrete tanks are usually constructed by excavating the ground and building up the sides of the tank, so that the top of same finishes about 6 in. above the ordinary ground level Water-tightness is obtained by encasing the bottom and side walls of the tank in a layer of clay puddle, or by coating the inside surface of the tank walls with cement. Steel tanks are usually erected on a flat bed of concrete, laid at a foot or so below the normal ground level, the sides being formed of a number of tiers of steel plates varying in thickness to suit the pressure due to the depth of water. in the tank. Steel tanks are much less costly than either brick or concrete tanks, and can be much more quickly erected.

Frame Guided **Gasholders.**—These consist of a series of columns or standards fixed at equal distances round the circumference of the tank, which are connected together by one or more tiers of horizontal girders or struts, and a series of diagonal bracing rods, thus forming a continuous tie all round. The guide framing may be carried up to the full height of the holder when fully inflated, or to the top of the second lift only, thus allowing the inner lift to run clear of the guide framing, which is then known as a "flying lift." Channel guide runs are fixed to the inner face of the standards, to form a pathway for the guide rollers—which are attached to the crown and the dip of each lift—to work up and down for the purpose of guiding the gasholder and enabling it to withstand the overturning force of the wind. The underside of each cup is fitted with a corresponding number of radial rollers, which run in channel guides fixed to the inside of the next adjoining lift; the bottom curb of the outer lift is also fitted with similar rollers working in channel guides fixed to the sides of the tank.

Spirally Guided **Gasholders.**—The floating lifts of a spirally guided gasholder (fig. 3) are practically the same in construction

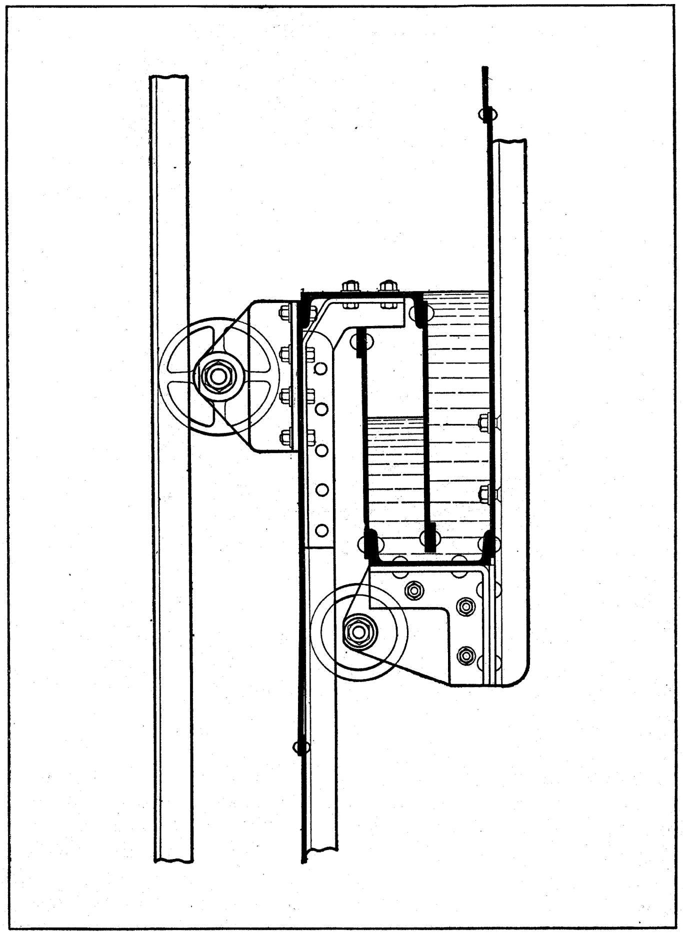


FIG. 2.—CROSS-SECTION OF THE "CUP AND DIP." WHICH MAKES THE CONNECTION BETWEEN THE TWO LIFTS AND FORMS THE HYDRAULIC SEAL

as the frame guided holder, with the exception that a number of double flanged rails, inclined at an angle of 45° are secured to the side sheeting of each lift at equal distances round the circumference. The spiral guides run between a corresponding number of sets of rollers (fig. 4) mounted in adjustable carriages, secured to the dips of the holder and top curb of the tank. The action of the holder in rising or falling is comparable with the action of a coarse-threaded screw, and the spiral motion thereby imparted to the floating vessel is sufficient to maintain the holder in a level condition, and enables it to resist the overturning force produced by the wind. This form of holder costs from 10% to 15% less than the frame guided holder.

Dry **Gasholders.**—In this type of holder (fig. 5) the tank with its water content is dispensed with, thereby greatly reducing the cost of foundations. The tankless gasholder consists of a cylindrical steel plate tower, within which a horizontal disk or piston moves up or down, receiving or expelling the gas. The piston is guided in its vertical movement by a system of rollers, travelling up or down the inner sides of the steel cylinder. The periphery or outer edge of the piston is lubricated and maintained gastight by means of several layers of moulded rubber packing rings, which

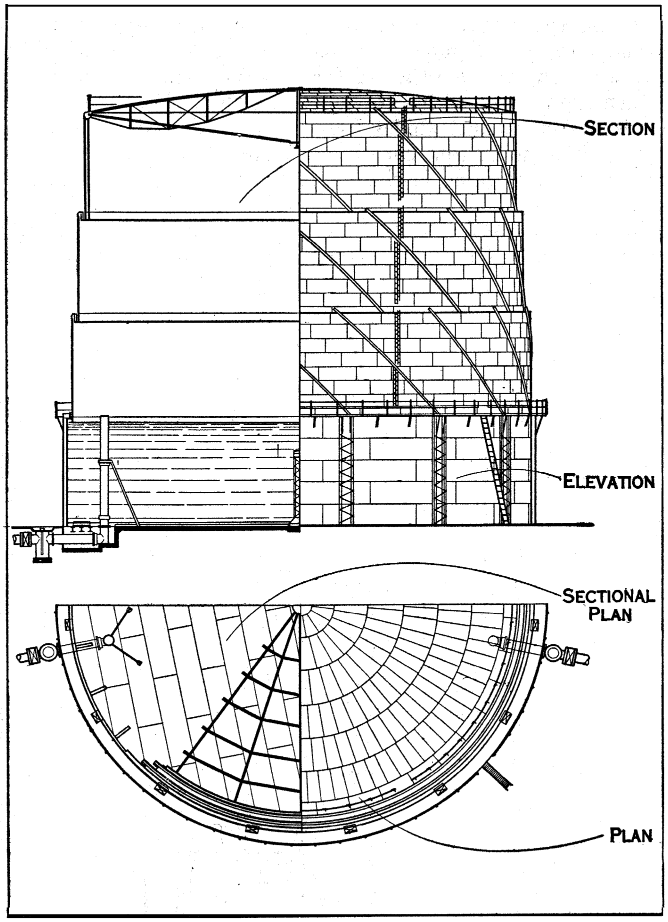


FIG. 3.—THE ELEVATION AND PLAN OF SPIRALLY GUIDED GASHOLDER

The construction differs from the telescopic type in having a number of double-flanged rails, inclined at 45°, secured to the side sheeting of each lift

effectively confine the gas to the underside of the piston. The interior of the tower above the piston is freely accessible, well ventilated and lighted by openings provided in the sides of the tower above the highest gas level. The packing seal, guide rollers and lubricators can, therefore, be readily inspected at any time, without interfering with the normal working of the gasholder. The roof of the dry gasholder does not enclose the gas—this being the function of the moving piston—and is only required to perform the duty of sheltering the moving piston from rain, snow and dust.

Another type of dry gasholder consists of a polygonal steel tower, with movable piston, similar in construction to that previously described, but in this design the periphery of the piston is maintained gastight by means of a light gas tar of moderate viscosity, contained in an annulus formed on the outer edge of the piston. As this seal is not absolutely tartight, a small quantity of tar escapes and flows to the bottom of the cylinder, where it is collected in a series of chambers and is pumped up again by a number of automatically controlled electric pumps to the top of the tower.

Spherical **Gasholders.**—This type (fig. 6) is principally used for storing gas under pressure. It is a plain sphere of simple construction, usually about 50 ft. in diameter, formed of steel plates about $\frac{9}{16}$ in. thick. The gas to be stored is forced by a com-

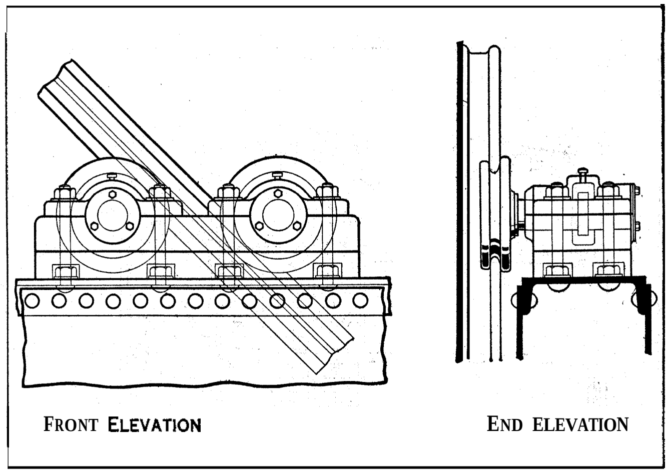


FIG. 4.— FRONT AND END ELEVATIONS OF SPIRAL GUIDE RUN BETWEEN SET OF ROLLERS

pressing plant into the sphere at a pressure of about 50 lb. per sq.in. When the gas leaves the outlet of the sphere, it is passed through suitable controlling governors, which reduces the pressure to such an extent as will meet the needs of the consumers. A sphere filled at a pressure of 50 lb. per sq.in. will store and de-

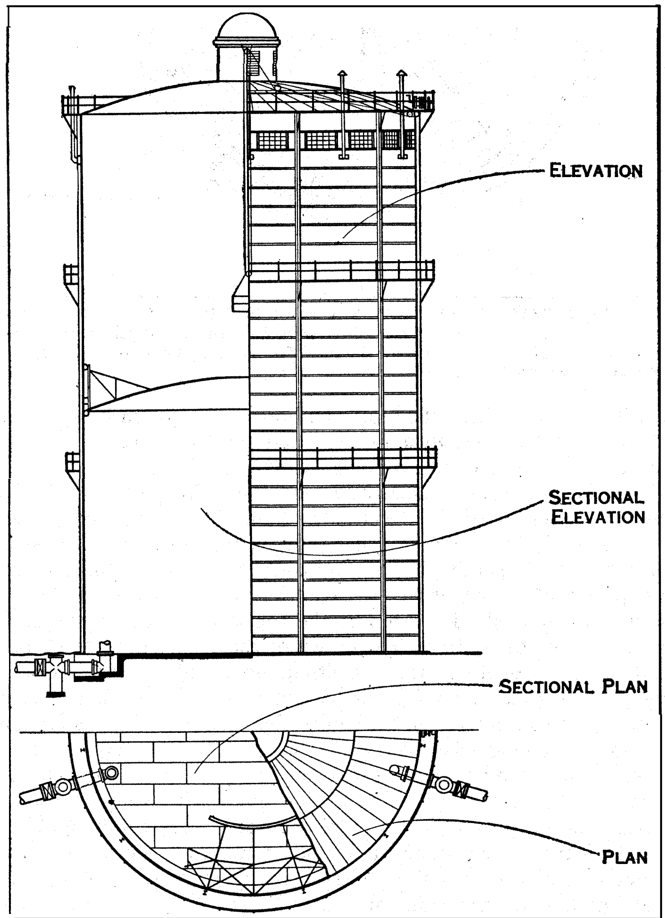


FIG. 5.— DRY GASHOLDER IN WHICH WATER TANK IS ELIMINATED

In this type of holder a great reduction in foundation costs is effected. The holder consists of a cylindrical steel tower in which a horizontal piston moves up and down, receiving or expelling the gas liver about 33 times its cubical content at the lower pressure required in the distributing mains.

See R. J. Milbourne, *Gasholder Design and Construction.*

(R. J. Mi.)

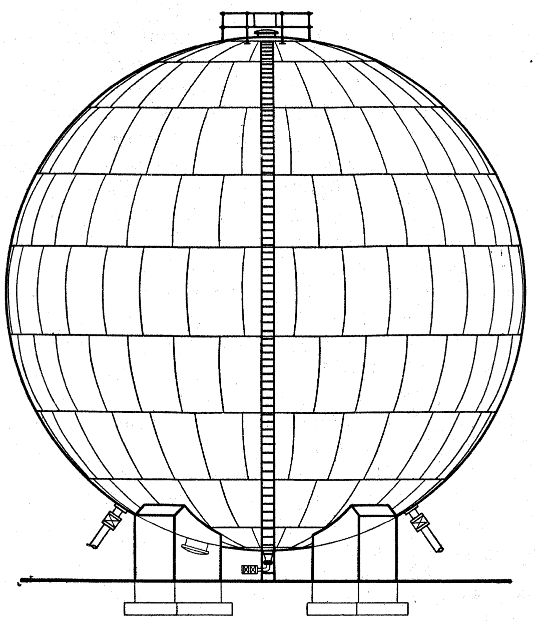


FIG. 6.—SPHERICAL GASHOLDER USED FOR STORING GAS UNDER PRESSURE

This type consists of a plain steel sphere, the contained gas being forced in at a pressure of 50 lb. per square inch

GAS INDUSTRY. Despite the increasing use of oil, coal remained, in the middle of the 20th century, the main source of heat and energy for the industries and homes of Great Britain, supplying about 90% of the country's energy requirements in 1953. Coal production was about 220,000,000 tons a year; of this more than 40,000,000 tons were processed annually to produce secondary or derived fuels, mainly coke and gas. Gaseous fuels are of various types, dependent upon the particular process employed and whether the source is coal itself or coke. Coal heated in the absence of air yields a solid residue. known as coke, together with volatile matter, most of which is the gas known as coal gas. This process. termed carbonization. was in the 1950s still by far the most important method for producing derived fuels from coal, but other gaseous fuels were being manufactured by methods known as gasification; *i.e.*, water gas made by the action of steam upon red-hot coke; and producer gas made by blowing air, usually niixed with some steam. through a deep bed of hot coke or coal. Coal gas has the highest heating value, averaging about 500 B.T.C. per cubic foot; water gas averages about 300 B.T.U., but may be enriched with oil vapours (carburetting; Table I) up to or above the value for coal gas. The heating value of producer gases is much lower (120–160 B.T.U. per cubic foot) because about one-half or as much as two-thirds of their volume is mdde up from nitrogen contained in the air used for gasification. The familiar "gas," or town gas, distributed for public supply after purification. is coal gas itself, or coal gas mixed with straight or enriched water gas. In some cases, coke-oven gas may also be added; this is essentially similar to coal gas in that it is produced by carbonizing coal. but the process is different because it is directed more to the production of coke than of gas. Producer gas is used mainly for large-scale industrial furnaces. including in particular the retorts used for the manufacture of coal gas. A broad comparison of the properties of these gases is given in Table I.

Structure and Development of the Gas Industry.— The first use of coal gas was as an illuminant which burned with a characteristic yellowish luminous flame. The earliest demonstration of this property has been variously ascribed to Jean Pierre Minckelers of Belgium. to Philippe Lebon of France and to Lord Dundonald and William Murdock of Great Britain; but William Murdock is usually given entire credit for being the first to apply coal gas on any considerable scale. Murdock set up a small experimental plant in 1795, lighted a Soho (Birmingham) factory by gas a few years later and in Feb. 1808 was awarded the Rumford medal of the Royal society of London for his invention as described in a paper read before the society.

The year 1813 saw the foundation of the London and Westminster Gas company, soon to become the famous Gas Light and Coke company. It possessed three manufacturing stations with 15 mi, of mains, and Westminster bridge was lit by its gas. Gas lighting was introduced in Bristol in 1823, by which time the Gas Light and Coke company in London was producing nearly 250,000,000 cu.ft. of gas annually for distribution through 122 mi. of street mains. Rapid expansion followed. so much so that the gas companies which had sprung up in the metropolis and in the provinces are recorded as "innumerable" in 1860. Public supply was governed by many local and general acts of parliament. With the advent of electric lighting in 1882 the industry encountered serious competition, which appeared to threaten its very existence. In fact, however, the severe shock that it experienced was a stimulus to the industry to look elsewhere than to lighting for the disposal of its products, and the great potential market available to gas in its capacity of a heating medium was soon recognized. The year 1920 stands out as epoch-making in the history of the industry. Then the Gas Regulation act was introduced. the main provision of which was to make it obligatory to charge for gas on the basis of its declared and attested heating value; furthermore, gas had to be supplied at a minimum pressure of 2 in. water gauge in mains or services of 2 in. or more in diameter. These and earlier regulations, including the requirement that gas should be entirely free from the very poisonous and objectionable hydrogen sulphide, fully protected the interests of the consumer. At that time the annual production of gas in Great Britain had risen to 250,000,000,000 cu.ft.; and there were 7,000,000 consumers (4,250,000 supplied through prepayment or "slot" meters) receiving gas through some 40,000 mi. of mains.

On May 1, 1949, the gas industry passed into national ownership in accordance with the provisions of the Gas act, 1948. Many of the provisions of the acts which previously had nationalized the coal and electricity industries were repeated, but there was one significant difference: the larger measure of decentralization and regional responsibility accorded to the gas industry.

Twelve area boards were constituted to assume the ownership of 1,037 undertakings for the nation. The area boards were separate, corporate bodies, each charged with the prime duty of developing and maintaining an efficient, co-ordinated and economical system for the supply of gas and coke and to develop and maintain efficient methods of recovering the by-products of gas manufacture.

TABLE I.—Properties of Coal, Water and Producer Gases

Properties	Coal gas	Water gas		Producer gas	
		Straight (blue)	Carburetted	From coal	From coke
Composition					
Oxygen	0.4%	—	0.4%	—	—
Carbon dioxide	2%–4%	4.7%	5.6%	4%	5%
Cnsaturated hydrocarbons	2%–4%	—	7.0%	0.4%	—
Carbon monoxide	8%–18%	41%	30.5%	29%	29%
Hydrogen	50%–54%	49%	37%	12%	11%
Methane	20%–30%	0.8%	14%	2.6%	0.5%
Nitrogen	4%–6%	4.5%	5.5%	52%	54.5%
Heating value B.T.U. per cubic foot	475–560	295	500	163	132
Density (relative to air=1)	0.4–0.48	0.55	0.63	0.87	0.90

At the same time parliament decided that a central body, the Gas council, was needed to represent the industry as a whole and to be responsible for such matters as capital finance, labour relations, research and others calling for central action. The Gas council was to consist of a chairman. a deputy chairman and the 12 chairmen of the area boards; its duty was to advise the minister of fuel and power on questions affecting the industry and generally to assist the area boards to exercise their statutory functions. Thus, after about 140 years of progressive expansion, the gas industry was unified under its central council but at the same time possessed a regional structure that was acknowledged to be well suited to its particular requirements and conducive of the best service to its consumers. Research was specified to be one of the council's responsibilities, and its obligation in this respect was interpreted as being the search for fundamental knowledge and the development of new ideas up to and including the pilot-plant stage. Large-scale plant development and the normal improvement of appliances was entrusted to the area boards and to the plant manufacturers. A permanent committee, including scientists from outside the industry, was set up to advise the council on methods of research. Research stations were established in London and Birmingham; in addition, the council contributed to a number of research associations engaged on work of interest to the industry. It also maintained the industry's close association with the University of Leeds and with the British Ceramic Research association. Statistics for the year from April 1, 1953, to March 31, 1954, showed that the area boards during that period controlled fixed and current assets amounting to £489,345,518; had a revenue of £170,138,530 from selling 2,451,000,000 therms of gas (1 therm= 100,000 B.T.U.) to 12,474,818 consumers; used 27,091,000 tons of coal in gasmaking; kept 83,427 mi of mains in use (there were thus 150 consumers per mile of main); and employed 145,031 people, comprising 109,098 operatives and an administrative and clerical staff of 35,933. The average selling price of gas per therm rose from 12.55*d.* in 1949–50 to 16.25*d.* in 1953–54, mainly because of rising coal costs and national increases in wage scales.

TABLE 11. —Composition of Coal Gas

Gases	High temperature			Low temperature
	Horizontal retort	Vertical retorts		
		Without steam	With steam	
Carbon dioxide .	2.0%	2.2%	3.4%	4.5%
Unsaturated hydrocarbon;	3.1%	2.3%	1.8%	3.8%
Oxygen	0.5%	0.4%	0.7%	0.2%
Carbon monoxide . .	8.0%	10.3%	15.1%	8.3%
Hydrogen	50.6%	49.5%	49.3%	29.1%
Methane	28.1%	28.5%	21.2%	49.1%
Nitrogen	7.7%	6.8%	8.5%	5.0%

MANUFACTURING METHODS

In Murdock's apparatus coal was contained in an inclined iron retort heated by a fire burning on a grate below. Cast-iron retorts were used for a long time in the early days of manufacture. Charged with the coal to be carbonized, the retorts were heated by small coal to temperatures of about 600°–700° C., much lower than those used in modern practice. At this point it is convenient to consider the principles involved in the carbonization process.

Coal is the term applied to those rocks in the earth's crust produced by the decay of plant remains and accumulated many millions of years ago. Coal is thus a complex mixture of organic substances which so far cannot be recognized except in broad terms. The essential elementary constituents are carbon, hydrogen and oxygen, with small quantities of nitrogen and sulphur and some incombustible matter — the ash. When heated out of contact with air, the coal more or less fuses and partially decomposes. Gaseous products of decomposition force their way through the plastic mass and give it a honeycombed structure. As the temperature of the mass increases, the coal becomes less fusible and is transformed into a porous solid known as coke. Further heating drives off more gas and results in shrinking and hardening of the-coke. The volatile matter evolved in the lower-temperature stages is rich in easily condensible tarry matter and gaseous hydrocarbons. At temperatures above 800° C. the volatile matter is principally hydrogen, with some carbon monoxide.

The manufacturing process thus consists essentially in driving off the volatile products by heat, leaving the solid residue of coke in the retort for subsequent extraction. The volatile matter, or crude gas, leaves the retorts at a temperature usually between 700°–800° C., heavily charged with steam (derived from hydrogen and oxygen in the coal as well as from actual moisture) and with condensible tarry vapours, hydrocarbons, some sulphur-containing gases, some hydrogen cyanide and ammonia. These constituents must be removed before the gas is distributed to consumers.

When the gases enter the collecting main they are cooled so that condensation takes place; and this is further assisted by washing with water. Water from condensation or from washing dissolves part of the ammonia and other constituents, forming "ammonia liquor." As a consequence of the condensation process, the volatile matter is divided into three portions; two, the tar and the ammonia liquor, are liquid. but they do not mix; the third is the gas itself, which, after further purification from tar fog, residual ammonia and hydrogen sulphide. is ready for distribution.

The proportions of gas. coke, tar and liquor vary according to the particular method used for carbonization and to the nature of the coals carbonized. In broad terms, however, the yield of these products per ton of coal processed in horizontal retorts is about 14 cwt. of coke, 10 gal. of tar and 30 gal. of liquor, the last representing a recovery of approximately 25 Ib. of ammonia as sulphate. Table II shows the composition of coal gas according to the method of carbonization employed. The tar is composed of pitch (61 3%), creosote oil (13%), carbolic oil (12.1%), light oils (9.4%), crude naphtha (2.6%) and water (1.6%). The liquor, when horizontal retorts are used, yields for every 100 c c. of its volume, 1.5 g. of fixed ammonia; 0 5 g. of free ammonia; 0.25 g. of sulphide as H_2S; 0.01 g. of cyanide as HCN; 0.1 g. of thiosulphide as S; 0.2 g. of thiocyanate as CNS; and 0.2 j g. of phenols as C_6H_5OH.

Of the various circumstances that determine the quantities and compositions of the tar, liquor and gas, the temperature at which the coal is carbonized is particularly important. The low-temperature products are those resulting from the first processes of breakdown in the coal. The high-temperature products contain many of the substances formed by the secondary decomposition of the primary products, brought about by subjecting them to a higher temperature. The difference shows itself very plainly both in the gas yield, which is much higher for high-temperature working, and in the nature of the gas, which contains much more hydrogen and less of the easily decomposable compounds of carbon and hydrogen. The tar is usually smaller in amount for high-temperature working. when it is characterized by the presence of the so-called aromatic hydrocarbons of the benzene type, which are products of secondary decomposition and are absent from low-temperature tars. The increased yield of gas in high-temperature working is partly due to the secondary decomposition of some of the more decomposable tar constituents, although it is mainly accounted for by an extensive formation of hydrogen peculiar to high-temperature working.

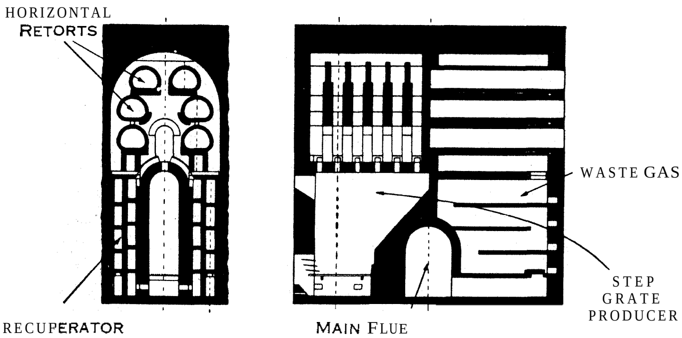
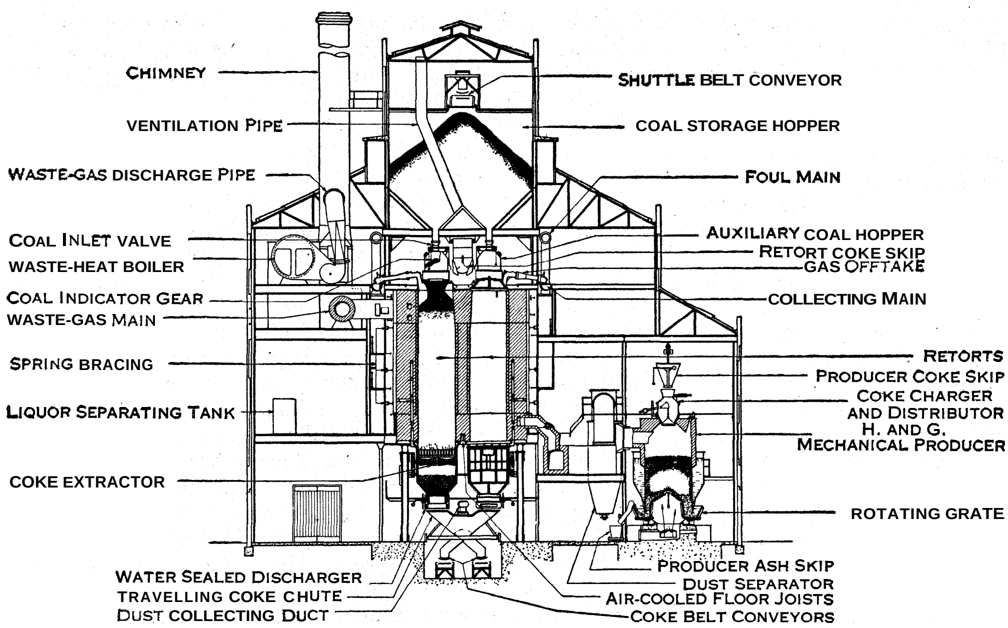


FIG. 1.—CROSS SECTION AND LONGITUDINAL SECTIONS OF A SETTING OF 6 HORIZONTAL RETORTS

Retorts.—The volume of gas obtainable by working in iron retorts was limited by the properties of this material. An important advance was made when fire clay was substituted for iron, as a higher temperature was permissible. Further improvements of a radical character followed when. in the heating of these retorts, gas firing and the recuperative principle could be employed.



BY COURTESY OF WOODALL DUCKHAM CONSTRUCTION COMPANY LTD.

FIG. 2.— CROSS SECTION OF A CONTINUOUS VERTICAL RETORT INSTALLATION

Recuperative.—The principle of the recuperative retort will be understood from fig. 1, which shows a setting of  -shaped horizontal fire-clay retorts. They are heated by producer gas made by passing air through a deep layer of red-hot coke. This gas, meeting hot air immediately under the retorts, burns around them and carbonizes the coal contained therein. The waste gases, after heating the retorts do not. hen-ever pass away directly to a chimney, as in older methods of "direct" firing, but are turned downward into the recuperator, where they pass along channels in which they are only separated by a thin fire-clay partition from air travelling upward to meet the gas. In this way some of the heat is abstracted from the waste gases and restored to the setting in the air used for combustion. Consequently, less heat leaves the setting and a higher temperature can be attained together with economy in fuel. This system of carbonization in horizontal recuperative fire-clay retorts rapidly became standard practice and remains so to some extent, although horizontal retorts are now obsolescent. It enabled an average gas yield of 10,000 cu.ft. of gas per ton of coal to be obtained; and it lowered the proportion of fuel required for heating the setting from 25%–30% of the weight of coal carbonized to 15–20%.

Although excellent in many mays. the horizontal retort setting as so far described had the disadvantage of requiring heavy labour for hand charging. This drawback has been to some extent neutralized by the use of mechanical charging machines. Other methods were hen-ever, coming forward by which the aid of gravity could be invoked for the moving of the coal and coke during carbonization and some other advantages secured. In the second half of the 20th century new installations were invariably of the vertical retort type.

Vertical.—The simplest form of the vertical retort was one in which the retorts were all set vertically (instead of horizontally, as in the past). and, being filled with coal, were heated until the whole of the charge had been carbonized, after which it was withdrawn. This so-called intermittent vertical system was patented in England by J. Bueb in 1904, after previous trial at the Dessau gasworks. It had the advantage, as compared with the hand-charged horizontal retort setting, of reducing labour and requiring less ground space for a given output. Another novel advantage was that the retort could be fully charged, thereby lessening that contact of the volatile matter with red-hot coke and the walls of the retort which gives rise to secondary decomposition. A further advance was made almost at once by the introduction of continuous working into the vertical retort system by which, instead of completing the carbonization of the whole charge before withdrawing any portion of the coke residue, a continuous feed of coal was made to the top of the retort and coke was continuously withdrawn from the bottom by an extraction mechanism.

The principal firms associated with this system are Woodall-Duckham, Glover-West and Robert Dempster and Sons. and it has been widely adopted. The idea had been applied with limited success previously by Settle and Padfield. Fig. 2 illustrates a typical setting of retorts. The heating gas from the producer passes through apertures, which can be regulated, into heating channels surrounding the retorts. The upper sections are heated by waste gases alone.

The heating quality of the gas being now of paramount importance, the heating value of a gas per cubic foot superseded its illuminating power in "standard candles" as the statutory method of defining its quality. The British Gas Regulation act of 1920 introduced the sale of gas by the therm, a therm being 100,000 B.T.U., and allowed gas companies and authorities to specify the standard quality in B.T.U. per cubic foot of the gas that they would supply (insistence, however, being rightly made upon the maintenance of that standard as all-important). These changes in the conditions of manufacture and of use, together with the new legislation, permitted and encouraged such developments in gas manufacture as make for more complete gasification of coal; *i.e.*, for obtaining a larger proportion of its potential heat in the gas made.

Steaming.--One method of achieving this aim. to which reference has already been made, was to work at a higher temperature. This, in turn, called for special attention to the quality of the refractory materials used in the construction of the retorts and their settings and led to an increase in the use of silica instead of fire clay in vital parts subject to the higher temperatures. In modern practice silica refractories are preferred for the walls of retorts

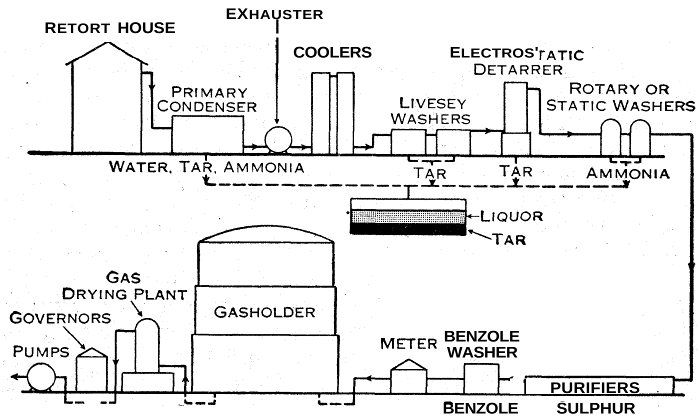


FIG. 3.— DIAGRAMMATICLAYOUT OF A GASWORKS PURIFICATION SYSTEM

(except for a few feet at the top and the bottom) because of their higher stability, strength and general durability. By such means, higher yields of gas per ton (13,000 cu.ft. per ton) have become common. The gas so made is rich in hydrogen and poorer in illuminating constituents than what mas usually supplied for lighting purposes and is lower in calorific value (say 500 as compared with 600 B.T.U. per cubic foot). Another widely used method of increasing the yield in volume and thermal units is known as the "steaming" of vertical gas retorts which is carried out by introducing steam at the base of the continuous vertical retort where it can react with the red-hot coke. By this means an addition is made to the volume of gas by the interaction of carbon and steam which generates water gas, as already mentioned.

An investigation by the joint research committee of the University of Leeds and the Institution of Gas Engineers, carried out on a Glover-West setting of continuous vertical retorts, showed that a lean coal gave 10,400 cu.ft. of gas per ton of a calorific value of 544 B.T.U. per cubic foot (gross), when steaming was not used. This corresponds to 56.j therms in the gas per ton of coal carbonized. When steaming was employed, to the extent of 26.4% of steam on the weight of the coal used, the yield increased to 16,900 cu.ft. of gas with a calorific value of 447 B.T.U. per cubic foot representing 75.7 therms in the gas made per ton of coal.

Thermal Efficiency.—The development.of gas practice, as traced above, has resulted not only in a greater yield of gas but in an increased thermal efficiency for the whole process of carbonization. In other words, the total number of heat units obtainable by the combustion of gas, coke and tar has become more and more a higher proportion of the heat units originally contained in the coal carbonized. This has been effected by improved design of the setting and the use of the recuperative principle, resulting in a lowered consumption of coke for the heating of the retorts. Moreover, by the use of higher temperatures and steaming, the proportion of the heating value of the coal obtained in the gas has been increased, as compared with that left in the coke. This is of primary importance, because in the consideration of a carbonization process it is necessary to bear in mind that, because of the efficiency of gas in use as compared with a solid fuel, the thermal value of a heat unit carried by gas is usually greater than that of a heat unit in coal or coke, and the comparative monetary value is correspondingly increased. The need for economy in fuel has encouraged the development of more efficient appliances for burning solid fuel. and the margin between the utilization efficiency of gas and solid fuels has narrowed considerably. There are, however, still many cases where gas can be utilized as a heating medium with twice or more the efficiency of solid fuels.

In normal horizontal-retort practice it may be taken that, for every 100 heat units contained in the coal carbonized. 24 will appear in the gas, 42 in the coke available for sale after the heating of the retorts has been provided for and 5.6 in tar, which means that 71.6 of the original 100 heat units have been obtained in the available useful products of carbonization. Otherwise expressed, the thermal efficiency of the carbonization process so conducted is 71.6%, 28.4% having been used and lost in the manufacture. In modern large installations of vertical retorts, higher values would usually be attained. The report of the Gas council for 1953–54 gave the average figure of production efficiency (as expressed on the basis given above) as 75.2% for the whole of the industry. The figure in 1948 had been 71.0%; the increase was due to improved methods of working, to the replacement of obsolete with modern plant and to concentrating manufacture in larger and more economic units.

Purification.— As already indicated, the crude gas leaving the retorts contains constituents which have to be removed in order to purify the gas before distribution and to recover by-products of commercial value. Many of these constituents are more or less easily condensed or washed out, and the appropriate plant consists of a train of vessels that vary widely in detail from one works to another but are essentially the same in principle. Fig. 3 shows diagrammatically the individual plant units in a typical gasworks and the sequence of steps in the manufacturing process.

Gases travel from the retorts through an "ascension" pipe, which then bends over and dips below the liquid seal in the so-called hydraulic main, the seal being used to prevent access of air to the main when the retort is opened for charging and discharging. Some cooling and consequent condensation of tarry matter occurs in ascension pipes. It is usual for the gas from a number of retorts to be collected in a common hydraulic main. Easily condensible constituents gather there and in the foul main which leads to the condensers. The condensers consist of nests of pipes cooled externally by air or water; the temperature of the gas within them is thus lowered resulting in further condensation of both tar and water, which collect at the base of the pipes.

The next stage is the washing or scrubbing of the gas, in which further cooling and removal of constituents by solution in water are secured. There are many designs of washers and scrubbers but all act on the principle of obtaining the greatest possible contact between gas and liquid. In the Livesey washer, for example, the gas stream is repeatedly broken up and forced through mater. In modern practice there may follow an electrostatic detarrer, for the complete removal of tar. Next in sequence are rotary or static washers, in which the gas is brought into intimate contact with water or weak liquor. Ammonia is completely removed from the gas at this stage, although a trace may be allowed to pass forward to preserve alkalinity in the purifiers used later for extracting hydrogen sulphide. Additional scrubbing, using suitable oil solvents, is needed if it is intended to remove volatile tar constituents such as benzene and toluene. The tar and liquor condensed at different points in the system are usually led away to a common well, but there is good reason to suppose that some separation of the various liquors is desirable because some may be more potent than others, so that the question of disposal is not equally easy for all.

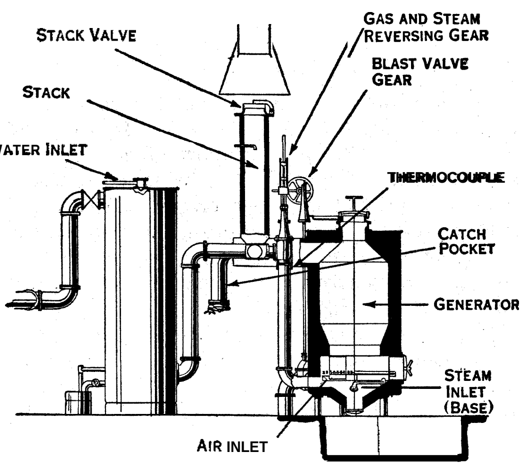
It has already been mentioned that one constituent of coal gas which by law has to be completely eliminated if the gas is to be used for public supply is hydrogen sulphide. The final process of purification in ordinary practice is to pass the gas through iron oxide purifiers and thence to gasholders (*q.v.*). The purifiers contain hydrated oxide of iron spread on grids. The oxide absorbs hydrogen sulphide rapidly, becoming converted into iron sulphide. The formation of iron sulphide tends to render the material inactive for absorbing hydrogen sulphide but it can be reactivated by removal and exposure to air, or by admitting a little air into the gas stream, when regeneration takes place in ***situ.*** In both cases the sulphided material is reoxidized with the formation of free sulphur. When the sulphur content has risen to about 50%, the so-called spent oxide is removed and sold for sulphuric acid manufacture. Most of the sulphur in crude coal gas is present as hydrogen sulphide (about 1%) and is completely removed by this process. Smaller quantities of sulphur are present, however, in the form of organic sulphur compounds which are not extracted to any extent by iron oxide but which may be reduced considerably in amount by special additional processes. In 1942 a special committee set up by the industry recommended that the organic sulphur should be reduced to 10 grains per 100 cu.ft. (about 0.01%) as a first step and that processes should be introduced to obtain lower figures as they became available. The recovery of benzol by oil washing simultaneously removes much of the organic sulphur so that additional processing is more the exception than the rule in general practice. Satisfactory methods for reducing the organic sulphur, to, say 5–6 grains per 100 cu.ft., are available, however, and are applied when gas of exceptionally low sulphur content is needed. Such processes are frequently used to purify the gas after distribution to the consumer's works.

Ammonia and Tar.—Liquor containing the ammonia washed out of the gas is either sold as such or used at gasworks for the production of ammonium sulphate. Distillation of the liquor with lime drives off ammonia which may be absorbed in sulphuric acid to form the sulphate, which constitutes a valuable fertilizer. The quantity obtained at gasworks usually lies between 20 and 30 lb. of ammonium sulphate per ton of coal carbonized. The ammonia yield can be increased by steaming the retorts, but the liquor obtained is usually weaker because of the passage of undecomposed steam from the top of the gas retort into the gas. A weaker liquor has a lower commercial value if it has to be sent away for treatment and has the further disadvantage that after distillation for ammonia the residual liquor is greater in amount.

The direct method of recovering ammonia, in which the gas is passed through sulphuric acid for the absorption of ammonia, instead of effecting a separation of the ammonia liquor and distilling it, has found little application in gasworks.

The disposal of the residual liquor after distillation for ammonia. or sometimes of the crude undistilled liquor itself, presents the gas industry with a problem all the more serious because of the stringent regulations designed to minimize the pollution of rivers and streams. Although liquor is relatively weak, it is nonetheless a strong trade effluent and its direct disposal into streams is prohibited. The usual method is to feed it into the local sewer for eventual decomposition in bacteria beds. It has, however, long been known that the constituents of liquor throw an increased load on the sewage-purification process, so that the rate at which liquor may be discharged into sewers has to be carefully controlled. Normally the maximum permissible discharge of spent liquor is about 0.5% of the dry-weather flow of the sewage. Much attention has been given both to re-examining the amount of liquor that can properly be discharged into sewers and also to developing alternative methods of disposal, the latter being particularly directed to meet the needs of those gas (and coke-oven) works whose situation is remote from suitable sewage-disposal plant.

The tar made at gasworks is subjected to a complicated process of distillation which resolves it into fractions boiling over in different temperature ranges, the fractions being afterward refined. These operations are usually carried out at separate tar distilleries.



BY COURTESY OF THE INSTITUTION OF GAS ENGINEERS

FIG. 4.— BLUE WATER-GAS PLANT. SHOWING PARTS

Among the many products from tar may be mentioned toluol, cresol, naphthalene and anthracene, which find application in the production of dyes, medicines, perfumes, disinfectants, solvents, plastics and paints. Tar oil is used for fuel and also for road construction, whereas distilled tar and pitch is used for many purposes; *i.e.,* in connection with building materials, roofing felts, briquettes. etc.

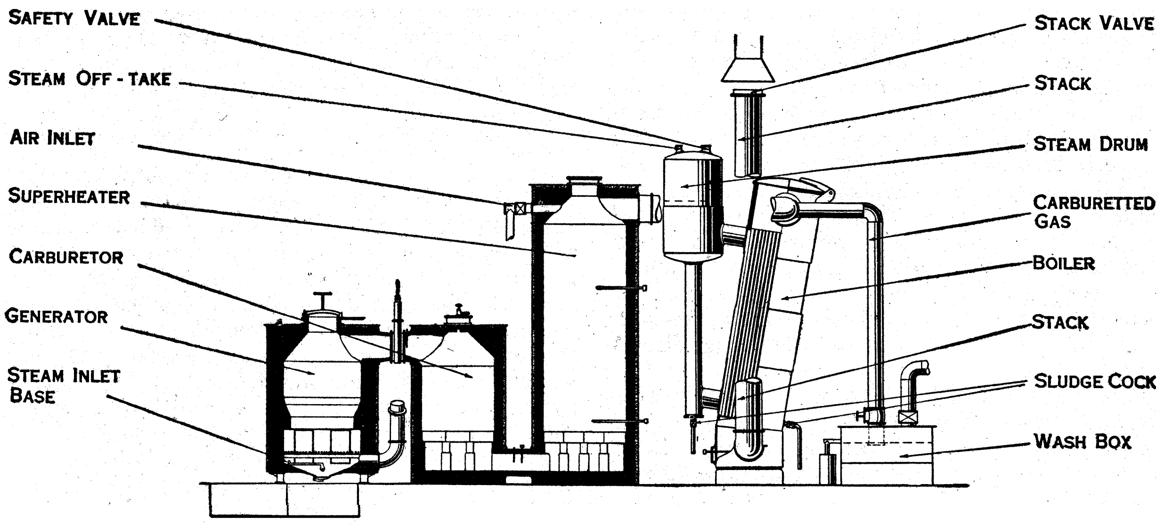
The average yield of tar by the ordinary gasworks process can be taken as 5% of the weight of coal carbonized. At lower temperatures, more tar is produced and the light oil fraction coming over on distillation is usually greater in volume.

Costs of Manufacture.— The relative costs of the different processes used in gas manufacture depend on the size of the production unit as well as on many other factors, but the over-all picture for works of reasonably large size may be taken as follows: net cost of coal carbonized. 60%; carbonization process, 10%; purification, 1.0%; power and sundry processes. 8.5%; maintenance and repairs, 11.5%; and general charges, 9%.

The actual average price at which gas was sold to the consumer in 1953–54 was 16.2 jd. per therm, made up as follows: surplus, 0.2*d.*; rates, 0.39*d.*; administration, 0.58*d.*; employees' welfare, 0.62*d.*; interest. 1.13*d* : depreciation and amounts written off. 1.56*d.*; distribution and consumer service, 1.86*d.*; and cost of gas produced and purchased, 9.91*d*.

Water Gas.—Limited gasification of coke in steam can be effected in the continuous vertical retort as already described, but complete gasification of carbon in coke is carried out in an entirely different type of apparatus known as a water-gas plant. At high temperatures, carbon decomposes steam into hydrogen and carbon monoxide, but with an absorption of heat according to the equation $C+H_2O \rightarrow CO+H_2-56{,}145$ B.T.U. When the temperature of the carbon has been brought down. by this absorption of heat, the reaction is altered with the production of carbon dioxide. An equilibrium tends to be established by the catalytic action of the solid carbon (and inorganic ash constituents) so that a ratio $\frac{CO \times H_2O}{CO_2 \times H_2}$ may be set up between the gas constituents, the ratio being constant for any one temperature but falling as the temperature becomes less. The reversible reaction occurring ($CO+H_2O \rightleftarrows CO_2+H_2$) results in a higher carbon-dioxide content of the gas as the temperature is lowered; and, moreover, since the velocity of gasification is rapidly lowered with falling temperature, the gas made with the same rate of steam supply comes to contain more undecomposed steam. Carbon dioxide lowers the calorific value of the gas and the steam requires condensation. The high temperature of the carbon can, however, be restored by stopping the steam and blowing with air, thus raising the temperature of the fuel bed and generating a producer gas. The industrial process based upon this principle of alternately blowing a bed of coke with steam and air was developed by Gaillard (1849), Tessié du Motay and T. S. C. Lowe (1873) and called the water-gas process. The plant as illustrated in fig. 4, is that of Humphreys and Glasgow. The coke bed is enclosed in a steel casing, lined with firebrick, and may be blown through the grate below by either air or steam. An arrangement of valves also enables the steam to be introduced above the coke for a "down run." The exact arrangement and time in the up run with steam, down run with steam and blowing with air is varied to suit the fuel and other conditions and constitutes a cycle of operations which is carried out systematically and automatically in modern plant. The coke is blown with steam until, as the temperature falls. the carbon dioxide produced in the water gas is reducing its quality too far. During the steam blow, the water gas made is carried forward to a scrubber down which water is running and then goes fonvard to join the main gas stream of the works for purification from hydrogen sulphide. This water gas should have a calcrific value of 300 B.T.U. per cubic foot. When the steam blast is replaced by air, in order to restore the high temperature in the fuel bed, the producer gas generated, being heavily charged with nitrogen, is not allowed to go forward to the scrubber but is turned up the stack as waste. That continues until a satisfactory high temperature has been re-established in the fuel bed, when steam is again employed. The heaviest thermal loss in the process is that of the potential and thermal heat in the producer gas, but this is lessened in modern plants by the installation of a waste-heat boiler.

Carburetted Water Gas.—It has been noted that the water gas made by the process as described above has a calorific value approximating to 300 B.T.U. per cubic foot. It is known as "blue" water gas because of the characteristic colour of its flame and is definitely lower in grade than the coal gas made from retorts. The calorific value can be increased, however, by using some of the heat in the gases leaving the generator to crack oil (*i.e.,* to convert it into permanent gas rich in hydrocarbons), so obtaining a "carburetted" water gas of enhanced calorific value. Fig. 5 illustrates a Humphreys and Glasgow plant used for the process. The gas from the generator passes through two chambers, a carburettor and a superheater packed with brickwork, which are raised to redness, some air being admitted for the combustion of the "blow" gas therein. The oil is run in from the top of the carburettor and should be such as can be efficiently cracked under the conditions of the process. (In early stages of the development of the plant the oil was run directly upon the coke in the generator, but this was unsatisfactory for various reasons.) In this plant, blue water gas leaves the generator with a calorific value of 300 B.T.U. per cubic foot, but leaves the superheater enriched by the carburetting to an extent determined by the amount of oil used. The thermal efficiency of the oil cracking in the plant is high, amounting to something like 90%; consequently the thermal efficiency of the carburetted water-gas process is higher than that of the blue water-gas process and increases with the amount of oil used. The extent of carburetting employed is influenced by this factor, by the price of oil and by the quality of the gas desired. In Great Britain, carburetting is



BY COURTESY OF THE INSTITUTION OF GAS ENGINEERS

FIG. 5.— CARBURETTED WATER-GAS PLANT AND WASTE-HEAT BOILER

usually carried out so far as to bring the carburetted water gas up to something like the same calorific value as the coal gas made at the same works, say 500 B.T.U.; but in the U.S. it has in the past been usually carried much farther. It is plain, too, that blue water gas, enriched by carburetting to the extent desired, can be used as a means of modifying the calorific value of the mixture of coal gas and water gas supplied from a works. The extent to which the coke made in a gasworks may be economically gasified and water gas supplied depends on relative capital and operating costs and the prices of coal. coke and oil.

The main advantages of water-gas plant are that it can be put rapidly into full operation. to meet maximum demands and that the yield of gas per ton of fuel is high; for example, modern plants may give about 50,000 cu.ft. of 300-B.T.U. water gas or 70,000 cu.ft. of 500-B.T.U. carburetted water gas per ton of coke (the compositions of these gases have already been indicated).

Modern carburetted water-gas plants are entirely automatic, with an annular boiler around the generator and self-clinkering grates. A regular quantity of coke is fed to the generator during each gas-making cycle without interruption to the gasification process. Large-capacity plants are now virtually self-supporting in their requirements of steam.

Modern Trends in Gas-Making Processes.—The processes so far described represent what by the middle of the 20th century had long been established as standard practice; but much attention had meanwhile been paid, especially in the later years of the period, to methods of completing the gasification of coal in one process instead of carbonizing it first and then gasifying the coke residue, so far as may be desired, in a separate generator.

Alternative methods for making gas, particularly from coals of poorer quality than had been used hitherto, then came to assume great importance to the industry because of the increasing scarcity of the special coals needed for the manufacture of gas and coke by orthodox methods. Furthermore, oil fuels became so plentiful and cheap as to demand attention as raw materials for gas-making on a greater scale. The pattern of the future industry could be seen as a system of interlinked large stations of high efficiency, preferably situated at or near the coal fields and operating processes best suited to the coal available. However, the object of complete-gasification methods is to process the coal solely into gas with no solid residue other than ash; so that the extent to which such processes could be effectively introduced depended upon the balance needed between the supply of gas and of coke (it should be pointed out in this connection that the new emphasis on minimizing atmospheric pollution was bound to result in a greater demand for smokeless fuels, such as coke). But complete gasification methods, being efficient and flexible, seemed certain to find extensive application in the gas industry.

Most of these processes depend upon a combination of carbonization and generation of water gas. In the modern plant of Humphreys and Glasgow, the blow takes place in the lower part of the generator, the blow gases being led to the carburettor via an annulus surrounding the generator. Available heat in the blow gases is stored in the carburettor and superheater and used to assist carbonization of the coal by transference back to the generator. Part of it may also be used for carburetting. A back-run produced by admitting steam to the top of the superheater and then to the base of the generator gives water gas; the heat in this gas then carbonizes coal in the upper part of the generator. In another part of the run steam admitted to the generator base, this time without superheat, generates hot water gas which again passes through the coal in the upper part of the generator. This gas also can be fed to the carburettor if desired. The yield may be from 175 to 190 therms of 345-B.T.U. gas per ton. The plant is designed to gasify coal, coke or any mixture, with subsequent enrichment by oil as may be desirable.

Considerable importance was attached to finding a means of developing these processes and applying them on a large scale. The availability of low-cost oxygen stimulated the development of methods in which the gasification of solid fuels is carried out in oxygen and steam. In the U.S., where the reserves of natural gas and oil, great as they are, were seen to be quite small when related to the reserves of coal, a large section of opinion held that it would eventually become necessary to augment natural gas with gas of comparable heating value from coal. This, together with an unprecedented industrial and domestic demand for natural gas, oil gas and oil, was the prime reason for the U.S. concentration upon complete gasification in the 1950s. In Germany and elsewhere, from *c.* 1945, the Lurgi process of gasification in steam and oxygen under pressure was successfully applied on a large scale to lignites (young coals unsuitable for carbonization by orthodox means). This process came to be accepted as having many attractive features for the manufacture of town gas: it can make use of small coal of high ash-content and of weakly caking coals unsuitable for carbonization; the plant operates at very high output; and the gas can be readily freed from sulphur and is available at pressure for long-distance transmission. For Great Britain, the search for new gasification processes was given first place in the research program of the Gas council (the former Gas Research board); and exhaustive studies of the Lurgi process applied to British coals were being conducted (on the pilot-plant scale) by 1954. An important achievement of the British work was the demonstration that the considerable proportion of methane characteristic of Lurgi gas was not due to the synthesis under pressure from carbon monoxide and hydrogen produced on gasification but resulted directly from the hydrogenation of coal, a reaction which proceeds vigorously under pressure. As a consequence, the possibility of manufacturing gas comparable in quality with town gas by gasification methods adapted to favour hydrogenation appeared to be most promising, although many technical problems would have to be solved before large-scale application could follow.

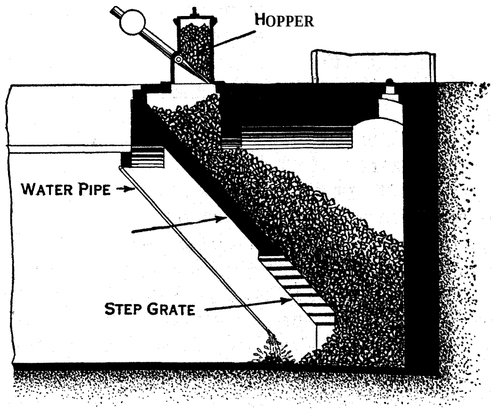
Complete-gasification methods were therefore expected to play an important part in the gas manufacture of the immediate future. Full details of contemporary trends and practice may be found in the *Proceedings* of the International Conference on Complete Gasification, held at Liège in 1954 (Organisation Européenne de Coöpération Économique, Paris).

New processes for the direct gasification of oil, without recourse to water-gas production, were adopted by certain area boards in Great Britain. The plant developed by the North Thames Gas board and installed at their Southend works produces a rich gas by the partial combustion of oil. Another process, devised by the South Eastern Gas board and installed in its own area and also within the North Eastern board's area, generates gas by the catalytic decomposition of oil. Other methods include the Onia-Gegi, giving an oil gas (from 300 to 1,000 B.T.U.) by the cyclic catalytic cracking of heavy oil; and the Geim process for the continuous production of gas (from 370 to 470 B.T.U.) by the thermal cracking of gas oil. The synthesis of gases rich in methane by hydrogenating coal under pressure was an important objective of the search for new gas-making processes.

In addition, a country-wide search for new sources of natural gas was sponsored by the Gas council, and by 1954 experimental supplies of methane drained from coal mines were being taken by some area boards in Great Britain.

Producer Gas.—The gas manufactured for public supply, as opposed to producer gas, finds extensive and increasing applications for industrial heating. Being thoroughly cooled and cleansed it can be well controlled through taps and valves, which make for convenience, cleanliness and efficiency in use. It is a smokeless fuel, and its use saves ground space and obviates expenditure on *ad hoc* gas-making apparatus. Since, too, such gas is of high calorific value and does not carry into its Aame any large proportion of nitrogen or other inert constituents, it can be used for high-temperature processes in simple apparatus without that preheating of the air or of the gas or of both which is necessary for such processes when the leaner producer gas is employed. On the other hand, producer gas is simple to manufacture and is the usual means adopted for the beating of steelmaking and other large industrial furnaces.

When air is passed through a deep bed of carbon maintained at a high temperature, above 1,000° C., such that complete contact



FROM RAMBUSH'S "MODERN GAS PRODUCERS" (BENN BROS.)

FIG. 6.— OLD-TYPE PRODUCER WORKING WITH MATERIAL DRAUGHT AND NO BLAST UNDER PRESSURE

with the carbon is ensured and equilibrium obtained, almost the whole of the carbon is obtained as carbon monoxide, according to the equation

$$C+\frac{1}{2}\{O_2+4N_2\}\rightarrow CO+2N_2+29{,}000 \text{ cal.}$$

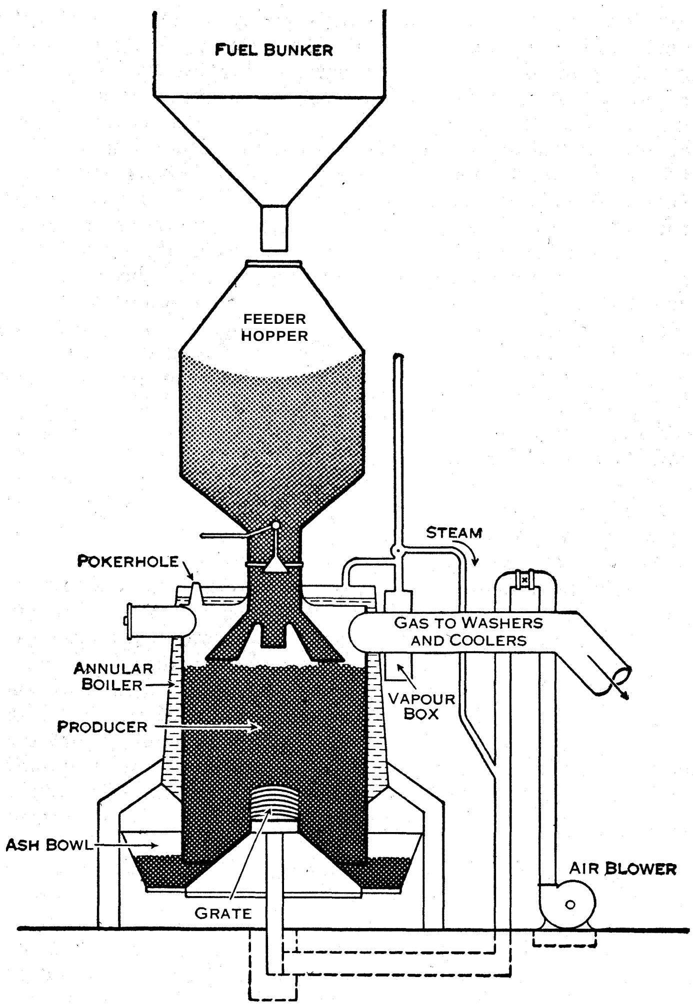


FIG. 7.— DIAGRAM OF A GAS PRODUCER

If the temperature is lower, even although the contact is complete and equilibrium is still attained, some carbon will be burned to CO_2 according to the equation

$$C+O_2+4N_2\rightarrow CO_2+4N_2+97{,}000 \text{ cal.}$$

If, however, the high temperature has been maintained and the carbon entirely converted to CO, it is plain that the gas will consist of one-third carbon monoxide and two-thirds nitrogen, and the equation representing its formation may be called the ideal producer gas equation. If this producer gas is collected and burned with air, it will generate heat according to the equation

$$CO+2N_2+\frac{1}{2}\{O_2+4N_2\}\rightarrow CO_2+4N_2+68{,}000 \text{ cal.}$$

It will be seen that even if the whole of the heat generated in making the producer gas by converting the carbon to CO were lost, some 70% (actually $\frac{68}{97}$ths) of the total heat of combustion of carbon to CO_2 would still remain available for use by its combustion of the gas. This large proportion of heat available for the second stage of the combustion of the carbon in burning carbon monoxide to carbon dioxide is the basis of producer-gas practice. There are various factors which cause divergence in the composition of producer gas from that of the ideal producer-gas equation. In the first place, when coal is used as a fuel and is fed down on the fuel bed. it is at once subjected to a process of distillation or carbonization in the current of producer gas ascending from below, made by the action of the blast upon the carbonized fuel. Producer gas is in this way enriched to some extent with hydrogen and hydrocarbons, particularly methane, and the percentage of nitrogen is correspondingly diminished. More important, however, is the modification in composition brought about by the steam consequent upon a lowering of the temperature of the fuel bed and the formation of water gas by interaction with carbon. The more steam is used, the lower the temperature and the more carbon dioxide and hydrogen at the expense of carbon monoxide is formed. The percentage of nitrogen is further lowered by the admixture with water gas. Moreover, as the quantity of steam is increased and the temperature decreases, the rate of steam decomposition by the carbon lessens and steam passes through the fuel bed undecomposed. The quantity of steam supplied is best controlled by the temperature of the mixed blast at a point well beyond the introduction of the steam, so as to allow a thorough mixing. The temperature of the blast rises with the proportion of steam. It will be understood that undecomposed steam, which begins to occur in quantity as soon as the saturation temperature of 60° C. has been exceeded, is an objectionable constituent in the producer gas, since it is thermally useless and would tend to prevent the attainment of high temperatures on combustion because of its high specific heat. W. A. Bone and R. V. Wheeler followed changes brought about in the composition and yield of producer gas, by gradually increasing the proportion of steam, with results shown in Table III. The coal used was washed nut screened over a 1 in. mesh.

As the saturation temperature was raised by more steam, the gas composition shows a rise in carbon dioxide from 5% to 13% and a change-over from a carbon monoxide producer gas, in which that constituent is dominant to a hydrogen producer gas is explained. The nitrogen has fallen and the percentage of total combustibles has also fallen on account of the increase of carbon dioxide, resulting from the lower temperature of the fuel bed. The calorific value of the gas has slightly diminished, but the volumetric yield increased. so that the yield in therms contained in the gas per ton of coal gasified shows little change. The weight of steam undecomposed per lb. of coal has run up from 0.09 to 0.9 lb. per ton of coal.

Producer Construction.—The development of the apparatus in which the manufacture of producer gas is carried out can now be traced. It would appear that the earliest gas producers were deep shafts of brickwork, but the name most closely identified with the successful establishment of the gas producer is that of K. W. (Sir William) Siemens, and a diagram of his producer (1861) is given in fig. 6. It illustrates how the coal falls from

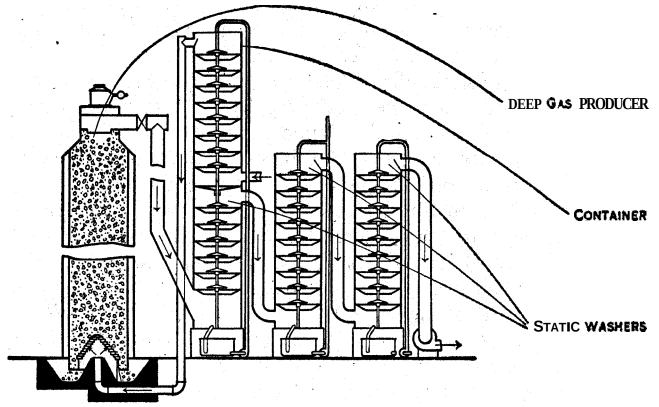
TABLE III.—*Producer* Gas as *Modified by Steam*

Steam saturation, temperature of blast	60° C.	70° C.	80° C.
Percentage composition of gas:			
Carbon dioxide	5·25	9·15	13·25
Carbon monoxide	27·30	21·70	16·05
Hydrogen	16·60	19·65	22·65
Methane	3·35	3·40	3·50
Nitrogen	47·50	46·10	44·55
Total combustibles	47·25	44·75	42·20
Cal. value oi gas, B.T.Us. per cu.ft. at 0° and 760 mm. Gross	1	177·5	169·5
net	173·0	163·3	154·3
Yield of gas cu.ft. at 0° C. and 760 mm. per ton of coal	138,250	141,450	147,500
Steam added to blast, lb. per lb. of coal	0·45	0·80	1·55
Percentage steam decomposed	87·0	61·0	40·0
*Therms in gas per ton of coal (gross)	256.6	251·1	250·0
*Weight of steam undecomposed per lb. oi coal	0·09	0·31	0·93
$\frac{\text{Therms in gas}}{\text{Therms in coal}}$ 100	82·4	80·6	80·3

*Not included in the original table.

the hopper and lies in the producer above the step grate. The producer was connected to a furnace, and the air for gasification was drawn through the fuel bed by natural chimney draft, operative on the furnace. but supplemented at times by a syphon effect induced by the disposition of the main between producer and furnace.

Pressure Producers.—Although producers based essentially on Siemens' simple design were in widespread use, the demands of industry for higher outputs per unit of space and grate area led to the development of producers working under a positive blast of air and steam. Today the gas producer is essentially of the design shown diagsammatically in fig. 7. The generator is a cylindrical body provided with a grate or tuyère through which



BY COURTESY OF THE POWER GAS CORP.

FIG. 8.—DEEP GAS PRODUCER FROM WHICH GAS PASSES THROUGH STATIC WASHERS FOR WASHING. AMMONIA ABSORPTION AND COOLING

the air-steam blast is admitted at the bottom and with an outlet for gas at the top. The generator is water-jacketed, with the object of preventing adhesion of clinker and at the same time raising the steam needed to saturate the blast. Fuel for a run of about six hours on full load is contained in a feed hopper from which it falls into the producer through several chutes arranged so as to ensure uniform distribution and to prevent segregation. The Koller grate is a series of superposed cast-iron rings, the space between which forms horizontal ports through which the blast is distributed evenly. The grate is secured to a revolving ashpan, designed to continuously shear the bottom from the column of ash, break up lumps of clinker and discharge both over a plow bolted to the sealing ring. Steam from the annular boiler passes into a vapour box and thence to the air-blast pipe. Blast is supplied by a blower and is measured by a Venturi meter; it is then saturated with steam at any desired temperature and admitted to the producer from beneath the grate. Satisfactory operation of a gas producer depends upon keeping the distribution of blast and ascending gas current as uniform as possible across the section of the fuel bed, so as to give proper contact in all parts with the descending fuel. For this purpose the producer may be provided with holes through which pokers may be inserted to keep the fuel bed level and free from channels which would tend to short-circuit the gas stream. Some designs incorporate mechanical revolving pokers.

In many cases the producer gas can be used hot and direct from the generator, without further cleaning; the advantage gained is that the sensible heat in the hot gases is retained. When a clean gas is required (as for example, in a gas engine) the gas must be cleaned and cooled. This is usually effected by means of a washer cooler containing water sprays, in which dust and some tar are removed. Next, a centrifugal washer takes out most of the remaining dust and tar; the gas then passes through a moisture eliminator and then ta a dry scrubber in which the final removal of dust is accomplished. This scrubber may consist of an oxide box to remove hydrogen sulphide.

In the past by-product recovery from producer gas was practised on a considerable scale, and modified designs and processes were developed to obtain larger yields of ammonia and tar than were normally obtainable. The essential feature was the use of a very deep fuel bed of coal (12 to 14 ft.) working at a lower temperature which favoured high yields of tar and ammonia. The recovery process called for a rather elaborate plant, the main features of which are indicated in fig. 8. The gas is washed; freed from ammonia and cooled by passing in turn through three Lymm static washers, the ammonia being absorbed in weak ammonium-sulphate solution maintained slightly acid. Gas leaving such a plant was ready for furnace use but needed more thorough cleansing by tar extractors and scrubbers before its use in engines. With such plants, coal could be gasified to yield an average of 122,000 cu.ft. of 178-B.T.U. gas per ton, with a recovery of 90 lb. of ammonium sulphate and 21 gal. of tar per ton of dry fuel gasified. A few such plants still remained in use in the 1950s, though the type was by then obsolete.

Blast-Furnace Gas. — Blast-furnace gas is a low-grade gas with a calorific value of about 95 B.T.U. produced on a large scale as the inevitable by-product of the smelting of iron. The blast furnaces used for the production of pig iron may be regarded as very deep, air-blown gas producers giving a gas containing some 27% of carbon monoxide and 11% of carbon dioxide, with 60% of nitrogen. The cleaned gas is used for steam raising and power production; but for furnace firing it usually needs to be mixed with a richer gas.

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(J. W. C.; A. L. Rs.)

GAS SUPPLY IN THE UNITED STATES

The First Gas Plants. — Following the discovery of gas making from coal and the unparalleled success of gaslighting in one or two European cities, gaslighting got its start in the United States in Baltimore. Although there were a few isolated instances of gas being used by individuals in other cities previously, introduction of gaslights in Rembrandt Peale's museum in Baltimore in 1816 proved to be such a success that the city council passed an ordinance on June 17, 1816, permitting Peale and others to manufacture gas, lay pipes in the streets and contract with the city for street lighting. The first recorded demonstration of gas in the United States was in Philadelphia in Aug. 1796. The gas was manufactured by M. Ambroise and Co., Italian fireworkers and artists. A few years later, in 1812, David Melville of Newport, R.I., lighted his home and the street in front with gas which he manufactured. He also lighted a factory at Pawtucket and induced the government to use gas at Beaver Tail lighthouse.

Baltimore, however, was the first city to use gas commercially, and other cities followed its lead.

Growth and Changes in the Industry. — By the second half of the 20th century the gas industry had grown into one of the key industries, showing remarkable ability to adapt itself to meet severe competition, changing raw materials, and drastic economic and labour conditions, while constantly maintaining and expanding its service. Initiated and long maintained as a lighting service, when this market was taken by the invention of electric lighting, the gas service emerged as a heat producing one; when the severe labour and raw material inflations and dislocations caused by World War II threatened the manufactured gas service and solvency, the industry maintained and expanded its markets by drawing more natural gas from transcontinental pipelines.

Changing Processes and Raw Material. — Public utility gas first was manufactured gas made by heating a high-volatile coal in a metal retort and subjecting the resulting gas to cooling and purification. A water gas process was introduced later. This injected steam over the coal which was heated externally. The work of Thaddeus Lowe, a Union balloon officer in the Civil War, made possible the economic manufacture of water gas in internally fired machines. This became the basis of the modern carburetted and blue water-gas processes. By-product coke-oven gas supplemented and often supplanted utility coal gas and water gas. Internally fired oil-gas processes were invented and developed. Prior to World War II these were used very little in the United States except on the west coast. Even there prior to World War II, oil gas was declining as natural gas became available.

All these changes, important, and, in some respects even revolutionary as they were, were dwarfed by the change from manufactured gas to natural gas. This tremendous exploitation of natural gas followed the discovery and proof of large reserves of natural gas in the midcontinental and southwestern areas in the 1920s, areas that were later expanded. In 1925 seamless electrically welded steel pipe made the transportation of oil and gas long distances economically feasible. The change was particularly striking after World War II freed transcontinental pipelines from petroleum transportation to gas transmission and the economic inflation and short labour supply made public utility gas manufacture based on solid fuels generally uneconomic.

By the mid-1950s intra- and interstate transportation of natural gas by major pipelines had become so far-flung that, except in six states, Maine, Vermont, Idaho, Nevada, Oregon and Washington, there was practically no major city in the United States beyond the reach of natural gas supplies and plans had been made to bring major supplies of natural gas to the Pacific northwest.

Long distance transmission of natural gas changed the engineering and economic problems of a gas industry. It involved heavy investments in long pipelines and, in many cases, the substitution of high thermal value natural gas for medium thermal value manufactured gas. These changes led to major new developments in gas manufacturing processes, storage and sales. The investments in long pipelines favour the use of these lines at high load factors; thus natural gas becomes the base gas or the base material for gas manufacture. Off-peak sales of natural gas at attractive rates to industry is favoured with shutoff agreements at peak public demands. Potential major or total interruptions to supplies from distant sources, requiring quick start-ups, coupled with labour and material problems, reduced reliance on the gas manufacturing processes based on solid fuels, and led to striking developments in quick-starting, flexible liquid-fuel processes.

A number of oil-gas processes have been designed and developed to utilize the cheaper grades of heavy oils. In many situations component parts of abandoned water-gas equipment have been built in the new heavy oil-gas machines. Other studies have developed new equipment as well as new processes for the purpose. Characteristic of these heavy oil developments has been the ability to manufacture high heat content gases with combustion characteristics such that they may be distributed for use in mixture with or as substitutes for natural gas. In general, such heavy oil-gas making machines use oil and air internally to create the heat they require; then inject oil and steam into the heated zone to make the gas. Partial combustion with air is sometimes simultaneously employed to increase the volume of the gas made. The cycle is then continued by returning to the heating phase, followed by another gas making phase. Good heat economy and good heat distribution within the machine are obtained in the same phase by heating alternately in a forward and a reverse direction, followed by making gas in the forward and reverse directions. The incoming oil, air and steam are preheated regeneratively by waste heat from the outgoing products, thereby securing good thermal efficiencies.

Where mixed gases of a total thermal content less than that of natural gas are distributed, or where liquefied petroleum gases are used for enrichment, natural gas, liquefied petroleum gases, gasolines and petroleum oils may be reformed in machines of the water-gas or oil-gas type to greater volume, lower thermal content and controlled combustion characteristics and gravity to meet production and mixing needs. The reforming processes may involve partial combustion, pyrolysis or reaction with steam or some combination of these. Reforming, with enrichment of the reformed gas with liquefied petroleum gases or refinery oil gases may also be used to meet peak loads on natural gas systems.

Unique in post-World War II gas-making processes was the development of catalytic reforming. The feed stock may be natural gas, propane, butane. refinery oil gases or natural gasoline. The reforming is carried on in chrome-nickel alloy tubes externally heated, usually with light fuel oil. The tubes are filled with a nickel oxide catalyst, and the reforming gas zone is maintained at a temperature of about 1,800° F. The type of reformed gas depends upon the relative proportions of air and steam in the feed mixture. Pyrolysis of the feed mixture is not attempted. The ultimate capacity depends upon the rate of deposition of carbon, excessive carbon being objectionable. The unit is very flexible. The reformed gas, usually of 180 to 350 B.T.U. per cubic foot (at 60° F. and 30 in. mercury barometer saturated with water), with a specific gravity from 0.52 to 0.65 referred to air, is then enriched with undecomposed feed stock. The unit can produce a perfectly matched gas that can be used as 100% replacement of the regular utility sendout. A continuous process, its automatic controls and flexibility permit feeding directly into the distribution system. A minimum of labour is required, capital investment is low, purification of the gas is not necessary and there are no tars and no waste disposal problems. As the plant produces no smoke or dust it can be tolerated in highly residential locations. Its flexibility and ability to match regular send-out gas permit it to be located in distant areas to relieve low pressure during peak loads and to feed back into the supply main from the primary plant or city gates, thereby affecting large increases in main capacities.

Natural Gas.—Although natural gas had been noted in the United States before manufactured gas was introduced, it was not used commercially until long after manufactured gas was distributed. There is a record of a "Burning Spring" in 1775 near Charleston. W.Va., on land which George Washington dedicated as a public park.

In 1821 near another "burning spring" at Fredonia, N.Y., the first natural gas well in the United States was drilled to a depth of 27 ft. In 1854 the first deep gas well, some 1,200 ft., was sunk at Erie, Pa. In 1859 Edwin L. Drake began the petroleum industry at Titusville, Pa. Natural gas is frequently associated with petroleum in the earth's crust and its pressure serves to drive the oil to the surface. Oil men in early days ignored natural gas. The gas liberated from the oil at the surface was piped to a flare and burned as a gigantic torch. Wells that gave gas only were flared and allowed to burn themselves out over the years.

The first natural gas corporation in the United States was the Fredonia Gas Light and Water Works Co., organized in 1858. In 1873, Titusville, Pa., was supplied with natural gas through a 2-in. iron pipe, five miles long. In 1870 a burning well at Bloomfield, N.Y.. was extinguished and connected to a 25-mi. pipeline of white pine logs bored with an 8-in. hole. In 1872, this gas was turned into the mains of the Rochester Gas Co., but the venture soon failed.

By the mid-1950s there were about 70,000 gas wells in the United States; these with gas producing oil wells, accounted for a total of about 8,500,000,000,000 cu.ft. of marketed production annually. Gas wells had been drilled to great depths, down as much as two or three miles. Recoverable reserves in the U.S. were estimated to total more than 200,000,000,000,000 cu.ft.; for a number of years more natural gas had been found than was consumed.

Estimates of recoverable reserves have run as much as 500,000,000,000,000 cu.ft.

Long distance high pressure transmission of natural gas through seamless steel pipes welded into a unitary metallic pipeline made available to cities and industries at a reasonable price, tremendous supplies of energy in the form of an ideal fuel. The marketed production of natural gas in the mid-1950s totalled 8,500,000,000,000 B.T.U. This was more than $5\frac{1}{2}$ times the electrical energy generated in all public and private plants in the United States in the same time (442,000,000,000 kw.hr. equivalent to 1,508,000,000,000,000 B.T.U.). Manufactured gas contributed 90,000,000,000,000 B.T.U. and liquefied petroleum gas for fuel 326,000,000,000,000 B.T.U.

Liquefied Petroleum Gases.—The liquefied petroleum gases, propane and butane, have been obtained from natural gas condensates at wellheads, in compression operations, or low temperature points in "wet" gas transmission systems. A very important source has been the crude natural gas gasoline extracted from natural gas by oil absorption. The enriched gasoline-oil mixture is stripped with steam and the vapours from the crude gasoline are then fractionally distilled. These hydrocarbons are also recovered in petroleum refining and petroleum cracking operations.

Propane alone has sufficiently high vapour pressure at the customary temperatures prevailing over the United States to permit it to be distributed as a gas without admixture. Butane, however, requires a carrier gas. For single consumer installations beyond gas mains a mixture of propane-butane compressed into steel cylinders is sold as bottled gas. Where a number of consumers are to be supplied, propane alone may be distributed by small mains. Larger communities, too small to warrant a gas plant, may be served with a butane-air mixture in which the content of air must be sufficiently high to avoid condensation of butane from the mixture, but the air must also be always very much less than 91.59% and the butane must be more than 8.41% by volume under ordinary atmospheric pressure. The proportions stated are required to form a high limit explosive mixture. Maximum air content usually does not exceed 67%.

Butane-air gas may be mixed with natural gas under some peak load conditions to assist in meeting consumer demands. A butane-air plant can be instrumented so that it is operated, controlled and safeguarded completely by automatic devices, consequently its small demands for labour and supervision make it very suitable for service to isolated small communities.

Storage of Gas.—The generation and transmission of gas for variable demand loads as in public utility possesses an important advantage over electricity in that gas can be stored in large quantities economically, whereas electricity must be generated and transmitted as consumed. This permits gas generating units and long distance transmission units to be designed for average rather than peak conditions, thereby reducing markedly the capital investment required. The long distance transmission of natural gas is maintained at high load factor in the summer season by moving large gas supplies to storage pools near the customers. Depleted gas fields or natural geological formations of porous rock completely capped by impervious rock formation can be used for this purpose. They may have storage capacities of billions of cubic feet. In the mid-1950s about 400,000,000,000 cu.ft. were pumped into storage annually to be withdrawn on "peak" demand days. There were at that time more than 167 underground pools with a total storage capacity of nearly 1,735,000,000,000 cu.ft.

The Use of Gas.—In the mid-1950s there were in the United States about 33,000,000 families who cooked with gas; 18,000,000 used gas to heat water, 15,000,000 heated their homes with gas, and 4,000,000 families owned gas refrigerators.

In industry, it was estimated that there-were more than 21,000 uses for gas. These included glassmaking, metal production and fabrication, food processing, printing, textile production, electronic equipment manufacture, plastics, paint and countless other products.

Petrochemicals.—Natural gas is an important raw material for the synthesis of petrochemicals. As the name suggests, these are chemicals that are synthesized from rock sources, such as natural gas, petroleum or coal. Important end products are ammonia, alcohols, synthetic rubber, plastics, fibres and detergents. The hydrocarbon-containing fuel is subjected to pyrolysis as in the formation of ethylene and benzene; or to reaction with steam over a catalyst, as in the formation of carbon monoxide and hydrogen, or to partial combustion as in the synthesis of phthalic acid by the partial combustion of naphthalene over a catalyst. The intermediate products are then used as building blocks to make the commercial petrochemicals.

(W. J. Hf.)

GAS IN WARFARE: *see* Chemical Warfare; Chloropicrin; Mustard Gas; etc.

GASKELL, ELIZABETH CLEGHORN (1810–1865), English novelist and biographer, was born on Sept. 29, 1810, in a house in Lindsay row, Chelsea, London; now 93 Cheyne walk.

Her father. William Stevenson (1772–1829), had been successively Cnitarian minister, farmer. boardinghouse keeper for students at Edinburgh, editor of the *Scots Magazine,* and contributor to the *Edinburgh Review* before he received the post of keeper of the records to the treasury. which he held until his death His first wife. Elizabeth Holland, died a month after her daughter, Elizabeth, was born, and the babe was taken to Knutsford, Cheshire, to be adopted by her maternal aunt, Mrs Lumb. Thus her childhood was spent in the environment idealized in *Cranford.* From 1824 to 1826 Elizabeth went to school at Stratford-on-Avon, from 1827 to 1829 she lived in London with her father and his second wife; and after two winters at Neucastle-on-Tyne in the family of William Turner. a Cnitarian minister. and a third in Edinburgh. she married, on Aug 30, 1832, William Gaskell, minister of the Unitarian chapel in Cross street. Manchester. and from 1846 to 1853 professor of English history and literature in Manchester New college They lived first in Dover street, then in Rumford street. and finally. in 1850, at 84 Plymouth grove.

Mrs Gaskell and her husband thought to emulate George Crabbe and write the annals of the Manchester poor, but only one poetic "sketch" appeared (*Blackwood's Magazine,* 1837). In 1844, while they were visiting North Wales, their infant son died, and to distract Mrs Gaskell from her sorrow her husband suggested a long work of fiction. Hence *Mary Barton, a Tale of Manchester Life* was begun It was published in 2 vol., 1848; its appeal for neighbourly love, its dramatic power and humour winning for the author the friendship of Carlyle, Landor and Dickens. Dickens asked her, in 1850, to contribute to his new magazine, *Household Words,* and here the whole of *Cranford* appeared at intervals from Dec. 1851 to May 1853. exclusive of one sketch, which was published in *All the Year Round* for Nov. 1863. *Cranford* was published in book form in 1853. *Cranford* is an English classic. It is a picture of Knutsford indeed, but a work of imagination that has a place in literature beside the much earlier work of Jane Austen. In *Ruth* (1853) Mrs Gaskell again presents Knutsford, thinly disguised, and the little Unitarian chapel in that town.

North and South, a powerful tale of the industrial revolution, first published serially in *Household Words,* was separately published in 1855. Then came—in 1857—the *Life of Charlotte Bronte,* in two volumes. Two years earlier Miss Bronte had begged her publishers to postpone the issue of her own novel, *Villette,* in order that her friend's *Ruth* should not suffer. This biography, by its vivid presentation of the tragic story of the three Brontë sisters, gave its author a place among English biographers.

In 1863 Mrs Gaskell published her last long novel, *Sylvia's Lovers,* a romantic tale of Whitby smugglers and the press-gang riots. In the same year a one-volume story, A *Dark Night's Work,* and *Cousin Phyllis and other Tales,* appeared.

Mrs Gaskell died on Nov. 12, 1865, at Holyburn, Alton, Hants, and was buried in the graveyard of the Knutsford Unitarian church. Her unfinished novel, *Wives and Daughters,* was published in 2 vol. in 1866.

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GAS MASK. Casualty gas, as a weapon of war, was first used in World War I by the Germans against Allied forces north of Ypres in Belgium, on April 22, 1915. (*See* CHEMICAL WARFARE.) The first military gas masks used by the Allies in that war were cumbersome affairs consisting of the mask proper. which fitted around the face, attached by a tube to a canister suspended around the soldier's neck and hung in front of his body. The wearer breathed air through a tube in his mouth from which the poison gases were filtered through charcoal contained in the canister. A nose clip prevented breathing through the nostrils. The use of this type of mask greatly impeded the soldier's movements and efficiency in battle and made it impossible for him to "hug the ground" closely when under attack by machine gun fire.

Considerable improvement in the gas mask was made after World War I and soldiers in World War II were provided with a mask that was lighter in weight, better fitting, ensured clearer and wider-range vision and, by eliminating the nose clamp and mouth inhaler, lowered breathing resistance. Another advantage of the World War II equipment was that the canister was slung over the shoulder and carried at the soldier's side, thus permitting greater freedom of action in combat.

A later type of military gas mask was known as the "assault type." Complete, it weighed less than three pounds. The canister fitted directly onto the side of the facepiece of the mask, thus eliminating the long connecting tube and the necessity for slinging the canister from neck or shoulder. The pure, filtered air came into the mask at the top and kept the glass eyepieces from blurring as it was drawn down to the nostrils. For soldiers with defective vision, specially prescribed lenses for the mask were provided. Although many improvements were made in the mask itself in the decades following World War I, the chemical agencies used to filter impurities from gas-infected air remained fundamentally the same. The canisters were filled with charcoal and soda lime which absorbs all gases known to be usable for tactical purposes. However, some of the chemicals used to produce poison gases on the battlefield remain suspended in the air as fine, solid particles for long periods. These particles were filtered from the air entering the canisters by pads of felt inserted in the air passage.

In addition to military uses, gas masks are widely used in industry to protect workmen employed in mining and in chemical and other types of plants where fumes and gases resulting from natural circumstances or manufacturing processes are known to be injurious. Firemen and members of rescue squads also carry gas masks as part of their normal equipment. During World War II masks designed for civilian use in the event of air raid or other form of attack delivering poison gases, were also provided, particularly in Europe. (M. B. H.)

GAS METER, a device for measuring gas volumes. Companies selling gas to the public commonly use a positive displacement meter, a rotary meter, an orifice meter or a heat capacity meter to compute charges for gas usage or purchase.

For small volumes of consumption as in residential premises or most commercial installations, a positive displacement dry meter is used. Its operation involves the alternate expansion and contraction of each side of a double bellows of leather or synthetic material. The meter case, of tin, iron or aluminum, houses two working compartments, each of which encloses a bellows. The compartments are separated by a vertical partition which intersects a horizontal above the bellows and below the gear mechanism. Valve parts and seats are located in the horizontal partition, one set for the two working spaces thus provided for each bellows, one space inside and one outside the bellows diaphragm in each compartment. As each bellows alternately fills from the meter inlet and empties through the meter outlet, the gas volume is measured through a gear mechanism to the meter index dial.

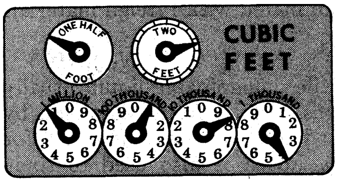
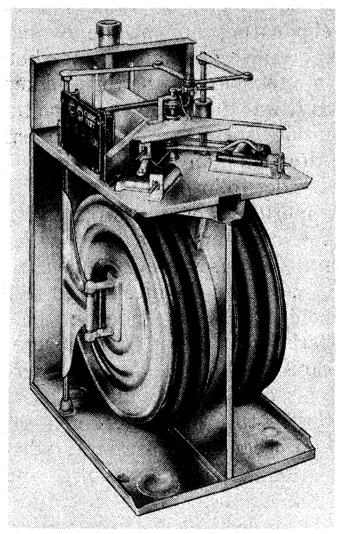


FIG. I.— TIN-CASE METER INDEX

The number of index circles in the dial of the dry meter varies with the capacity of the meter. At the top are one or two test circles, usually two. For leak testing, one of the two makes a complete revolution for each cubic foot of gas or designated fraction thereof. The second dial registers two to five cubic feet and is used for checking the accuracy of the meter. The lower dials register the total volume passed. The right-hand index turns clockwise and adjacent indexes turn in opposite directions. The meter is read from left index to right by taking in each the figure behind the position of the index. Two ciphers are added, giving the result in cubic feet. Usually the customer is billed on company readings but prepayment meters are set by an inspector to deliver the purchased volume of gas. In another type, an inserted coin permits a definite volume to pass the meter.

For higher rates of delivery the rotary meter is used. This is a case with semicylindrical ends in which are two or three revolving impellers (rotors). Each rotor moves exactly counter to that adjacent. The entering gas is trapped and must move the rotors to be discharged. The trapped constant gas volume is recorded through gear mechanism to a dial. In some rotary meters the capacity may be large enough to supply gas to a small town.

For measurement of large volumes of gas, an orifice meter is used. Essentially, a steel plate in which a hole is machined and centred is fitted across and inside the gas pipe. This obstruction causes the gas to jet downstream, creating there a partial vacuum. A differential pressure can be measured by connecting the upstream space and the downstream space to the two sides of a recording manometer. The differential pressure varies with the flow through the orifice, thus measuring the volume of gas flowing. Orifice meters are relatively simple, sturdy and precise, but they have two disadvantages: there is a large loss of pressure, and the mathematical relations between the differential pressures and the volume of the gas passed are very complex. Fortunately, natural gas is often available at pressures much higher than is reauired bv consumers, so the loss of pressure may not be objectionable. The mathematical relationships have been carefully analyzed and compiled into tables that simplify the readings.



BY COURTESY OF AMERICAN METER CO.

FIG. 2.—CUTAWAY VIEW OF A TIN-CASE METER

Where the gas measured has a uniform known heat capacity per unit volume, a device for measuring the passing heat capacity can be employed as a gas meter. Two thermometers of the electrical grid type may be placed some distance apart in a gas pipe. Between these is placed a source of heat, such as an electrical heating coil. The thermometers control the heat input to the coil to maintain a constant rise of temperature between them. The readings of a recording electric wattmeter establish the volumes of gas flowing. An alternate but similar device measures the varying rise in temperature caused by a fixed rate of heat input. Heat capacity meters cannot be used on gas contaminated with foreign materials such as tar fog, moisture or dust.

See also GAS INDUSTRY. (W. J. HF.)

GASOLINE (PETROL). a volatile, inflammable liquid usually consisting primarily of hydrocarbons derived from petroleum by various processes. By far the most important use is as a fuel for internal-combustion engines (*q.v.*), but it is also used to some extent in special stoves and as a solvent.

In the early days of the oil industry, gasoline (termed "straight run") was simply the portion of petroleum that distilled off at a lower temperature than kerosene, the principal product desired. It was largely wasted until the advent of the automobile. Gasoline became the preferred motor fuel because of two important properties: it had the high energy of combustion typical of hydrocarbons, and it was sufficiently volatile to form a combustible mixture with air in a simple, relatively inexpensive carburetor. It was also cheap and plentiful.

As the demand for gasoline increased during the first two decades of the 20th century, it ceased to be a by-product, and more and more of the kerosene cut began to be included. By 1913 even this became inadequate and a gasoline shortage threatened the further rapid development of the automobile. Fortunately, the first commercial cracking process, the Burton process, was developed about this time to convert heavier oils, particularly the gas oils which boiled just above kerosene, into gasoline by subjecting them to temperatures of around 750° F. and pressures of around 100 lb. As a result of this and many later improvements in cracking processes, gasoline yields have increased to about 50% of the crude oil processed, a figure well over twice the amount of hydrocarbons of suitable boiling point found in average crude oil.

Gasoline is a complex mixture containing hundreds of different hydrocarbons. Most of them are saturated and contain 4 to 12 carbon atoms per molecule, but they differ widely in structure. Motor car gasoline boils mainly between 90° and 410° F., the precise blend being adjusted to the climate and the season. More light, volatile components are needed for quick starting and fast warm up when the weather is cold, but these are likely to cause high evaporation losses and vapour lock at summer temperatures. The heavier portions of the gasoline are valuable for their higher heating value, but in excess they may cause carbon deposits and uneven fuel distribution. Aviation gasoline is a "heart cut" containing less of both the lighter and heavier ends than motor car gasoline.

As engine designers sought greater efficiency through higher compression ratios, they encountered increasing trouble with engine "knock," a rapid detonation occurring toward the end of the combustion. The shape of the gasoline molecules was found to be very important in determining the knocking tendency of a gasoline. Straight-chain molecules knock much more readily than branched or ring-shaped molecules, especially of the saturated type naturally present in crude oil. It soon became evident that the extent to which the compression ratio, and hence the efficiency, of gasoline engines could be increased depended on changing the kind of molecules present in gasoline.

To establish a definite scale for measuring antiknock characteristics, iso-octane (2,2,4-trimethylpentane), a highly branched hydrocarbon, was assigned a value of 100 on the knock-rating scale, and normal heptane a value of 0. The octane number indicates simply that a gasoline has the same knocking tendency (in a standard engine under standard conditions) as a particular blend of heptane and iso-octane, the percentage of the iso-octane in the blend being termed the octane number. However, the actual behaviour in different engines is likely to vary somewhat from the results of the standard test.

The straight-run gasoline found in average crude oil has a low octane number. Needed high-octane components are made by a variety of processes which have been developed over the years. Branched hydrocarbons are plentiful in gasoline made by cracking — particularly if the cracking has been brought about by catalysts instead of by older processes using only heat and pressure. Branched structures are even more abundant in alkylate and polymer, both of which are made by joining together, nith the aid of catalysts, small molecules of gases made as a by-product in most cracking processes. Of the ring-shaped hydrocarbons, among the most valuable are benzene and toluene, which are obtained from coal tar or may be made by passing certain cuts of straight-run gasoline over platinum or other catalysts.

By the end of World War II about 60% of the average motor fuel was composed of synthetic molecules, and aviation gasoline was more than 90% synthetic. By the early 1960s most motor gasoline was fully 80% synthetic. This illustrates forcibly the revolution in refining methods brought about by the advent of cracking. The discovery that the cheap hydrocarbons in petroleum could be readily changed in composition and structure led also to a rapidly growing petrochemical industry *(see* PETROLEUM: *The Petrochemical Industry),* which makes from petroleum or natural gas a wide variety of chemicals for solvents, plastics, fibres, synthetic rubber and for many other purposes.

Another important way of increasing antiknock is by the addition of tetraethyl lead, as was discovered by Thomas Midgley in 1920. Though the amount used in motor fuel is less than 0.1% by volume, it may increase the octane number by as much as 15 points.

By the early 1960s the average octane number of U.S. gasoline had risen to about 91 for the regular grade and 99 for the premium grade, as compared with a figure of 55 octane or below before the advent of cracking. Military aviation gasoline reached the 100-octane level just before World War II, and still better fuels were later developed. Their antiknock quality is stated in terms of performance numbers. which indicate the knock-free power obtainable in an engine of suitable compression ratio as a percentage of the power obtainable from pure iso-octane. The most widely used grade of aviation gasoline had a performance number of 115 under cruising conditions, 145 under take-off conditions. However, further substantial increases in octane number promised to be quite expensive. As the result of these improvements, the compression ratios of new automobile engines have gone up from an average of 4.4 to 1 in 1925 to an average of 9.5 to 1 in 1958, with an improvement in the efficiency of gasoline utilization of about 60%. The average power generated per cubic inch of engine displacement has gone from .234 h.p. to .779 h.p. in the same period.

Additives are also used in gasoline for purposes other than antiknock improvement. Chlorine and bromine compounds convert the lead in tetraethyl lead to relatively volatile salts and thus assist in its removal by the exhaust gases and in reducing the build-up of deposits on exhaust valves, etc. Antioxidants are used to inhibit gum formation. Metal deactivators prevent deterioration caused by contact with the metal of the fuel tank. De-icers prevent engine stalling caused by the icing of carburetor throttle plates.

Although petroleum is the principal source of motor fuel, other raw materials are used. Natural gas often contains moderate amounts of liquefiable hydrocarbons, which are recovered as "natural" or "casinghead" gasoline. In Europe alcohol is sometimes included in motor fuel blends. Motor benzol recovered from coal tar is also used at times.

Gasoline can be produced by combining carbon monoxide and hydrogen at high pressure in the presence of a suitable catalyst. The needed mixture of gases may be produced by the partial oxidation of natural gas (methane) with pure oxygen. To be commercial the process requires cheap natural gas as the starting material, and good prices for the by-product alcohols, acids, ketones and other organic chemicals. In the distant future, coal may be used to provide the hydrogen and carbon monoxide. Direct hydrogenation of coal is also possible, but is expensive. Gasoline can likewise be made from tar sands, of which there are very large deposits in Canada. The most promising of the long-range sources, however, appeared in the early 1960s to be oil shale. The U.S. reserves of shale are much larger than the country's known reserves of petroleum.

In 1958 the U.S. oil refining industry produced about 1,500,000,000 bbl. of gasoline and the rest of the free world about 600,000,000 bbl. Of course, the yield of gasoline obtained in the United States is much higher than in the rest of the free world, which converts a much larger proportion of its crude petroleum into light and heavy fuel oil.

See PETROLEUM. (R. E. WN.)

GASPARRI, PIETRO (1852–1934), Italian cardinal and canonist, was born at Capovalazza de Ussita on May 5, 1852. He received the degrees of doctor of philosophy, theology and canon law after study at the pontifical seminary at Rome, and from 1880 to 1898 was professor of canon law at the Catholic institute in Paris. In 1904 Pius X, having decided to codify the canon law, confided to Gasparri the direction of the work. The new code was promulgated in 1917 *(see* CANON LAW).

In 1907 Gasparri was made cardinal, and in Oct. 1914 Benedict XV appointed him secretary of state, which office he held throughout the arduous World War I period and the almost equally strenuous reconstruction period which followed. He was retained by Pius XI and in 1926 began negotiations which resulted in the Vatican treaty. He resigned in Jan. 1930 and was succeeded by Eugenio Cardinal Pacelli (later Pius XII). Cardinal Gasparri died at Rome on Nov. 18, 1934. (B. TY.)

GASPÉ, PHILIPPE AUBERT DE (1786–1871), "the grand old man of French-Canadian literature," was the author of the first important novel published in French Canada, *Les Anciens Canadiens* (1863). Born on Oct. 30, 1786, into a distinguished Quebec family whose first Canadian ancestor had been ennobled by Louis XIV of France, de Gaspé was the epitome of gentlemanly dignity as hereditary *seigneur* of his estate on the St. Lawrence river. He received a classical education in Quebec, studied law there and later became sheriff of the city. Bankruptcy, for which he spent over three years in debtors' prison, forced him out of public life in his 40s.

After years of reading and meditation, inspired by a rebirth of nationalism in mid-19th century, de Gaspé composed *Les Anciens Canadiens* late in life. It is a romantic historical novel set in Canada at the time of the British conquest (1760), written to preserve the old French traditions for posterity. De Gaspé makes use of known historical material, personal family records, folklore and folksongs. The novel has a nostalgic charm spiced with avuncular humour. It was enthusiastically received and became a classic in French Canada. an aristocratic precursor of *Maria Chapdelaine* (1916) by Louis Hémon, and hence of the whole regionalist school that flourished into the 1930s. The common features are idealization of the "good, old days" and of the habitant farmer, loyalty to the soil and distrust of English Canada.

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GASPÉ PENINSULA (GASPÉSIA) juts into the Gulf of St. Lawrence and comprises that part of eastern Quebec province which lies between the St. Lawrence river and the province of New Brunswick. It is a hilly to mountainous area with well-forested slopes. The central portion is occupied by the Shickshock range, a continuation of the Appalachians. which rises in places to over 4.000 ft. Settlement is light, occurring only in widely separated coastal villages. The area is best known as a tourist centre because of its rugged and picturesque coastal scenery, its striking hills and excellent hunting and fishing. Lumbering and coastal fishing are the principal occupations but there is some mining of copper, zinc and lead and a small production of pulp for paper making. (W. F. SS.)

GAS PLANT *(Dictamnus albus)*, a hardy perennial herb of the Rutaceae family. known also as Dittany. Fraxinella and as burning bush The stems are stout. woody at the base. bear alternate odd-pinnate leaves, with glossy leathery leaflets dotted with oil glands and surmounted by long, showy, terminal racemes of snouy white or rose-coloured fragrant flowers with a strong smell of lemon. The gas plant makes a sturdy upright growth, and a clump three feet high and as much in breadth makes a pleasing show when in floner. On a still, sultry summer evening a lighted match held under the flower cluster near the main stem will give a flash, whence the name. The gas plant is a well-knonn and popular old garden ornamental (J M. BL.)

GASQUET, FRANCIS NEIL (in religion AIDAN) (1846–1929) Roman Catholic historian and cardinal, was born in London on Oct 5, 1846. Educated at Downside school, he entered the Benedictine monastery there and was prior from 1878 until 1885. From 1888 onward he published works on monastic history, including the influential *Henry VIII and the English Monasteries* (1888–89), of considerable value but somewhat marred by inaccuracies and bias. He nas created cardinal in 1914, and became prefect of the Vatican archives in 1918. Cardinal Gasquet died in Rome on April 5, 1929.

See M D Knowles, *Cardinal Gasquet as a Historian* (1957); Shane Leslie, *Cardinal Gasquet* (1953) (J D. A.)

GASSENDI (GASSEND) **PIERRE** (1592–1655), French philosopher, scientist and mathematician, famous for his revival of Epicureanism, was born of poor parents at Champtercier in Provence on Jan. 22. 1592. Educated at Digne and Xix, he eventually took holy orders and became professor of philosophy at Aix (1617). After travels in Flanders and Holland (1628–31), he secured an appointment as provost of the cathedral at Digne (1634), which had been disputed for ten years. He then spent some time accompanying the duc d'Angoulême on a tour of his *gouvernement* of Provence. In 1645 Gassendi became professor of mathematics at the Collège Royal in Paris He died in Paris on Oct. 24, 1655.

Gassendi's writings include: *Exercitafionesparadoxicae adversus Aristotelaeos* (1623; new ed , 1649); *Epistolica ercrcitutio in qua principia philosophiae Roberti Fluddi reteguntur* (1630). written at the instance of Marin Mersenne; a letter on the parhelia observed in 1629 (1630); lives of Peiresc and Tycho Brahe (1641 and 1654); a series of objections to the *Meditationes de prima philosophia* of Descartes, which was likewise undertaken at Mersenne's behest and appended to the second edition of the work in question (1642) but republished separately (1644); *Institutio astronomica* (1647); *De vita et moribus Epicuri* (1647); *Animadversiones in decimum librum Diogenis Laertii, qui est de vita, moribus placitisque Epicuri,* with *Philosophiae Epicuri syntagma* as an appendix (1649); and the *Syntagma philosophicurn,* published posthumously among his collected works (1658). The last three works are those on nhich his lasting reputation depends.

As a philosopher, Gassendi opposed the blind acceptance of Aristotle, revived atomism and advocated an empirical realism. But he was not a consistent empiricist, for while he maintains "that there is nothing in the intellect which has not been in the senses" and that the imaginative faculty is the counterpart of sense, he admits that the intellect, which he affirms to be immaterial and immortal, attains notions and truths of which sensation or imagination can give us not the slightest apprehension. He instances the capacity of forming "general notions" and universals, the notion of God and the power of reflection.

The first part of the *Syntagma philosophicum,* which deals with logic and method, contains a praiseworthy sketch of the history of science and contends that the true method of research is the analytic, rising from lower to higher notions, though it admits that inductive reasoning, as conceived by Francis Bacon, rests on a general proposition not itself proved by induction. In the second part of the *Syntagma,* the physics, Gassendi approves of the Epicurean physics, but rejects the Epicurean negation of God, of particular providence and of an immaterial rational soul, endowed with immortality, capable of free determination and specially created. In the third part, the ethics, there is little beyond a milder statement of the Epicurean moral code and a mass of historical quotations. The final end of life is happiness, and happiness is harmony of soul and body.

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GASSER, HERBERT SPENCER (1888–), U.S. physiologist and Nobel laureate. was born in Platteville, Wis., on July 5, 1888. After graduating from the University of Wisconsin, and in medicine from the Johns Hopkins school of medicine (1915), he taught at Washington university. St. Louis. Mo., beginning there, with Joseph Erlanger (*q.v.*), the brilliant series of researches on nerve fibres that led to their joint award in 1944 of the Nobel prize in physiology and medicine. In 1931 Gasser became professor of physiology at Cornell university medical college. and in 1935 director of the Rockefeller Institute for Medical Research, which position he held until his retirement in 1953.

Gasser pioneered in the use of the cathode ray oscilloscope as an inertialess instrument for recording the action potentials of nerve impulses. With it he demonstrated the compound nature of the action potential of nerves containing various types of nerve fibres, formulated the rules relating conduction velocity to diameter of the individual nerve fibres, and characterized the several groups of nerve fibres in terms of their electrical properties and conduction velocities. Crucial to this characterization was his study of the after-potentials, which he showed to be different in the several groups of nerve fibres and to be closely correlated with the excitability cycles during recovery of nerve fibres following impulse conduction. An outstanding contribution was his study of the finest of all nerve fibres, the unmyelinated fibres, in which he elucidated their functional properties and, with the aid of the electron microscope, their anatomical structure and relation to the sheaths in which they are imbedded. (D. P. C. L.)

GASTEIN, a side valley of the Salzach river in the province of Salzburg. Aus., is situated between 3.000 and 3,500 ft. above sea level and is crossed by the Gasteiner Ache river. The principal settlements in the valley are Badgastein and Bad Hofgastein on the main railway with direct connections to the lines Munich–Venice and Vienna–Ziirich.

BADGASTEIN at an altitude of 3,320 ft.. is Austria's most important spa and winter sports resort. Pop. (1961) 8.414. It has radioactive thermal springs with a natural temperature of 110° F.. an underwater therapy station and, since 1950, a thermal gallery. For skiers there is a gondola cable car leading to the Stubnerkogel (7,365 ft.) and four ski lifts. Badgastein is also known for its magnificent waterfalls.

BAD HOFGASTEIN, the capital of the valley commune, lying at a lower level, is also a spa, the waters being conveyed from Badgastein by a pipeline. Pop. (1961) 4,612. At one time it was. after Salzburg. the richest place in the province because of its gold and silver mines, which were worked from the Roman period until the 20th century. (H. ZG.)

GASTER, MOSES (1856–1939), Rumanian Jewish scholar, rabbi and Zionist. a noted folklorist and philologist, was born at Bucharest and educated at Bucharest university, where he became lecturer in Rumanian language and literature (1881–85). His championship of the cause of persecuted Jews, which included aiding projects for settling Jews in Palestine, led to his expulsion from Rumania, and he went to England, where he held a lectureship at Oxford in Byzantine and Slavonic languages (1886 and 1891). In 1887 he was appointed chief rabbi of the Sephardic communities of England. Gaster retired in 1919 because of failing eyesight. He died near Abingdon. Eng., on March 5, 1939.

Gaster was author of an enormous body of literature. Among his works were *The Folk Literature of Rumania* (1883); *The Hebrew Version of Secretum Secretorum of Aristotle* (1908); *The Samaritan Book of Joshzca* (1908); *Example of the Rabbis* (1924); and many Rumanian translations and contributions to learned journals. His monumental *Crestomatia Romana* was uncompleted at his death.

GASTONIA, an industrial city and seat of Gaston county, is 20 mi. W. of Charlotte in south-central North Carolina, U.S. Gaston county, a leading cotton-mill county in North Carolina since 1860. had at the time of the U.S. census of manufactures in 1954 more cotton mills than any county in the United States. The manufacturing establishments in the county produce principally textiles and textile machinery.

Gastonia was incorporated in 1877 and became the county seat in 1909. The county, named in honour of William Gaston, a member of congress and judge of the North Carolina supreme court, was formed in 1846. The state-operated Gaston Technical school, the Vocational Textile school and the North Carolina Orthopedic hospital are located in the city. Kings Mountain National Military park is 20 mi. S.W.

In 1929 Gastonia was the scene of a textile strike and severe labour disorders that attracted national attention. Following the death of the Gastonia police chief in a raid on the National Textile Workers union headquarters, union organizer Fred Beal and six associates were convicted of conspiracy to commit murder.

In 1919 Gastonia adopted the council-manager form of government.

For comparative population figures *see* table in NORTH CAROLINA: *Population.* (R. N. E.)

GASTRIC AND DUODENAL ULCER. Peptic ulcer is an inclusive term referring to a sharply circumscribed, punched-out defect or loss of tissue in the mucosa or lining of the stomach or duodenum. The ulcerative process occurs because of the inability of the mucosal lining of the stomach or duodenum to withstand the corrosive and digestive action of acid gastric juice. It is important to distinguish between gastric (stomach) ulcer and duodenal ulcer because of differences in diagnosis, treatment and prognosis.

Peptic ulcer is a common cause of recurring or persistent upper abdominal distress, especially in young men. Duodenal ulcer occurs five to ten times more frequently than gastric ulcer, and is commoner in men than in women; in gastric ulcer the sex ratio is about equal.

Gastric juice, consisting primarily of hydrochloric acid of a concentration of 0.45% and an enzyme, pepsin, which digests proteins, is secreted by glands in the mucosa of the stomach. It is capable of digesting all living tissue. including the stomach itself. Protective mechanisms, such as secretion of mucus by the stomach glands, dilution of the acid juice by swallowed food and saliva. and intermittency of the secretion, act to prevent digestion of the stomach in the normal person. The secretion of acid gastric juice is controlled primarily by nervous impulses traveling via the vagus nerve. These impulses are stimulated by the sight, taste or smell of food, by the hormone gastrin, which is liberated from the lower part of the stomach after contact with food, and by other hormones from the duodenum. A person with a duodenal ulcer usually secretes more gastric juice with a higher hydrochloric acid concentration than a normal person does. The fact that this is not true in the case of gastric ulcer indicates that gastric mucosa may be less resistant than duodenal mucosa to the action of gastric juice.

The causes of peptic ulcers are not completely understood. although many factors have been implicated. Nervous tension, ingestion of certain drugs (such as salicylates and corticoids) and hormonal factors may play roles.

The symptoms of gastric and duodenal ulcer are similar, consisting of gnawing, burning. aching, hungerlike pain or discomfort in the mid-upper abdomen, occurring from one to three hours after meals or when the stomach is empty. Pain frequently occurs at 1 or 2 A.M. This pain is characteristically relieved by ingestion of materials such as food, milk and baking soda, which dilute and neutralize acid.

Several complicating conditions may occur secondarily to peptic ulcer: obstruction of the stomach outlet, due to inflammation or scar formation. may cause vomiting; hemorrhage may occur, manifested by vomiting of bloody material or material resembling coffee grounds, or by black tarry stools; if the bleeding is excessive, weakness and anemia may occur. The wall of the stomach or duodenum occasionally may perforate, causing severe localized abdominal pain and peritonitis. This catastrophic event requires immediate surgery.

Gastric ulcer is diagnosed by the roentgenographic appearance of a crater or defect in the lining of the stomach. It may also be seen directly through the gastroscope. Gastroscopy, especially when biopsy or microscopic examination of aspirations from the stomach (cytological examination) is also performed. usually enables differentiation of a benign gastric ulcer from an ulcerating carcinoma, symptoms of which are similar. The diagnosis of a duodenal ulcer, invariably benign. is usually based upon the, roentgenographic appearance of a characteristic crater or deformity in the duodenum.

Treatment of peptic ulcer is based upon the principle of complete and prolonged neutralization of the gastric hydrochloric acid. This is accomplished by the use of antacids, such as calcium carbonate, aluminum hydroxide, dihydroxy aluminum aminoacetate. dihydroxy magnesium aluminate, or milk. In the acute phase, which may last two to three weeks, these agents are given every half hour; later they may be given every one to two hours. Anticholinergic or antisecretory drugs, such as belladonna. atropine or Pamine, nhich inhibit the secretion of gastric acid. are also valuable. In selected cases. roentgen therapy to the stomach is valuable in producing a decrease in gastric acidity. Sedatives and tranquilizers are used to allay tension and nervousness.

During the first several days of therapy only small feedings of bland foods are allowed. Following this period a full bland diet—meals including two cooked fruits, tno cooked vegetables and lean meat—is tolerated. Prolonged use of a strict diet of pureed foods is rarely necessary. It is. however, best to avoid spices, gas-forming foods and alcohol or other irritants. Since coffee, chewing gum and tobacco stimulate gastric secretion. their use should also be discontinued if possible. In addition, a person with an ulcer should understand the nature of the disease so that he may reorient himself to a life of moderation, relieve nervousness and anxiety and obtain adequate rest and sleep.

Surgical treatment may be necessary in approximately 10% of all cases, either because of complications or because of unwillingness or inability of patients to follow a medical regimen. When it is not possible to differentiate nith certainty a benign gastric ulcer from an ulcerating cancer of the stomach, surgery is indicated. In the surgical treatment of a gastric ulcer, the ulcer is is removed along with three-fourths of the stomach. In the case of a duodenal ulcer the stomach may be removed in a similar manner or else the more physiological procedure of vagotomy and gastroenterostomy is employed. In the latter procedure, the vagus nerves to the stomach are severed and an opening is made from the stomach to the small intestine. The purpose of this operation is to eliminate the secretion of gastric juice caused by nervous impulses.

For ulcers in other parts of the gastrointestinal tract, see ULCER.

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GASTRITIS. The term gastritis signifies inflammation of the stomach, acute or chronic. Acute gastritis is caused usually by dietary indiscretions, excessive intake of alcohol, irritating drugs. food poisoning and infectious diseases. The smooth, glistening, orange-red appearing inner lining (mucosa) of the normal stomach becomes reddened, swollen and dulled; hemorrhages, adherent mucus and occasionally small superficial ulcerations also may develop. The chief symptoms are severe upper abdominal pain, nausea, vomiting. loss of appetite, thirst and diarrhea; the illness develops suddenly and subsides rapidly. The only treatment necessary is temporary avoidance of food. followed by a nonirritating diet, sedatives and antispasmodics; rarely, fluids by intravenous injection may be required. The intentional or accidental ingestion of corrosives (acids, alkalies) causes a severe chemical gastritis, necessitating immediate emptying and thorough washing of the stomach. general supportive care and. if the poison has systemic effects. administration of the specific antidote.

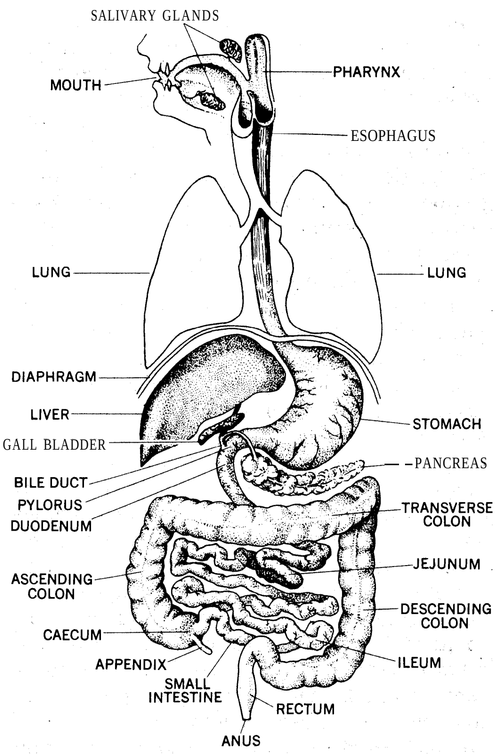
Chronic gastritis is classified into four varieties; mixtures of several types are not unusual. Superficial gastritis is characterized by redness. snelling and hemorrhage of the mucosa, nith adherent mucus and erosions. In atrophic gastritis the mucosa is thinned. grayish-green in colour and easily injured; the underlying blood vessels are abnormally visible. In hypertrophic gastritis the stomach wall is thickened, the folds are enlarged and irregular and the mucosa presents a swollen, spongelike appearance. The gastritis following operations upon the stomach combines features of these three types. The incidence of chronic gastritis in the general population is not known; in patients examined because of digestive symptoms the recorded frequency has varied from 15% to 60%. The cause of chronic gastritis and the conditions contributing to its development are not established; the eating of excessively hot or cold food. condiments, alcohol, tobacco, irritating medicines. stomach acids, allergy. infection. nutritional deficiencies and emotional disturbances all have been implicated. Since the stomach from early life is exposed continuously to various mechanical. chemical. thermal, bacterial. psychogenic and physiologic influences, chronic gastritis probably results from a combination of factors.

The symptoms in patients with chronic gastritis are indefinite and often resemble the manifestations of functional digestive disorders. They include discomfort, fullness or pain in the upper abdomen, poor appetite, flatulence, belching and variable bowel habits. In erosive gastritis the symptoms may be those of peptic ulcer; bleeding may occur. There are no characteristic laboratory or X-ray findings; these examinations are valuable chiefly to exclude serious organic disease.

There is no specific treatment for chronic gastritis; nor. indeed. is therapy usually necessary. Reassurance as to the absence of serious illness, a bland diet eliminating irritating foods and avoiding large quantities of alcohol, tea and coffee; and sedatives and antispasmodics to relieve nervous tension and quiet the congested, hyperactive stomach are helpful. Vitamins and other nutritional supplements are indicated when the food intake has been poor. Antacids and antisecretory drugs neutralizing and decreasing acid production in the stomach are useful in gastritis with erosions and with bleeding. Surgery is necessary when hypertrophic gastritis cannot be differentiated from tumour, for obstruction at the outlet of the stomach and for uncontrollable hemorrhage; however. such cases are rare. Chronic gastritis tends to be persistent or recurrent, with unpredictable variations in type, severity and distribution. However, it usually does not lead to serious disease. Minor surface alterations, such as congestion, hemorrhage and erosions, usually heal rapidly and completely.

BIBLIOGRAPHY.—J. B. Kirsner and W. L. Palmer, "Gastritis," *Cyclopedia of Medicine*, 13:157–176A (1955); **R.** Schindler, *Gastritis* **(1942)** and *Gastroscopy,* 2nd ed (1950). (J. B. KR.)

GASTROINTESTINAL TRACT, strictly speaking, is the term applied to that portion of the food canal that includes the stomach and the small and large intestines as an anatomical and a functional unit. The more inclusive term "alimentary canal" (formerly, digestive tube) includes also the esophagus, whereas "digestive tract" denotes the complete food canal, from the mouth through the anal canal. In the adult human being the digestive tract is 25 to 30 ft. long, and the food passes through the following parts one after the other: mouth, pharynx, esophagus, stomach, small intestine, caecum, colon, rectum and anal canal (the caecum, colon, rectum and anal canal constitute the large intestine). Into the digestive tract at various points the salivary glands, liver and pancreas (*qq.v.*) pour their secretions by special ducts.



ADAPTED FROM A. J. CARLSON AND V. E. JOHNSON, "THE MACHINERY OF THE BODY"; BY PERMISSION OF THE UNIVERSITY OF CHICAGO PRESS

FIG. 1.— ORGANS AND GLANDS OF THE DIGESTIVE TRACT. PART OF RESPIRATORY APPARATUS IS DRAWN TO INDICATE ITS RELATIONSHIP TO DIGESTIVE TRACT

This article deals chiefly with the anatomy, comparative anatomy and embryology of the gastrointestinal tract but includes also a discussion of the esophagus. The mouth (*q.v.*) and the pharynx (*q.v.*) are dealt with elsewhere. For the physiology of the digestive tract, *see* DIGESTION. *(See* also GASTROINTESTINAL *TRACT,* DISEASES OF.) The Anatomy section discusses structure in man exclusively; the other two major sections are more general in scope.

ANATOMY

Esophagus.—The esophagus or gullet, a muscular tube lined with mucous membrane, stretches from the lower limit of the pharynx or throat, at the level of the cricoid cartilage, to the cardiac orifice of the stomach. It is about 10 in. long (25 cm.) and $ in. to 1 in. in diameter. At first it lies in the lower part of the neck, then in the chest and lastly, for about an inch, in the abdomen. As far as the level of the fourth or fifth thoracic vertebra it lies behind the trachea, but when that tube ends it is in close contact with the pericardium and, at the level of the tenth thoracic vertebra, passes through the esophageal opening of the diaphragm (*q.v.*), accompanied by the two vagus nerves, the left being in front of it and the right behind. In the abdomen it lies just behind the left lobe of the liver. In both the upper and lower parts of its course it lies a little to the left of the mid-line. Its mucous membrane is thrown into a number of longitudinal pleats to allow stretching.

Stomach.—The stomach is an irregularly pear-shaped bag, situated in the upper and left part of the abdomen. When moderately distended, the thick end of the pear or fundus bulges up ard and to the left, while the narrow end is constricted to form the pylorus, by means of which the stomach communicates with the small intestine. The cardiac orifice, where the esophagus enters, is placed about a third of the way along the upper border from the left end of the fundus and between it and the pylorus; the upper border is concave and is known as the lesser curvature. From the cardiac to the pyloric orifice, round the lower border, is the greater curvature.

In front of the stomach are the liver *(see* fig. 1), the diaphragm and the anterior abdominal wall, while behind it are the pancreas, left kidney, left adrenal, spleen, colon and mesocolon. When the stomach is empty it contracts into a tubular organ and the transverse colon ascends to occupy the vacant space.

The pylorus is an oval opening, averaging one-half inch in its long axis but capable of considerable distention; it is formed by a special development of the circular muscle layer of the stomach, and during life is tightly closed, except during the periodic escape of gastric contents into the duodenum. The mucous membrane of the stomach is thrown into pleats or rugae when the organ is not fully distended.

Superficial to the mucous coat is a submucous, consisting of loose connective tissue, while superficial to this are three coats of unstriped muscle, the inner oblique, the middle circular and the outer longitudinal.

Small Intestine.—The small intestine is a tube, from 22 to 25 ft. long, beginning at the pylorus and ending at the ileocaecal valve; it is divided into duodenum, jejunum and ileum.

The duodenum is from 9 to 11 in. long and forms a horseshoe or C-shaped curve, encircling the head of the pancreas. It differs from the rest of the gut in being retroperitoneal. Its first part is horizontal and lies behind the fundus of the gall bladder, passing backward and to the right from the pylorus. The second part runs vertically downward in front of the hilum of the right kidney, and into this part the pancreatic and bile ducts open. The third part runs horizontally to the left in front of the aorta and vena cava, while the fourth part ascends to the left side of the second lumbar vertebra, after which it bends sharply downward and forward to form the duodenojejunal flexure.

The jejunum forms the upper two-fifths of the rest of the small intestine; it, like the ileum, is thrown into numerous convolutions and is attached by the mesentery to the posterior abdominal wall.

The ileum is the remaining three-fifths of the small intestine, though there is no absolute point at which the one ends and the other begins. Speaking broadly, the jejunum occupies the upper and left part of the abdomen below the subcostal plane, the ileum the lower and right part. At its termination the ileum opens into the large intestine at the ileocaecal valve.

Caecum.—The caecum is a blind sac occupying the right iliac fossa and extending down two or three inches below the ileocaecal junction. From its posterior and left surface the vermiform appendix protrudes, and usually is directed upward and to the left. This wormlike tube is blind at its end and is usually three or four inches long. Its internal opening into the caecum is about one inch below that of the ileum.

On transverse section it is seen to be composed of: (1) an external muscular coat; (2) a submucous coat; (3) a mass of lymphoid tissue, which appears after birth; and (4) mucous membrane. In many cases its lumen is wholly or partly obliterated, though this is probably due to disease. Guarding the opening of the ileum into the caecum is the ileocaecal valve, which consists of two cusps projecting into the caecum; of these the upper forms a horizontal shelf, while the lower slopes up to it obliquely. At birth the caecum is a cone, the apex of which is the appendix; it is bent upon itself to form a U, and sometimes this arrangement persists throughout life.

Colon. — The ascending colon runs up from the caecum at the level of the ileocaecal valve to the hepatic flexure beneath and behind the right lobe of the liver; it is about eight inches long and posteriorly is in contact with the abdominal wall and right kidney. It is covered by peritoneum except on its posterior surface (see fig. 1).

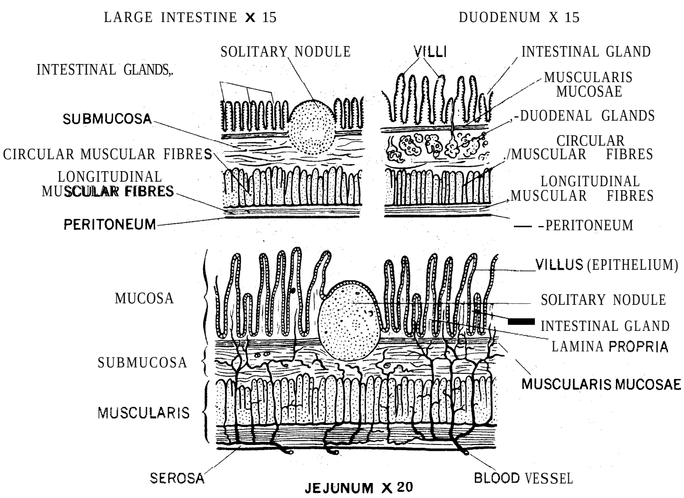


FIG. 2.—STRUCTURE OF INTESTINAL WALL AS SEEN IN LONGITUDINAL SECTIONS

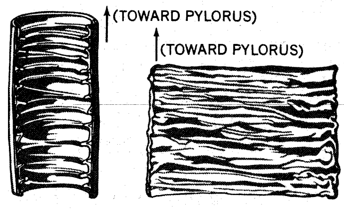
The transverse colon is variable in position, depending largely on the distention of the stomach, but usually corresponding to the subcostal plane. On the left side of the abdomen its ascends to the splenic flexure, which may make an impression on the spleen (*q.v.*), and is bound to the diaphragm opposite the 11th rib by a fold of peritoneum.

The descending colon passes down in front of the left kidney and left side of the posterior abdominal wall to the crest of the ilium; it is about six inches long and is usually empty and contracted while the rest of the colon is distended with gas; its peritoneal relations are the same as those of the ascending colon, but it is more likely to be completely surrounded.

The iliac colon stretches from the crest of the ilium to the inner border of the psoas muscle, lying in the left iliac fossa, just above and parallel to Poupart's ligament. Like the descending, it is usually uncovered by peritoneum on its posterior surface. It is about six inches in length.

The pelvic colon lies in the true pelvis and forms a loop, the two limbs of which are superior and inferior while the convexity reaches across to the right side of the pelvis. In the fetus this loop occupies the right iliac fossa, but, as the caecum descends and enlarges and the pelvis widens, it is usually driven out of this region. The distal end of the loop turns sharply downward to reach the third piece of the sacrum, where it becomes the rectum. Formerly the iliac and pelvic colons were spoken of as the sigmoid flexure.

Rectum. — The rectum, according to modern ideas, begins in front of the third piece of the sacrum. It ends in a dilatation or rectal ampulla, nhich is in contact with the back of the prostate in the male and of the vagina in the female and is in front of the tip of the coccyx. The rectum is not straight, as its name would imply, but has a concavity forward corresponding to that of the sacrum and coccyx.



FROM D J CUNNINGHAM, TEXTBOOK OF ANATOMY BY COURTESY OF OXFORD MEDICAL PUBLICATIONS

FIG. 3.—JEJUNUM OF THE SMALL INTESTINE SHOWING TRANSVERSE FOLDS. OR PLEATS

(Left) Section preserved or hardened In alcohol; (right) fresh portion spread out under water

At the end of the pelvic colon the mesocolon ceases, and the rectum is then covered only by peritoneum at its sides and in front; lower down the lateral covering is gradually reflected off and then only the front is covered. About the junction of the middle and lower thirds of the tube the anterior peritoneal covering is also reflected off onto the bladder or vagina, forming the rectovesical pouch in the male and the pouch of Douglas in the female. This reflection is usually about three inches above the anal aperture.

Anal Canal. — The anal canal, the termination of the digestive tract, runs downward and backward from the lower surface of the rectal ampulla between the levatores ani muscles. It is about an inch long and its lateral walls are in contact. Its opening is the anus.

(See also ANATOMY, GROSS.) (P. C. M.; X.)

Structure of the Intestine. — The intestine conforms to the general structural plan of hollow organs but shows some regional adaptations in agreement with local requirements. There are four coats: serous, muscular, submucous and mucous (see fig. 2). The tunica serosa is an external investment of peritoneum continuous with the mesentery, where present; it is incomplete on those surfaces of the intestine that are pressed against the body wall. Like serous membranes in general, it has a smooth, shiny surface and consists of a single layer of flat epithelial cells (mesothelium) lying upon a bed of connective tissue.

The tunica muscularis is composed of unstriped (involuntary) muscle fibres arranged in two sharply demarcated layers; the outer fibres' are directed longitudinally, whereas the inner fibres are disposed circularly. In the large intestine the longitudinal fibres, instead of being arranged evenly around the tube as in the small intestine, are especially concentrated in three longitudinal bands called taeniae.

In adapting itself to these shorter bands the remaining wall of the intestine is thrown into a series of sacculations named haustra. The taeniae of the caecum lead to the vermiform appendix, where they give way to an evenly disposed layer of muscle; in the rectum, on the other hand, the taeniae are effaced only partially. The circular layer of muscle is always thicker than the longitudinal; it is thickest in the duodenum and rectum.

The tela submucosa is a fairly thick layer of loosely arranged connective tissue in which many vessels form networks. In the duodenum it is characterized by containing closely packed duodenal glands (of Brunner), whose mucoid secretion is discharged into the intestinal lumen. In the duodenum and jejunum the submucosa elevates into a series of permanent, transverse pleats known as plicae circulares (see fig. 3) ; over these the mucous membrane drapes.

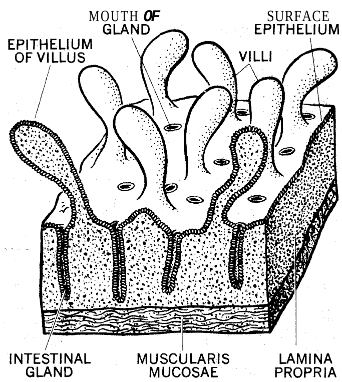


FIG. 4.—SAMPLE BLOCK OF MUCOUS MEMBRANE OF THE ILEUM (MAGNIFIED 35 TIMES)

The innermost coat is the tunica mucosa (see fig. 2, 4). The most important component of this membrane is its epithelium, nearest the lumen. This is a single layer of columnar cells, some of which have become specialized as unicellular slime glands (goblet cells). The epithelium rests upon a rather homogeneous basement membrane, beneath which is the lamina propria consisting largely of reticular tissue and lymphocytes. Most externally is a thin layer of unstriped muscle called the muscularis mucosae. The surface of the mucous membrane throughout the entire small intestine has a velvety appearance, due to the presence of closely set, minute, fingerlike elevations named villi. The myriad microscopic villi and the grossly folded plicae increase the secretory and absorptive area enormously.

The entire intestine, large and small, is specifically characterized by simple tubular intestinal glands (of Lieberkiihn) that are set close together vertically and extend through the thickness of the lamina propria. There are about 180,000,000 of these glands in both the small and large intestine; their length ranges from 0.1 mm. in the small intestine to 0.7 mm. in the large intestine. Each gland extends below the general surface as a tiny pit, narrow but relatively long. Its slender cavity is enveloped by a tube of epithelium, continuous with that covering the general internal surface of the organ. The glandular epithelium contains ordinary columnar and goblet cells, the latter preponderating in the large intestine; it also contains special Paneth cells and argentaffin cells, both of which are presumably secretory although their exact functions are still obscure.

Scattered throughout the entire intestinal mucosa, and sometimes intruding into the submucosa, are minute masses of lymphoid tissue termed solitary nodules; these are about the size of a pinhead and their number totals tens of thousands. Such nodules are especially abundant in the vermiform appendix. In the small intestine, but mainly in the ileum, they collect in oval groups called aggregate nodules (or Peyer's patches) which may attain a length of an inch or more.

Apposed folds of the mucosa and submucosa produce the ileocaecal valve between the small and large intestine. The rectum bears three shelflike transverse folds that project into the lumen. The anal canal contains a series of permanent longitudinal folds called rectal columns; the circular layer of muscle thickens to produce the internal sphincter of the anus. Outside the canal is an external sphincter of voluntary muscle.

Blood vessels reach the intestine by way of its mesentery and form an extensive plexus in the submucosa; arterial branches supply the muscular coat and mucous membrane, while venous branches return from the same regions. Lymphatic vessels provide a one-way drainage system for tissue fluids. The intrinsic nerve supply emanates from ganglion cells, located between the muscular layers and in the submucosa; extrinsic fibres come from the vagus nerves (and end on the intrinsic ganglion cells), and from the celiac sympathetic plexus (see NERVE; NERVOUS SYSTEM). (L. B. AY.)

Peritoneum. — For a discussion of the peritoneum, the membrane that surrounds the organs of the abdomen, see COELOM AND SEROUS MEMBRANES.

COMPARATIVE ANATOMY

The primitive condition of the vertebrate digestive tract may be described as a straight, simple tube, consisting of an anterior portion, formed by an ectodermal invagination, a long median portion lined by endoderm, and a short posterior portion formed by ectodermal invagination. In the lower vertebrates the primitive tube subserved also the purpose of respiration, and traces of the double function remain in the adult structure of all vertebrates. In fish, the pharynx, or branchial region, suddenly becomes narrower, posterior to the gill slits, to form the esophagus; in adults of higher animals the esophagus is separated from the primitive pharyngeal region and lies dorsal to it. In the primitive vertebrates, the entire digestive tract probably was lined with ciliated cells. Traces of this ciliation persist in many living forms.

Esophagus. — The esophagus is essentially merely a passage, as straight as may be, from the pharynx to the stomach, varying in length with the length of the neck and thoracic regions in different animals, and in calibre with the nature of the food. It is almost invariably lined with a many-layered epithelium, forming a tough coating, readily repaired and not easily damaged by hard food masses. There are only a few exceptions to this structural and functional simplicity. In fishes (see FISHES) the swim bladder is developed as a dorsal outgrowth of the esophagus and may remain in open connection with it. In many birds part of the esophagus may be temporarily dilated, forming a "crop," as for instance in birds of prey and hummingbirds. In the flamingo. many ducks, storks and the cormorant the crop is a permanent although not a highly specialized enlargement. Finally, in the vast majority of seed-eating birds, in gallinaceous birds, pigeons, sand grouse, parrots and many songbirds, particularly the finches, the crop is a permanent globular dilatation, in which the food is retained for a considerable time, mixed with a slight mucous secretion, and softened and partly macerated by the heat of the body. Many birds feed their young from the soft contents of the crop, and in pigeons, at the breeding season, the cells lining the crop proliferate rapidly and are discharged as a soft cheesy mass into the cavity, forming the substance known as pigeon's milk.

Stomach. — Where the esophagus passes into the stomach, the lining wall of the gastrointestinal tract changes to a mucous epithelium, consisting of a single layer of endodermal cells, frequently thrown into pits or projecting as processes; from being chiefly protective, it has become secretory and absorbing, and maintains this character nearly to the anus. The fundamental form of the stomach is a saclike enlargement of the canal, the whole forming an enlarged bent tube. At the distal end of the tube the intestinal tract proper begins, and the two regions are separated by a muscular constriction. In fishes the stomach may be a simple bent tube, or an expanded. globular or elongated sac. In amphibians and reptiles it is in most cases a simple sac, marked off from, the esophagus only by increased calibre. In the Crocodilia, however, the anterior portion of the stomach is much enlarged and very highly muscular, the muscles radiating from a central tendinous area on each of the flattened sides. The cavity is lined bv a hardened secretion and contains pebbles and gravel for mechanical trituration of the food, so that the resemblance to the gizzard of birds is well marked. This muscular chamber leads by a small aperture into a distal, smaller and more glandular chamber.

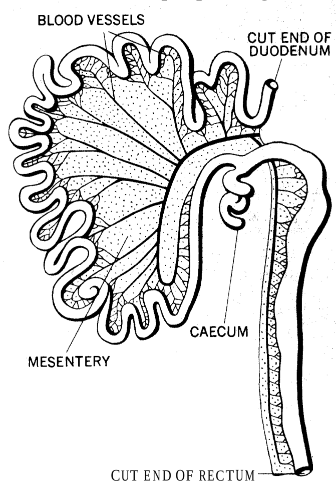


FIG. 5.—INTESTINAL TRACT OF THE FOX. SHOWING RELATIVELY SIMPLE SMALL INTESTINE. ADAPTED TO A CARNIVOROUS DIET

In birds the stomach exhibits two regions: an anterior glandular region, the proventriculus, the walls of which are relatively soft and contain enlarged digestive glands, and a distal region (gizzard). The distal region is larger and is lined in most cases by a more or less permanent membrane which is thick and tough in birds with a muscular gizzard, very slight in others.

In mammals the primitive form of the stomach consists of a more or less globular or elongated expansion of the esophageal region, forming the cardiac portion, and a forwardly curved, narrower pyloric portion, from which the duodenum arises. The whole wall is muscular, and the lining membrane is richly glandular. In many mammals one, two or three protrusions of the cardiac region occur, while in the manatee and in some rodents the cardiac region is constricted off from the pyloric portion. In the Artiodactyla the stomach is always complex, the complexity reaching a maximum in ruminating forms. In the chevrotains, which in many other respects show conditions intermediate between nonruminant artiodactyls and true ruminants. the esophagus opens into a wide cardiac portion, incompletely divided into four chambers. Three of these, toward the cardiac extremity, are lined with villi and correspond to the rumen or paunch; the fourth, which lies between the opening of the esophagus and the pyloric portion of the stomach, is the ruminant reticulum and its wall is lined with very shallow "cells." The fourth or true pyloric chamber is an elongated sac with smooth glandular walls and is the abomasum,

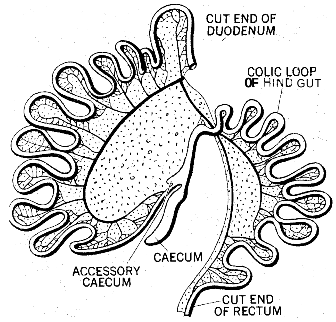


FIG 6.— INTESTINAL TRACT OF THE WALLABY, ADAPTED TO AN OMNIVOROUS DIET OF PLANT MATTER AND INSECTS

or rennet sac. In the camel the rumen forms an enormous globular paunch with villous walls and internally showing a trace of division into two regions. It is well marked off from the reticulum, the "cells" of which are extremely deep, forming the well-known water chambers.

In the true ruminants the rumen forms a capacious villous reservoir, nearly always partly sacculated, into which the food is passed rapidly as the animal grazes. The food is subjected to a rotary movement in the paunch, and is thus repeatedly subjected to moistening with the fluids secreted by the reticulum, as it is passed over the aperture of that cavity, and is formed into a rounded bolus The food bolus, when the animal is lying down after grazing, is passed into the esophagus and reaches the mouth by antiperistaltic contractions of the esophagus After prolonged mastication and mixing with saliva, it is again swallowed, but is now passed into the psalterium which. in true ruminants is a small chamber with conspicuous longitudinal folds. Finally it reaches the large abomasum where the last stages of gastric digestion occur.

In the whales the stomach is different from that found in any other group of mammals. The esophagus opens directly into a very large cardiac sac. the distal extremity of which forms a long caecal pouch. At nearly the first third of its length this communicates by a narrow aperture with the elongated, relatively narrow pyloric portion. The latter is convoluted and restricted into a series of chambers that differ in different groups of whales. In most of the pouched mammals (Marsupialia) the stomach is relatively simple; in the kangaroos, on the other hand the stomach is divided into a relatively small, caecal cardiac portion and an enormously long sacculated and convoluted pyloric region, the general arrangement of which closely recalls the large caecum of many mammals

Intestinal Tract. — It is not yet possible to discuss the general morphology of this region in vertebrates as a group. While the modifications displayed in birds and mammals have been compared and studied in detail, those in the lower groups have not yet been systematically coordinated.

Fishes.—In the cyclostomes (lamprey, hagfish), chimaeras and a few bony fishes the course of the gut is practically straight from the pyloric end of the stomach to the exterior, and there is no marked differentiation into regions. In the lungfishes a contracted sigmoid curve between the stomach and the dilated intestine is a simple beginning of the complexity found in other groups. In very many of the more specialized bony fishes the gut is much convoluted, exhibiting a series of watch-springlike coils.

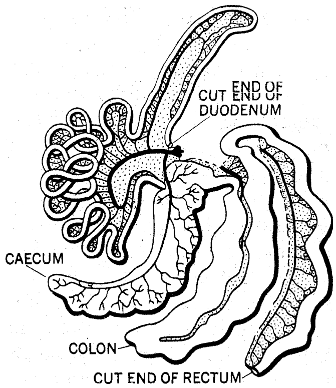


FIG 7 — INTESTINAL TRACT OF THE TAPIR, WITH WELL-DEVELOPED CAECUM, ADAPTED TO A DIET OF SOFT WATER PLANTS

In a number of different groups, increased surface for absorption is given, not by increase in length of the whole gut but by the development of an internal fold known as the spiral valve. A set of organs peculiar to fish, known as the pyloric caeca, is present in numbers ranging from 1 to nearly 200 in the vast majority of fish. These are outgrowths of the intestinal tract near the pyloric extremity of the stomach, and their function is partly glandular, partly absorbing.

In the amphibians the course of the intestinal tract is nearly straight from the pyloric end of the stomach to the cloaca; in the case of the salamanders that retain the gills through life (mud puppy, olm) there are no more than a few simple loops between the expanded "rectum" and the straight portion that leaves the stomach.

In fishes, amphibians and reptiles the intestinal tract is swung from the dorsal wall of the abdominal cavity by a mesentery which is incomplete because of secondary absorption in places. There are also traces, more abundant in the lower forms, of the still more primitive ventral mesentery.

Birds and *Mammals.*—The primitive gut must be supposed to have run backward from the stomach to the cloaca suspended from the dorsal wall of the body cavity by a dorsal mesentery. This tract, in the course of phylogeny of the common ancestors of birds and mammals, became longer than the straight length between its extreme points and, consequently, was thrown into a series of folds.

The mesentery grew out with these folds, but the presence of adjacent organs, the disturbance due to the outgrowth of the liver and the secondary relations brought about between different portions of the gut, as the outgrowing loops invaded each other's localities, disturbed the primitive simplicity.

Three definite regions of outgrowth, however, are to be recognized in the actual disposition of the gut in existing birds and mammals. The first of these is the duodenum. The second portion is Meckel's tract. It consists of the part generally known as the small intestines, the jejunum and ileum of human anatomy, and stretches from the distal end of the duodenum to the caecum or caeca. It is the chief absorbing portion of the gut. and in nearly all birds and mammals is the longest portion. It represents, however, only a very small part of the primitive straight gut, corresponding to not more than two or three somites of the embryo. The third portion of the gut should be termed the hind-gut, and lies between the caecum or caeca and the anus, corresponding to the large intestines, colon and rectum of human anatomy. It is formed from a much larger portion of the primitive straight gut than the duodenum and Meckel's tract together, and its proxirnal portion, in consequence, lies very close to the origin of the duodenum.

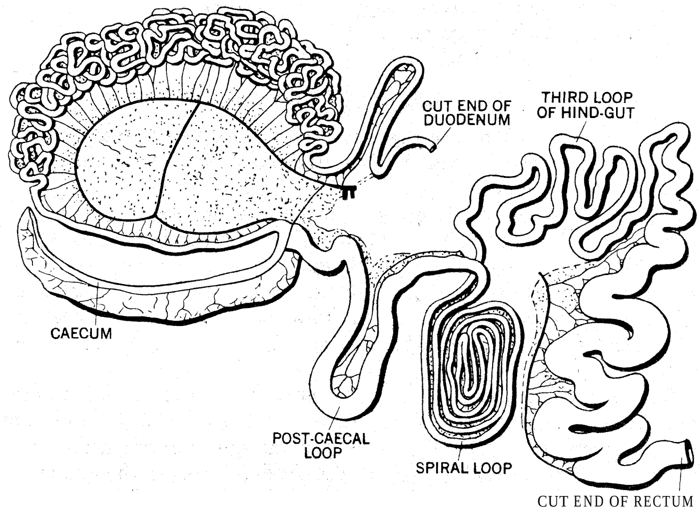


FIG. 8. — INTESTINAL TRACT OF THE GIRAFFE, COMPLEXLY DEVELOPED AND ADAPTED TO A DIET OF LEAVES OF SHRUBS AND TREES

Adaptations of *the* Intestinal Tract to Function. — The chief business of the gut is to provide a vascular surface to which the prepared food is applied so that the nutritive material may be absorbed into the system. Overlying and sometimes obscuring the morphological patterns of the gut are many modifications correlated with the nature of the food. Thus in birds and mammals alike there is a direct association of herbivorous habit with great relative length of gut.

In fish-eating birds and mammals the gut is very long, with a thick wall and a relatively small calibre, while there is a general tendency for the regions of the gut to be slightly or not at all defined. In fruit-eating birds the gat is strikingly short, wide and simple, while a similar change has not taken place in fruit-eating mammals. Carnivorous birds and mammals have a relatively short gut.

The **Colic** Caeca. — These paired or single organs lie at the junction of the hind-gut with Meckel's tract and are homologous in birds and mammals although their apparent position differs in the majority of cases in the two groups. The caeca are hollow outgrowths of the wall of the gut, the blind ends being directed forward. They vary in size within very wide limits and there is no invariable connection between the nature of the food and the degree of their development. The caecal wall is in most cases highly glandular and contains masses of lymphoid tissue. In birds and in mammals this tissue may be so greatly increased as to transform the caecum into a solid or nearly solid sac.

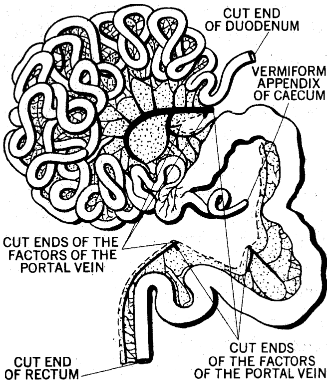


FIG. 9.—INTESTINAL TRACT OF THE GORILLA. ADAPTED TO A DIET OF FRUIT AND LEAVES

EMBRYOLOGY

The greater part of the digestive tract is formed by the closing in of the entoderm to make a longitudinal tube, ventral and parallel to the notochord.

This tube is blind in front and behind (cephalad and caudad), but the middle part of its ventral wall is for some distance continuous with the wall of the yolk sac, and this part of tlie tract, which at first opens into the yolk sac by a very wide aperture, is called the mid-gut. The part in front of it, which lies dorsal to the heart, is the fore-gut, while the part behind the aperture of the yolk sac is the hind-gut.

The pharynx, esophagus, stomach and part of the duodenum are developed from the fore-gut, a good deal of the colon and the rectum from the hind-gut, while the mid-gut is responsible for the rest. The cephalic part of the fore-gut forms the pharynx (see THROAT), and about the fourth week the stomach appears as a fusiform dilatation in the straight tube.

Between the two the esophagus gradually forms as the embryo elongates. The opening into the yolk sac, which at first is very wide, gradually narrows, as the ventral abdominal walls close in, until in the adult the only indication of the connection between the gut and the yolk sac is the rare presence (about 2%) of Meckel's diverticulum.

The stomach soon shows signs of the greater and lesser curvatures. the latter being ventral, but maintains its straight position. About the sixth week the caecum appears as a lateral diverticulum, and until the third month is of uniform calibre; after this period the terminal part ceases to grow at the same rate as the proximal, and so the vermiform appendix is formed. The mid-gut forms a loop with its convexity toward the diminishing vitelline duct, or remains of the yolk sac, and until the third month it protrudes into the umbilical cord. The greater curvature of the stomach grows more rapidly than the lesser, and the whole stomach turns over and becomes bent at right angles, so that what was its left surface becomes ventral. This turning over of the stomach throws the succeeding part of the intestine into a duodenal loop, which at first has a dorsal and ventral mesentery. The intestine now grows very rapidly and is thrown into a series of coils; the caecum ascends and passes to the right ventral to the duodenum, and presses it against the dorsal wall of the abdomen; then it descends toward its permanent position in the right iliac fossa.

From the ventral surface on the hinder (caudal) closed end of the intestinal tube the allantois grows to form the placenta and bladder (see URINARY SYSTEM; REPRODUCTIVE SYSTEM; PLACENTA), and this region is the cloaca into which the gastrointestinal, urinary and generative canals or ducts all open. Later, two lateral folds appear which, by their union, divide the cloaca into a ventral and a dorsal part, the former being genitourinary and the latter alimentary or intestinal. In this way the rectum or dorsal compartment is shut off from the genitourinary. Later an ectodermal invagination at the hind end of the embryo develops and forms the anal canal; this is the proctodaeum, and for some time it is separated from the hind (caudal) end of the rectal part of the mesodaeum (or part of the intestinal canal formed from the mesoderm) by a membrane called the anal membrane. This is eventually absorbed, and the digestive tract now communicates with the surface by the anus. See also references under "Gastrointestinal Tract" in the Index volume. (P. C. M.; X.)

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GASTROINTESTINAL TRACT, DISEASES OF. Diseases of the gastrointestinal tract are numerous. Only the more important disorders affecting the stomach and intestines are considered in the discussion that follows.

STOMACH

Peptic Ulcer. — A peptic ulcer is a localized loss of tissue in the membrane that lines the stomach or the immediately adjacent portion of the duodenum. This disorder, which occurs much more often in the duodenum than in the stomach, affects from 5% to 10% of all people at some time in their lives. Though there are certain important differences between ulcers in the stomach and those in the duodenum, the two types are considered together here.

The precise cause of peptic ulcer is unknown. It is generally agreed, however, that the hydrochloric acid normally present in the gastric juice plays an important role. The prevailing concept is that the corrosive action of the gastric acid renders the affected area of the stomach or duodenum susceptible to digestion by pepsin, a digestive enzyme also found in gastric juice. The fact that ulcer patients, especially those with duodenal ulcer, invariably have free (excess) hydrochloric acid in their gastric juice lends support to the importance attributed to the acid-peptic mechanism. Emotional stress also appears to contribute to the formation of peptic ulcer and to the precipitation of ulcer attack.

Recurrent attacks of upper abdominal pain or distress occur periodically in ulcer patients. The pain generally occurs one to two hours after eating or during sleep. Characteristically, relief is temporarily obtained by food, milk or certain neutralizing drugs known as antacids. Each attack lasts several days or weeks and reappears after several weeks or months. Recurrences are especially frequent in the spring and fall. The ulcer may erode a blood vessel and give rise to hemorrhage; it also may extend through the wall of the stomach or duodenum and cause perforation; or it may form sufficient amounts of scar tissue to obstruct the outlet of the stomach.

The keystone of medical treatment is a program that rests the stomach. This includes physical and mental rest; mild sedation; a bland diet with frequent milk feedings between meals; drugs, such as atropine and belladonna, that reduce acid secretion; and acid neutralizers, such as calcium carbonate and aluminum hydroxide. Surgery is necessary in from 10% to 15% of patients with duodenal ulcer; surgery becomes necessary when patients fail to respond to intensive medical treatment or when they develop some complication of the disease. A gastric ulcer that does not heal in four to perhaps six weeks should be treated surgically, principally because of the possibility that it may represent an ulcerating cancer rather than a simple benign ulcer. This fear does not apply to duodenal ulcers, which practically never are cancerous. (See also GASTRIC AND DUODENAL ULCER; ULCER.)

Gastritis. — Gastritis is an inflammation, either acute or chronic, of the stomach, principally of its lining membrane. The acute variety is usually a temporary affair and is manifested principally by vomiting and upper abdominal distress. The inflammation usually clears up after removal of the exciting cause. which may be dietary indiscretion. excessive consumption of alcohol, the use of certain drugs or infection. The cause of chronic gastritis is unknown. Patients with this form of gastritis may experience little or no distress. or they may complain of vague dyspepsia or present symptoms simulating peptic ulcer. Erosive or ulcerative gastritis, whether acute or chronic. may on occasion cause hemorrhage. Inspection of the lining membrane of the stomach through a gastroscope may disclose one or several changes, each with its own characteristics. One of these, designated as chronic atrophic gastritis or gastric mucosal atrophy, is thought to predispose to the development of stomach cancer. The treatment of chronic gastritis consists chiefly of a bland diet and antacids. Liver extract and vitamins have also been reported to be beneficial. (See also GASTRITIS.)

Cancer. — Carcinoma of the stomach is one of the most frequent malignant diseases of the digestive tract, particularly in men over the age of 40 years. It occurs in all races and in all parts of the world. The disease usually appears in one of three anatomical forms: (1) an ulcer; (2) a projecting tumour; or (3) a diffusely infiltrating and spreading growth. Although the cause of gastric carcinoma is unknown, it is generally agreed, on the basis of present evidence, that a peptic ulcer of the stomach rarely, if ever, turns cancerous. The problem rather is to distinguish an ulcerating cancer from a benign ulcer of the stomach.

The symptoms of cancer of the stomach are often insidious in their development. Indeed, the disease is usually fairly well developed before the first symptoms appear. The patient may initially experience a diminution of appetite, some weight loss or mild upper abdominal discomfort or pain. The pain may resemble that of peptic ulcer and may be relieved by eating. Indigestion is especially suspect when it appears for the first time in a middle-aged or older person whose gastric secretion fails to show free acid after appropriate stimulation. The free acid secretion of the stomach is absent or diminished in most of the patients with gastric cancer. X-rays usually give evidence of the disease (80%–90% of the cases) when symptoms are present Additional methods of examination, notably gastroscopy and the search for cancer cells in gastric washings, increase diagnostic accuracy.

Cure depends upon early diagnosis and early removal of the cancer along with part or all of the stomach. See also CANCER; ABDOMEN, SURGERY OF: *Gastrointestinal* Surgery.

THE INTESTINES

Regional Enteritis (Ileitis).—This is a chronic inflammatory disease of one or more segments of the small bowel. In its classical form it is confined to the terminal portion of the ileum; *i.e.*, where the ileum joins the colon. In some cases, however, a major part of the small intestine may be affected, either continuously or irregularly with skip areas. In a type of enteritis known as enterocolitis, varying lengths of the adjoining colon also may be involved. In rare cases, the duodenum or even the stomach may be affected by the disease. Consequences of the disease are that the bowel is thickened. its channel is narrowed and its lining is ulcerated. The cause of regional enteritis is unknown. It affects both sexes of all ages but particularly those between 15 and 30 years. Patients may recover completely from an initial acute attack. but the usual course is one of progression with continuously smoldering disease for many years. Periods of relative freedom from symptoms are interrupted by acute exacerbations; or the patient is never entirely well and complications ensue.

The symptoms are extremely variable. The initial attack may simulate acute appendicitis. The usual picture is that of a continuous or intermittent diarrhea, sometimes bloody, accompanied by painful abdominal cramps. Fever is very common and sometimes overshadows the digestive symptoms. Chronic debility, weight loss and anemia produce progressive physical deterioration. Grave complications may occur, such as obstruction or perforation of the intestine, the formation of an abscess within the abdomen, or an abnormal communication (fistula) between the diseased gut and adjacent coils of small bowel, the colon. urinary bladder or vagina. Infections about the anus, particularly a perianal fistula, occur fairly commonly.

Diagnosis is confirmed by X-ray examination of the small bowel and colon. Uncomplicated cases are preferably managed by conservative, nonsurgical measures. These consist basically of physical rest and a bland, nutritious diet with minimal roughage, supplemented with vitamins and iron. Corticotrophin (ACTH), a hormone derived from the pituitary gland, and adrenal cortical hormones, such as cortisone. often produce gratifying improvement. These agents, however, do not cure the disease. Antibiotics are often helpful in the treatment of secondary infection but are not curative. Surgery is reserved for patients who do not benefit from medical treatment or who exhibit the more serious complications. The principle of surgery is to remove the diseased segment or to isolate it from the intestinal stream by connecting normal bowel above the level of the disease to the colon at a point well beyond the diseased segment.

Appendicitis (inflammation of the appendix) generally occurs as an acute attack; such attacks may culminate in perforation of the appendix with peritonitis or localized abscess formation. The typical picture is one of pain, tenderness and muscular spasm in the right lower quadrant of the ahdominal wall. This is often preceded by pain that is vaguely localized in the middle or upper abdomen. The patient's temperature is usually elevated and the white blood cell count is increased. If appendicitis is suspected, nothing should be taken by mouth; laxatives are especially hazardous. Treatment is surgical removal of the appendix as early in the disease as possible.

Chronic appendicitis, a term often used to describe low-grade, recurring pain in the right lo er quadrant of the abdomen, is infrequent. Usually the pain is found to result from a disorder other than chronic inflammation of the appendix. (See also APPENDICITIS.)

Functional Disorder of the Colon.––Functional disorder of the colon, also known as the "irritable colon syndrome," is probably the most common cause of abdominal discomfort, pain and irregular bowel action. The disorder is due predominantly to disturbed motility of the colon, but it may be associated with similar disturbance of function in other parts of the digestive tract. It results from a "nervous" or irritable state of the bowel and not from organic or structural disease. X-ray and other examinations do not disclose organic abnormalities. The terms "mucous colitis" and "spastic colitis" are popularly used to designate this condition. They are undesirable terms, however, because there is no true "colitis" (inflammation of the colon) in this disorder. The disturbed activity of the colon is usually related to nervous tension, worry and anxiety. The eating of irritant and laxative foods, the overuse of harsh laxatives. allergic response to certain foods and excessive smoking also may contribute to the irritability of the bowel.

The patient experiences abdominal discomfort, pain and irregularity of bowel evacuation. Constipation is more common than diarrhea, but both may occur alternately in the same individual. Excessive mucus in the stool is sometimes present. Abdominal distension or bloating, rumbling sounds and excessive passage of flatus are common symptoms. Usually the digestive complaints are accompanied by general symptoms of nervousness. weakness and fatigue.

Treatment begins with a thorough examination to exclude organic disease. Reassurance about the nature of the disorder and zttempts to alleviate emotional tension are important in treatment. A bland diet free of physically and chemically irritant foods and the use of mild sedatives and antispasmodic drugs are helpful. The patient is urged to discontinue the use of laxatives and enemas and is encouraged to adjust his daily routine so as to provide more rest and relaxation. Development of a regular bowel habit is desirable. Constipation is treated by providing a greater intake of cooked fruits and vegetables and such natural laxatives as prune juice. In addition, the ingestion of a simple hydrophiiic colloid may be useiul in providing a soft stool.

Constipation. — Constipation is actually a symptom and not a disease. Because of its frequency and the importance attached to it, however, it merits special consideration. Constipation may be defined as the infrequent evacuation of excessively hard, dry stools. Frequency is a less important criterion than the physical character of the stool since healthy persons vary greatly in the frequency of defecation. The mistaken notion that a daily evacuation is essential for good health has, unfortunately, led to colossal overuse of laxatives and cathartics. (See CATHARTIC.)

Constipation may be subdivided into functional and organic types. Functional constipation, in which there is no structural abnormality, is a major symptom of the irritable colon syndrome discussed above under Functional Disorder of the Colon. Organic causes are numerous and include such diverse conditions as carcinoma of the colon and rectum, diverticulitis, inflammatory diseases that produce constricting scars in the intestine, a pelvic mass pressing on the colon and painful diseases of the anus such as fissure or hemorrhoids. Treatment of organic constipation depends on its cause.

Diarrhea. — Diarrhea, like constipation, is a symptom and not a disease. Diarrhea may be defined as the frequent passage of loose or watery stools. It, too, may be either functional or organic in origin. Diarrhea frequently is a manifestation of the irritable colon and is commonly associated with emotional states, such as fear and anxiety. Laxative foods, cathartics, excessive alcohol and certain foods to which the individual is sensitive may produce or aggravate diarrhea. Organic causes of diarrhea are numerous. They include infection (*e.g.*, bacillary and amoebic dysentery, Staphylococcus food poisoning, cholera, paratyphoid fever, etc.); poisoning, as by mercury, arsenic or other chemical agents; regional enteritis and chronic ulcerative colitis; cancer of the intestinal tract; sprue (*q.v.*) and celiac disease, in which intestinal absorption of foodstuffs is impaired; and overgrowth of fungi or actual organic changes that develop as a complication of antibiotic therapy.

Diarrhea is treated basically by physical rest, clear fluids or soft bland foods and medication; this treatment is designed to relieve pain, reduce intestinal hyperactivity and soothe the inflamed or irritated bowel. More specific measures depend on the cause for the diarrhea. (See also DYSENTERY; BACTERIAL AND INFECTIOUS DISEASES.)

Chronic Ulcerative Colitis. — This is a chronic disease of unknown etiology in which the lining membrane of the colon and rectum is diffusely inflamed and studded with bleeding pinpoint ulcers. The disease affects the left (lower) half of the colon and rectum more often than the right (upper) side of the colon. However, the entire colon is affected in more than 50% of cases. In approximately 5% of all cases, the disorder is confined to segments of the colon above the rectum. Ulcerative colitis most commonly affects persons between 20 and 40 years of age. A few patients recover completely, but most suffer recurrent episodes or are chronically and continuously ill for many years. The disease may at any time become acute and fulminating.

No specific cause is known. It may well be that there are multiple causes, each playing some part. The resemblance of the disease to infection is striking, but no microorganism has been clearly implicated. Emotional disturbance is almost invariably present and probably plays an important role. There is some evidence suggesting that the malady may be an autoimmune disease. According to this concept, antibodies injurious to the colon develop as the result of an alteration in the colonic tissue brought about by some noxious agent.

The patient experiences intermittent or continuous diarrhea with blood commonly present in the stools. Fever, anemia, weight loss and malnutrition are common symptoms. Serious complications may occur. These include hemorrhage, perforation of the bowel, development of a perianal fistula or abscess and arthritis or arthralgia.

In addition to the classical multiple small ulcers, the lining of the affected colon often exhibits projecting tags or islands of tissue referred to as pseudopolyps. The incidence of colonic cancer is decidedly greater in patients who have had this disease for a number of years than it is in the general population. Sigmoidoscopic inspection of the lining membrane and an X-ray of the colon ordinarily establish the diagnosis.

Medical treatment is similar to that for regional enteritis. Physical rest and the alleviation or control of emotional factors are essential for good results. Corticotrophin and adrenal cortical hormones are even more helpful in this disease than in regional enteritis. Antibiotics and sulfonamides are used for secondary infection with some benefit.

Surgery is reserved for patients who remain debilitated or incapacitated despite prolonged and intensive medical treatment, or who suffer from certain of the complications. The operation usually employed consists of removing the colon and rectum and bringing the termination of the small intestine to the outside through the abdominal wall. This opening, termed an ileostomy, serves as a substitute for the anus. The fecal discharge from the ileostomy is collected in a rubber or plastic bag. In those few cases in which the rectum is spared, the diseased portion of the colon may be surgically removed and the continuity of the normal bowel re-established by joining the remaining portions of uninvolved colon.

Diverticulosis and Diverticulitis. — Diverticula (abnormal outpouchings or saccules) are frequently seen in the colons of older persons, especially those who are constipated. When these diverticula are present, a person is said to have diverticulosis. If the diverticula become inflamed, the condition is described as diverticulitis. Diverticula usually cause no symptoms. However, if they become inflamed or complicated by perforation or abscess formation, abdominal pain, diarrhea, bleeding, fever or intestinal obstruction may occur. Treatment of uncomplicated diverticulosis requires no particular measures other, perhaps, than those directed against constipation. Diverticulitis requires antibiotics and measures designed to keep the bowel at rest; in some cases removal of the inflamed segment of colon is necessary. (See also DIVERTICULITIS AND DIVERTICULOSIS.)

Cancer of the Colon. — This disorder occurs even more frequently than cancer of the stomach. Colonic polyps, the benign tumours (adenomas) of the colon and rectum that are found in about 10% of all persons beyond the age of 40, are considered to be potentially precancerous. This has led to the practice of removing polyps of the colon and rectum whenever they are found.

In the lower part of the colon, cancer tends to be constricting in type, producing symptoms of bowel obstruction. The manifestations of this change include abdominal discomfort and an alteration in bowel habit in the direction of constipation. Alternating attacks of diarrhea and constipation may occur. Blood is commonly seen in the stool. (See also INTESTINAL OBSTRUCTIONS.)

Cancer situated in the upper part of the colon is less apt to be obstructive and produces poorly defined symptoms. The patient often complains of vague dyspepsia and abdominal discomfort. Diarrhea and constipation are less frequent than in cancer of the lower colon. Weakness and fatigue, caused by anemia, are prominent. A tumour mass may be palpable.

Diagnosis is established principally by X-raying the colon (barium enema) and by direct visualization of the rectum and lower colon through a sigmoidoscope. The treatment of choice is surgical removal of the tumour with restoration of bowel continuity by end-to-end anastomosis of the remaining colon. The prognosis following curative resection is the most favourable of all cancers of the digestive tract. See also CANCER.

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(J. E. BK.; I. A. W.)

GASTROLITH, a term given to concentrations of solid material formed in the digestive tract or, more commonly, to pebbles swallowed and retained in the gizzard by birds, reptiles and certain fish to help grind food which their teeth or beaks cannot chew.

Groups of pebbles found within or near the skeletons of dinosaurs and plesiosaurs, or in geologic formations in which such bones are numerous, are thought to be gastroliths and suggest that the stomachs of these ancient reptiles were gizzardlike, with thick muscular walls. These pebbles have common characteristics. maximum dimension one inch to four inches. shape ellipsoid, surface smooth and generally highly polished, material resistant (quartz. quartzite, chert, flint, jasper, agate, granite and gneiss), They are found almost entirely in strata of Cretaceous and Jurassic Ages; in the United States chiefly in Colorado. Kansas, Wyoming, Montana and Utah, also in France, Germany and other parts of central Europe.

These ancient gastroliths possess a higher polish than modern ones, perhaps because of the more powerful abrasive action they underwent, in which softer pebbles were crushed and served as polishing materials. along with primitive silica-bearing grasses

Another view is that many or all of these so-called gastroliths are merely deposits of wind-worn stones. However, the variety of rocks. often from distant sources. in a single assemblage and their isolation in fine-grained rocks makes this explanation difficult.

(L. W P.)

GASTRONOMY, MODERN. Is gastronomy an art or a science? This is a question on which epicures and cooks are at issue. La Rochefoucauld wrote that "eating is a necessity, but eating intelligently is an art." Vauvenargues admitted unhesitatingly that "great thoughts come from the stomach." The doctrine of Epicurus bids us find an agreeable employment ior our faculties in the intelligent enjoyment of the pleasures of the table. And finally, to go back still farther, Ecclesiastes himself teaches us that "a man hath no better thing under the sun, than to eat, and to drink, and to be merry. . . ."

Throughout the ages, meals have been made a time of relaxation, comfort and enjoyment. The feasts of the middle ages mere, as we know, assemblies of people desperately hungry after long days of hunting in the forests, trained to violent exercise, capable of wearing heavy armour and of doing justice to a prodigious bill of fare.

In the 17th century, the spirit of order, reason and dignity which characterized the literature of the period found a further outlet in the elaborate organization of banquets: these were conducted according to a regular program, involving a whole series of minute observances. The result was that the guests got nothing but congealed gravy.

The 18th century, witty, pugnacious, enthusiastic and volatile, introduced into cookery its elegance, its instinct for pleasure and refinement. But modern cookery really dates from the end of the First Empire, the time of Brillat-Savarin and Carême. It was they who substituted the "made dish" for masses of roast meat, piled in pyramidal form and held together by skewers. These enormous, barbaric accumulations of food were yet another Bastille nhich the French Revolution overthrew.

Gastronomy Is an Art.—It may fairly be said that modern gastronomy is an art, and that Molière talked like a Philistine when he made one of his characters say that "we eat to live, we do not live to eat." It is an art because it demands the cooperation of all the senses. The crispness of fried dishes and pastry is agreeable to the ear. The softness of well thickened sauces and melting *foies gras,* the succulent freshness of fruit, are pleasant to the touch. Is there anything more delightful to the eye than a dish *au* gmtin, with its captive flavours imprisoned under its golden dome? Do not odours like those of seasonings of herbs, or of truffles, afford the highest possible gratification to the sense of smell? Of the palate there is no need to speak.

It may even be said that gastronomy is a perfect art, for so wide a range of enjoyment could not, in the opinion of the present writer be derived from listening to a symphony. hearing a poem read, or gazing at a beautiful building. Indeed, it would not be unreasonable to maintain, not merely that gastronomy is a perfect art. but that it is the only art which is perfect.

Gastronomy Is a **Science.**—Unquestionably gastronomy is a science, for it has its laws, its formulas, its fixed processes. Art cannot be taught. nhereas the profession of cookery should be preluded by a long apprenticeship. Certain physico-chemical laws have to be observed in the preparation of our food; and cooks often make scientific discoveries without knowing it. Why does red wine go well with roast meat and cheese? Because tannin combines with albuminous substances in a manner propitious to digestion. Why do we put lemon juice on fried dishes, or in a salad? Because acids attack cellulose and saponify oil, and make them easier to digest.

Likenise, there are culinary processes uhich are scientific applications of the laws of nature. Roast meat, for example, must be exposed to great heat for a short time in order that a crust may form all over the surface, and then placed in a moderately heated oven and left there as long as possible in order that the browned skin may imprison all the juices of the meat and that these, by a slow process, as it were of digestion, may make the flesh tender.

Again, cooks know that a sauce the principal ingredient of which is the yolk of an egg must never be alloned to boil, or else its elements will become disunited: as we say, they will curdle. They knon, too, that, if need be, they can be reunited simply by the addition of the yolk of another egg and a little boiling water. If a dish is too salt. add at once a few spoonsful of milk or a little butter.

The Revival **of Cookery.**—For some time past a good deal has been heard about new dishes. **As** a matter of fact, there is hardly a dish which has not been attempted already.

Many people, it is certain, do not know that in the Middle Ages, at the Tour d'Argent, the oldest restaurant in Paris, dormouse pastry, mixed dishes of snakes, porpoise, roast swan and crane stuffed with plums were served to the guests. Nor that Frederick the Great made his coffee with champagne and added mustard to give the remarkable drink a still stronger taste. Nor that, before the war, a cook named Jules Maincave gave to the world fillets of mutton with crayfish sauce, beef cooked in kummel, bananas with Gruyère cheese, sardines with Camembert cheese and herring soup with raspberry jelly.

These last experiments, it must be confessed, are highly unpleasant; for the ingredients in question could not possibly be made to harmonize, any more than cat and dog. Nor is it at all clear how a mixture, for example, of chocolate and red wine could be rendered palatable.

At the same time, it would be a mistake to go to the opposite extreme and content ourselves with the stereotyped dishes turned out by cooks devoid of imagination. When a writer uses hackneyed words—a habit of which journalism affords only too frequent examples—we say that he writes in cliche's and that he writes badly. When a painter always paints the same picture over and over again, we are quick to compare him to a photographer lazily taking a succession of proofs from the same negative. Similarly, in the domain of cookery, the most modest dishes should afford a good housewife an opportunity of using her inventive faculty and her intelligence. There is no reason why the culinary fashions of years gone by should immobilize and enslave us, nor why the gastronomists of to-day should be less adventurous, less eager for knowledge than their predecessors who, throughout the ages, have enriched cookery with a stream of new discoveries. We should not abandon hope of improving on first results. We should pay no attention either to dogmatists who accept the existing order of things, repeat and solemnly hand on to posterity what they have heard from their elders, and irrevocably condemn the unknown as a matter of principle, or to those who take fright at an unfamiliar flavour, like children swallowing their first oyster. If men had always acted thus, if no risks had been taken and no experiments made, whereby alone the adventurous instinct learns self-restraint, the range of our enjoyments would to-day be exceedingly limited. We should be no more tolerant of the conservatism of people who will not eat roast chicken unless surrounded by watercress, or veal unless in the company of carrots or peas, or a leg of mutton with anything else than a dish of haricot beans.

What we should aim at doing is to combine with familiar recipes something which, while setting off their good qualities, yet introduces an element of surprise and provides what was wanting in them. We should not hesitate to transform a sauce possessing its traditional flavour into something more savoury and unexpected.

The harmonies which can be obtained from certain combinations of crisp and fatty substances and of watery and farinaceous vegetables are worth studying.

Here follow a few recipes in the new style of cookery; these will give an idea of the kind of dish which harmonizes with a modern dining room.

Tomato Tart. — This is a simple family dish which is sure to be appreciated by old and young alike. Make an open tart of unsweetened pastry. Fill it with a thick be'chamel (a sauce made of flour and butter) flavoured with cheese, mixed with concentrated tomato essence.

Place on this foundation tomatoes which have been cooked in butter flavoured with onion and stuffed with mushrooms and olives.

The tomatoes should have been put in the oven just before being placed in the tart. Then cover the whole with bread crumbs done with butter to a golden brown, and the tart is ready to be served.

It forms a dish of three storys and each of them succulent.

Cold Pork with **Truffles.**—*Foie* gras flavoured with truffles is excellent; but it seems a pity to mix two decided flavours. Surely it is better to use truffles to give flavour to something which in itself is comparatively tasteless. M. Verdier, former manager of the *Maison Dorée* and one of the greatest chefs of the day, recommended that pieces of raw truffle should be pressed as deeply as possible into a piece of fresh pork. Choose a piece which is close-grained and not too lean. When the pork is inlaid with a sort of mosaic of truffle, roll it, tie it up and roast it. Let it cool in its own fat and serve it cold the next day with whatever salad is in season.

Haricot Beans with Cream Sauce. — Schoolboys and soldiers learn to hate haricot beans, but they are a vegetable which can be either detestable or delicious according to the way in which they are cooked.

If you want to make haricot beans really exquisite, let them soak for 24 hr. and then boil them slowly.

Meanwhile, get ready in a saucepan a spoonful of good be'chamel (see above), half a litre of cream and plenty of grated Gruyère cheese.

Put in plenty of pepper and not much salt. When the sauce has been brought to a creamy consistency, pour it over the haricots after first straining them.

Sprinkle the whole with a little grated cheese and brown lightly in the oven.

Lettuce and Orange Salad. — You need to have the soul of a rabbit to eat salad as it is usually served — green leaves slightly lubricated with oil and flavoured faintly acid with vinegar. A salad is only a background; it needs embroidering. To give character to a lettuce salad, cut up slivers of orange rind as small as pine needles and sprinkle them over the salad. It you want something still more entertaining for your guests, cut up a carrot into equally small slips.

This will at once arouse the attention of any gourmet. Which is orange and which is carrot, he will wonder. How does the orange come to have a flavour of carrot and the carrot a flavour of orange?

You will find that you have given him a real gastronomic entertainment.

Stewed Apples Flavoured with Tangerine. — A dish of stewed apples, rust-coloured and unadorned, is usually a melancholy sight.

Yet this economical dish, which is to be found in the least pretentious homes, can be given an attractive flavour. All that is needed is to put in little pieces of the rind of tangerines after removing all the white pith. The dish can easily be decorated with slices of tangerine which have first been freed from their pips and soaked in rum.

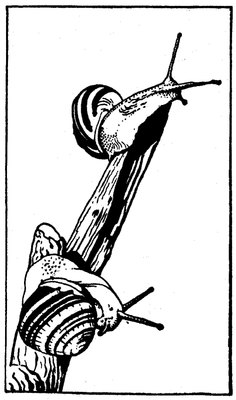
These dishes are much easier to make than might be thought from the description. They are far less difficult than most of the recipes of high-class cookery, for which strong bouillon of meat or fish is usually required. Guests may at first be rather suspicious of their novelty, but the first mouthful will remove their apprehensions and they will soon be in the proper frame of mind to appreciate the new style of cooking. When an unfamiliar harmony of flavours forms itself on the palate, we should try to analyze the sensation just as we identify the different instruments in an orchestra.

This is the right way to train our taste. We shall create new sources of pleasurable sensation. and we may even enrich humanity by fresh progress in the culinary art.

(See also FOOD PREPARATION.)

BIBLIOGRAPHY —Among works on gastronomy which have recently appeared, or which can definitely be regarded as authoritative, the following may be mentioned: Ali-Bab, *La Gastronomie Pratique;* Auguste Escoffier, *Le Guide Culinaire;* Edouard Nignon, *Les Plaisirs de la Table;* Paul Poiret, *107 Recettes* ou *Curiosités Litteraires;* Paul Reboux, *Plats Nouveaux;* E. Richardin, *La Cuisine Française;* Bertrand Guegan, *La Fleur de la Cuisine Française;* Paul de Cassagnac, *Les Vins de France;* Salles and Prosper Montagné, *La Grande Cuisine;* and the works of Philéas Gilbert, Edouard de Pomiane, Paul Bouillard and Maurice des Ombiaux (P. RE.)

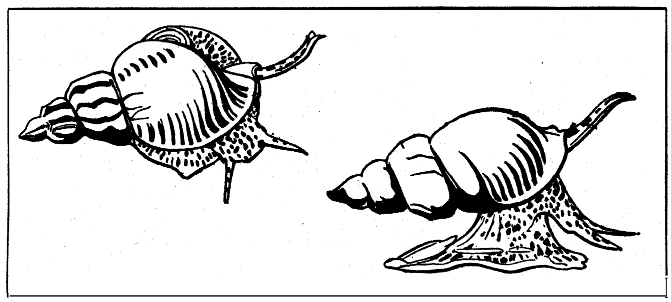
GASTROPODA, a large group of invertebrate animals ranked as a class of the phylum Mollusca and represented by such familiar forms as the limpet, the whelk, the common snail and slug. There is no single English name which can be given to this group. The land and fresh-water forms which have shells may all be termed "snails" and the shell-less land forms "slugs," and by a reasonable usage the name "snails" or "sea snails" may be given to marine Gastropoda with shells (whelks, periwinkles, etc.), and the shell-less marine forms (Nudibranchia, etc.) may be called "slugs" or "sea slugs."



BY COURTESY OF S. CROOK

FIG. 1.— GARDEN SNAILS CLIMBING (½ NAT. SIZE)

The Gastropoda are primarily distinguished from other molluscs by their shell, which is a single structure and is spirally coiled, at least in the larval state. In many Gastropoda, however, it is very much modified in the adult and, though it is spiral in a large number of genera, it may lose this appearance and become; *e.g.,* cup-shaped or tubular. In some forms it is covered over by the mantle and degenerate, and it may also be entirely absent. The Gastropoda are also distinguished from other molluscs by their asymmetrical organization. The latter is brought about by a process which takes place in larval development, during which the anus and the organs adjacent to the latter are moved forward ventrally from their originally posterior position and then twisted through 180°, so that they come to lie above and to one side of the head. The flexure of the intestine is a phenomenon seen in other molluscs; the twisting or "torsion" of the anal complex is peculiar to gastropods, and it is believed to bring about the asymmetry mentioned above. the chief feature of which is the atrophy or the complete disappearance of the kidney, gill and auricle originally situated on the right side of the body, those of the original left side persisting in a more or less unmodified condition. The clearly defined and well-developed head is likewise distinctive.

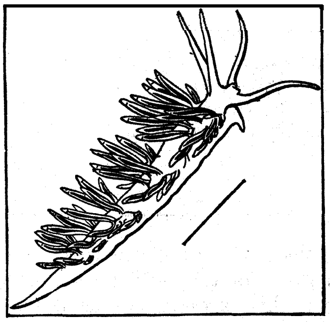


FROM MEHEUT, "ETUDE DE LA MER" (ALBERT LEVY)

FIG. 2.— THE WHELK. BUCCINUM UNDATUM (½ NAT. SIZE)

The Gastropoda constitute the largest class of molluscs and number about 30,000 living species, which range in size from giant whelklike forms 2 ft. in length, down to minute species of Vertigo barely a millimetre long in the adult state. An enigmatic fossil from the Wealden of Kent (Dinocochlea ingens) measuring over 6 ft. in length has been described as a fossil gastropod.

In all probability the earliest gastropods were marine animals and gastropods still constitute an important part of the marine fauna. They have also populated fresh-water and land habitats, and the familiar Helicidae, the Zonitidae and Bulimulidae are among the largest groups of land invertebrates. In general, their range of habitat is diversified. They are found at very great depths in the sea as well as in the shallower water, and the pelagic gastropods (Pteropoda and Heteropoda) form part of the marine plankton (minute floating organisms). The fresh-water and terrestrial Gastropoda occupy a great varietv of habitats and as a whole are to be reckoned as a very adaptable group, though the need for moisture and lime salts renders them less universally distributed than, *e.g.*, millepedes and Collembola.

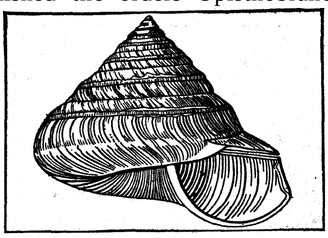


FROM ALDER AND HANCOCK, "BRITISH NUDIBRANCHIATA" (RAY SOCIETY)
FIG. 3.—HERMAEA DENDRITICA

Generally speaking, gastropods are sedentary, inactive animals that rely on their hard shells and unobtrusive habits for protection. The cumbrous shell and the absence of a jointed skeleton render them slow in their movements. On the other hand, they are capable of very considerable muscular exertion and tend to be very tenacious of life. A limited number of genera are more active and mobile and have taken to swimming, climbing and burrowing. Many marine gastropods and the majority of the terrestrial and fresh-water forms feed upon plants or on organic debris, and such a diet was no doubt characteristic of the primitive gastropod stock. Several groups, however, have become carnivorous and are modified accordingly in habits and structure.

Classification. — The classification of the Gastropoda has undergone many changes in the past. Even at the present time there is no universally accepted system so far as the main subdivisions are concerned, although there is a general measure of agreement as to the composition of certain of the lesser groups.

The class Gastropoda, including the orders Nudibranchiata, Tectibranchiata and Pulmonata, was created by Cuvier in 1795; later he created the Pteropoda as equal in rank with the Gastropoda. In 1812 Lamarck created the group Heteropoda, ranking it also equal with Gastropoda. In 1846–48 Milne-Edwards established the orders Opisthobranchiata and Prosobranchiata. The Pteropoda were held as a distinct class until Paul Pelseneer in 1888 showed their affinities to the Opisthobranchiata.

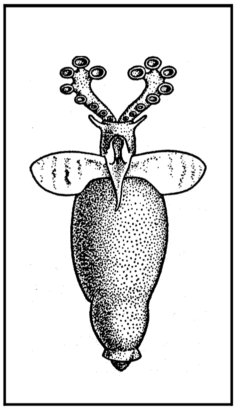


FROM MARTINI AND CHEMNITZ, "CONCHYLIEN CABINET" (GUSTAV FOCK)
FIG. 4.—PLEUROTOMARIA RUMPHII (⅔ NATURAL SIZE)

The diversity of opinion about the main subdivisions may be taken to imply that any natural groups of these dimensions (subclasses, orders) that may exist in the class have not yet been made apparent by morphological research. Nevertheless, certain broad groupings are recognized by those authors who in the last two decades have subjected the class to comprehensive treatment.

It will be convenient to contrast three such systems which have been proposed by Paul Pelseneer, H. Simroth and J. Thiele respectively. Different as these three schemes appear at the offset, they tend in fact to recognize the same main groupings. For table of systems see top of page 60.

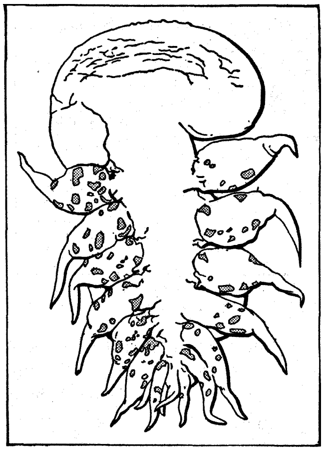
The Streptoneura of Pelseneer contain precisely the same families (limpets, trochids, periwinkles, whelks, etc.) as do the Prosobranchia of Simroth and Thiele. The rest of the class is treated as a single sub-class by Pelseneer. Thiele divides them into two sub-classes (as also seems to be the intention of H. Hoffmann, who is continuing Simroth's treatise in Bronn's *Tierreich*). But this does not involve any re-arrangement of the contents of Pelseneer's Euthyneura, as the latter are divided into two orders, equivalent in their contents to Thiele's sub-classes. In short, both authors recognize the distinction between the Opisthobranchia and the air-breathing pulmonata. Thiele's promotion of these two groups to the rank of sub-classes is advantageous, however, as it emphasizes the marked structural and bionomic differences between these groups. It is true that they resemble each other in certain distinctive features (*e.g.*, they are hermaphrodite and the visceral complex is detorted) in which they both differ from the Streptoneura. But they are otherwise very clearly defined and have a radically dissimilar evolutionary history.



FROM CHALLENGER, "ZOOLOGY" (H.M. STATIONERY OFFICE)
FIG. 5.—SPONGIOBRANCHAEA AUSTRALIS AUSTRALIS. NOTE THE SUCKERS (ABOUT NAT. SIZE). AFTER ORBIGNY & PELSENEER

Thiele's Archaeogastropoda contain the same families as Pelseneer's Aspidobranchia and Simroth's Scutibranchia. His Mesogastropoda are Pelseneer's Taenioglossa and his Stenoglossa are equivalent to Pelseneer's sub-order of that name. With regard to the status given to these groups Pelseneer's scheme seems at present more rational. While Thiele's elevation of the Stenoglossa to the rank of an order is to some extent justified by the marked specialization of these forms as carnivores and carrion-feeders, it leaves the Taenioglossa, a large and miscellaneous group with too great an appearance of uniformity. Probably Thiele's rating of the Stenoglossa is justifiable, and what is required is a more complete knowledge of the relationships of families constituting the Taenioglossa.

Little can be said concerning the numerous minor divisions. A great deal of work remains to be done in elucidating the constitution and relationships of families, the structure of which is imperfectly known. Many of the minor groups are probably very far from representing natural associations. The work of H. A. Pilsbry (1909–28) on the enormous group of land pulmonata has gone a long way towards disentangling the chaotic assemblages originally treated as Helicidae, Bulimulidae and Zonitidae, and the course of pulmonate evolution is becoming correspondingly clearer to us. But even so, this large and unwieldy order is in need of comprehensive treatment along bionomic as well as morphological lines.



FROM "ANIMALS OF ALL COUNTRIES" (HUTCHINSON'S PERIODICALS)
FIG. 6.—TETHYS LEPORINA, SHOWING COWL-LIKE FRONTAL VEIL FORMED FROM ANTERIOR TENTACLES (ABOUT ⅓ NAT. SIZE)

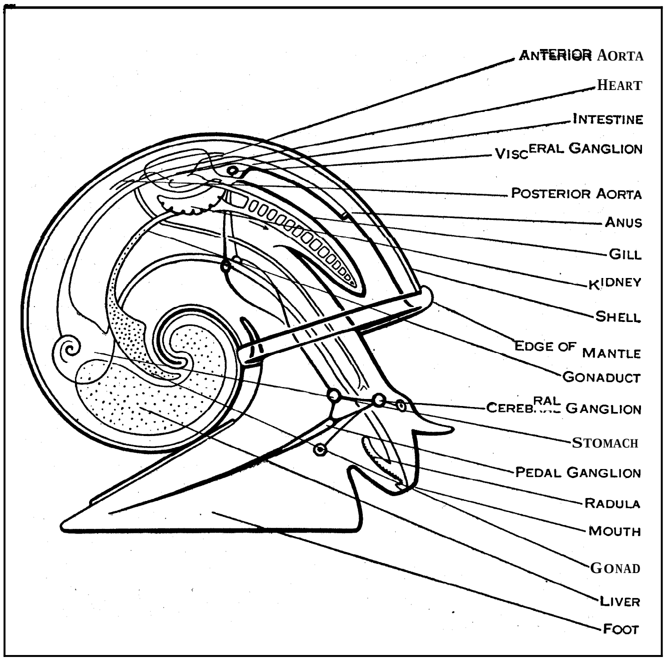
ANATOMY AND PHYSIOLOGY

The Gastrcpoda are divisible, as we have already seen, into a large number of groups, each distinguished by anatomical and bionomic peculiarities. The significances of these divisions will be easier to grasp, if the main evolutionary tendencies that have been manifested.within the class are briefly indicated in advance. The details of gastropod structure and morphology are well described in the standard textbooks on this subject, and the description given here consists of a selection of such of the more important modifications as illustrate the main evolutionary changes within the group. The most primitive of living gastropods are slow moving marine animals which feed upon algae, sea weeds or organic debris. They creep about by means of a flattened foot and rely for protection on an external shell, which is usually coiled in the adult. Their internal organization, though it is affected

CLASS GASTROPODA

	Pelseneer 1906	*Simroth* 1907	*Thiele* 1925–26
Sub-class 1.	Streptoneura.	Order Prosobranchia.	Sub-class 1. Prosobranchia.
Order 1.	Aspidobranchia.	Sub-order 1. Pectinibranchiata.	Order 1. Archaeogastropoda.
Sub-order a.	Docoglossa.	A. Siphonostomata.	
" 2.	Rhipidoglossa.	B. Heteropoda.	Order 2. Mesogastropoda.
		C. Holostomata.	Order 3. Stenoglossa.
Order 2.	Pectinibranchia.	Sub-order 2. Scutibranchiata.	Sub-class 2. Opisthobranchia.
Sub-order 1.	Taenioglossa.	A. Podophthamata.	Order 1. Pleurocoela.
" 2.	Stenoglossa.	B. Edriophthalmata.	Order 2. Saccoglossa.
		Order Pulmonata.	
Sub-class 2.	Euthyneura.		Order 3. Acoela.
Order 1.	Opisthobranchia.		Sub-class 3. Pulmonata.
Sub-order 1.	Tectibranchia.		Order 1. Basommatophora.
" 2.	Nudibranchia.		Order 2. Stylommatophora.
Order 2.	Pulmonata.		
Sub-order 1.	Basommatophora.		
" 2.	Stylommatophora.		

by the "torsion" already mentioned as far as the visceral nervous commissure and alimentary canal are concerned, is still more or less symmetrical. *Pleurotomaria, Fissurella* and *Haliotis* among the Rhipidoglossa exemplify this type of organization. In the course of evolution the main departures from the latter are as follows: (1) The visceral complex (heart, gills and kidneys) becomes asymmetrical through the atrophy and disappearance of those of the above named organs which are situated on the right



FROM SPENGEL, "ERGEBNISSE UND FORTSCHRITTE DER ZOOLOGIE" (FISCHER)
FIG 7.— DIAGRAM OF GASTROPOD ORGANIZATIONS

side of the adult body. (2) The shell may become internal and degenerate and finally disappear and a secondary external symmetry may be established. (3) A terrestrial and air-breathing mode of life has been adopted independently by several groups. (4) A carnivorous or carrion-eating habit has been acquired on several occasions. (5) The creeping mode of progression has been abandoned by certain families in favour of swimming and floating or of a truly sessile (adherent) mode of life.

These by no means exhaust the list of specialization exhibited by the class; but they are the most frequent and lead to the most striking modifications of structure.

External Features and General **Organization.**—The body of a gastropod is divisible, like that of nearly all molluscs, into four main parts—the visceral sac, the mantle which covers the latter, the head and the foot. The morphological unity of the head and foot has been suggested by A. Naef, and this subject is discussed in the article MOLLUSCA. The whole animal may be visualized as having an elongate and wormlike body with the head and foot at one end. The greater part of the body is spirally coiled, and the coiled portion (the visceral sac) is sheathed in a fleshy coyering, the mantle, which projects as a free fold at the anterior end and hangs down like a skirt around the head and foot. In the cavity thus formed between the mantle and head the function of respiration is normally carried out either by gills or by a lung. In the former case the mantle cavity is largely open to the exterior; in the second the edge of the mantle is adherent to the "neck," a small hole (the pneumostome) being left for the admission of air into the lung. In certain Rhipidoglossa the mantle edge is not complete anteriorly and dorsally, but is interrupted either by a longitudinal slit or a series of holes probably representing a slit, the edges of which have fused.

The mantle secretes a shell which consists of a single piece and is in most cases spirally coiled. The minute structure of the shell and its chemical composition is described in the article MOLLUSCA. In individual development the shell appears in the embryo as a plate or caplike rudiment which becomes coiled and grows in size by the deposition of mineral salts round the edge of the open end (aperture). It is likely that the forerunners of the Gastropoda had a cap-shaped shell in the adult state.

In the most archaic representatives of the class, however (*e.g. Bellerophon,* among the extinct Cambrian genera and *Pleurotomaria* among living forms) the shell is coiled. It is worthy of note that in *Bellerophon* the shell is not of an elongate or screw-like spiral shape, its coils being all in one plane (planospiral), like that of the primitive cephalopod *Nautilus.* The modifications of the adult shell are complex and manifold. The general plan and the terminology employed in describing shells are shown in fig. 9 and the various modifications are described and illustrated in text books and conchological treatises. It is sufficient here to allude to the most important change that is encountered in the class.

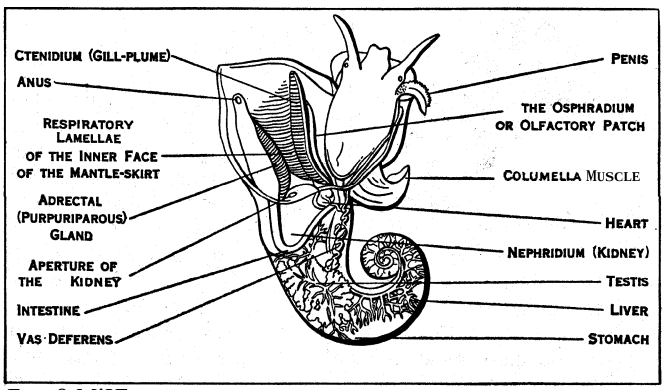
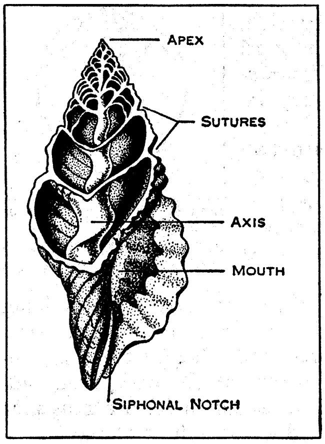


FIG. 8—MALE OF LITTORINA LITTOREA, REMOVED FROM ITS SHELL. SHOWING THE ORGANS ON ITS INNER FACE

The shell, which is to be regarded as primitively spiral, becomes unwound and secondarily cap-shaped in many Streptoneura *(Patella, Capulus)*. Furthermore, the edges of the mantle may grow over the shell and cover a large part of its surface. This condition is found in such genera as *Fissurella, Cypraea,* and *Marginella* among the Streptoneura and in various Opisthobranchia (*Aplysia*) and Pulmonata (*Vitrina*). The overgrowth of the mantle may be complete and the shell is thus internal and degenerate (Lamellariidae and sluglike Pulmonata). Finally, the shell may disappear entirely (*Titiscania,* many nudibranchs, *Onchidium*). This progressive atrophy of the shell occurs in many groups of gastropods. Although it may become of advantage to the animal as allowing it greater freedom of movement, the loss of the shell is to be regarded at least at the offset as an innate tendency of the class and probably of the molluscan phylum as a whole.



FROM SIR RAY LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)

FIG. 9.— SECTION THROUGH A TRITON SHELL (ABOUT ½ NAT. SIZE)

The head in the Gastropoda is well developed and clearly defined from the rest of the body to which it is connected by a mobile "neck." It is usually provided with sense organs, a snout or muzzle and one or two pairs of tentacles. The foot is a powerful muscular organ. Usually it is rather elongate and has a flat surface suitable for a creeping gait.

Notable modifications of the foot are seen in marine forms which dig in sand (*Natica,* Bullomorpha). These gastropods have the foot transformed into a "digging-shield" shaped like a snowplow. In heteropods and "pteropods," it is modified for use in swimming.

On the posterior dorsal surface of the foot there is in nearly all Streptoneura a solid plate, the operculum. When the animal withdraws itself into its shell, this plate by reason of its position and shape remains applied to the aperture of the shell which it closes like a lid. The operculum is absent in nearly all the Euthyneura, but certain terrestrial forms such as the Helicidae secrete a glutinous or calcareous plate over the mouth of the shell when they estivate or hibernate.

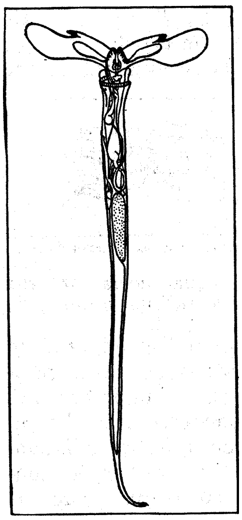

FROM MURRAY AND HJORT, "THE DEPTHS OF THE OCEAN" (MACMILLAN LTD.)

FIG. 10.—CRESEIS ACICULA.

The foot often exhibits along its sides a ridge (epipodium) which extends from the head to the posterior extremity. The epipodium is well developed in the Rhipidoglossa and often bears appendages and sense organs. It has been assumed to have a common origin with the funnel of the Cephalopoda. The head and foot are joined to the visceral mass by a narrow and highly mobile "neck." The animal is attached to the shell by the strong columellar muscle, and by the contraction of the latter the animal can withdraw itself into the shell. This muscle is inserted into the columella or axial pillar of the shell (*cf.* fig. 9).

The disposition of the chief external parts having thus been sketched, it will now be convenient to describe how the characteristic gastropod asymmetry is attained. Some details of the internal organization are given below; but it is necessary at this stage to recall the preliminary statement that, while some primitive forms are symmetrically organized, the main parts of the visceral complex (gills, kidneys, etc.) being paired, in most gastropods the organs of the right-hand side are atrophied or absent in the adult, and that in the Streptoneura the visceral commissure is twisted into a figure-of-eight. In addition, the spiral winding of the shell and visceral mass has to be accounted for.

Before considering how and in what circumstances this highly characteristic organization was developed in the course of gastropod evolution, it will be best to describe the main organization and metamorphosis of a gastropod larva.

As will be seen in the section on Reproduction and *Development*, the larva is symmetrical in the early stages of growth, the mouth and the anus lying at opposite ends of the body. At a stage which more or less corresponds with the appearance of the shell, the anus shifts downward and forward and ultimately comes to lie below and near the mouth. At this stage the mantle cavity is seen as a small space surrounding the anus. Such coiling as the shell may show at this stage is "exogastric," *i.e.,* the coils are situated above the head and away from the foot. Soon, however, the anus, the mantle cavity and the adjacent parts rotate upward and come to lie above the head and to the right of the latter. The coils of the shell at the same time roll downward and assume an "endogastric" position, *i.e.,* they lie over the foot and away from

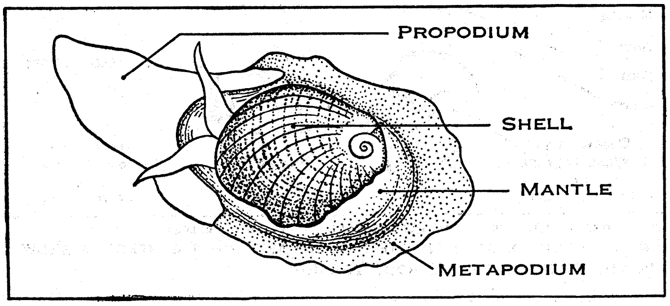


FIG. 11.—SIGARETUS LAEVIGATUS (NAT. SIZE). AFTER SOULEYET. 1841

the head. It will be seen that there are two movements involved in this reorganization of the larval symmetry, viz., the ventral flexure of the intestine and the torsion or rotation of the pallial complex up the right side of the body. Though these two changes may be merged into one in individual development they must be carefully distinguished. The ventral flexure is found in the Gastropoda, Cephalopoda, Scaphopoda and Lamellibranchia, torsion is hound in the Gastropoda alone.

If processes of this kind, which occur in the course of individual development, may be taken to epitomize events which happened during the evolutionary history of the race, then it is to be inferred that metamorphosis is a summary of changes which took place in gastropod evolution. Many theories have been put forward to account for these processes. They agree in attributing great importance to the influence of the spiral shell and the acquisition of a flat and elongate sole. If it is true that the Gastropoda are descended from animals with a simple caplike shell and a relatively small foot, then it seems likely that, as the shell acquired a tubular shape, it became necessary to bring the originally posterior anus and associated organs into a position in which they would not be covered in by the growing shell. Hence the flexure of the intestine, the result of which was to bring the anus near the head. But it plainly could not persist in this position, as the elongation of the foot would tend to drive it backward. Its rotation up the side of the body, until it came to lie above and to the right of the head, brought it into the most convenient position. It is also likely that the change in the spire of the shell from an exogastric to an endogastric position may have influenced the torsional process. Naef assumes thbt the animals which gave rise to the primitive gastropods were swimming forms. In such a mode of life the exogastric spire would be no inconvenience. But with the advent of a creeping habit the heavy, forwardly directed shell could no longer maintain its position and would fall on one side. This displacement of the shell would almost inevitably affect the position of the pallial complex. The position ultimately taken up by the latter may be explained either as directly due to the displace-

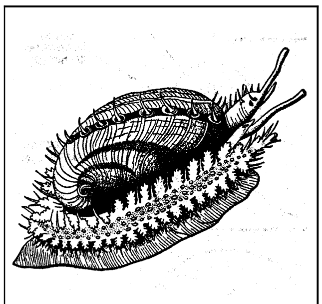
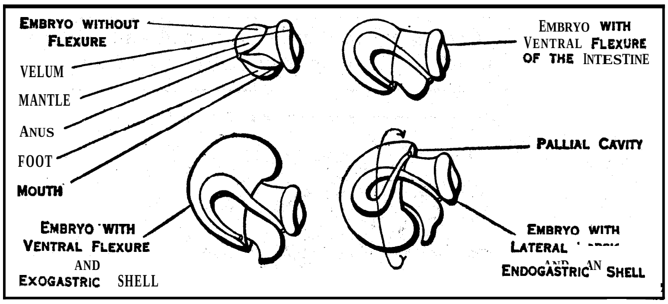

FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)

FIG. 12 —HALIOTIS TUBERCULATA (⅓ NAT. SIZE)

ment of the shell or as an adaptation that placed the pallial complex in a less cramped and restricted situation. It is quite uncertain whether the rotation of the shell or growth of the foot was most influential in bringing about torsion. It is likely that both contributed.

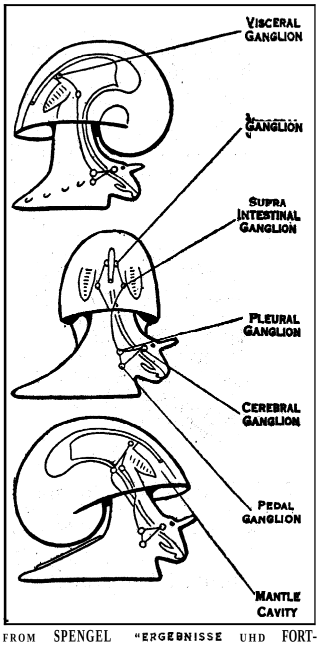
The foregoing account must not be taken as a description of actual events but of the factors which are likely to have been concerned in producing flexure and torsion. The spiral winding of the shell and the torsion of the viscera are to be carefully distinguished, as they are probably not causally connected. The main process of torsion, at least in ontogeny, takes place before the



AFTER ROBERT LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)
FIG. 13.— FOUR STAGES IN THE DEVELOPMENT OF A GASTROPOD SHOWING THE PROCESS OF THE BODY TORSION

spiral winding of the shell and visceral mass is manifest. The cause of the actual asymmetry of the internal organs is not entirely clear. The twisting of the visceral commissure may be due to the effect of the torsion; but the atrophy and reduction of the originally left-hand organs are not at first sight referable to the latter. They have been explained as due to the pressure of the shell after it has assumed the endogastric position.

In the Euthyneura the process outlined above tends to be reversed (detorsion). The visceral commissure is untwisted, the anus and pallial complex in certain forms are carried to the posterior end of the body, and with the loss of the shell a secondary symmetry may be attained. Naef wishes to distinguish between the detorsion of the Pulmonata and that of the Opisthobranchia and to refer them to different causes.

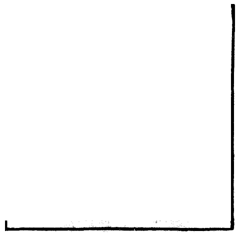


FROM SPENGEL "ERGEBNISSE UND FORTSCHRITTE DER ZOOLOGIE" (FISCHER)
FIG. 14.— DIAGRAM ILLUSTRATING TORSION IN THE GASTROPOD

INTERNAL ORGANIZATION

The Alimentary System, The mouth is situated at the anterior end of the head, which is usually snoutlike and bent somewhat downward. In many of the Streptoneura the mouth is at the end of a proboscis which can be thrust out or withdrawn into the cavity of the head. A proboscis is found in certain Taenioglossa (e.g., *Natica, Copulus*), the Rachiglossa and sundry opisthobranchs, notably the Gymnosomata, and is usually associated with a carnivorous diet.

The mouth leads into the buccal, or pharyngeal cavity, which is furnished in most cases with solid cuticular mandibles and a tonguelike organ, the radula, which is beset with numerous rows of teeth and is used for rasping the food. The mandibles are absent in certain forms—Toxoglossa, Helicinidae, Heteropoda—and are rudimentary in the Rachiglossa. It is uncertain whether the mandibles are to be correlated with a vegetarian diet, but they are without doubt absent or rudimentary in many carnivorous forms. The radula is secreted in a pharyngeal coecurn, and is a narrow, ribbonlike organ consisting of a basal membrane supporting a number of rows of teeth usually arranged in two symmetrical sets, one on each side of a median tooth. The number, arrangement and shape of the teeth are very characteristic and are of great systematic value as they serve to distinguish not only the larger groups (sub-classes, orders, etc.) but also genera and species. The range in the number of teeth is very wide. In some of the Eolids there are only 16 rows each with a single tooth. In *Umbraculum*, on the other hand, there may be as many as 750,000 teeth.



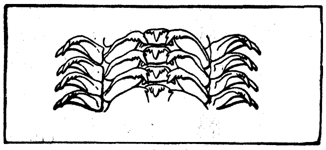
FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)
FIG. 15.—MANDIBLES OF JANUS (MAGNIFIED)

On either side of the radula are two salivary glands which usually secrete only mucus, though in sundry carnivorous genera they contain an acid which dissolves the hard parts of animals which serve as food.

The oesophagus is generally long and tubular and its inner wall is thrown into numerous folds. In the Stenoglossa it bears a characteristic gland, which in *Conus* and other Toxoglossa constitutes the "poison gland." The portion of the oesophagus adjacent to the stomach is sometimes enlarged to form a muscular "gizzard," the walls of which are lined with teeth or plates.

The stomach is usually thin-walled, but it is lined with a hard cuticle in many genera. It has no digestive function other than that of containing food which is being digested. Digestion is effected by the liver and (when present) the crystalline style. The liver is usually a bilobed organ, the left lobe being larger than the right in most cases. It secretes a digestive ferment which is poured into the stomach by two ducts, and it also has absorptive and excretory functions. The crystalline style is a rod-shaped structure usually of tough, gelatinous consistency, which is either lodged in a special pyloric coecum or lies free in the proximal part of the intestine. It is composed of globulin and, according to Mackintosh, contains an amylolytic enzyme.

The intestine is long or short, according as the animal is herbivorous (e.g., Patella) or carnivorous (e.g., Pterocera). Its inner wall is raised into a prominent ridge, the typhlosole. The anus usually lies on the right side of the body adjacent to the head; but in "detorted" forms it is at the posterior extremity of the body.



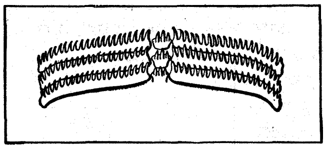
FROM "CAMBRIDGE NATURAL HISTORY" (MACMILLAN)
FIG. 16—FOUR ROWS OF THE RADULA OF VERMETUS (MAGNIFIED)

Circulatory and Respiratory Organs.—The blood is usually colourless and contains amoebocytes. Haemoglobin is found in the blood of certain species of *Planorbis* and haemocyanin in a few genera. The lymphatic tissue is either diffuse or concentrated in a special gland (*e.g.,* in certain Opisthobranchia). The heart is always dorsal in position. It is usually in front of the visceral mass, but it becomes posteriorly situated in some of the Opisthobranchia as the result of complete detorsion and the reacquisition of bilateral symmetry. In the Rhipidoglossa (with few exceptions) it consists of a ventricle and two auricles, but even in this group the left auricle is larger than the right. In *Fissurella* alone are the auricles equal in size. In all other Gastropoda there is only one auricle, the left.

There is a well-developed arterial system in nearly all Gastropoda. The venous blood, on the other hand, is carried to the gills through a system of irregular cavities that extends between and among the various organs. From these it is carried to the gills either directly or through the kidney by means of a "portal" system.

Respiration is aquatic in the majority of Gastropoda and is usually carried out by gills. The latter are expansions of the underside of the mantle and are primitively feather-like structures (Ctenidia), a number of delicate vascularized filaments being borne on each side of a central stem in which are situated two blood-vessels. By one of these the venous blood is carried to the filaments for oxygenation, after which it passes in the other to the heart.

In mare specialized Gastropoda the gills become comb-like owing to the suppression of the filaments of one side. There are two gills in the more primitive Rhipidoglossa (*Pleurotomaria, Fissurella* and *Haliotis*). In all other gill-bearing forms the topographically left gill alone persists.

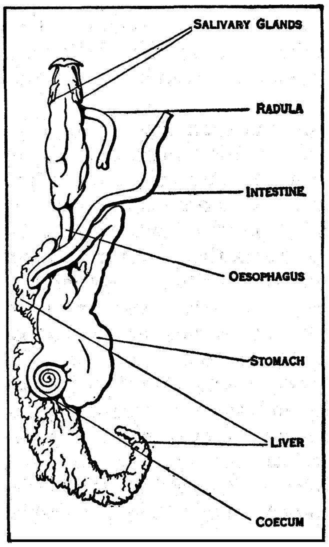


FROM "CAMBRIDGE NATURAL HISTORY" (MACMILLAN)

FIG. 17.—THREE ROWS OF RADULA OF FASCIOLARIA TRAPEZIUM (MAGNIFIED)

Although the respiration of the Gastropoda is primitively aquatic and is of this nature in the larger part of the class, several important groups have become terrestrial in their habitat and either breathe air or are amphibious. The consequent modifications of the respiratory apparatus are manifold and even among marine forms the normal gills are liable to curious and rather inexplicable modification. The mantle in fact retains to a surprising degree a generalized capacity for discharging the respiratory function and for putting forth respiratory organs not homologous with true gills. Thus respiration from the surface of the mantle may coexist with ctenidial respiration (Heteropoda, Acmaea) or a true gill may be found along with secondarily developed respiratory outgrowths (Scud). The true gill may disappear and be replaced by numerous secondary outgrowths (Patella) or there may be no special branchial organs at all, and respiration is effected by the surface of the mantle (*Lepeta*).

In the Gastropoda which have taken to living on land, the whole mantle cavity is transformed into a lung. Among certain marine and fresh-water Streptoneura there are sundry genera (Littorina, *Cerithium, Hypsobia*) which are accustomed to live out of the water for long periods. Their mantle cavity has an incipient lung-like structure, though the gill is still more or less normally developed. The fully developed lung is formed by the adhesion of the mantle edge to the "neck" and the consequent closure of the mantle cavity which remains in communication with the outer air by a small aperture (the pneumostome). The pulmonate condition has been acquired separately by at least three groups of Gastropoda, viz., the Helicinidae among the Rhipidoglossa, the Cyclostomatidae among the Taenioglossa and the Pulmonata among the Euthyneura.



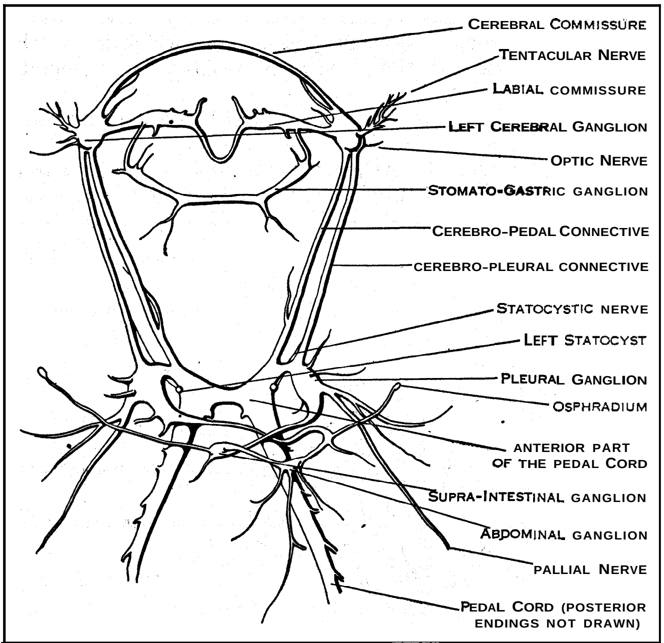
FROM BRONN, "KLASSEN UND ORDNUNGEN DES TIERREICHS"

FIG. 18.—ALIMENTARY CANAL OF TROCHUS GIBBOSUS

The Nervous System.—Except in certain parasitic forms the nervous system is well developed. It consists of nerve cords, ganglia connected by commissures and sense organs. The various ganglionic centres and commissures are those found in other molluscs, viz., cerebral, pleural, pedal, Visceral and stomatogastric. Archaic traits are seen in certain Rhipidoglossa, *e.g.,* the slight differentiation of some of the ganglia in *Pleurotomaria.* The more primitive Gastropoda are distinguished by the diffuseness of the system, the various ganglia being separated by fairly long commissures. In certain Taenioglossa and the Stenoglossa, among the Streptoneura, and in the Nudibranchia and Pulmonata, the commissures are shortened and the ganglia are concentrated in the head. The visceral commissure is twisted into a figure-of-eight in all the Streptoneura and in a few Tectibranchia (*Actaeon, Bulla,* etc.), but in nearly all the Euthyneura it is untwisted.

The sense organs are eyes, statocysts (organs of balance) and rhinophores or osphradia (olfactory organs). In addition to these organs there are special sensory tracts in various regions of the body which have a less defined and less complex structure.

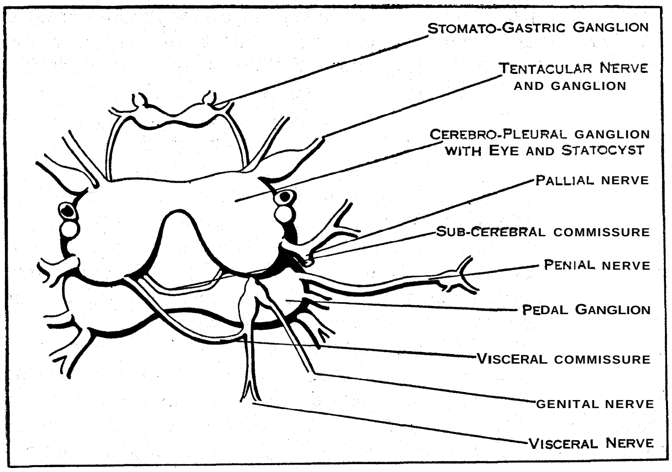
The eyes are found upon or at the base of the tentacles of the head. They are primitively cuplike invaginations with a pigmented retinal layer, which is thus exposed to the sea water. Such simply constructed eyes are seen in the limpets (Docoglossa). In



FROM LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)

FIG. 19.—NERVOUS SYSTEM OF PATELLA

other Rhipidoglossa the aperture of the cup is still open, though it is very small, and a lens is secreted. In most other Gastropoda the aperture is closed by the approximation and fusion of the edges of the original aperture, and a double cornea is formed. The olfactory function is discharged by the osphradia in nearly all aquatic Gastropoda. There are two of these organs in such Aspidobranchia as have two gills and in the Docoglossa, and a single osphradium in the rest of the class. They are situated in the mantle cavity near the gills or gill and are essentially organs for testing the respiratory quality of the water. In structure they may be described as ridges of ciliated epithelium. In terrestrial



FROM LANKESTER. "TREATISE ON ZOOLOGY" (A. & C. BLACK)

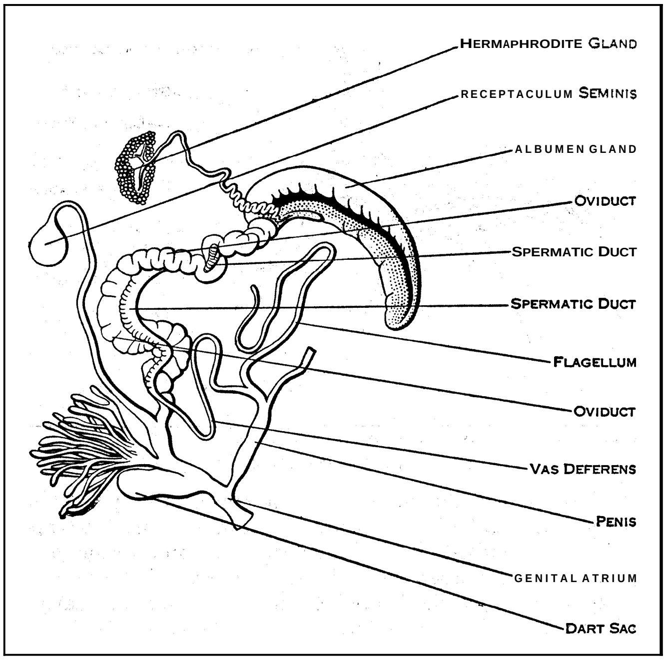
FIG. 20.—NERVOUS SYSTEM OF GONIODORIS

gastropods the osphradia are replaced by rhinophores which are borne on the tentacles. The organs of balance (statocysts) are hollow vesicles lined with ciliated epithelium in which sensory cells occur. They contain hard concretions (statoliths) which impinge on ciliated endings of epithelium and transmit stimuli to the sensory cells. Statocysts are found in the foot in creeping forms; but are sometimes nearer the cerebral ganglia.

Coelom, Renal and Reproductive Systems.—The coelom is represented by the pericardium, kidneys and, theoretically, by the reproductive gland. The latter, however, is a more or less solid or acinous gland, and the cavity from the walls of which it is developed is obliterated in the adult. The kidneys are paired in all the Aspidobranchia, except the Neritacea. In the latter and all other Gastropoda the right-hand kidney is aborted and, at least in such a form as Viviparus, in which its development has been studied, transformed into part of the generative duct.

The functional kidney communicates with the pericardium by a ciliated canal.

In all the Gastropoda the gonad or reproductive gland is unpaired. In certain Aspidobranchia it opens into the reno-pericardial canal, as in some of the Lamellibranchia, or into the kidney itself, which thus acts as a gonaduct. In the Neritacea and all other Gastropoda there is a separate gonaduct.



FROM MEISENHEIMER, "DIE WEINBERGSCHNECKE"

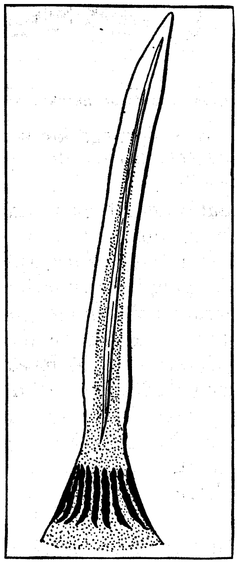
FIG. 21.—REPRODUCTIVE ORGANS OF HELIX POMATIA

The sexes are separate in the Streptoneura with the exception of a few genera, which include certain parasitic forms. Sexual dimorphism is only slightly marked. The male duct ends in a penis which is developed at different points at the anterior extremity of the body. The female system in certain groups exhibits accessory organs and in the forms in which the eggs are incubated in the maternal body there is a brood pouch. The Euthyneura are hermaphrodite and the gonad is an ovo-testis. In the more primitive Euthyneura the gonaduct passes both the eggs and spermatozoa to the exterior. By various stages a more specialized condition is attained in which the male and female ducts are separated and acquire separate openings (diaulic condition). In the stylommatophorous Pulmonata these are secondarily joined together. Certain Nudibranchia are "triaulic," *i.e.*, they have three genital orifices, the female duct being subdivided into vaginal and oviducal conduits. Accessory glands and organs are a marked feature of the Euthyneura. The latter are usually protandric hermaphrodites, *i.e.*, the spermatozoa come to maturity before the ova. Self-fertilization is not unknown, but usually one individual is fertilized by another. It is worth noting that in one or two cases (Patella, *Crepidula*) among the Streptoneura a change of sex may take place in the same individual and that in sexually differentiated forms hermaphrodite individuals are occasionally found (*Acmaea,* Lottia, *Ampullarius, Conus*). Parthogenesis (development of the ovum without fertilization) is known in one case (*Paludestrina jenkinsi*).

REPRODUCTION AND DEVELOPMENT

Breeding Habits, **Oviposition, etc.**—The breeding habits of very many Gastropoda are unknown and in few cases is the life history from fertilization onwards known in all its details.

In certain primitive Streptoneura the eggs are fertilized externally in the sea water; but in most members of the class the male has a penis and fertilization is internal. The courtship of certain land snails has been carefully studied, and as an example the complex behaviour of the Roman snail (Helix *pomatia*) which has been described by Meisenheimer should be studied. In many land snails courtship is usually accompanied by some act of violent stimulation, usually by means of a calcareous pointed rod (the dart) secreted in part of the male reproductive system.

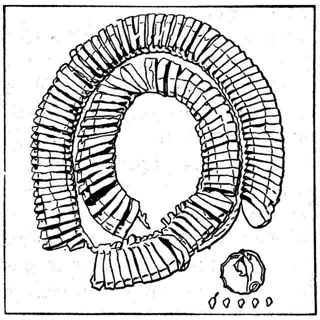


FROM MEISENHEIMER, "DIE WEINBERGSCHNECKE"

FIG. 22.—DART OF HELIX POMATIA (MAGNIFIED)

The eggs are usually laid soon after fertilization. They are either deposited singly (Haliotis, Gibbula, *Paludestrina*) or in clusters which sometimes form an elaborate "nidus." This may be a simple gelatinous mass (*Lymnaea*) or a ribbon (certain Opisthobranchia) or a series of horny capsules each containing many eggs may be accumulated in a mass or strung together as a sort of "roulette" (Rachiglossa). The capsules in the latter are formed by a special gland of the foot, a lengthy operation lasting many days. Certain Streptoneura attach their eggs to the external surface of their own shells or those of their neighbours (Paludestrina, some species of *Theodoxus, Capulus*) or deposit them inside the shell (Vermetus). *Ianthina* secretes a gelatinous raft on the under surface of which the eggs are suspended. Most of the land snails lay their eggs in holes underground. These are enclosed in a gelatinous envelope (*Limax*) or in a calcified shell (Helicidae). Certain Bulimulids lay eggs with calcified shells, 2–3 cm. long, resembling those of birds.

The habit of carrying the eggs on the shell may be perhaps considered as a prelude to more definite and protracted care of the young. Vermetus, as has been pointed out, carries the eggs inside the aperture of the shell and certain species of Libera (a pulmonate) places its eggs in the umbilicus of the shell and covers them over with a secretion rather like an epiphragm. There are, however, a good many viviparous or ovoviviparous gastropods, Viviparus, *Typhobia*, a certain species of *Melania*, and sundry pulmonates incubate their eggs in the terminal part of the oviduct (uterus), while in *Tanganyicia* and *Melania episcopalis* there is a special brood pouch which is separate from the oviduct.



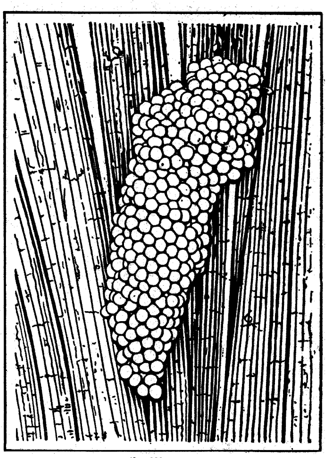
FROM ANIMALS OF ALL COUNTRIES' (HUTCHINSON S PERIODICALS)

FIG. 23 — EGG CAPSULES OF BUSYCON (ABOUT 1/5 NAT. SIZE)

The number of eggs varies according to the mode of life and oviposition. *Purpura lapillus* (the dog whelk) deposits up to 150,000 eggs in its capsules and sundry species of *Doris* lay as many as 600,000. It should be noted that in those Rachiglossa which form capsules containing many eggs some of the latter are devoured by those embryos which emerge first. Intrauterine cannibalism has been recorded in the pulmonate Lzmicolaria. The Pulmonata do not as a rule lay as many eggs as the Streptoneura and Opisthobranchia. *Helix aspersa* deposits up to 100

Development.—Although the Gastropoda display very considerable variation in the adult form, the cleavage of the eggs is more or less the same in all the cases in which it has been studied. Such variation as may have been observed is due to variation in the amount of yolk.

In all Gastropoda which have been so far studied cleavage is total and of the type known as spiral. The egg divides into two and then into four cells which are either equal in size (Patella) or approximately equal. A third division then cuts off four small cells (micromeres) from the four original cells (macromeres). There are now eight cells consisting of a "quartette" of micromeres and the four larger macromeres. The next division gives rise to 16 cells, viz., four more micromeres, which are given off from the macromeres (second quartette) and the products of the sub-division of the first quartette of micromeres. Division proceeds in this way until a cap of numerous micromeres is found lying on top of the four macromeres. In Patella, in which the development is well known, the embryo is at the 32-cell stage radially symmetrical. On the attainment of the 64-cell stage this is replaced by bilateral symmetry. Owing to certain features of the mode of cleavage, it is possible to trace the "lineage" (developmental history) of individual organs back to individual cells or quartettes produced by very early cleavage. This type of research has been a very fruitful source of embryological knowledge, but can only be summarily mentioned here. The micromeres give rise to the ectoderm and its derivatives, the macromeres to endoderm and mesoderm. In Patella gastrulation is by epibole (overgrowth) of the macromeres by the micromeres. At the end of 24 hours the embryo, which up till now has been contained in an egg membrane, escapes and begins its free-swimming period as a trochophore larva. It is more or less spherical and surrounded by a girdle of long cilia (the prototroch) developed from special trochoblasts.

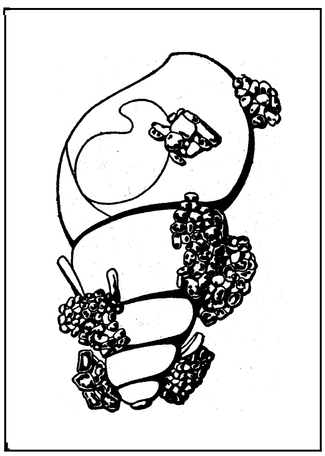


BY COURTESY OF F. W. BOND

FIG. 24.— EGGS OF THE AMPHIBIOUS SNAIL (AMPULLARIUS)

The gut is now developed, the endodermal cells dividing to form the stomach and the mouth and anus arising as ectodermal invaginations. Dorsally, a thickened plate of cells gives rise to the shell gland, the foot is indicated by two slight prominences on either side of the mid-ventral line, and the mesoderm bands are now formed.

Enlargement of the prototroch to form the velum and the growth of the foot characterize the veliger stage. The metamorphosis of the larva has already been described.

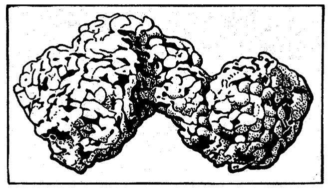


AFTER HENKING IN "BERICHTE" (NATURFORSCHENDE GESELLSCHAFT)

FIG. 25. — PALUDESTRINA ULVAE CARRYING EGGS COATED OVER BY A LAYER OF SAND-GRANULES (ABOUT 9/1 NAT. SIZE)

The detailed development of the individual organs is not very well known in marine molluscs. We owe the bulk of our knowledge on the subject to the studies of Raphael Slidell von Erlanger, James L. Drummond and C. Tönniges on *Viviparus,* the pond snail (originally called Paludina). The ganglia of the nervous system arise as thickenings of the ectoderm which subsequently become joined together by connectives. The statocysts and eyes are ectodermal invaginations. The pericardium originates as a hollow in the mesoderm and the heart is first seen as a vesicle projecting down from the dorsal wall of the pericardium. The kidneys are tubular extensions of the pericardial cavity; they are joined by ectodermal invaginations which constitute the ureters. The gill appears as a series of folds in the wall of the mantle cavity. The germ cells seem in the first instance to be budded off the pericardial wall and subsequently form a spherical vesicle, the gonad. The kidney of the originally left-hand side forms part of the genital duct. The origin of the mesoderm in Viviparus has been the subject of controversy. (See E. W. MacBride, Text Book of Embryology.)

The account of larval development and organogeny given above is founded very largely upon the study of Viviparus, but it probably represents the course of events in many other gastropods. Departures from this developmental history are mainly of secondary importance, and are due, for example, to the development of special larval organs (*e.g.,* the cephalic vesicle and "podocyst" of Stylommatophora), and the presence of a larger amount of yolk than is usual. The velum is suppressed in oviparous and viviparous forms; but traces of it can be seen in certain of the latter (*Cenia,* some of the Pulmonata). In certain highly modified pelagic larvae the velum is drawn out into extensive lobes (*e.g.,* in that of Dolium).

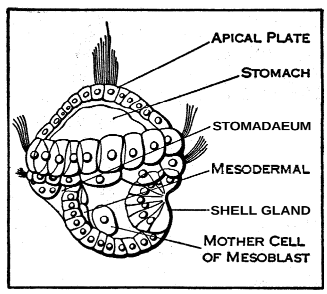


BY COURTESY OF F. W. BOND

FIG. 26.— EGG CAPSULES OF COMMON WHELK (ABOUT 1/3 NAT. SIZE)

DISTRIBUTION AND NATURAL HISTORY

The Gastropoda have practically a world-wide distribution and are found in the sea, in brackish and fresh water and on land. Marine gastropods occur in all seas. In high latitudes they live in the bays and fjords of the Antarctic continent (*e.g.,* in the Ross sea, 77° S.) and off the northern coasts of Greenland and Franz Josef Land. Exactly how far north they occur is uncertain; but in all probability they range right across the north Polar sea. The exclusively marine gastropods are limited in their distribution by salinity and other environmental factors. But, though it is true that the life zones that prevent them from invading fresh water and land interpose a strict barrier to their invasion of those habitats, there are certain groups which are intermediate between truly marine gastropods and those which habitually live in fresh water and on land. The common periwinkle (*Littorina* littorea) can tolerate very protracted exposure to air and the estuaries of most great rivers contain certain forms which can endure daily and seasonal changes of salinity, etc. Similarly, among terrestrial and fresh-water gastropods there are forms which are of wide tolerance and live indifferently in water or on land, either being structurally adapted, as in the case of the lung snail (*Ampullarius*) which lives in swamps, and has both a gill and a lung, or having a more or less generalized adaptability (certain species of *Lymnaea*). Hesse records that an exclusively terrestrial Pulmonate (*Lauria cylindracea*) has taken to living in springs in certain parts of Germany.

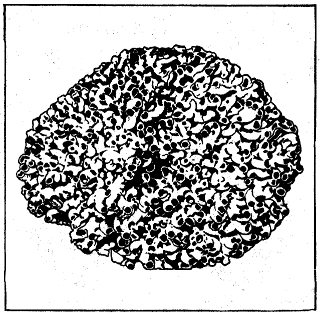


MACBRIDE "TEXT BOOK OF EMBRYOLOGY" (MACMILLAN)

FIG. 27.— LATERAL VIEW OF YOUNG TROCHOPHORE LARVA OF PATELLA COERULEA (MAGNIFIED)

The majority of the Streptoneura are marine, but the Helicinidae among the Rhipidoglossa, the Cyclophoridae and Cyclostomatidae among the Taenioglossa have become terrestrial. The members of the genus Theodoxus (*Neritina*) are the only Rhipidoglossa that have invaded fresh water; but many groups of Taenioglossa inhabit the latter, viz., the Viviparidae, Melaniidae, Ampullariidae, Valvatidae, etc. The Stenoglossa are exclusively marine. Among the Euthyneura the Opisthobranchia are likewise a marine group. The Pulmonata are mainly terrestrial, though certain large families (Planorbidae, Lymnaeidae) live in fresh water, and a few (Amphibola, Siphonaria) are marine or littoral (Auriculidae).

The horizontal distribution of marine gastropods can only be treated very summarily here. It is sufficient to say that certain main distributional areas can be recognized which have their peculiar and characteristic faunas, the latter being composed of genera and species which are either restricted to those areas or are more frequently found there than elsewhere. For example, in the region between Delagoa Bay and Cape Agulhas, which we may regard as the South African marine province, are found the following genera which occur nowhere else: *Abyssochrysos*, *Jeffreysiopsis*, Alcira, Cynisca, *Neptuneopsis* and *Alexandria*. Furthermore, *Bulla*, Terebra, *Ancilla*, Patella, *Mitra* and *Turritella*, though they occur in other parts of the world, are in this region very richly represented in species, so that South Africa may rightly be considered the metropolis of these genera.

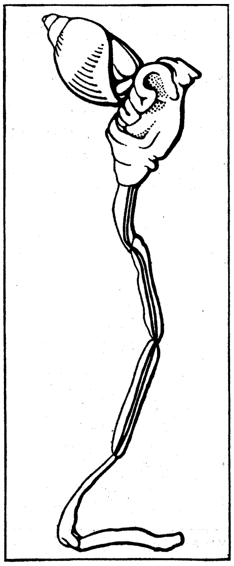


FROM "ANIMALS OF ALL COUNTRIES" (HUTCHINSON S PERIODICALS)

FIG. 28.—SHELL-MASS OF VERMETUS SPIRATUS, A SESSILE GASTROPOD (ABOUT NAT. SIZE)

The range of individual species is, as in other groups, limited to special areas: but ambiguity as to the precise limits of species makes it difficult to define these areas with exactness in any particular case (see SPECIES), while our ignorance as to the opportunities for dispersal and of the physiological constitution and reactions of individual species usually make it impossible to state to what extent the range of species is the expression of a definite constitutional peculiarity.

The vertical distribution of marine Gastropoda shows a broad grouping of genera according to the preference of special habitats. At the landward limit of marine conditions and often beyond the high-water mark of spring tides are found semi-terrestrial forms, such as the Littorinidae. Well up to high-water mark forms like the marine Pulmonate Siphonaria are found, while the limpets (Patellidae) range up to the same level. Between tide marks (littoral zone) are found the Fissurellidae, ormers (*Haliotis*), Onchidium, the top shells (Turbo) and dog whelks (*Purpura*), as well as those which ascend further beyond the reach of maritime conditions, such as the Littorinidae. Farther down the strand in the shallow water of the Laminarian zone occur a great variety of forms, notably the Nudibranchia. Adaptation to a particular kind of bottom is here of great importance. Burrowing forms, like *Sinum*, Natica, Cypraea and *Bullia* are more frequently found in sand, while the less active creeping forms keep to fronds of *Laminaria* and other seaweeds, the surface of algae, smooth rocks, and the like. Vermetus, which is a sessile gastropod with an uncoiled shell, forms irregular masses on rock and coral. *Eulima* and other parasitic forms are found on the external surface or in the body cavity of starfishes and also in Holothuria. *Magilus* and *Coralliophila* burrow into corals. From the shallow waters downward the gastropod fauna becomes more sparse. The late W. H. Dall, in his report on the marine Gastropoda, obtained by the "Blake" in the gulf of Mexico and the Caribbean sea, gives the following numbers of shallow and deep-water forms: Littoral species, 280; species found down to the edge of the continental shelf (about 100 fathoms) 222; deep water species, 83. Among typical abyssal genera are *Mangilia*, *Margarita* and Pleurotoma. The greatest depth from which a gastropod has been taken so far is 2,845 fathoms (U.S.S. "Albatross" off the coast of Peru).



FROM VOELTZKOW, "REISE IN OSTAFRIKA" (SCHWEIZERBART)

FIG. 29.—MUCRONALIA VARIABILIS, A PARASITIC GASTROPOD SHOWING LONG PROBOSCIS

The forms which have so far been considered are those which in adult life live permanently on the sea bottom. The larvae of very many of these are floating organisms which form part of the marine plankton until they metamorphose into the adult condition. There are, however, three groups and some isolated genera of Gastropoda which permanently live floating off the bottom. These are the Heteropoda, an interesting group of Taenioglossa, some of which are curious, highly modified creatures, and the Thecosomata and Gymnosomata. The last two groups, which are sometimes erroneously united into a single group called Pteropoda, form a very large part of the minute plankton of all seas. More than 4,000 specimens of *Limacina helicina* were obtained by the "Terra Nova" in a single haul in McMurdo Sound (antarctic). The purple snail *Ianthina*, which secretes a gelatinous float for its eggs, and the nudibranchs Phyllirrhoe, *Glaucus* and Scyllaea, are similarly pelagic, while several tectibranchs such as *Aplysia* and Tethys are modified for swimming, though they seem to keep near the bottom.

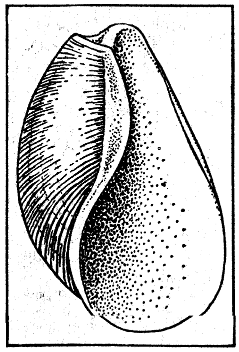


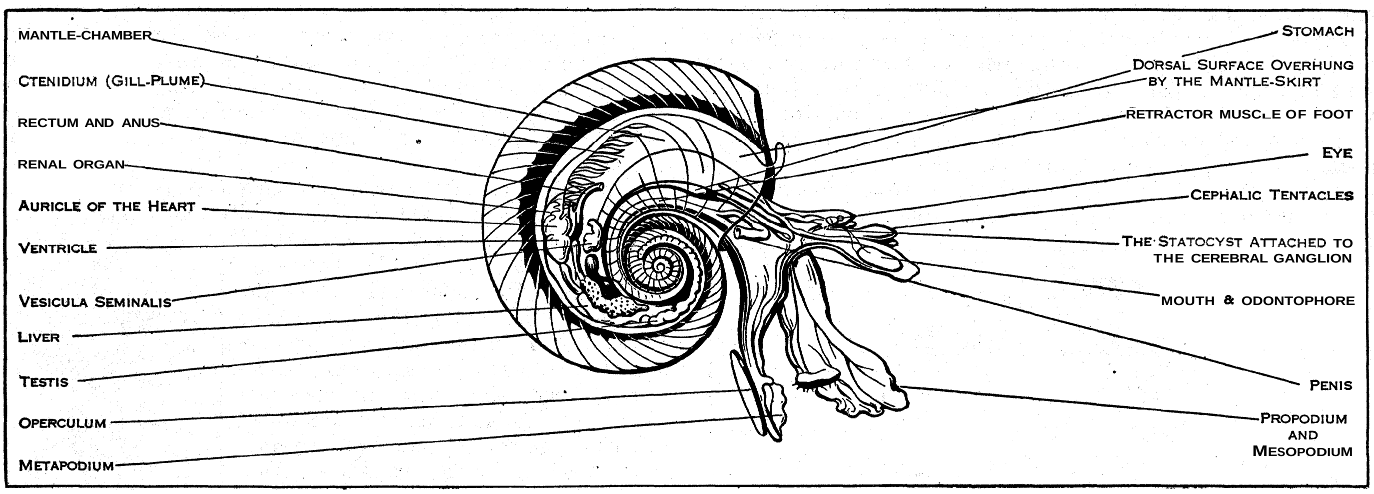
FIG. 30.—SCAPHANDER LIGNARIUS (ABOUT ½ NAT. SIZE). AFTER SARS, 1878

Fresh-water Gastropoda are omnipresent. They are found in high tarns in the Himalayas, where Lymnaea *hookeri* has been taken at a height of more than 18,000 ft. above sea level. *Aplecta hypnorum* reaches as far north as 73° N. in the Taimyr peninsula. The most characteristic and widely spread fresh-water Gastropoda are members of the *Viviparidae*, *Melaniidae*, *Theodoxus*, *Lymnaea* and Planorbis. They occupy a great variety of habitats—not only rivers, lakes, streams and smaller stretches of water, but also hot springs, torrents, the "trickles" down the faces of cliffs and marshes. They also invade cattle troughs, irrigation ditches, water mains and cisterns. As in the case of marine Gastropoda, there is some uncertainty as to the precise range and exact habitat of individual species, though in particular areas the habitat of certain species is fairly well defined. *Viviparus* viviparus, the common river snail of the British Isles, prefers slowly-flowing rivers and canals; Valvata macrostoma is usually found in marshes and ditches. Pilsbry and Bequaert record the fact that *Lymnaea natalensis* undussumae, *Physopsis* africana, and certain species of Planorbis prefer open shallow pools of small size. Certain great river systems are occupied by characteristic genera. For example, species of *Cleopatra* and Lanistes are peculiar to the Nile drainage area. Other genera are practically cosmopolitan, such as *Viviparus* and Lymnaea.

The Gastropoda which live on land are not so tolerant of external conditions as are certain other groups of terrestrial invertebrates. In Spitsbergen, which on account of divers adverse factors (low winter temperature, etc.) does not sustain a very large and varied animal population, there are no land Mollusca at all, though there are a number of Collembola, Diptera, spiders, mites and other invertebrates.

Extremes of temperature do not as a rule limit the distribution of land Gastropoda. Lack of moisture and of lime in the soil on which they live appear to be the most important factors in preventing their spread. In tropical countries lack of shade and suitable places for concealment from excessive heat and light act in a similar way. As a rule they are not found plentifully on "acid" soils. Alkins and Lebour found that of 27 species, 20 were found on rather alkaline soils (pH7.0), 14 tolerated rather more alkaline soils (pH8.0), while only four were found on acid soil (pH5). They are likewise poorly represented in deserts and other dry habitats, although they are not necessarily absent from the latter if there are opportunities for burrowing and a plentiful dewfall.

Apart from these limitations the terrestrial Gastropoda are almost world-wide in distribution. A slug *Anadenus* is found at 17,000 ft in the Himalayas, and *Chronos sublimis* was taken at more than 16 000 ft on Mt. Carstensz in New Guinea Land snails and slugs are found in well-vegetated areas, *e.g.*, woodland, pas-

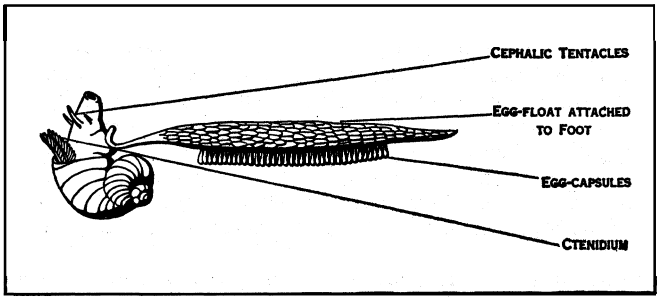


AFTER SOULEYET IN LANKESTER, "TREATISE ON ZOOLOGY" (A. & C. BLACK)

FIG. 31.—OXYGYRUS KERAUDRENI (MAGNIFIED)

tures, hedges and banks, jungle, among mosses and lichens and in more arid situations such as cliff faces, rocks and sand dunes. They burrow underground, climb trees and invade houses.

The means by which land Gastropoda are dispersed act rather more slowly than those by which marine and fresh-water forms are carried about. As a result, land snails and slugs are more localized in their distribution. Extreme cases of such restricted distribution are seen among the Achatinellidae (tree snails) of



FROM LANKESTER, "TREATISE ON ZOOLOQY" (A. & C. BLACK)

FIG. 92.— FEMALE JANTHINA WITH EGG FLOAT

the Hawaiian Islands and the Partulas of Tahiti. Many species of these groups are restricted to single valleys or ridges, and well marked mutational forms are even said to be restricted to a single tree or group of trees.

On the other hand, given suitable conditions, dispersal may be to a certain degree facilitated by their habits and constitution. Bartsch has pointed out that the Cerions of the Florida Keys, etc., which can live for four days in sea water and have the habit of fixing themselves to dead wood during estivation, have probably been transported from island to island after hurricanes which have washed away such timber from the low-lying coastal regions which the Cerions inhabit. The chief continental areas of the world are each characterized by a number of peculiar families and genera, and certain deductions as to former land connections between such areas may be made. Thus the Achatinidae, Dorcasiidae, Limicolaria, Burtoa, etc., are exclusively found in Africa and the Bulimulidae, *Drymaeus* and *Borus,* in South America. Among the land Mollusca of South America, however, are representatives of the Stenogyridae, a family characteristic of African fauna, and conversely there are *Bulimulus*-like genera in Africa.

Habits, etc.—The greater number of Gastropoda are passive animals of relatively small size and limited powers of locomotion. Usually increase of activity is associated with the carnivorous habit. Their inertia and lack of mobility are compensated by the shell, their more or less obscure appearance and secretive habits, which are their chief defenses against enemies. Among marine forms the great power of adhesion manifested by the foot prevents them from being washed away to unfavourable ground. On land the habits of burrowing and entering crevices, of estivation and hibernation are safeguards against climatic excess. Protection against drought is of great importance for animals which require much water. The shelled terrestrial forms are protected against desiccation, and in addition many have the faculty of secreting a covering (the epiphragm) to the aperture of the shell after they have retired into the iatter. The naked forms die very quickly if exposed to very dry air or strong sunlight. Both shelled and naked forms tend to secrete themselves in the daytime and to emerge in the evening or during rainy spells.

Apart from the dependence upon certain necessary external conditions Gastropoda seem to be adaptable animals and peculiarly tenacious of life. There are well-authenticated records of land snails which have lived for years without food.

Marine and terrestrial Gastropoda have to contend with other hostile forces besides the physical factors of their environment. Marine Mollusca are preyed upon by a variety of enemies. As eggs and larvae they are eaten by very many vertebrate and invertebrate animals. Fish and sea birds feed on them in the adult state and whales consume large quantities of the planktonic forms. Birds, carnivorous beetles and small mammals such as rats and mice, take a heavy toll of land snails. Ducks, geese and water beetles feed on pond and river snails.

The Gastropoda are vegetable eaters, carnivores or live on organic debris of all kinds. Most Aspidobranchia and Taenioglossa feed on plants, the marine forms browsing on algae. Natica, the Lamellariidae, and the Heteropoda are, however, carnivorous. Natica preys on lamellibranchs, through the shells of which it bores by means of an acid secretion. Captain F. Davis found that the clam *Spisula* elliptica is persistently preyed upon by *Natica alderi* on the Dogger Bank, about 88% of the clams taken on certain hauls having their shells bored by their enemy. The sessile Taenioglossa, like Vermetus, are plankton-feeders. The Stenoglossa are mainly carnivorous and prey upon other molluscs, or else they feed on carrion. Among the Opisthobranchia the Eolids feed on hydroids, the stinging cells (nematocysts) of which are retained and stored in the dorsal papillae, from which they are discharged when the animal is attacked. The majority of the land Pulmonata feed on green plants, fungi, lichens or vegetable debris. The snail slug (*Testacella*) feeds on earth worms, and *Glandina*, *Oleacina* and the Streptaxidae are similarly carnivorous.

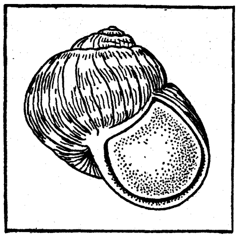


FIG. 33.—HELIX POMATIA, SHELL WITH EPIPHRAGM (ABOUT ½ NAT. SIZE)

Commensalism is not of such frequent occurrence among Gastropoda as it is among Lamellibranchia. A certain number of Taenioglossa are ectoparasitic (*Stilifer*, *Thyca*, etc.), and endoparasitic (*Entoconcha, Entocolax*) upon echinoderms. The only other animal that has so far been recorded as being the host of a gastropod is the stomatopod crustacean Gonodactylus *chiraja,* which harbours *Epistethe* gonodactyli. In their turn gastropods serve as hosts for parasites of various kinds. Certain trematode worms pass part of their life-cycle in marine and fresh-water gastropods, and in two cases the association is of serious consequence to man. The effect of these parasites on the snail is sometimes disastrous. The author of this article found a high percentage of a small gastropod *Paludestrina* ventrosa castrated

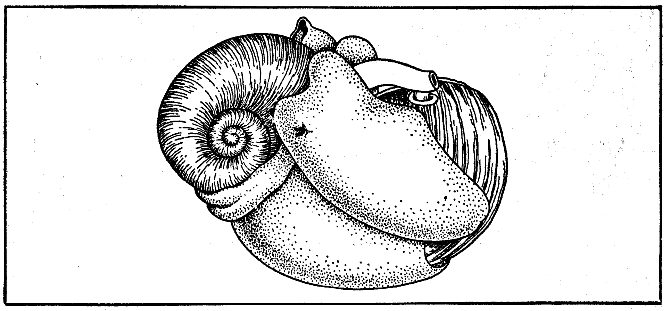
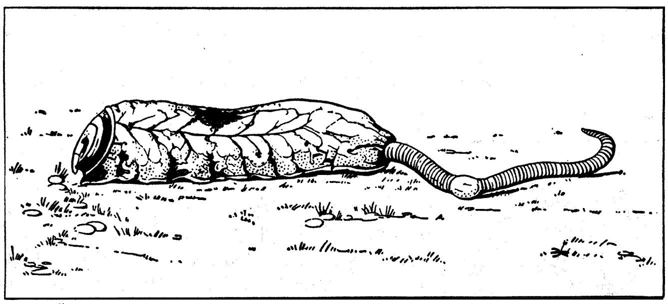


FIG. 34.—NATICA JOSEPHINIA, DRILLING A CLAM (ABOUT ¾ NAT. SIZE). AFTER ANKEL. 1938

by a trematode which had invaded the reproductive organs of its host. Infection by such parasites is probably high when the parasite passes the rest of its life-cycle in a vertebrate host which preys on the gastropod, as in the case of sea birds which feed on small water snails in tidal ditches. Certain dipterous flies are parasitic on land snails and several kinds of mites are found on the latter, though it is uncertain if they are actually parasitic.

The Gastropoda are protected, as has been stated above, from the attacks of enemies by passive means (their shell and retiring habits). The shell, however, is not always an adequate safeguard from assault. Carnivorous beetles thrust their heads into the aperture and drag the inmate out. Boettger produced some very interesting and suggestive observations on the relation between attacks of this sort and the development of projections from the sides of the shell aperture in certain land snails (Otale) which are attacked by carabid beetles. Whether the colour-pattern and sculpture of the shell, which is often very elaborate, are of any protective value is uncertain at present. Observations upon the



FROM KÜKENTHAL, "HANDBUCH DER ZOOLOGIE," BY PERMISSION WALTER DE GRUYTER & CO.

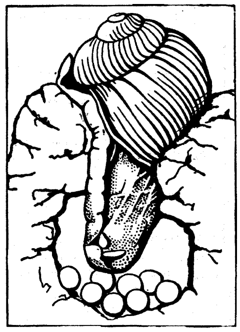
FIG. 35.— TESTACELLA EATING AN EARTHWORM

destruction of the common hedge snails (Cepaea) seem to show that birds do not discriminate between the banded and the unbanded varieties of C. *hortensis* and C. *nemoralis.* Few positive instances of protective or warning coloration are known, as the habits and enemies of the animals concerned are so imperfectly studied. Various species of *Cochlicella* certainly resemble the seed pods of the plant on which they mainly feed, and certain Clausilias are sufficiently like leaf buds; but it is difficult to decide if these resemblances are more than fortuitous. Sundry marine forms which feed on holothurians and tunicates resemble these animals in colour; but again the protective value of the resemblance is uncertain. Strombus *pugilis,* as indicated by its name, and other members of the same family, defend themselves by active blows dealt with the foot, to which the sharp-edged operculum is attached. An aggressor (such as a shell collector) may receive a deep wound.

PALAEONTOLOGY AND EVOLUTION

A great deal is known concerning the fossil remains of gastropod shells; but unfortunately we know practically nothing about the internal structure of extinct members of the class. The status of many interesting and important fossils cannot therefore be satisfactorily discussed in terms of the classification usually employed.

The earliest undoubted gastropod remains found in the Lower Cambrian (*Olenellus*) beds include spirally-coiled shells (*Raphistoma*) and others which are cup-shaped (Scenella, Palaeacmaea). The latter are usually treated as representatives of the Docoglossa (limpets) which, owing to the presence of a spiral protoconch (embryonic whorl), must be considered as descended from spiral ancestors. In somewhat later Cambrian horizons are found undoubted gastropod shells of a planospiral (nautiloid) shape (Cyrtolites, *Bel*lerophon). These were actually regarded as nautiloids by Deshayes and placed by him in the Cephalopoda. They are now held to be gastropods and have been compared with the pelagic Taenioglossan *Atlanta.* The slit at the edge of the shell-aperture comparable with that found in the rhipidoglossate *Pleurotomaria,* a genus which appeared in the Silurian (possibly in the Cambrian), justifies the inclusion of Bellerophon among the Rhipidoglossa rather than the Taenioglossa. Nevertheless, the similarity of their shell to that of the pelagic Atlanta suggests that they were of a swimming or floating habit and gives some support to the theory of Naef that the profound changes in symmetry and general organization that mark off the Gastropoda from the rest of the Mollusca were due to or associated with a change of habit, the floating pelagic life being abandoned for one spent creeping about on the sea bottom. We have, however, no grounds for believing that the Cambrian Bellerophontidae represent the most primitive grade of gastropod organization. In short, neither from these nor any other Cambrian genera do we obtain any clue as to the structure of the primitive Gastropoda.



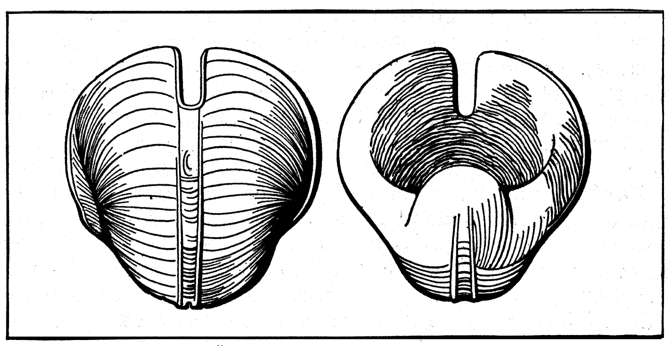
FROM MEISENHEIMER, "DIE WEINBERGSCHNECKE"

FIG 36.—OVIPOSITION OF HELIX POMATIA (ABOUT ½ NAT. SIZE)

Along with the undoubted Rhipidoglossa (Aspidobranchia) above described there are found gastropods which are usually held to be representatives of the Pectinibranchia. Stenotheca seems to be related to the taenioglossan *Capulus,* and the modern Pyramidellidae are traced to other Cambrian forms.

The Streptoneura are thus well represented in the oldest fossiliferous rocks. In lower and upper Silurian times they increased and many families still flourishing appeared at that epoch, *e.g.,* the Scalaridae, the Capulidae and Turbinidae. Many groups of Rhipidoglossa now extinct reached their developmental climax in mid-Primary times. The Pleurotomariidae, represented at the present day by four very rare species, numbered several hundred species.

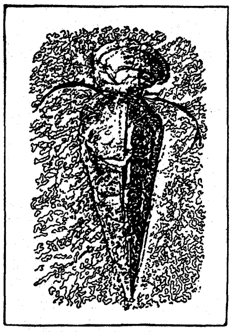
Undoubted Euthyneura do not appear until the Carboniferous, when tectibranchs like *Actaeon,* etc., are found. With this fact in mind, it is necessary for us to consider briefly one of the most



FROM A. V. ZITTEL, "GRUNDZÜGE DER PALAEONTOLOGIE"

FIG. 37.— SHELL OF A CAMBRIAN BELLEROPHON

puzzling series of fossils that have been found in Primary rocks. For a long time certain tubular shells resembling somewhat those of Pteropods have been known from Cambrian strata. They have variously been interpreted as thecosomatous pteropods, as cephalopods and tubicolous annelids. Broili (in the last edition of Zittel's *Grundzüge* der Palaontologie) retains them in the Gastropoda as an enigmatic class, the Conularida. In 1911 Walcott, in describing the Cambrian fauna of the Burgess shales (British Columbia) figured a species of the genus Hyolithes, *H.* carinatus, in which are seen structures somewhat resembling the fins of pteropods. It is not easy, however, to accept these structures as indicative of fins like those of thecosomatous pteropods, and as the shells of these forms are not in themselves sufficient clue to the identity of the animals it is better to accept Broili's verdict. Nevertheless, if these remains are subsequently proved to be those of pteropods, and if the hiatus in time between their appearance and that of the other Opisthobranchia is not merely due to the imperfection of the geological data, then we shall be driven to one of the two very interesting conclusions. It will be necessary to assume either that the Thecosomata were developed directly from the primitive streptoneuran stock and are not from the Opisthobranchia, as is usually believed, or that the Cambrian Thecosomata have nothing to do with modern "Pteropoda," but represent an early essay in pteropod-like specialization.

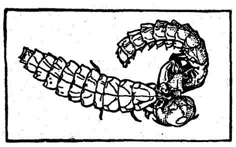


BY COURTESY OF THE SMITHSONIAN INSTITUTE
FIG. 5-. — HYOLITHES CARINATUS

The Pulmonata first appear in the Carboniferous. *Anthracopupa,* which seems to be undoubtedly a form of land pulmonate, referable to the modern family of the Ellobiidae, is found in the Carboniferous of North America. Undoubted Basommatophora (*Auricula, Lymnaea,* Planorbis) appear in the Jurassic; but it is by no means certain if the terrestrial Pulmonata actually preceded the fresh-water forms. Since their first appearance in the Carboniferous the Pulmonata, both terrestrial and aquatic, steadily increased through Secondary and Tertiary times until the present day, when they are one of the largest and most highly diversified groups of living animals.

ECONOMIC USES

Although the gastropods are not of outstanding service or disservice to man in any one respect they are of considerable importance in a number of ways. Their chief value is perhaps as an article of diet; for since the earliest stages in man's development they have been used as food. In middle and late Palaeolithic deposits in Europe, limpets, periwinkles and top shells occur. In certain "kitchen middens" of the Upper Palaeolithic in the west of Scotland they occur in such profusion as to lead one to suppose that the people who formed these deposits lived principally upon these molluscs. The natives of Tierra del Fuego, according to Tylor, used similarly to subsist on various kinds of shellfish, and gastropods of various kinds occur in their middens. At the present day H. Lang (quoted by Pilsbry) states that the Achatinas (large land snails) "are a welcome addition to the food supply of most tribes" in the Belgian Congo, and that their shells "are seen lying on refuse heaps and along the rivers." Among European peoples whelks, periwinkles and ormers are largely consumed; 889 tons of whelks and 3,245 tons of periwinkles were delivered at Billingsgate market, London, in 1922. Though land snails are eaten in only a few districts in England they are largely used in all Christian Mediterranean countries and in France and southwest Germany, where *Helix pomatia* (the Roman snail) is cultivated on snail farms.



FROM A PHOTOGRAPH BY HUGH MAIN
FIG 39 — GLOWWORM LARVAE EATING SNAIL

As bait and as the food of edible fishes, birds and whales, gastropods are of substantial indirect value to man.

The shells of Gastropoda have been put to a variety of uses by the different races of mankind. The mother-of-pearl obtained from large specimens of Turbo and *Haliotis* is imported into Europe for button-making, inlaying and sundry articles of virtu. Among native tribes shells are put to many uses. Those of *Cypraea* moneta (the money cowry) are used as currency in Africa and elsewhere, and other species of *Cypraea* are reserved as ornaments for kings and chieftains in the Pacific islands. The left-handed chank (*Turbinella rapa*) is used in the ritual of the god Vishnu in India. Trumpets are still made from Triton shells in Africa and the East, just as they apparently were among the early inhabitants of the Mediterranean. The natives of Central Africa use the large shells of various species of *Achatina* as drinking vessels and salt containers.

The rock whelk (*Murex*) is no longer fished in the Mediterranean for the sake of the dye which was used in preparing "Tyrian" purple; but other species of the muricids and of Fasciolaria are still employed for obtaining dye by various native races.

Gastropoda are obnoxious to man in at least two important connections. Considerable damage is done to crops by slugs and land snails. A small snail Zonitoides *arboreus* causes sugar-cane root disease in Louisiana. Marine gastropods are less obviously obnoxious to man, but one at least has proved itself a troublesome pest of oyster beds. This is the American slipper limpet (*Crepidula* fornicate), which was accidentally introduced many years ago into European waters and which has since then multiplied excessively and overruns the oyster beds. A more disastrous work is done by those fresh-water gastropods which harbour parasites harmful and even fatal to man and one of his more valuable domestic animals. (a) In the Middle East, in Japan, various parts of Africa and in South America and the West Indies, species of a trematode, *Schistosoma* (=Bilharzia) which cause bladder disease in man, pass part of their life cycle in various species of *Isidora* and Planorbis. A focus of this disease has been detected in Portugal, where Planorbis *metidjensis* is probably the intermediate host of the parasite. (b) The liver fluke (*Distomum hepaticum*) passes part of its life in the water snail *Lymnaea truncatula.* Sheep grazing in flooded meadows or near streams become infected with the fluke, which causes liver rot.

For the historical treatment of this subject see MOLLUSCA.

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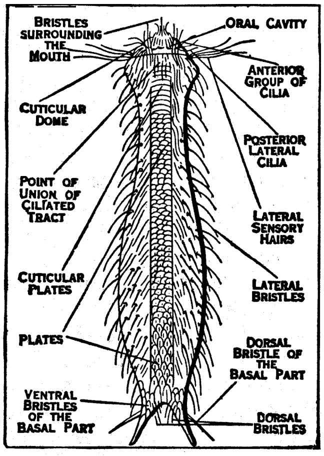
(*G.* C. R; X.)

GASTROTRICHA, a small group of fairly uniform animals which live at the bottom of ponds and the sea, hiding among the recesses of water plants or in sand and eating organic debris and Infusoria. They vary in size from one-fifteenth to one-threehundredths of an inch, and move by long cilia. Two ventral bands of regular transverse rows of cilia are usually found. The head often bears some especially large cilia. The cuticle which covers the body is usually raised into overlapping scales which may be prolonged into bristles. The body, otherwise circular in section, is slightly flattened ventrally. Chaetonotids have a protrusible pharynx armed with eversible bristles. This leads to a muscular oesophagus with a triradiate lumen, which acts as a sucking pump and ends in a funnel valve projecting into the oval stomach. The nitrogenous excretory apparatus consists of a coiled tube on each side of the stomach, ending internally in large flame cells. A cerebral ganglion rests on the oesophagus; it is continued backward as two dorsal nerve trunks. In some species there are eyes. The two ovaries lie at the level of the juncture of the stomach and rectum. The large eggs are laid among water weeds. Marine forms are hermaphrodite and fresh water forms parthenogenetic. The group is divided into two orders: Macrodasyoidea, marine, oesophageal pores present, no salivary glands: Chaetonotoidea, mostly fresh water, no oesophageal pores, salivary glands present. About 140 species are known. The group shows no clear affinities with any of the great phyla.



FROM "ZEITSCHRIFT FÜR WISSENSCHAFT," AFTER ZELINKA (ENGELMANN)

GASTROTRICHA (CHAETONOTUS MAXIMUS), A SMALL GROUP OF ANIMALS LIVING AT THE BOTTOM OF PONDS AND THE SEA AND FEEDING ON ORGANIC DEBRIS AND INFUSORIA. IN SIZE THEY RANGE FROM 1/15 OF AN INCH TO 1/300

See Th. Griinspan. *Zool. Jahrb.* (Syst.) *26* (1907); A. Remane, *Tierwelt Nordund Ostsee, VII* d1, p. I (1927).

GATES, HORATIO (1728–1806), American general, was born at Maldon in Essex, England, in 1728. He entered the English army at an early age, and was rapidly promoted. He accompanied Gen. Braddock in his disastrous expedition against Ft. Duquesne in 1755, and was severely wounded in the battle of July g; he saw other active service in the Seven Years' War. After the peace of 1763 he purchased an estate in Virginia, where he lived till the outbreak of the American Revolution in 1775, when he was named by Congress adjutant-general. In 1776 he was appointed to command the troops which had lately retreated from Canada, and in Aug. 1777, as a result of a successful intrigue, was appointed to supersede Gen. Philip Schuyler in command of the Northern Department. In the two battles of Saratoga (*q.v.*) his army defeated Gen. Burgoyne, who, on Oct. 17, was forced to surrender his whole army. This success was, however, due largely to the previous manoeuvres of Schuyler and to Gates's subordinate officers. The intrigues of the Conway Cabal to have Washington superseded by Gates completely failed, but Gates was president for a time of the board of war, and in 1780 was placed in chief command in the South. He was totally defeated at Camden, S.C., by Cornwallis on Aug. 16, 1780, and in December was superseded by Greene, though an investigation into his conduct terminated in acquittal (1782). He then retired to his Virginian estate, then moved to New York in 1790, after emancipating his slaves and providing for those who needed assistance. He died in New York April 10, 1806. *See* J. H. Brandow, "Horatio Gates," N.Y. *State Hist. Assoc. Proc.*, vol. iii, pp. 9–19 (1903).

GATESHEAD, a municipal, county and parliamentary borough of County Durham, Eng., on the south bank of the Tyne (crossed there by five bridges), opposite Newcastle upon Tyne. Population 11961) 103,232. Gateshead is a closely built-up area rising steeply to 538 ft. above the river, the waterside being lined with wharves and quays used by coasting vessels and for shipbreaking and repairing. There is one of the largest flour mills in England. Many Gateshead residents still cross the Tyne to work in Newcastle, but as a consequence of the interwar depression there was developed after 1936 the Team Valley trading estate, an area of 700 ac. in the southwestern part of the borough, where there is a great variety of light industries which include light engineering (pumps, micro-switches, light sheet metal, etc.), clothing and packaging. Gateshead has iron, steel and engineering works, and coal mines in the vicinity. There is a large technical college specializing in engineering.

Gateshead probably grew up during Saxon times and Saxon grave covers are preserved in the present church of St. Mary. Except for a short period, the town was under the control of the bishop of Durham, who exercised the right of appointing the keeper of Gateshead tower on the 13th-century stone bridge across the Tyne. The first charter was granted by Bishop Hugh de Puiset (Pudsey) in 1164. The common seal of the borough is referred to in 1480, but under Edward VI Gateshead was merged for a time with Newcastle. The bishops of Durham incorporated nearly all the trades of Gateshead, and Oliver Cromwell continued this policy. As part of the palatinate of Durham, Gateshcad mas not represented in parliament until 1832. The county borough was created in 1889 and returns two members to parliament.

St. Mary's church dates mainly from the 14th century, but there was extensive restoration in 1854 after a fire which destroyed much of the town. Holy Trinity church, rebuilt in 18.37, incorporates the south aisle of the 13th-century monastic chapel. The Shipley art gallery was opened in 1917. The Saltwell Park museum, opened in 1933, has exhibits relating to local antiquities and industries and a natural history collection.

GATH, one of the five royal cities of the Philistines. It would seem to be identical with the Kn-tu in the lists of Thuthmose III and Gimtu (Gintu) of the Tell-Amarna letters. The name occurs several times in the Old Testament, especially in connection with the history of David. Goliath, the Philistine champion, hailed from Gath. Rehoboam is said to have fortified Gath, but Uzziah found it still a Philistine city. Sargon's records show that he took it in 712 B.C. Gath was evidently a place of importance, a walled city (2 Chr. on xxvi. 6), and it is surprising its exact location has been lost since the time of Sennacherib. The *Onomasticon* of Eusebius fixes the site near the road five Roman miles from Eleutheropolis (Beit Jibrin) on the way to Diospolis (Lydda). The Roman road is traceable and at the place indicated stands Tell es-Sāfi, a small mud village, having near it the mound marking the site of the Crusaders' castle, Blanchegarde. The village stands on a cliff about 300 ft. high in which are many caves. A fenced city on such an eminence would be remarkably strong, and surprise is felt at its complete disappearance.

The position of the village at Tell es-Sāfi has precluded a complete survey, but the excavations carried out there have, on the whole, proved disappointing and rendered the identification with Gath highly questionable. This and the fact that the sister Philistine cities do not occupy sites naturally strong, but are merely mounds on the plain, make it possible that Gath may yet be found between the coast and the Shephelah. Albright suggests 'Arāk el-Minshiyeh, or rather Ahmad el-'Araini a hill close beside it, as the site of Gath. Tell es-Sāfi he would identify with Makkedah.

See W. F. Albright, in ***Bulletin of the American School of Oriental Research,*** 1921 and 1924. (E. Ro.)

GATHAS, the name given to certain chapters of the Zend-Avesta of Zoroaster. It contains the discourses and exhortations of the prophet as well as 17 hymns written in an archaic metre. The language is of considerable antiquity, differing from that ordinarily used in the Avesta. *See* AVESTA and ZOROASTER.

GATINEAU, a river of southwestern Quebec, Canada, and long a highway for lumber trade. rises in a chain of large lakes due north of 48° N. lat., and continues southtlesterly until it merges into the Ottawa river, about one mile below the city of Ottawa. This is one of the main sites of hydroelectric power development in Canada.

GATLING, RICHARD JORDAN (1818–1903), U.S. inventor for whom the Gatling gun was named, was born in Hertford county, N.C., Sept. 12, 1818. He assisted his father in the construction and perfecting of machines for sowing cotton seeds. and for thinning the plants. In 1839 he perfected a practical screw propeller for steamboats, only to find that a patent had been granted to John Ericsson for a similar invention a few months earlier. He established himself in St. Louis in 1844, and taking the cotton-sowing machine as a basis he adapted it for sowing rice, wheat and other grains. The introduction of these machines did much to revolutionize the agricultural system in the country.

Becoming interested in the study of medicine through an attack of smallpox, he completed a course at the Ohio medical college in 1850. In the same year he invented a hemp-breaking machine, and in 1857 a steam plow. At the outbreak of the Civil War he devoted himself at once to the perfecting of firearms. In 1861 he conceived the idea of the rapid fire machine gun which is associated with his name. By 1862 he had succeeded in perfecting a gun that would discharge 350 shots per minute; but the war was practically over before the federal authorities consented to its official adoption. The invention was adopted by almost every civilized nation. Gatling died in New York city, Feb. 26, 1903.

See MACHINE GUN.

GATTY, MARGARET (1809–1873), English writer, daughter of the Rev. Alexander Scott (1768–1840), chaplain to Nelson, was born at Burnham, Essex, and married in 1839 the Rev. Alfred Gatty, vicar of Ecclesfield, near Sheffield. Mrs. Gatty is remembered for her many admirable books for children, the most famous of which is the *Parables from Nature* (5 vols. 1855–71). As "Aunt Judy" of *Aunt Judy's Magazine* she became the personal friend of thousands of her child readers and correspondents.

GAUCHOS, a nomadic South American race inhabiting the Argentine Republic and Uruguay of mixed Spanish and Indian descent. They are tall, handsome, strikingly dressed and of great endurance, with a combination of dignity and arrogance in their bearing. Their chief occupation is leather making and ranching, the wild conditions under which they live having made them excellent horsemen, skilled in the use of the lasso and bolas (*q.v.*).

GAUDEN, JOHN (1605–1662), English bishop and writer, reputed author of the *Eikon Basilike,* was born at Mayland, Essex, where his father was vicar. Educated at Bury St. Edmunds and at St. John's college, Cambridge, he seems to have been at Oxford until 1630. when he became vicar of Chippenham. His sympathies were at first with the parliamentary party. He was chaplain to Robert Rich, second earl of Warwick, and preached before the House of Commons in 1640. Apparently his views changed as the revolutionary tendency of the Presbyterian party became more pronounced, for in 1648/9 he addressed to Lord Fairfax *A Religious and Royal Protestation . . .* against the proceedings of the parliament. Under the Commonwealth he faced both ways. At the Restoration he was made bishop of Exeter. He complained to Hyde, earl of Clarendon, of the poverty of the see, and based claims for a better benefice on a certain secret service, which he explained on Jan. 20, 1661 to be the sole invention of the *Eikon Basilike, The Pourtraicture of his Sacred Majestie in his Solitudes and Sufferings,*put forth within a few hours after the execution of Charles I. as written by the king himself. To which Clarendon replied that he had been before acquainted with the secret and had often wished he had remained ignorant of it. Gauden was advanced in 1662, not as he had wished to the see of Winchester, but to Worcester. He died on May 23 of the same year.

See *Private Correspondence between Chas. I. and Sir Ed. Nicholas* pubd. as vol. v. of the *Memoirs of John Evelyn* (1827); C. Wordsworth, *Who wrote Eikon Basilike?* two letters addressed to the archbishop of Canterbury (1824), and *King Charles the First, the Author of Icon Basilikè* (1828); E. J. L. Scott's introduction to his reprint (1880) of the original edition; articles in the *Academy,* May and June 1883, by C. E. Doble; another reprint edit. by E Almack for the King's Classics (1904); and E. Almack, *Bibliography of the King's Book* (1896) which summarizes etc. the arguments on either side and gives a full bibliography.

GAUDÍ, ANTONIO (ANTONIO GAUDÍ Y CORNET) (1852–1926), Catalan architect, sculptor and ceramic artist, noted for the spatial freedom and organic unity of his work, was born at Reus, Tarragona, Spain, on June 26, 1852. He studied at the Barcelona school of architecture. Valued early in the 20th century primarily for his "bizarre" imagination, he became appreciated as a great architectural inventor, as a constructer and as a sculptor of organic form. He studied natural form and developed an expressive *art nouveau* by giving vitality to line, space and volume as well as by original constructions (sloping pillars to take diagonal pressure). Barcelona was the centre of this deeply religious man's steadfast and uncompromising life work. For his patron, Count Guell, he built there a town house (1885–89), the "Palace Güell," and "Park Güell" (1900–02). In this last he made brilliant use of raised ground to create a grandiose children's play terrace. This is bounded by a bench formed of swinging curves, which he encrusted with coloured tile mosaics, carrying out, even at that time, the Cubist "collage" principle in ceramic remainders.

The church of the Holy Family (1883–1926) was the problem of his life, and it remains a huge unfinished building, of significant plan, with brilliant tower construction and ornamental figures. Unfinished also was his best monumental building, the Guell colony church at S. Coloma de Cervello (1898–1914).

Gaudi deserts the original neo-Gothic elements and embodies new constructive ideas. His apartment houses and office buildings in the Paseo Gracia — Casa Batlló (1905–07) and Casa Milá (1905–10) — expound a style which simultaneously exploits façade and space. His fluid lines, the fantastic sculptural imagination of his chimneys and ventilators and the fluctuating iron trelliswork of gates and balconies here reach their highest expression.

Gaudi died at Barcelona on June 7, 1926. (C. G.-WR.)

GAUDIER-BRZESKA, HENRI (1891–1915), Franco-English sculptor, an outstanding exponent of the Vorticist movement, was born at St. Jean-de-Braye. Loire, Oct. 4, 1891, the son of a woodworker, Joseph Gaudier. (The name Brzeska was that of his devoted Polish companion Sophie Brzeska.) Although he was given a scholarship to study art at Bristol, he was largely self-taught. The poet Ezra Pound became his patron and propagandist; the writer and painter Wyndham Lewis drew him into the Vorticist movement just before World War I. The early carvings of Sir Jacob Epstein affected him, but he showed original attitudes toward form and content. He was an admirable linear draftsman. His letters are deeply moving.

Gaudier-Brzeska was killed in combat in World War I at Neuville-St.-Vaast, June 5, 1915. Much of his work is at the South Kensington museum.

See Ezra Pound, *Gaudier-Brzeska: His Life and Work* (1916); Harold S. Ede, *Savage Messiah* (1931); Horace Brodzky (ed.), *Gaudier-Brzeska, Drawings* (1946). (L. E. K.)

GAUDY, as a noun, in the sense of rejoicing or feast, a word used of a commemoration dinner at an Oxford college.

GAUGAMELA (ARBELA), BATTLE OF (Oct. 1, 331 B.C.). After his defeat at Issus, Darius assembled a vast horde of men at Babylon. Thence, marching northwards, he crossed to the left bank of the Tigris, and established his magazines and harems at Arbela (Erbil). From Arbela he moved forward to Gaugamela, some 32 miles westwards. Having conquered Egypt, Alexander marched northwards through Palestine, crossed the Tigris at Bezabdi, north of modern Mosul, and, learning of the Persian king's whereabouts, he at once moved forward with a picked force of cavalry. Having located the enemy, he rested his army for four days and fortified his camp. Whilst this was taking place, Darius deployed his army on the plains of Gaugamela, which he converted into a huge parade ground by levelling it. On the fourth night Alexander advanced, but when $3\frac{1}{2}$ miles distant from him he called a halt, and assembled his generals. Parmenio suggested that they should encamp where they were, and reconnoitre the ground and the enemy. To this Alexander agreed, and whilst the camp was being fortified, "he took the light infantry and the companion cavalry and went all round, reconnoitring the whole country where he was about to fight the battle." On his return he called together a conference at which he discussed what he had seen, and urged upon his generals the importance of the immediate execution of orders. Whilst the soldiers were resting, Parmenio came to Alexander's tent and suggested a night attack. This proposal Alexander refused to consider, his reason (more probable than the story of his disdaining such craft) being that in the approaching battle he had planned to deliver a decisive blow, and he knew well the difficulties coincident with night operations. Having rejected this advice, Alexander drew up his army. The phalanx was marshalled in the centre, the right wing consisting of its three right divisions, the hypaspists, the agema and the Companion cavalry; the left wing of the remaining three divisions of the phalanx, the Grecian cavalry and the Thessalian cavalry. Thus far the order of battle was normal. The problem which faced Alexander was very similar to that which confronted Cyrus in Xenophon's account of the battle of Thymbra. Alexander applied the tactics

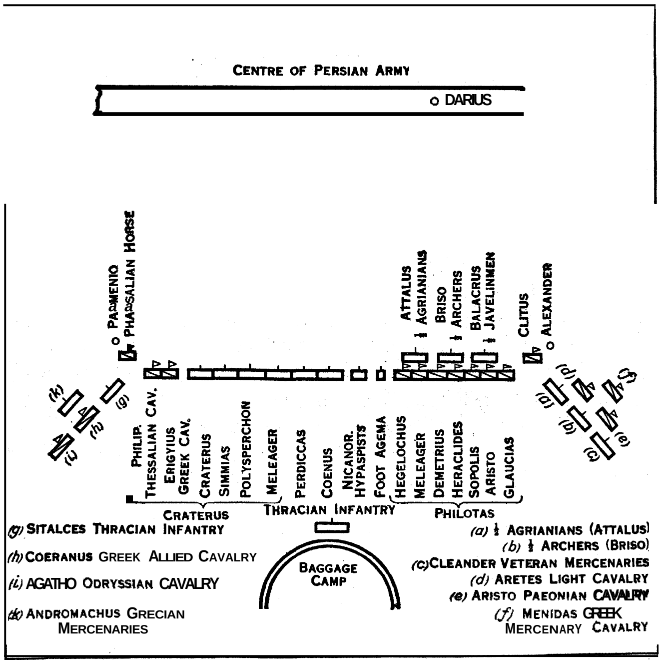


FIG. 1.—DIAGRAM OF BATTLE OF GAUGAMELA (ARBELA), OCT. 1, 331 B.C., SHOWING DISPOSITION OF ALEXANDER'S ARMY UNDER SEPARATE GENERALS

The Greeks numbered 7,000 cavalry and 40,000 foot, while the Persians were probably five times as strong. The battle ended in the complete shattering of the Persian army

made use of at Thymbra. Behind his front he drew up a reserve force consisting of two flying columns; these he posted one behind each wing at an angle to the front, so that they might take the enemy in flank should an attempt be made to turn the wings; or, if this did not take place, then they were to wheel inwards and reinforce the main army. In front of the Companion cavalry he posted half the Agrianians, archers and javelin-men to oppose the charge of the Persian chariots. The baggage guard consisted of Thracian infantry. In all Alexander's army numbered 7,000 cavalry and 40,000 foot, the Persians were, in all probability, about five times as strong. This order of battle should be kept clearly in mind, for, as it will be seen, it was through Alexander's ability to develop his tactics from it that he won the battle.

The Battle.—The initiative was taken by Alexander. He advanced, not directly on the Persians, but towards their left, and so compelled Darius to move on to the unlevelled ground. Darius, fearing that his chariots would become useless, ordered his left-wing cavalry to ride round Alexander's right and halt him. Alexander met this attack with his light cavalry, and a general cavalry engagement took place. Then Darius launched his chariots, but they never got home, as the charioteers were shot down by the light infantry in front of the Companion cavalry. The Persian left was now unmasked and in some confusion, whereupon Alexander wheeled round the Companion cavalry and with the four right divisions of the phalanx he led them towards the gap formed in the Persian front by the advance of their cavalry, and made straight for Darius. This cavalry charge, closely supported on its left by the dense array of bristling pikes in echelon, smote such terror into Darius that he fled the field. Meanwhile the Persian cavalry on Alexander's original right, finding their rear threatened took to flight, and the Macedonians, following up the fugitives, slaughtered them. The left wing, on account of the diagonal march, was in rear of the right, and the impetuous advance of Alexander appears to have created a gap between it and the right wing. Through this gap the Indian and Persian cavalry burst, and advanced towards the baggage camp. While this action was in progress, the Persian cavalry on Darius's right wing rode round Alexander's left wing and attacked Parmenio in flank. Parmenio, now completely surrounded, sent a messenger to Alexander informing him of his critical situation. He received this message whilst he was pursuing the fragments of the Persian left wing, and at once wheeled round with the Companion cavalry, and led them against the Persian right. The Persian cavalry, who were now falling back, finding their retreat menaced, fought stubbornly. "They struck and were struck without quarter" but were routed by Alexander. The pursuit was now taken up, and was continued until midnight, when a forced march was made on Arbela. About 32 miles were covered, but in vain, for Darius made good his escape. Arrian states that the Persians lost 300,000 in killed and Alexander only 100, and 1,000 horses. These figures are obviously unreliable.

Tactics.—This battle was not won by reckless courage but by audacity tempered by a wonderful grasp of what the enemy intended to do, and how his actions could be turned to advantage. This is clearly seen if the diagrams are studied. The order of battle is the normal one, but out of it is developed a very different type of attack to those of the battles of Granicus and Issus. Alexander is never obsessed by past successes, also he never invents what may be called experimental attacks. What he does is to measure up his antagonist and to act accordingly: First he seeks information; this is the foundation of his security, for in spite of his audacity security is always the foundation of his offensive action. Once he has made up his mind he distributes his force economically; his order of battle consists of a protective left and an offensive right, and in his right he concentrates his punch. Having secured his plan, he rapidly moves towards the Persian left flank, not only to get beyond the level ground, but to prevent a double envelopment, and to increase the distance between his left

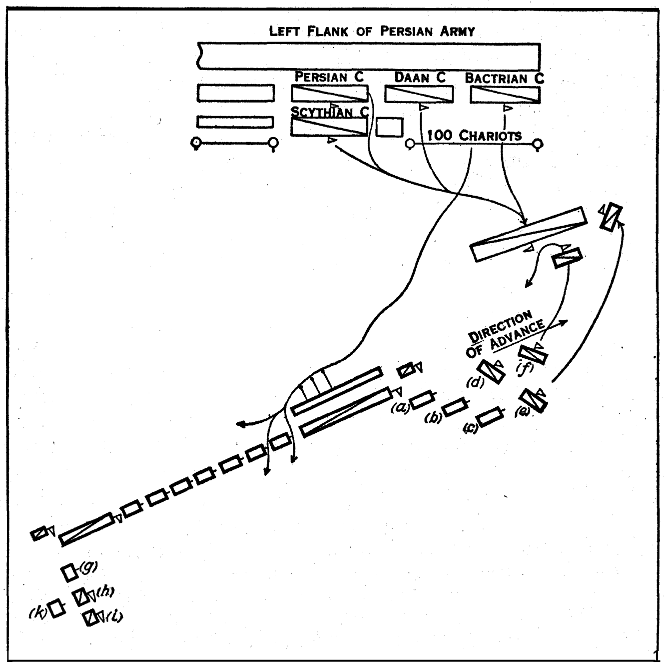


FIG. 2.—ALEXANDER'S FIRST ATTACK ON THE PERSIAN EXTREME LEFT

This manoeuvre compelled Darius to uncover his left centre, thereby leaving a gap, through which Alexander foresaw he could penetrate the Persian line

and the Persian right. This will enable him to shatter the Persian left before the Persian right can annihilate his own left. Also, if he can only draw the Persian right well inwards, should he be able to smash the enemy's left, he will then be in a position to take their right in reverse. In diagram 2, the position of Darius, the decisive point, is off the plan to the left, yet it is the point Alexander intends to strike. He opens the battle by moving away from it, and so compels Darius to uncover the immediate left flank of his centre. Though now well placed to attack in oblique order the outer flank of the Persian left wing he does not do so, for the decisive point is not the left wing but the centre. In diagram 3 it will be seen that under cover of his right flying column, he suddenly obliques inwards, and concentrates superiority of force opposite the gap once filled by the Scythian and Persian cavalry. Through this gap he charges at top speed and strikes Darius in *rear*. This charge succeeds, not because the Companion cavalry are advancing at top speed, but because their mobility is developed from the security afforded by the flying column and the phalanx.

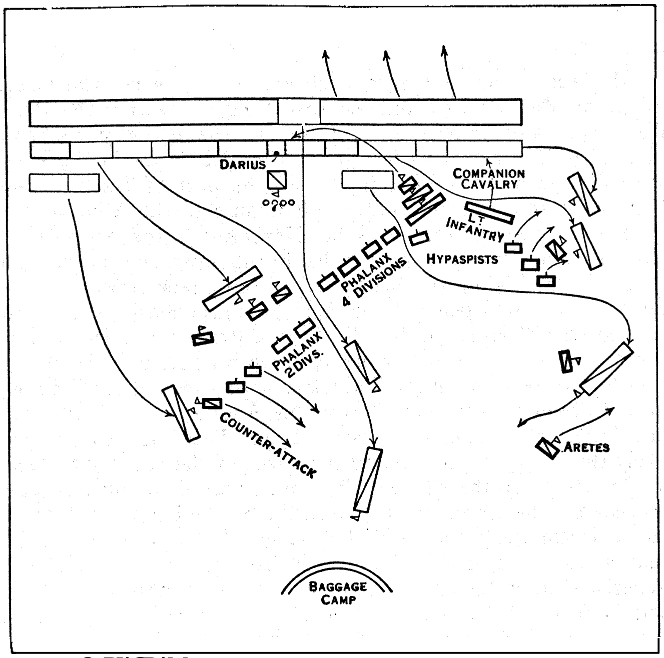


FIG 3—DIAGRAM SHOWING PENETRATION TACTICS OF ALEXANDER
By suddenly turning inwards, under cover of his right flying column, Alexander concentrated superior forces in the gap caused by his initial manoeuvre (see fig. 2) and was thus able to take the army of Darius in the rear

The penetration by shock is absolutely successful. Gaugamela is one of the most perfect examples of the tactics of penetration to be found in history.

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GAUGUIN, PAUL (1848–1903), French painter, one of the pioneers of the Post-Impressionist movement. He was born in Paris on June 7, 1848, the son of a journalist from Orleans and of a mother partly of Peruvian descent He spent his childhood in Peru and at Orleans, and after having done his military service in the marines he entered the banking firm of Bertin in Paris in 1871. In 1873 he married Mette-Sophie Gad, a Danish lady. In 1875 he began to spend his free time in painting. Encouraged by his friend, C. Pissaro, he acquired the Impressionist technique. His interest in art took more and more hold of him, and in 1881 he decided to give up his appointment at the bank. His means soon gave out and after an unfortunate attempt to get assistance from his wife's relations at Copenhagen, he separated from her and his children, returning to Paris without means. A period of travel followed. He worked on the island of Martinique (1887–88) and then went to Pont Aven in the Bretagne, where he soon became the leading spirit of a group of painters.

The movement thus started was known as "Synthesism." Gauguin himself was not a theorist. He wished to be rid of all that might intervene between the artist's vision and his canvas; but the other members of the group felt otherwise. Emile Bernard lectured on the synthetic doctrine, Filiger contributed his mediaeval fancies, Sérusier propagated the new ideas; he clarified the vague doctrines of Gauguin The new tendency is explained by Maurice Denis, one of Sérusier's disciples in Paris; he says: "It was on our reassembling in 1888 that the name of Gauguin was revealed to us by Sérusier, who had just returned from Pont Aven and who allowed us to see not without a show of mystery the lid of a cigar box, on which we could make out a shapeless landscape synthetically designed in violet, vermillion, Veronese green and other unmixed colours, just as they are pressed out of a tube, almost without white in them. 'How does that tree appear to you,' Gauguin had asked—'very green?—Well then use green—the finest green on your palette—and that shadow is rather blue? Do not be afraid to paint it as blue as possible.' " "Thus," continues Denis, "was presented to us for the first time the fruitful conception of the plane surface covered with colours put together in a certain order . . . we learned that every work of art is a transposition, a caricature, the passionate equivalent of a sensation which has been experienced. . . . Gauguin freed us from all restraints which the idea of copying placed on our painter's instinct. . . . Henceforth we aspired to express our own personality. . . . If it was permissible to use vermillion in painting a tree which seemed to us at that moment reddish . . . why not stress even to the point of deformation the curve of a beautiful shoulder, exaggerate the pearly whiteness of a carnation, stiffen the symmetry of boughs unmoved by a breath of air?" *(Theories 1890–1910,* published in 1920.)

Thus Gauguin's ideas were taken up by a group of young students in Paris, which included Bonnard Denis, Ibels, Ranson, Vuillard and Maillol. In 1889 "the school of Pont Aven" moved to Pouldu near by. Their life there and the inn at Pouldu, the rendezvous of artists, which was adorned by Gauguin, was described by Mr. Ch. Chassé in *l'Occident* (1903). In 1888 Gauguin went to Arles to meet his friend, Van Gogh. The two artists had planned to work together, but Van Gogh succumbed to an attack of lunacy and Gauguin left him. *(See* P. Gauguin, *Avant et Après.)* Among Gauguin's best work of this period are "Le Christe Jaune," and "La Lutte de l'Ange avec Jacob." He copied Manet's "Olympia," which he considered one of the masterpieces of the age, he etched a portrait of Mallarmé, executed some lithographs and carved reliefs in wood. But in spite of all his efforts his financial position did not improve. His journey to Martinique had inspired him with a love for the tropics and he conceived a plan of going to the South Seas where he could live cheaply and devote himself to his vocation. He sold all his pictures by auction for 9,860 frcs. and went to the island of Tahiti in 1891. There he lived a simple life with the natives which he described in his autobiographical novel *Noa* Noa.

On his return to Paris he exhibited his paintings at Durand Ruel, but the life in the big city no longer suited him; he left for Tahiti in 1895 never to return. Out there, inspired by his admiration for primitive life, for the luminous colour of the tropical landscape, he produced paintings of great decorative beauty and originality. "L'esprit Veille," "Seule," "Devant la Case," "La Fuite" and "Jours Delicieux" are among his most notable works. They represent the bronzed native Maoris in their surroundings of exotic plants and primitive dwellings. In 1901 he moved to Dominiha on the Marquesas isles. He built himself a house and decorated it with carvings and paintings. The natives treated him as one of their own and he sided with them against the overbearing European representatives of the administration. The end of his life was approaching; he lived in extreme want; in order to pay his taxes he worked in a Government office for 6 frcs. a day; his health was failing. He died on May g, 1903, and was buried in the Mission cemetery. Victor Ségalen, a navy doctor and writer, who was in the Marquesas isles at the time, gave a vivid and sad account of his end *(Mercure de France,* June 1904).

His last important picture, entitled "D'où venons nous? Que sommes-nous? où allons-nous?" is one of his masterpieces. It was painted under the shadow of an attempted suicide. His description of this work in a letter to his friend, D. de Montfreid, is of interest, as it throws light on his artistic creed. "Before I died I wished to paint a large canvas that I had in mind, and I worked day and night that whole month in an incredible fever. To be sure it is not done like a Puvis de Chavannes, sketch after nature, preparatory cartoon, etc. It is all done straight from the brush on the sackcloth full of knots and wrinkles, so the appearance is terribly rough. . . . I put in it all my energy, a passion so dolorous, amid circumstances so terrible, and so clear was my vision that the haste of the execution is lost and life surges up. It does not stink of models, of technique, or of pretended rules, of which I have always fought shy, though sometimes with fear. It is a canvas four metres, fifty long and one metre, seventy high. The two upper corners are chrome yellow, with an inscription on the left and my name on the right, like a fresco whose corners are spoiled with age and which is appliquéed upon a golden wall. To the right at the lower end a sleeping child and three crouching women. Two figures dressed in purple confide their thoughts to one another. An enormous crouching figure, out of all proportion and intentionally so, raises its arms and stares in astonishment upon these two, who dare to think of their destiny; a figure in the centre is picking fruit; two cats near a child; a white goat; an idol, its arms mysteriously raised in a sort of rhythm seems to indicate the Beyond. Then, lastly, an old woman nearing death appears to accept everything. . . . She completed the story. . . . It is all on the bank of a river in the woods. In the background the ocean, then the mountains of a neighbouring island. Despite changes of tone the colouring of the landscape is constant-either blue or Veronese green. Where does the execution of a painting commence and where does it end? At that moment when the most intense emotions are in fusion in the depths of one's being, when they burst forth like lava from a volcano . . .? The work is created suddenly, brutally if you like, and is not its appearance great, almost superhuman?"

Gauguin, then, had left Impressionism behind; he had profited by its technique in the use of using colours pure and unmixed; but his work was impregnated with symbolism, his design was expressive, his colour arrangements decorative. His influence on modern art was far-reaching. Besides the school of Pont Aven and the Synthesists, he inspired such artists as Ed. Munch and Toulouse Lautrec. His ideas revolutionized poster design and design in all Arts and Crafts work (Van de Velde, Lemmen, Gallé-Nancy.) His primitive woodcarving and his terra-cotta figure called "Oviri," the Tahitan Diana, was admired by such artists as Picasso and led to the appreciation of nrgro sculpture. His lithographs and woodcuts opened new fields in the graphic arts.

See Jean de Rotonchamp, Paul Gauguin (1925); Ch. Morice, Paul Gauguin (1919); Gauguin's writings: Noa Noa (1924), *Choses Diverses* (1896–97), Le *Sourire* (a journal), Racontars d'un *Rapin* (1902), Lettres de *Paul* Gauguin *à* G. D. de *Montfreid* (1920); The Intimate Journal of P. Gauguin, with a preface by Emile Gauguin (1923); M. Guerin, L'oeuvre *Gravé* de Gauguin (1927). (I. A. R.)

GAUHATI, headquarters town of Kamrup district, Assam, India, on the Brahmaputra. Pop. (1951) 43,615.

During the 17th century it was taken and retaken by Mohammedans and Ahoms eight times in 50 years, but in 1681 it became the residence of the Ahom governor of lower Assam, and in 1786 the capital of the Ahom raja. On the cession of Assam to the British in 1826 it was made the seat of the British administration of Assam, and so continued till 1874, when the headquarters were moved to Shillong in the Khasi hills.

Two much-frequented places of Hindu pilgrimage are situated in the immediate vicinity, the temple of Kamakhya on a hill 2 mi. west of the town, and the rocky island of Umananda in the Brahmaputra.

Gauhati is an important centre of river trade, and the largest seat of commerce in Assam. It is the seat of the only university in the state, Gauhati university (established 1948).

GAUL, WILLIAM GILBERT (1855–1919), **U.S.** artist known for his Civil War scenes, was born in Jersey City, N.J., on March 31, 1855. He was a pupil of J. G. Brown and L. E. Wilmarth, and he became a painter of military pictures. He was elected an associate of the National Academy of Design in 1880, and in 1882 a full academician, and in the latter year became a member of the Society of American Artists. His important works include "Charging the Battery," "News From Home," "Cold Comfort on the Outpost," "Silenced," "On the Look-out" and "Guerrillas Returning From a Raid." He died in New York, Dec. 21, 1919.

GAUL, Lat. Gallia, the name of the two chief districts known to the Romans as inhabited by Celtic-speaking peoples, (a) Gallia *Cisalpina* or *Citerior, i.e.,* North Italy between Alps and Apennines and (b) the far more important Gallia *Transalpina* or Ulterior, usually called Gallia simply, the land bounded by the Alps, the Mediterranean, the Pyrenees, the Atlantic and the Rhine, *i.e.,* modern France and Belgium with parts of Holland, Germany and Switzerland.

(a) Gallia Cisalpina (*q.v.*) was mainly conquered by Rome by 222 B.C.; later it adopted Roman civilization, whence it was often known as "*Gallia* Togata"; about 42 B.C. it was united with Italy.

(b) Gaul proper first enters ancient history when the Greek colony of Massilia was founded (?600 B.C.). During the Punic Wars it became important to Rome as the highway to Spain (*q.v.*). In 121 B.C. the coast from Montpellier to the Pyrenees (*i.e.,* all that was not Massiliot), with its port of Narbo (mod. Narbonne) and its trade route by Toulouse to the Atlantic, was formed into the province of Gallia Narbonensis and Narbo itself into a Roman municipality. Gradually the province was extended north of Massilia, up the Rhone, while the Greek town itself became weak and dependent on Rome. Narbonensis was distinguished from "Gallia Togata" as "Gallia Bracata," from the long trousers (bracae, incorrectly braccae) worn by its inhabitants.

Gallia Narbonensis apart, Gaul was at that time divided among three more or less distinct peoples, the Aquitani, the Gauls (who called themselves Celts), and the Belgae. These occupied respectively the south, the centre and the north of the country between the Pyrenees and the Rhine. The tribes were numerous. Prominent among them were the Helvetii, the Sequani and the Aedui in the basins of the Rhone and the Saône; the Arverni in the Cévennes; the Senones and Carnutes in the basin of the Loire; the Veneti and other Armorican tribes between the mouths of the Loire and the Seine. These were all Celts. The Nervii, Bellovaci, Suessiones, Remi, Morini, Menapii and Aduatuci were Belgic; the Tarbelli and others were Aquitani; while the Allobroges inhabited the north of Gallia Bracata. (See CELT and articles on the chief tribes.)

As the result of the Gallic wars (58–51) of Caesar (*q.v.*) the whole of Gaul to the Rhine and the ocean became Roman territory, and in 49 Massilia was annexed. As settled by Augustus, and in part perhaps also by his successor Tiberius, Gaul fell into five administrative areas:—

(i.) Narbonensis, that is, the land between Alps, sea and Cévennes, extending up the Rhone to Vienne, is a sun-steeped southern region, the home of the vine and olive, of the minstrelsy of the Provençal and the exuberance of Tartarin. Augustus found it already familiar with Roman ways and civilized enough to need no garrison. Accordingly, it was governed by a proconsul and freed from the burden of troops, while its local government was assimilated to that of Italy. The old Celtic tribes were broken up; instead, municipalities of Roman citizens were founded to rule their territories. Thus the Allobroges now disappear and the *colonia* of Vienna (Vienne) takes their place; the Volcae vanish, and we find Nemausus (Nimes). By A.D. 70 the area was "Italia verius quam provincia" (Pliny). The Gauls obviously had a natural bias toward the Italian civilization, and there soon became no difference between Italy and southern Gaul.

(ii.-iv.) Across the Cévennes lay Caesar's conquests, Atlantic in climate, new to Roman ways. The whole area, often collectively styled "Gallia Comata," from the inhabitants wearing their hair long, often "Tres Provinciae," was divided into three provinces, each under a *legatus* pro praetore appointed by the emperor, with a common capital at Lugdunum (Lyons). The three were: Aquitania, reaching from the Pyrenees almost to the Loire; Lugdunensis, the land between Loire and Seine, reaching from Brittany in the west to Lyons in the southeast; and Belgica in the north. Here also it was found possible to dispense with garrisons, not because the provinces were as peaceful as Narbonensis, but because the Rhine army was close at hand, while the splendid system of roads rendered the movement of troops easy. As befitted an unromanized region, the local government was unlike that of Italy or Narbonensis. Roman municipalities were not unknown, though very few; the local authorities were the magistrates of the old tribal districts. In general, Roman civilization was accepted more or less rapidly; in particlar, the worship of "Augustus and Rome," devised by the first emperor as a bond of state religion connecting the provinces with Rome, was eagerly welcomed. It agrees with the vigorous development of this worship that the three provinces, though romanized, retained their own local feeling. As late as the 3rd century. the cults of Celtic deities (Hercules Magusanus, Deusoniensis, etc.) were revived, the Celtic *leuga* reintroduced instead of the Roman mile on official milestones, and a brief effort made to establish an independent, though romanized, Gaul under Postumus and'his short-lived successors (A.D. 259–273). The *chefs-lieux* of the tribes became practically, though not officially, municipalities, and many of these towns reached considerable size and magnificence of public buildings. But they attest their tribal relations by their appellations, which are commonly drawn from the name of the tribe and not of the town itself; to this day Amiens, Paris, Rheims, Soissons and others perpetuate the memory of tribes like the Ambiani, the Parisii, the Remi, and the Suessiones.

(v.) The fifth division of Gaul was the Rhenish military frontier, which was organized as two military districts. The northern one was the valley of the Meuse and that of the Rhine to a point just south of Bonn; the southern was the rest of the Rhine valley to Switzerland. Each district was garrisoned at first by four, later by fewer, legions, which were disposed at various times in some of the following fortresses: Vetera (Xanten), Novaesium (Neuss), Bonna (Bonn), Mogontiacum (Mainz), Argentorate (Strasbourg) and Vindonissa (Windisch in Switzerland). At first the districts, being purely military, were called after the garrisons "exercitus Germanicus superior" (south) and "inferior" (north). Later one or two municipalities were founded — the oldest, Colonia Agrippinensis, at Cologne in A.D. 51—and about A.D. 80–90 the two "Exercitus" were turned into the two provinces of Upper and Lower Germany (see GERMANY).

These provincial divisions were modified by Diocletian, but without seriously affecting the life of Gaul. The whole country continued Roman and fairly safe from barbarian invasions till after 400. In A.D. 407 a multitude of Franks, Vandals, etc., broke in; the three kingdoms of the Visigoths, Burgundians and Franks began to form, and in A.D. 486 Clovis the Frank brought Roman rule in Gaul to a final end. (F. J. H.; G. M.)

GAULLE, CHARLES ANDRÉ JOSEPH MARIE DE: *see* DE GAULLE, CHARLES ANDRÉ JOSEPH MARIE.

GAUR or LAKHNAUTI, a ruined city of India, in the Malda district of West Bengal. The ruins are situated about 8 mi. south of English Bazar, the civil station of the district of Malda, and on the eastern bank of an old channel of the Ganges. It is said to have been founded by Lakshman, the Sena king of Bengal, and its ancient name was Lakshmanavati, corrupted into Lakhnauti. Its known history begins with its conquest at the end of the 12th century by the Mohammedans, who retained it as their capital in Bengal for more than 300 years. The seat of government was transferred about 1340 to Pandua (*q.v.*), also in Malda district.

When Pandua was in its turn deserted (about 1455), Gaur once more became the capital, but in 1564 because of a change in the course of the Ganges it was abandoned for Tanda, a place somewhat nearer the main stream. Gaur was temporarily reoccupied by Akbar's general in 1575, when Daud Shah, the last of the Afghan dynasty, refused to submit to the Mogul emperor. This occupation was followed by a virulent epidemic, which depopulated the city and completed its downfall.

The finest ruin in Gaur is that of the Great Golden mosque, also called Bara Darwaza, or "12-doored" (1526). The Small Golden or Eunuch's mosque has fine carving and is faced with stone fairly well preserved. The Tantipara mosque (1475–80) has beautiful molding in brick, and the Lotan mosque is unique in retaining glazed tiles.

The citadel mas entered through a magnificent gateway called the Dakhil Darwaza (?1460–74). At the southeast comer was a palace surrounded by a wall of brick 66 ft. high.

GAUR (*Bibos gaurus*), the wild ox of India. The gaur, which extends into Burma and the Malay Peninsula, is the typical representative of an Indo-Malay group of wild cattle characterized by a ridge on the withers, compressed horns, and white legs. The gaur, which reaches a height of nearly 6 ft. at the shoulder, is characterized by the forward curve and great elevation of the ridge between the horns. The colour is blackish-gray. Hill forests are the resort of this species.

GAUSS, (JOHANN) CARL FRIEDRICH (1777–1855), German mathematician and scientist, to whom history has accorded a place with Archimedes and Newton as one of the three greatest mathematicians of all time, is frequently called the founder of modern mathematics. The importance of his work in astronomy and physics is scarcely less than that in mathematics. His full stature became known only in the 20th century since many of his discoveries were published long after his death. During his lifetime he published 155 titles. He was born at Brunswick, April 30, 1777, and died at Gottingen, Feb. 23, 1855.

Gauss was of Nether-Saxon peasant origin. Many anecdotes refer to his prodigious precocity, particularly in mental computation. As an old man he said facetiously that he could count before he could talk. In elementary school he soon impressed his teacher, who is said to have convinced Gauss's father that the son should not learn a trade, but follow a learned profession. In secondary school, after 1788, he rapidly distinguished himself in ancient languages and mathematics. At the age of 14 Gauss was presented to the duke of Brunswick at court, where he was permitted to exhibit his computing skill. On this occasion he was given several mathematical textbooks. Until his death in 1806 the duke generously supported Gauss.

Gauss conceived almost all his fundamental mathematical discoveries between the ages of 14 and 17. In 1791 he gave attention to the arithmetico-geometric mean. Gauss now manifested his outstanding trait of critical analysis and thus began to do creative work. He called this acuteness the *rigor antiquus*. In 1792, the year that he entered the three-year Collegium Carolinum in Brunswick, his interests led him to question the foundations of geometry. Gauss shunned controversy, and though a pioneer he published nothing on non-Euclidean geometry. In 1793–94 he did intensive research in number theory, especially on the frequency of primes. He made this study his life's passion and is regarded as its modern founder. Gauss obtained a copy of Newton's *Principia* in 1794; in that year he discovered the method of least squares. In 1795 he completed important research on quadratic residues.

Gauss studied at the University of Gottingen from 1795 to 1798; there he had access to the works of Fermat, Euler, Lagrange and Legendre, the masters in his field. He soon realized'that he too was a master and decided to write a book on the theory of numbers. It appeared in 1801 under the title *Disquisitiones arithmeticae;* this classic work, establishing the theories of cyclotomy and arithmetical forms, usually is held to be Gauss's greatest accomplishment. In studying the roots of the equation $x^p = 1$, Gauss discovered on March 30, 1796, that the regular heptadecagon (polygon with 17 sides) is inscriptible in a circle, using only compasses and straightedge — the first such discovery in Euclidean construction in over 2,000 years. Gauss had been undecided whether to make mathematics or philology his life work; he now resolved to devote his life to the former.

In late 1796 Gauss was busy with research in infinitesimal calculus and algebra and began an investigation of the lemniscate functions; he found a proof of Lagrange's theorem (reversion formula) and discovered the connection between the elliptic quadrant and the arithmetico-geometric mean, as well as its connection with the power series whose exponents are squares. The theories of elliptic functions and of linear differential equations were rediscovered some decades after Gauss had developed them for himself; he discovered double periodicity and operated with the general theta functions.

His interest then turned to astronomy as he developed formulas for the calculation of parallax in April 1799. He went to Helmstedt in Dec. 1799 to live in the home of the mathematician J. F. Pfaff and to use the university library. That month he found the relation of the arithmetico-geometric mean to the elliptic integral of the first order. He returned to Brunswick at Easter in 1800; in May he developed his formula for determining the date of Easter and promptly published it.

The discovery of Ceres, the first planetoid, by Giuseppe Piazzi in Palermo on Jan. 1. 1801, gave Gauss the opportunity of revealing, in a spectacular way, his remarkable mathematical superiority over all his contemporaries. His calculations of the orbit of Ceres began in Nov. 1801; on this problem he succeeded where others had failed. Gauss set up a speedy method for the complete determination of the elements of a planet's orbit from three observations; he elaborated it in his second major work, a classic in astronomy, published in 1809. He said that had it not been for Newton's *Principia* he could not have devised the new method.

Astronomy occupied Gauss's attention the remainder of his life. In 1807 he was appointed director of the University of Gottingen observatory and professor of mathematics, a position he never left in spite of many efforts to lure him away. He trained a considerable number of students who later distinguished themselves and always regarded him as a great teacher. The years 1816–17 marked the close of his work in theoretical astronomy; later he worked in spherical and observational astronomy.

In 1812 Gauss published the first rigorous treatment of the hypergeometric series. He was a pioneer in topology and contributed much to crystallography, optics, biostatistics, mechanics and the study of capillarity and fluids in a state of equilibrium. Gauss was commissioned in 1818 to make a geodetic survey of the kingdom of Hanover; this triangulation occupied him for many years, leading to his invention of the heliotrope and his brilliant work in the theory of surfaces. There he found full application for his method of least squares in solving the problem of determining the earth's figure.

After 1831, Gauss collaborated with Wilhelm Weber in basic research in electricity and magnetism. In 1833 they devised an electromagnetic telegraph. They stimulated others in many lands to make magnetic observations and founded the Magnetic union in 1836, the year that Gauss invented the bifilar magnetometer.

Gauss married twice and became the father of six children; two of his sons emigrated to Missouri in the 1830s. His private life was simple and harmonious although he had his share of grief and trouble. He did not like to travel. Gauss left an estate of 152,892 thalers. His personal and scientific correspondence was voluminous. As a celebrity, he had numerous visitors from abroad. Newton was his ideal. Frequently he meditated on religion and philosophy but was reluctant to talk on these subjects and published nothing on them. His *Collected Works* were published over a long period, from 1863 to 1933; they exhibit the elegant and concise form on which he insisted. He was well versed in the Greek and Roman classics, studied Sanskrit and read extensively in European literature, particularly English and Russian. His library contained 11,424 items. In later years he was showered with honours from scientific bodies and governments everywhere. He was extremely patriotic and politically conservative, though never active beyond watching current events. He served several terms as a dean at the University of Gottingen and always participated wholeheartedly in its affairs. Gauss enjoyed social life but usually limited this in favour of his research. He loved music, especially singing. His unusually strong character prevented others from trifling with him.

Gauss enjoyed good health until the last year of his life. His fame lives even more strongly than ever, for rarely has the mind of a commanding world figure been so richly furnished.

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GAUTAMA BUDDHA (*c.* 563–483 B.C.), the historic founder of the religion known as Buddhism, lived, taught and died in northeast India, but his influence spread throughout central, northern and southern Asia, where it continues to provide a common cultural bond. Traditions of his life were not written earlier than 236 years after his death, but they are preserved variously in the Pali, Sanskrit, Chinese and Tibetan languages. From these, modern historical inquiry has been able to obtain a relatively stable outline of main events in a career still celebrated after 2,500 years.

Buddha was born among the Sakyas, a tribe of the warrior (Kshatriya) caste whose capital, Kapilavastu, was situated in what is now Nepal. His father, Suddhodana, was ruling noble (or king) of the Gautama clan, whence the name Gautama by which the son was later known, although his given personal name was Siddhartha. His mother, Maya, died soon after he was born. From poetic tales and legends surrounding his birth, infancy and youth, it may be inferred that the prince was a remarkable personality, that although reared in luxury he was of a serious, meditative turn of mind, and that he was early attracted to a nonworldly religious life. From this neither wife nor the birth of a son could divert him. Actually, in his 29th year, the prince renounced home and secular life to seek the "supreme peace of Nirvana." This goal envisaged deliverance from the painful realities of life's transitoriness, as evidenced by the ceaseless round of birth, old age, sickness and death, repeated according to Indian belief through countless successive rebirths. As monk he sought instruction under two religious teachers.

Unsatisfied, he next tried extreme ascetic practices for six years, equally fruitless. Returning to a natural regimen, he finally gained his great enlightenment through sitting quietly in concentrated meditation. He detected the cause of suffering in craving due to ignorance, and discovered a path to its removal through right living and mental discipline. Thus he became Buddha, or the Enlightened One.

Feeling compassion for all suffering mortals, he decided to share his wisdom. His remaining 45 years spent as wandering teacher among his own and neighbouring tribes earned him the title Sage of the Sakyas (Sakyamuni). From among his numerous followers he organized a community of monks (the sangha) to carry on after him. In old age he was menaced by a schismatic monk, Devadatta (*q.v.*), who plotted to seize leadership, but this danger was averted. In his 80th year, still exhorting his disciples to strive earnestly for what is beyond perishing things, Gautama Buddha died. History attests the deep and lasting impression left by his noble spirit and selfless, devoted life. See also BUDDHA AND BUDDHISM; LUMBINI; MAHAYANA; ZEN.

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GAUTIER, LÉON (1832–1897), French literary historian, was born at Havre, educated at the École des Chartes and became successively keeper of the archives of the department of Haute-Marne and of the imperial archives at Paris under the empire. In 1871 he became professor of paleography at the École des Chartes. He was elected member of the Academy of Inscriptions in 1887 and became chief of the historical section of the national archives in 1893.

Léon Gautier rendered great services to the study of early French literature, the most important of his numerous works on medieval subjects being a critical text (1872) with translation and introduction of the *Chanson de Roland,* and *Les Epopdes françaises* (3 vol., 1866–67; 2nd ed., 5 vol., 1878–97, including a *Bibliographie des chansons de geste).* He died in Paris Aug. 25, 1897.

GAUTIER, THEOPHILE (1811–1872), French poet and miscellaneous writer, was born at Tarbes on Aug. 31, 1811. He was educated at the grammar school of that town, and afterward at the Collège Charlemagne in Paris, but was almost as much in the studios. He very early devoted himself to the study of the older French literature, especially that of the 16th and the early part of the 17th century. This study qualified him well to take part in the Romantic movement, and enabled him to astonish Sainte-Beuve by the phraseology and style of some literary essays which, when barely 18 years old, he put into the critic's hands. In consequence of this introduction he at once came under the influence of the great Romantic *cénacle,* to which, as to Victor Hugo in particular, he was also introduced by his gifted but ill-starred schoolmate Gérard de Nerval. With Gérard, Petrus Borel, Corot, and many other less known painters and poets whose personalities he has delightfully sketched in the articles collected under the titles of *Histoire du Romantisme*, etc., he formed a minor romantic clique who were distinguished for a time by the most extravagant eccentricity. A flaming crimson waistcoat and a great mass of waving hair were the outward signs which qualified Gautier for a chief rank among the enthusiastic devotees who attended the rehearsals of *Hernani* with red tickets marked "Hierro," performed mocking dances round the bust of Racine, and were at all times ready to exchange word or blow with the *perruques* and *grisâtres* of the classical party. In Gautier's case these freaks were not inconsistent with real genius and real devotion to sound ideals of literature. He began (like Thackeray, to whom he presents in other ways some striking points of resemblance) as an artist, but soon found that his true powers lay in another direction.

His first considerable poem, *Albertus* (1830), displayed a good deal of the extravagant character which accompanied rather than marked the movement, but also gave evidence of uncommon command both of language and imagery, and in particular of a descriptive power hardly to be excelled. The promise thus given was more than fulfilled in his subsequent poetry, which, in consequence of its small bulk, may well be noticed at once and by anticipation. The *Comédie de la mort*, which appeared soon aiter (1832), is one of the most remarkable of French poems, and though never widely read has received the suffrage of every competent reader. Minor poems of various dates, published in 1840, display an almost unequalled command over poetical form, an advance even over *Albertus* in vigour, wealth and appropriateness of diction, and abundance of the special poetical essence. All these good gifts reached their climax in the *Émaux et camées,* first published in 1856, and again, with additions, just before the poet's death in 1872. These poems are in their own way such as cannot be surpassed. Gautier's poetical work contains in little an expression of his literary peculiarities. There are, in addition to the peculiarities of style and diction already noticed, and extraordinary feeling and affection for beauty in art and nature, and a strange indifference to anything beyond this range, which has doubtless injured the popularity of his work.

But it was not, after all, as a poet that Gautier was to achieve either profit or fame. For the theatre, he had but little gift, and his dramatic efforts (if we except certain masques or ballets in which his exuberant and graceful fancy came into play) are by far his weakest. It was otherwise with his prose fiction. His first novel of any size, and in many respects his most remarkable work, was *Madenzoiselle de Maupin* (1835). Unfortunately this book, while it establishes his literary reputation on an imperishable basis, was unfitted by its subject, and in parts by its treatment, for general perusal, and created, even in France, a prejudice against its author which he was very far from really deserving. During the years from 1833 onward, his fertility in novels and tales was very great. *Les Jeunes-France* (1833), which may rank as a sort of prose *Albertus* in some ways, displays the follies of the youthful Romantics in a vein of humorous and at the same time half-pathetic satire. *Fortunio* (1838) perhaps belongs to the same class. *Jettatura,* written somewhat later, is less extravagant and more pathetic. A crowd of minor tales display the highest literary qualities, and rank with Mérimée's at the head of all contemporary works of the class. First of all must be mentioned the ghost-story of *La Morte amoureuse,* a gem of the most perfect workmanship. For many years Gautier continued to write novels. *La Belle Jenny* (1864) is a not very successful attempt to draw on his English experience, but the earlier *Militona* (1847) is a most charming picture of Spanish life. In *Spirite* (1866) he endeavoured to enlist the fancy of the day for supernatural manifestations, and a *Roman de la momie* (1856) is a learned study of ancient Egyptian ways. His most remarkable effort in this kind, towards the end of his life, was *Le Capitaine Fracasse* (1863), a novel, partly of the picaresque school, partly of that which Dumas was to make popular, projected nearly thirty years earlier, and before Dumas himself had taken to the style. This book contains some of the finest instances of his literary power.

Yet neither in poems nor in novels did the main occupation of Gautier as a literary man consist. He was early drawn to the more lucrative task of feuilleton-writing, and for more than thirty years he was among the most expert and successful practitioners of this art. Soon after the publication of *Mademoiselle de Maupin,* in which he had not been too polite to journalism, he became irrevocably a journalist. He was actually the editor of *L'Artiste* for a time: but his chief newspaper connexions were with *La Presse* from 1836 to 1854 and with the *Moniteur* later. His work was mainly theatrical and art criticism. The rest of his life was spent either at Paris or in travels of considerable extent to Spain, the Netherlands, Italy, Turkey, England, Algeria and Russia, all undertaken with a more or less definite purpose of bookmaking. Having absolutely no political opinions, he had no difficulty in accepting the Second Empire, and received from it considerable favours. in return for which. however. he in no way prostituted his pen, but remained a literary man pure and simple. He died on Dec. 23, 1872.

Accounts of his travels, criticisms of the theatrical and literary works of the day, obituary notices of his contemporaries and, above all, art criticism occupied him in turn. It has sometimes been deplored that this engagement in journalism should have diverted Gautier from the performance of more capital work in literature. Perhaps, however, this regret springs from a certain misconception. Gautier's power was literary power pure and simple, and it is as evident in his slightest sketches and criticisms as in *Émaux et camées* or *La Morte amoureuse.* On the other hand, his weakness, if he had a weakness, lay in his almost total indifference to the matters which usually supply subjects for art and therefore for literature. He has thus been accused of "lack of ideas" by those who have not cleared their own minds of cant; and in the recent set-back of the critical current against form and in favour of "philosophic" treatment, comment upon him has sometimes been uniavourable. But this injustice will, beyond all question, be redressed again. He was neither immoral, irreligious nor unduly subservient to despotism, but morals, religion and politics (to which we may add science and material progress) were matters of no interest to him. He was to all intents a humanist, as the word was understood in the 15th century. But he was a humorist as well, and this combination, joined to his singularly kindly and genial nature, saved him from some dangers and depravations as well as some absurdities to which the humanist temper is exposed. As time goes on it may be predicted that, though Gautier map not be widely read, yet his writings will never cease to be full of indescribable charm and of very definite instruction to men of letters. Besides those of his works which have been already cited, we may notice *Une Larme du diable* (1839), a charming mixture of humour and tenderness; *Les Grotesques* (1844), a volume of early criticisms on some oddities of 17th century literature; *Caprices et zigzags* (1845), miscellanies dealing in part with English life; *Voyage en Espagne* (1845), *Constaiztinople* (1854), *Voyage en Russie* (1866), brilliant volumes of travel; *Ménagerie intime* (1869) and *Tableaux de siège* (1872), his two latest works, which display his incomparable style in its quietest but not least happy form.

There is no complete edition of Gautier's works, and the vicomte Spoelberch de Lovenjoul's *Histoire des œuvres de Théophile Gautier* (1887) shows how formidable such an undertaking would be. But since his death numerous further collections of articles have been made: *Fusains et eaux-fortes* and *Tableaux à la plume* (1880); *L'Orient* (2 vols., 1881); *Les Vacances du lundi* (new ed., 1888); *La Nature chez elle* (new ed., 1891). In 1879 his son-in-law, E. Bergerat, who had married his younger daughter Estelle (the elder, Mme. Judith Gautier—herself a writer of distinction—was at one time Mme. Catulle Mendès), issued a biography, *Théophile Gautier,* which has been often reprinted. With it should be compared Maxime du Camp's volume in the *Grands Écrivains français* (1890) and the numerous reierences in the *Journal des Goncourt.* Critical eulogies, from Sainte-Beuve (repeatedly in the *Causeries)* and Baudelaire (two articles in *L'Art romantique*) downwards, are numerous. The chief of the decriers is Émile Faguet in his *Etudes littéraires sur le XIXe siècle.* In 1902 and 1903 there appeared two respectable academic *éloges* by H. Menal and H. Potez. (G. SA.)

GAUTIER D'ARRAS, French *trouvère,* flourished in the second half of the 12th century. Nothing is knoi-sn of his biography except what may be gleaned from his works. He dedicated his romance of *Éracle* to Theobald V, count of Blois (d. 1191); among his other patrons were Marie, countess of Champagne, daughter of Louis VII and Eleanor of Guienne and Baldwin IV, count of Hainaut. *Éracle,* the hero of which becomes emperor of Constantinople as Heraclius, is purely a *roman d'aventures* and enjoyed great popularity. His second romance, *Ille et Galeron,* dedicated to Beatrix, the second wife of Frederick Barbarossa, treats of a similar situation to that outlined in the lay of *Eliduc* by Marie de France.

See the *Oeuvres de Gautier d'Arras,* ed. *E.* Löseth (1890); *Hist. litt. de la France,* vol. xxii (1852); A. Dinaux, *Les Trouvères* (1833–43).

GAUZE, a light, transparent fabric, originally of silk, and now sometimes made of linen or cotton, woven in an open manner with very fine yarn. It is said to have been originally made at Gaza in Palestine, whence the name. Some of the gauzes from eastern Asia were brocaded with flowers of gold or silver. In the weaving of gauze the warp threads, in addition to being crossed as in plain weaving, are twisted in pairs from left to right and from right to left alternately, after each shot of weft, thereby keeping the weft threads at equal distances apart, and retaining them in their parallel position. The textures are woven either plain, striped or figured; and the material receives many designations, according to its appearance and the purposes to which it is devoted. A thin cotton fabric, woven in the same way, is known as leno, to distinguish it from muslin made by plain weaving. Silk gauze was a prominent and extensive industry in the west of Scotland during the second half of the 18th century, but on the introduction of cotton-weaving it greatly declined. In addition to its use for dress purposes, silk gauze is much employed for bolting or sifting flour and other finely ground substances. The term gauze is applied generally to transparent fabrics of whatever fibre made, and to the fine-woven wire-cloth used in safety-lamps, sieves, window-blinds. etc.

GAVARNI, PAUL (1804–1866), pseudonym of GUILLAUME-SULPICE CHEVALIER, French lithographer and painter, was born on Jan. 13, 1804, in Paris. In early childhood he showed gifts for drawing and at the age of ten was working in the studio of the architect Dutillard and was later employed by a maker of precision instruments. All his life he regretted he could not devote his entire time to his principal interests : drawing, mathematics, literature and the stage. His first lithograph was published in 1824 and attracted the attention of E. Blaisot, who gave him employment. From 1824 to 1828 he traveled in the Pyrenees and at that time he adopted the name Gavarni. Upon his return he worked for the fashion journal La Mode, made many contacts in the world of society and art and became the friend of Balzac, M. J. Sue and the duchesse d'Abrantès. About 1831 he began publishing his scenes of everyday contemporary life, and praise from writers such as Balzac gained him popularity in England as well as France In 1833 he began publication of the Journal des gens du monde which failed after 18 numbers and was responsible for Gavarni's imprisonment for debt in 1835 for almost a year. He maintained his cheerful outlook, however, and from 1839 to 1846 he issued his famous series "Les Lorettes," "Les Débardeurs" and "Les Fourberies de Femmes." After the death of his mother and his marriage, about 1845. his style changed. deepening in seriousness and observation. Gavarni then turned his mirror to the grotesque sides of family life and of humanity. While showing the same power of irony as his former works, enhanced by a deeper insight into human nature, Gavarni's compositions of this time generally bear the stamp of a bitter philosophy. In 1847 he left for London, described as "the best-dressed man in France." but spent his time in England observing the life of the poor and producing some of his most compelling work. He traveled in Scotland in 1849 and did much work for English publications. After his return to Paris he devoted more time to water colour and in 1851 met the Goncourt brothers who had long been his admirers and were preparing their book for him. Again Gavarni took up lithography and brought forth another of his great series, "Thomas Vireloque." At the time of his death, on Nov. 24, 1866, he was working energetically in etching, lithography and the new and popular process, electric engraving.

Although Gavarni's work lacks the power of his great contemporary Daumier it can be appreciated for its polished wit, the finesse of his cultured observation and the all-embracing panorama he presents of the life of his time.

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GAVAZZI, ALESSANDRO (1809–1889), Italian preacher and patriot, was born at Bologna on March 21, 1809. He at first became a monk (1825), and attached himself to the Barnabites at Naples, where he afterward (1829) acted as professor of rhetoric. Driven into exile on account of his liberal views he found refuge in England, where he joined the Evangelical church, and became head and organizer of the Italian Protestants in London. Returning to Italy in 1860, he served as army chaplain with Garibaldi. In 1870 he became head of the Free Church (*Chiesa libera*) of Italy, united the scattered Congregations into the "Unione delle Chiese libere in Italia," and in 1875 founded in Rome the theological college of the Free Church, in which he himself taught dogmatics, apologetics and polemics He died in Rome on Jan. 9, 1889.

His publications include *No Union with Rome* (1871) ; *The Priest in Absolution* (1877) ; *My Recollections of the Last Four Popes*, etc, in answer to Cardinal Wiseman (1858); *Orations* (1851).

GAVELKIND, a peculiar system of tenure associated chiefly with the county of Kent, but found also in other parts of England. In Kent all land was presumed to be holden by this tenure until the contrary was proved, but some lands have been disgaveled by particular statutes. It is more correctly described as "socage tenure. subject to the custom of gavelkind." The chief peculiarities of the custom were: (1) A tenant could alienate his lands by feoffment at 15 years of age. (2) There was no escheat on attainder for felony. (3) Generally the tenant could dispose of his lands by will. (4) In intestacy the estate descended to the sons (or, in the case of deceased sons, their representatives) in equal shares: "Every son is as great a gentleman as the eldest son is." Though females claiming in their own right were postponed to males, yet by representation they inherited together with them. (5) A wife was dowable of one-half instead of one-third of the land. (6) A widower might be tenant by courtesy of one-half without having had any issue, but only so long as he remained unmarried. Gavelkind was, previous to the Conquest, the general custom of the realm, but was then superseded by the feudal law of primogeniture. It mas abolished by the Law of Property act, 1922, and the Administration of Estates act, 1925.

Irish gavelkind was a species of tribal succession, by which the land, instead of being divided at the death of the holder among his sons, was thrown again into the common stock, and redivided among the surviving members of the sept.

GAVESTON, PIERS (d. 1312), earl of Cornwall, favourite of the English king Edward II, was the son of a Gascon knight and was brought up at the court of Edward I as companion to his son. Early in 1307 he was banished by the king; but he returned after the death of Edward I a few months later, and at once became the chief adviser of Edward II. Made earl of Cornwall, he received lands and money, and married Edward's niece, Margaret de Clare (d. 1342). He was regent during the king's short absence in France in 1308, and was conspicuous at Edward's coronation. These proceedings and Gaveston's own arrogance aroused the anger and jealousy of the barons. They demanded his banishment; and the king, forced to assent, sent him to Ireland as lieutenant, where he remained about a year.

Returning to England in July 1309, Gaveston showed himself more insolent than ever. In 1311 the king was forced to agree to the election of the "ordainers," and the ordinances they drew up provided inter alia for the perpetual banishment of Gaveston, who retired to Flanders, but returned secretly to England at the end of 1311. Soon he was publicly restored by Edward, and the barons had taken up arms. Deserted by the king he surrendered to Aymer de Valence, earl of Pembroke (d. 1324), at Scarborough in May 1312, and was taken to Deddington in Oxfordshire, where he was kidnapped by Guy de Beauchamp, earl of Warwick (d. 1315). He was beheaded on Blacklow hill near Warwick on June 19, 1312. Gaveston, whose body was buried in 1315 at King's Langley, Hertfordshire, left an only daughter.

GAVIAL (from the native name gharial), a long-snouted fish-eating crocodilian inhabiting northern India. The snout is extremely slender and elongate, with numerous equal-sized teeth. Various crocodiles have relatively slender snouts, and the Malayan false gavial (Tomistoma), a close relative of the true crocodiles, approaches the gavial in this respect. See CROCODILIAN.

(K. P. S.)

GAVIIDAE: see LOON.

GAVOTTE, properly the dance of the Gavots or natives of Gap, a district in the upper Alps, in the old province of Dauphiné. It is a dance of a brisk and lively character, somewhat resembling the minuet, but quicker and less stately (see DANCE) ; hence also the use of this name for a form of musical composition.

GAWABRA: see ARABS.

GAWAIN, son of King Loth of Orkney, and nephew to Arthur on his mother's side, the most famous hero of Arthurian romance. The first mention of his name is in a passage of William of Malmesbury, recording the discovery of his tomb in the province of Ros in Wales. He is there described as *Walwen qui* fuit *haud* degener *Arturis* ex *sorore nepos*. Here he is said to have reigned over Galloway; and there is certainly some connection, the character of which is now not easy to determine, between the two. In the later *Historia* of Geoffrey of Monmouth, and its French translation by Wace, Gawain plays an important and "pseudo-historic" rôle. On the receipt by Arthur of the insulting message of the Roman emperor, demanding tribute, it is he who is despatched as ambassador to the enemy's camp, where his arrogant and insulting behaviour brings about the outbreak of hostilities. On receipt of the tidings of Mordred's treachery, Gawain accompanies Arthur to England, and is slain in the battle which ensues on their landing. Wace, however, evidently knew more of Gawain than he has included in his translation, for he speaks of him as

> Li quens Walwains
> Qui tant fu preudom de ses mains (11. 9057–58);

and later on says

> Prous fu et de mult grant mesure,
> D'orgoil et de forfait n'ot qure
> Plus vaut faire qu'il ne dist
> Et plus doner qu'il ne pramist (10. 106–109).

The English Arthurian poems regard him as the type and model of chivalrous courtesy, "the fine father of nurture," and as Prof. Maynadier has well remarked, "previous to the appearance of Malory's compilation it was Gawain rather than Arthur who was the typical English hero." It is thus rather surprising to find that in the earliest preserved mss, of Arthurian romance, *i.e.,* in the poems of Chrétien de Troyes, Gawain, though generally placed first in the list of knights, is by no means the hero *par excellence.* The latter part of the *Perceval* is indeed devoted to the recital of his adventures at the *Chastel Merveilleus,* but of none of Chrétien's poems is he the protagonist. The anonymous author of the *Chevalier à l'épée* indeed makes this apparent neglect of Gawain a ground of reproach against Chrétien. At the same time the majority of the short episodic poems connected with the cycle have Gawain for their hero. In the earlier form of the prose romances, *e.g.,* in the *Merlin* proper, Gawain is a dominant personality, his feats rivalling in importance those ascribed to Arthur, but in the later forms such as the *Merlin* continuations, the *Tristan,* and the final *Lancelot* compilation, his character and position have undergone a complete change, he is represented as cruel, cowardly and treacherous, and of indifferent moral character. Most unfortunately our English version of the romances, Malory's *Morte d'Arthur,* being derived from these later forms (though his treatment of Gawain is by no means uniformly consistent), this unfavourable aspect is that under which the hero has become known to the modern reader. Tennyson, who only knew the Arthurian story through the medium of Malory, has, by exaggeration, largely contributed to this misunderstanding. Morris, in *The Defence of Guinevere,* speaks of "gloomy Gawain"; perhaps the most absurdly misleading epithet which could possibly have been applied to the "gay, gratious, and gude" knight of early English tradition.

The truth appears to be that Gawain, the Celtic and mythic origin of whose character was frankly admitted by the late M. Gaston Paris, belongs to the very earliest stage of Arthurian tradition, long antedating the crystallization of such tradition into literary form. He was certainly known in Italy at a very early date; Prof. Rajna has found the names of Arthur and Gawain in charters of the early 12th century, the bearers of those names being then grown to manhood; and Gawain is figured in the architrave of the north doorway of Modena cathedral, a 12th-century building. Recent discoveries have made it practically certain that there existed, prior to the extant romances, a collection of short episodic poems, devoted to the glorification of Arthur's famous nephew and his immediate kin (his brother Gaheris, or Gareth, and his son Guinglain), the authorship of which was attributed to a Welshman, Bleheris; fragments of this collection have been preserved to us alike in the first continuation of Chrétien de Troyes *Percevpl,* due to Wauchier de Denain, and in our vernacular *Gawain* poems. Among these "Bleheris" poems was one dealing with Gawain's adventures at the Grail castle, where the Grail is represented as non-Christian, and presents fe'atures strongly reminiscent of the ancient Nature mysteries. There is good ground for believing that as Grail quester and winner, Gawain preceded alike Perceval and Galahad, and that the solution of the mysterious Grail problem is to be sought rather in the tales connected with the older hero than in those devoted to the glorification of the younger knights. The explanation of the very perplexing changes which the character of Gawain has undergone appears to lie in a misunderstanding of the original sources of that character. Whether or not Gawain was a sun-hero, and he certainly possessed some of the features—we are constantly told how his strength waxed with the waxing of the sun till noontide, and then gradually decreased; he owned a steed known by a definite name le Gringalet; and a light-giving sword, Excalibur (which, as a rule, is represented as belonging to Gawain, not to Arthur)—all traits of a sun-hero—he certainly has much in common with the primitive Irish hero Cuchullin. The famous head-cutting challenge, so admirably told in *Syr Gawayne and the Grene Knighte,* was originally connected with the Irish champion. Nor was the lady of Gawain's love a mortal maiden, but the queen of the other-world. In Irish tradition the other-world is often represented as an island, inhabited by women only; and it is this "Isle of Maidens" that Gawain visits in *Diu Crone;* returning therefrom dowered with the gift of eternal youth. The Chastel Merveilleus adventure, related at length by Chrétien and Wolfram, is undoubtedly such an "other-world" story. It seems probable that it was this connection which won for Gawain the title of the "Maidens' Knight," a title for which no satisfactory explanation is ever given. When the source of the name was forgotten its meaning was not unnaturally misinterpreted, and gained for Gawain the reputation of a facile morality, which was exaggerated by the pious compilers of the later Grail romances into persistent and aggravated wrong-doing; at the same time it is to be noted that Gawain is never, like Tristan and Lancelot, the hero of an illicit connection maintained under circumstances of falsehood and treachery. Gawain, however, belonged to the pre-Christian stage of Grail tradition, and it is not surprising that writers bent on spiritual edification found him somewhat of a stumbling-block. Chaucer, when he spoke of Gawain coming "again out of faerie," spoke better than he knew; the home of that very gallant and courteous knight is indeed Fairy-land, and the true Gawain-tradition is informed with fairy glamour and grace.

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(J. L. W.)

GAWAMA'A: *see* ARABS.

GAWLER, a town of Gawler county, South Australia, on the Para river, 2 j mi. by rail N.E. of Adelaide. It is one of the most thriving places in the colony, being the centre of a large wheat-growing district; it has also engineering works, foundries, flour-mills, breweries and sawmills. Some gold, silver, copper and lead are found in the neighbouring hills. Pop. (1954) 5,117.

GAY, JOHN (1685–1732), English poet and dramatist, author of *The Beggar's Opera,* was born on June 30, 1685, at Barnstaple, Devonshire, and educated at the local grammar school. He was apprenticed to a silk mercer in London, but was released early from his indentures and, after a further short period in Devonshire, returned to London where he lived most of his life. Among his early literary friends were Aaron Hill and Eustace Budgell, whom he helped in the production of *The British Apollo,* a question-and-answer journal of the day. His journalistic interests are clearly seen in a pamphlet, *The Present State of Wit* (1711), a survey of contemporary periodical publications.

From 1712 to 1714 he was steward in the household of the duchess of Monmouth, which gave him leisure and security to write. He had produced a burlesque of the Miltonic style, *Wine,* in 1708 and in 1713 his first important poem, *Rural Sports,* appeared. This is a descriptive and didactic work in two short books dealing with hunting and fishing, but containing also descriptions of the country-side and meditations on the Horatian theme of retirement. Here

Gay strikes at once his characteristic note of delicately absurd artificiality. In discussing bait, for example, he tells the reader:

> Those baits will best reward the fisher's pains.
> Whose polish'd tails a shining yellow stains
> Cleanse them from filth, to give a tempting gloss,
> Cherish the sully'd reptile race with moss. . .

He is, of course, aware of the comic disproportion between his language and the subject. But the contrast, while it produces the effect of a *reductio ad absurdum,* does so in a good-humoured way and in a tone of underlying sympathy. This note of sympathetic comedy is the staple one in Gay's poetry. It is strongly marked in his finest poem. *Trivia: or, the Art of Walking the Streets of London* (1; 16), a work modeled on Virgil's *Georgics* and fully alive today for the detailed observation of urban life which it displays. and for its assured technical dexterity. Something of its flavour can be gained from this couplet, describing a sophisticated lady crossing the street:

> Her shoe disdains the street; the lazy fair
> With narrow step affects a limping air.

The force of character observation in "disdains." and the way in which the rhythm of the second line echoes the angular movements of the lady. indicate the precision of Gay's craftsmanship. The effect is not to "startle with a fine excess," but to make the reader apprehend one facet of experience more clearly. It is this effect which Gay is constantly achieving. The full significance of a couplet often depends upon a literary parallel and references back to the *Georgics* are common. Virgil, for example, says that the influence of spring is felt throughout the whole of creation, a thought which Dryden renders by the lines:

> From hence proceeds the birds' harmonious voice;
> From hence the cows exult, and frisking lambs rejoice.

Gay varies the lines in *Trivia:*

> The seasons operate on ev'ry breast;
> 'Tis hence that fawns are brisk, and ladies drest,

and the effect is complex, at once satirical. sympathetic and. by its correlation of the animal and human kingdoms, philosophical. It is in this sort of delicate probing of the surface of apparently mundane social life that Gay excels.

Apart from *Trivia* and *Rural Sports,* Gay's most important works are *The Shepherd's Week* (1714), a series of mock classical pastorals, his two series of *Fables* (1727 and 1738) and *The Beggar's Opera* (1728). The *Fables* went through about 350 editions and until the 20th century were the best known of his poems. They are brief octosyllabic illustrations of moral themes, often satirical in tone and frequently directed at the court and courtiers.

Gay's most famous work. *Tlze Beggar's Opera,* was produced on Jan. 29, 1728. at Rich's theatre in Lincoln's Inn fields, where it was said to make "Gay rich, and Rich gay." Its basic idea was to mirror the moral degradation of society by means of a story about thieves and highwaymen, and more particularly to caricature Robert Walpole and his administration. It also makes fun of the prevailing fashion for Italian opera. The play is kept alive, however, not so much by the pungency of its satire as by the effective situations of the plot. and above all by the "singability" of the songs. It ran for 62 nights (not all consecutive) and temporarily drove Italian opera from the stage. Gay wrote a sequel, *Polly,* which is set in the West Indies and in which poetic justice is more clearly seen to be done than in *The Beggar's Opera,* but its production was forbidden by the lord chamberlain. no doubt through the influence of Walpole. The suppression proved an excellent advertisement. Gay's cause found support among his friends and indeed among all who were antagonistic to the government When it was decided to print the play, subscriptions were canvassed even in the court itself. John Arbuthnot describes the extent of the interest in a letter to Swift (March 19. 1729): "The inoffensive John Gay is noa become one of the obstructions to the peace of Europe. the terror of the Ministers, the chief author of . . . all the seditious pamphlets which have been published against the government . . . If he should travel about the country. he would have hecatombs of roasted oxen sacrificed to him." As a result of this uncharacteristic notoriety Gay made well over £1.000 from subscriptions and *Polly* sold nidely. The play was not produced until 1777 when it had a moderate success. Gay's less famous plays include *The What d'ye Call It* (1715), *Three Hours After Marriage* (1717) and *Achilles,* posthumously produced in 1733.

The adjective most often applied to Gay by his friends is "honest," and they agree that this was accompanied by a certain naïveté in the face of practical problems. He lost almost all his money on South Sea stock and suffered disappointments of official patronage. Nonetheless when he died, Dec. 4, 1732, in London, he was worth £6,000, a modest but not negligible fortune. He had been helped by various patrons, including the third earl of Burlington and the third earl of Queensberry; the duchess of Queensberry mourned his death deeply. He was buried in Westminster abbey, next to Chaucer. His monument is by John Rysbrack, his epitaph by Alexander Pope.

Gay's reputation remained high throughout the 18th century; during the 19th he was remembered chiefly as the author of the *Fables* but, following Nigel Playfair's enormously successful revival of *The Beggar's Opera* in 1920, Gay's general reputation gradually rose again and he became valued as a poet of a varied and considerable achievement.

BIBLIOGRAPHY.—The *Poetical Works,* including plays, were edited by G. C. Faber (1926). *See* also W. H. Irving, *John Gay, Favourite of the Wits* (1940); J. R. Sutherland, in *Pope and His Contemporaries* (1949). (JN. C.)

GAY, WALTER (1856–1937), **U.S.** artist who painted scenes of French interiors and French peasant life, was born at Hingham, Mass.. on Jan. 22, 1856. Most of his career was spent in Europe. In 1876 he became a pupil of Léon Bonnat in Paris. He received an honourable mention in the salon of 1885; a gold medal in 1888, similar awards at Vienna (1894), Antwerp (1895), Berlin (1896) and Munich (1897). He became an officer of the Legion of Honour and a member of the Society of Secession, Munich. His works are in the Luxembourg, the Tate gallery and the Boston and Metropolitan museums of art. He died July 14. 1937, in Paris.

GAYA, a city and district in the Patna revenue division of Bihar state. India, about 57 mi. S. of Patna city, with a station on the Grand Chord line of the Eastern railway. With a population in 1961 of 13'0.884 it is. next to Patna, the most populous city in the state. Gaya is a celebrated place of Hindu pilgrimage; it is a sacred duty for Hindus to make offerings there for the salvation of their parents and ancestors, and about 300.000 pilgrims come annually. There are 45 sacred places between (and including) Pretsil hill on the north and Bodh (Buddh) Gaya on the south, a distance of 1j mi., but most are in Gaya itself. The principal shrine is the Vishnupad temple built by the Mahratta princess, Ahalya Bai, in 1787. Others are the rocky temple-crowned hills of Ramsila (372 ft.) and Brahmajuni (450 ft.). The last, which overlooks the civil station, has been identified with the Gayasirsa hill on which Buddha preached. Gaya college is a constituent of Bihar university.

GAYA DISTRICT, with an area of 4,766 sq.mi. and a population (1961) of 3,647,268, consists of a wide plain, with wooded hills along the southern boundary, from which the country falls with a gentle slope toward the north. The hills in the south, which contain scenes of the most picturesque beauty, rise to a height of 2,202 ft. at Durvasarhi and to 1,832 ft. in the Mahabar hills. A long range extends from near Bodh Gaya northeastward, and elsewhere in the open plain, rocky hills occur, either detached or in groups, such as Maher, 1,620 ft.; Kauwadol and the Barabar hills. The northern part of the district is highly cultivated; the portions to the east and west are less fertile. In the south the country is thinly peopled; in the jungles covering the hills and the country below them: tigers, leopards. bear and deer are found. The principal rivers are the Sone (Son). which marks the boundary between Gaya and Shahabad districts, the Punpun and the Phalgu, formed by the junction of two large hill streams! the Nilajan and Mohana. The last three rivers are subject to heavy floods. Agriculture depends largely on irrigation, which is mainly effected by an indigenous system of channels leading from the rivers and storage reservoirs made by building embankments across the line of drainage. The northwest of the district is irrigated by part of the Sone canal system. Mica mines are worked in the southeast of the district, which contains part of the Bihar mica belt, one of the largest sources of the world's supply. Other industries are the production of shellac, which centres on Imamganj, the weaving of carpets and blankets, notably at Obra. and the manufacture of brass utensils and of black stoneware. chiefly ornaments sold to pilgrims at Gaya. The district is traversed by the Grand Chord line of the Eastern railway. the South Bihar railway running into the Monghyr district. and a branch to Patna. Gaya district is rich in ancient sites and has many archaeological remains associated with the early history of Buddhism. Bodh Gaya (6 mi. S. of Gaya), famous for the Bo-tree, is one of the holiest sites of Buddhism. A mound on the Sobhnath hill has been identified with the burial place of Kasyapa, the greatest of Buddha's disciples; the remains of a monastery are in a valley (Hasra Kol) near by. where fine sculptured figures have been found. In the Barabar hills there are rock-cut caves or rooms. in some of which the rock has been wrought to an extraordinary polish. An inscription of Asoka in one group shows they were dedicated to the use of ascetics called Ajivikas. The other group was hewn out of the rock for the use of the same sect by his grandson, Dasaratha; they are called the Nagarjuni caves, after a Buddhist teacher of that name who is believed to have lived in them in the 2nd century A.D.

GAYAL, a domesticated ox allied to the gaur (*q.v.*) but distinguished by the more conical and straighter horns, and the straight line between them. Gayal are kept by the natives of the hill districts of Assam, Tenasserim and Upper Burma.

GAY-LUSSAC, JOSEPH LOUIS (1778-ISSO), French chemist and physicist. pioneered in the study of the gaseous state. He was born at St. Léonard, in the *département* of Haute-Vienne, on Dec. 6, 1778. His father. Antoine Gay, added Lussac to the name to avoid confusion with others named Gay. (Lussac is an estate near St. Lemand.) He entered the École Polytechnique at the end of 1797; two years later he was transferred to the École des Ponts et Chaussées, and at the same time he assisted Claude L. Berthollet (*q.v.*) in his researches. In 1802 he was appointed demonstrator to Antoine F. Fourcroy at the École Polytechnique. He succeeded Fourcroy as professor of chemistry on Jan. 1, 1810. From 1808 to 1832 he was professor of physics at the Sorbonne, a post which he resigned for the chair of chemistry at the Jardin des Plantes. In 1806 he was made an academician. In 1831 he was elected to represent Haute-Vienne in the chamber of deputies, and in 1839 he entered the chamber of peers. He died in Paris on May 9, 1850. He lies buried in Père Lachaise cemetery.

Gay-Lussac's earlier researches were mostly physical in character and referred mainly to the properties of gases. vapour tensions, hygrometry, capillarity, etc. His first memoir, published in 1802, dealt with the expansion of gases. In 1803 the French academy, desirous of securing some observations on the force of terrestrial magnetism at great elevations above the earth, obtained the use of a balloon, and entrusted the task to him and Jean B. Biot. In their first ascent from the garden of the Conservatoire des Arts on Aug. 24. 1804 an altitude of 13,120 ft. was attained; Gay-Lussac made a second ascent by himself on Sept. 16, when the balloon rose 23,012 ft. above sea level. At'this height. he made observations not only on magnetism, but also on the temperature and humidity of the air, and collected several samples of air at different heights. The magnetic observations led him to the conclusion that the magnetic effect at all attainable elevations above the earth's surface remains constant; and on analyzing the samples of air he could find no difference of composition at different heights. This work places him among the founders of meteorology. In the same year, in conjunction with Alexander von Humboldt, he read a paper on eudiometric analysis (*Ann. de Chim.*, 1805); it contained the germ of his most important generalization, the law of combination of gases by volumes, which was. however. not enunciated in its general form until after his return from a journey through Switzerland. Italy and Germany.

In 1809 his important memoir on gaseous combination was published. In it he pointed out that when gases combine they do so in the simplest proportions by volume, and that the volume of any gaseous product formed bears a simple ratio to that of the constituents (*see* CHEMISTRY: *The Development of the Theory of Molecular Structure*). This is Gay-Lussac's law. He was one of the discoverers of the fact that all gases have approximately the same coefficient of expansion (Charles's law).

About this time Gay-Lussac's work became more purely chemical. In 1808. he succeeded. with the collaboration of Louis J. Thénard, in preparing potassium by the action of red-hot iron on fused potash. The properties of the element were studied and in 1809 he used it for the isolation of boron from boric acid. Gay-Lussac carried out some work on chlorine (1809) and iodine (1814) which brought him into direct rivalry with Humphry Davy (*q.v.*). He considered "oxymuriatic acid" (chlorine) to be a compound. whereas Davy saw no reason to suppose that it contained oxygen and regarded it as an element, a view which Gay-Lussac was reluctantly compelled to accept.

In 1810 Gay-Lussac published a paper which contains some classic experiments on fermentation, a subject to which he returned in a second paper published in 1815. At the same time he was working with Thénard at the improvement of the methods of organic analysis. and by combustion with oxidizing agents, first potassium chlorate and subsequently copper oxide, he determined the composition of a number of organic substances. His last great piece of pure research was on prussic acid. In a note published in 1811 he described the physical properties of this acid, but he said nothing about its chemical composition until 1815, when he described cyanogen as a compound radicle. prussic acid as a compound of that radicle with hydrogen alone. and the prussiates (cyanides) as compounds of the radicle with metals. The proof that prussic acid contains hydrogen but no oxygen was a most important support to the hydrogen-acid theory, and completed the downfall of Lavoisier's oxygen theory. Gay-Lussac proposed the prefix "hydro" for these oxygen-free acids. He discovered ethyl iodide and chlorcyanogen: The isolation of cyanogen was of importance for the subsequent era of compound radicles in organic chemistry.

As a result of his success as an investigator Gay-Lussac's services as a technical adviser became in great demand. He had been a member of the consultative committee on arts and manufactures after 1805. He was attached to the "administration des poudres et salpêtres" in 1818, and in 1829 he received the lucrative post of assayer to the mint. His services to industry included his improvements in the processes for the manufacture of sulfuric acid (1818) and oxalic acid (1829); methods of estimating the amount of real alkali in potash and soda and for estimating the available chlorine in bleaching powder by a solution of arsenious acid; directions for the use of the centesimal alcoholometer published in 1830 and specially commended by the institute; and the elaboration of a method of assaying silver by a standard solution of common salt. Among his research work of this period may be mentioned the improvements in organic analysis and the investigation of fulminic acid made with the help of Liebig, who gained the privilege of admission to his private laboratory in 1823–24.

The most complete list of Gay-Lussac's papers is contained in the Royal society's *Catalogue of Scientific Papers,* which enumerates 148. exclusive of others written jointly with Humboldt, Thénard, Welter and Liebig. Many were published in the *Annales de chimie,* which. after it changed its title to *Annales de chimie et physique* he edited, with Arago, up to nearly the end of his life; but some are to be found in the *Mémoires d'Arcueil* and the *Comptes rendus,* and in the *Rechevches physiques et chimiques,* two volumes. published with Thénard in 1811.

For biographical details *see* W. Tilden, *Famous Chemists* (1921); F. Arago, *Eloge de Gay-Lussac* (1854); Riot et Gardem le Brun, *Notice biographique de Gay Lussac* (1850); E Blanc and L. Delhoume, *La vie émouvante et noble de Gay-Lussac* (1950). (H. S. V. K.)

GAZA, the most southerly city of the Philistine Pentapolis. separated from the sea by 3 mi. of sand dunes. It was a centre where ancient trade routes met, and through it passed the frankincense from Arabia on its way to the Mediterranean world. It is on the railway from Egypt to Palestine and was capital of the southern province of Palestine. The town is well supplied with water. Before World War I it was a prosperous town with good bazaars, a considerable manufacture of black pottery, and a growing export trade in barley. It was more than half destroyed by the war, and the population, although somewhat replenished immediately after the war, dwindled away northward in search of sustenance. The small harbour of Gaza (El-Mineh) is used mainly for the export of grain.

History. — The Egyptian monarch, Thutmose III (c. 1500 B.C.) found in Gaza a convenient base for operations against Syria. Gaza's king was a vassal of the Pharaohs in the Tell Amarna period about a century later. Joshua's victories brought him to its neighbourhood but not within its walls. It was one of the strongholds from which the Philistines harassed Israel; and Gaza, famous for the worship of Dagon and Derketo, was the scene of Samson's glorious death. Solomon and Hezekiah gained a footing there without being able to retain it. Traffic in slaves evoked the curse of Amos. In 735 B.C. Tiglath-Pileser made it tributary to Assyria. Gaza coquetted with Egypt and received condign punishment from Sargon. In the three centuries following it was bandied between Babylon and Egypt. Gaza resisted Alexander the Great only to be broken and made a "desert." From the third to the first centuries B.C. Egyptian, Syrian and Jewish armies fought for its possession. The Romans made Gaza into an important place (named Minoa) and Augustus presented it to Herod. New Gaza was built on another site in the first century A.D.

Although it showed itself ill-disposed to accept Christianity, a Christian community settled there early, and the Philemon, to whom St. Paul addressed a letter, was said to have been its first head.

In A.D. 634 it surrendered to Omar's troops, and since Hashim the great-grandfather of the Prophet was buried there it became a sacred Moslem city. In the 12th century the crusaders found it almost desolate. Baldwin III erected a fortress (1149) but after Hattin Gaza surrendered. The Khwarismians inflicted a painful defeat there on the Christian and Saracen armies whom dire necessity drove into a strange and fleeting alliance. In the 16th century the Turks crushed the Mamelukes and Egypt lay open to Salim I. Gaza fell to Bonaparte (1799). Three battles were fought at Gaza during World War I (see PALESTINE, OPERATIONS IN). In 1948 Gaza came under Egyptian control. Israeli troops captured Gaza in the Sinai campaign of 19j6, but withdrew in March 1957. A special UN emergency force then moved in to police the Egypt-Israel border area near Gaza. For the Sinai campaign and its aftermath, see EGYPT; ISRAEL; SUEZ CANAL; UNITED NATIONS.

(E. Ro.; X.)

GAZELLE, the name given to a group of antelopes forming the genus *Gazella* (see ANTELOPE).

GAZETTE, a name given to newssheets or newspapers having an abstract of current events which were forerunners of modern newspapers (*q.v.*). The word came into English from the French, having been adapted from the Italian gazzetta, a name given to informal news or gossip sheets first published in Venice in the mid-16th century. Similar sheets soon made their appearance in France and in England. The type of gazette originating from the private newsletter existed in England before the middle of the 16th century, but was confined mainly to detailed accounts of diplomatic maneuvers or to the circulation of courtly verse among a restricted group of readers. Upon the accession of Queen Elizabeth I, however, a far greater variety of such sheets began to appear. Aimed at a wide popular audience, they disseminated gossip, trivia, unofficial news accounts from nongovernment sources, news of recent explorations, commercial advertisements and the more sensational news items of the day — reports of lurid crimes, supposed miracles, witchcraft and the like. The news collected in these sheets was contributed by volunteers, frequently based on the accounts of anonymous witnesses, and was notorious for its inaccuracy.

In the 17th century the term was increasingly applied to official government publications, such as the Oxford, *London,* Edinburgh and Dublin Gazettes.

See Matthias A. Shraaber, *Some Forerunners of the Newspaper in England, 1476–1622* (1929).

GAZIANTEP (AINTAB or AYINTAP), a city of Gaziantep, Turk. Pop. (1960) 125.498, all of which are Moslem Turks of Turkoman origin. During the second millennium B.C. Gaziantep was in the Hittite area and is probably of Hittite origin. The modern city stands high in the green valley of the Sajur, a tributary of the Euphrates, some 65 mi. N.E. of Aleppo. The city is connected to a main railway system. Dülük, the site of Doliche, famous for the worship of Zeus Dolichenus (Baal), is marked by a mound two hours distant to the northwest. In crusading times its strong castle (*Hamtap*) was a strategic point of importance and was captured by Saladin in 1183. Subsequently the city came under the rule, in turn, of Mamelukes and Seljuk Turks and in 1516 mas made a part of the Ottoman Turkish empire. Gaziantep served as the last base of Ibrahim Pasha before his victory over the Turks at Nezib (25 mi. E.) in 1839. In the winter of 1920–21 the armed opposition of the Turkish nationalists to the French occupation of north Syria centred in Gaziantep, which became the "Verdun of Anatolia," whence the prefix Gazi ("hero") is added to its name. After a siege lasting six months, despite determined Turkish efforts to relieve it, the city surrendered to the French troops. France returned it to Turkey under the Ankara treaty of Oct. 20, 1921.

The main industries of Gaziantep are the dyeing of yarn and the manufacture of striped dress materials (chiefly a mixture of silk and cotton), black goats' hair cloth for tents, morocco leather (*sakhtiyan*) made from goats' skins, Aleppo soap from olive oil and *pekmez,* a sweet paste made from grapes. Exports include pistachio nuts, tobacco, cotton and cereals.

GDYNIA, a Polish seaport and naval base, on the bay of Gdynia, opening out into Danzig bay, on the Baltic. It is 12 mi. N.W. of Danzig, with which it is connected by railway. The Polish government in building a railway to the port passing over territory entirely Polish, had also a scheme for a canal to the port from a convenient port on the Vistula, thus tapping the whole waterway system of Poland.

In 1924, when the port of Danzig proved insufficient for Poland's overseas trade, the Polish state decided to build another port in the bay of Gdynia, at that time a small fishing village. In ten years this port became one of the largest harbours in Europe.

The town was occupied by Germany during World War II.

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GEAR-CUTTING MACHINES: see MACHINE TOOLS.

GEARS are machine parts, operating in pairs, which transmit motion and force from one rotating shaft to another, or from a shaft to a slide (rack), by means of successively engaging projections called teeth. The smaller of a gear pair is called the pinion and the larger is the gear. When the pinion is on the driving shaft, the pair acts as a speed reducer; when the gear drives, the pair is a speed increaser. Gears are more frequently used as speed reducers than as increasers.

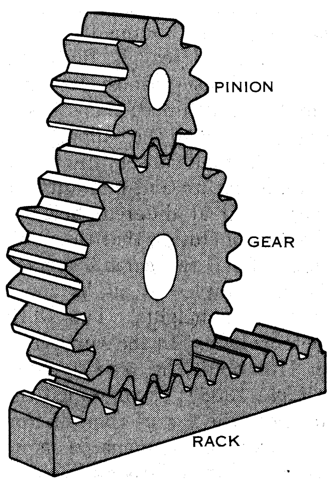

FIG. 1.—MESHING ACTION OF PINION. GEAR AND RACK

The gears in fig. 1 have teeth equally spaced on circles. If the pinion has 10 teeth and the gear 20, the pinion will rotate twice as fast as the gear. The speed ratio mill be 20/10 = 2. In general, if a pinion having T_P teeth rotates at N_P r.p.m. and a gear having T_G teeth rotates at N_G r.p.m., the speed ratio R will be

$$R = \frac{T_G}{T_P} = \frac{N_P}{N_G}$$

For gears of the type shown in fig. 1, there are physical limitations to both the minimum number of teeth on the pinion and the maximum number of teeth on the gear.

For a large speed ratio, two or more gear pairs may be required. Fig. 2 shows two pairs arranged in a compound train. If $T_A = T_C = 10$ and $T_B = T_D = 20$, the speed ratio will be

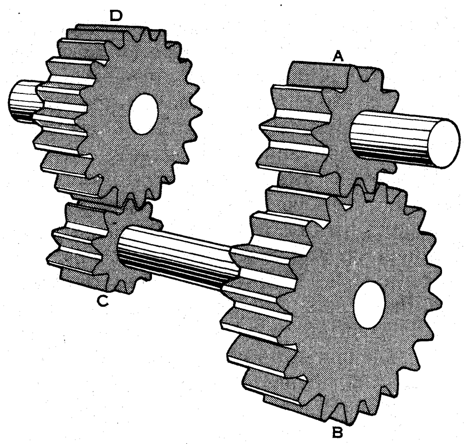

FIG. 2.—TWO GEAR PAIRS ARRANGED IN A COMPOUND TRAIN

$$R = \frac{T_B}{T_A} \times \frac{T_D}{T_C} = \frac{N_A}{N_D} = 4$$

The gears in fig. 1 rotate in opposite directions. If another gear is placed between them, the gear and pinion will rotate in the same direction. The intermediate or idler gear has no effect on the speed ratio. In many cases idler gears (one or more) are used to fill the space when the shafts are too far apart to be connected by one pair.

When the shafts are close together and must rotate in the same direction, a pinion and internal gear may be used, as shown in fig. 3. Teeth on the internal gear are cut on the inside of a cup-shaped member.

If it is required that the input and output shafts be co-axial, the arrangement shown in fig. 4 may be used; this is known as a planetary, or epicyclic, gear train. The sun gear S on the shaft B meshes with two or more planet gears P. which are carried on bearings on a carrier A attached to the shaft C. The planet gears also mesh with an internal gear I.

It can be shown that the speeds of the shafts N_B, N_C and the internal gear N_I are related in the following way:

$$N_C = \frac{N_B}{T_I/T_S + 1} + \frac{N_I(T_I/T_S)}{T_I/T_S + 1}$$

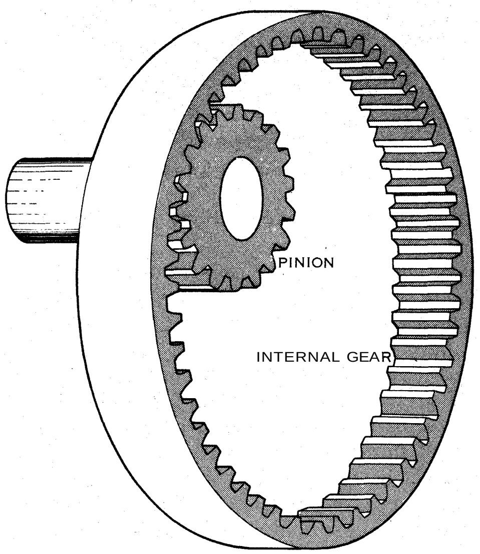

FIG. 3.—INTERNAL GEAR AND PINION

If $T_I = 60$, $T_S = 20$, and the internal gear is prevented from rotating by a brake, then $N_I = 0$ and $N_B = 4N_C$. If the sun gear rotates clockwise it will cause the planet gears to roll around on the inside of the fixed internal gear and rotate the arm and shaft C in a clockwise direction. If B is the input shaft and C the output shaft. the unit becomes a compact. symmetrical speed reducer, with a comparatively high-?ewer transmitting capacity, since the load is shared by three planet gears. For this reason planetary transmissions are used on aircraft where space is limited and weight must be kept to a minimum.

If the sun gear instead of the internal gear is fixed, $N_B = 0$ and $N_I = 4/3N_C$. If the gear I is the input, the output shaft C will rotate in the same direction at a slower speed.

If the arm is fixed, $N_C = 0$ and $N_B = -3N_I$. In this case, the term -3 indicates that shaft B rotates three times faster than gear I and in the opposite direction.

Lastly, if the sun gear and the arm are coupled together by means of a clutch so as to prevent gear tooth action and all members are allowed to rotate about the central axis, $N_I = N_C = N_B$.

Thus, with the three-element planetary system of fig. 4, the speed ratio obtained (4, 3, 4/3 or 1) depends on which element is fixed. It is this feature which makes planetary arrangements valuable in the automatic transmissions of automobiles. In these, the fixing and interconnecting of the members is accomplished automatically by brakes and clutches.

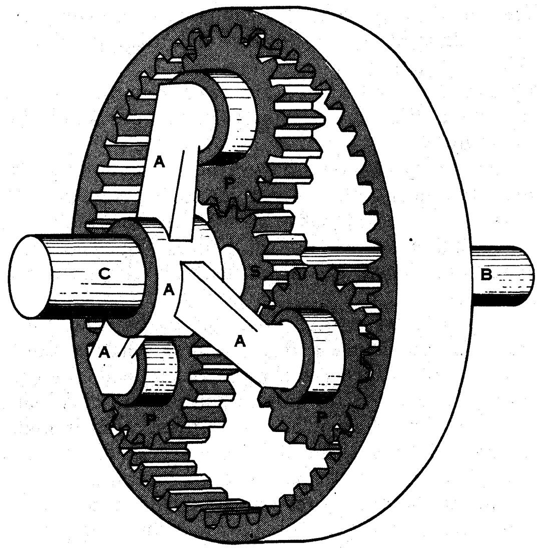

FIG. 4.—PLANETARY,OR EPICYCLIC. GEAR TRAIN

The number of ways in which the gears may be arranged in a planetary system is infinite. The planet gears may be compounded (*i.e.,* have more than one gear on the same shaft) and mesh with other sun and internal gears. None of the gears may be fixed. In this case any two (including the arm) may be attached to input shafts and the remainder to output shafts. Speed ratios of 10,000 are easily obtained in planetary transmissions.

All of the gears shown in figs. 1 to 4 are used for connecting parallel shafts. The shapes of the ends of the teeth shown in fig. 1 are involutes—the curve traced by any point on a taut string when the string is unwrapped from a cylinder (fig. 5[A]). Along their length, the teeth may be either straight and parallel to the shafts, as in fig. 5(A) or curved, as in fig. 5(B). Gears with straight teeth are called spur gears, while those with curved teeth are called helical gears. The latter may be thought of as twisted spur gears, the teeth curving around the gear like the threads on a screw.

On account of the overlapping action between the teeth, helical gears are less noisy in operation and have a higher load-carrying

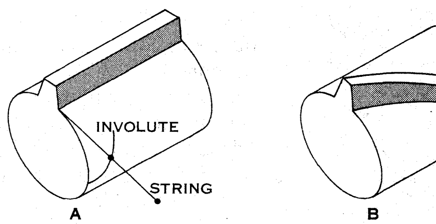

FIG. 5.—GEAR TEETH
(A) Straight or spur; (B) helical

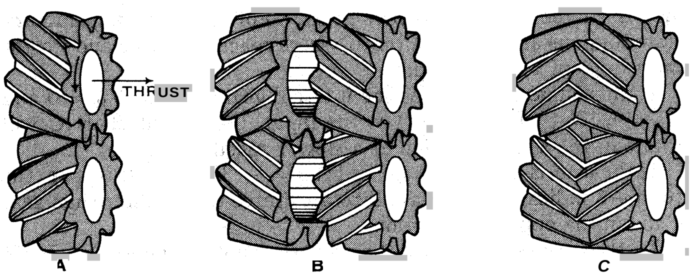

FIG. 6.— HELICAL GEARS
(A) Single helical; (B) double heiical; (C) herringbone

capacity than equivalent spur gears. If used singly, however, an axial thrust load is produced as shown in fig. 6(A). This thrust load is ineffective in turning the shaft and results in an undesirable thrust load on the shaft bearings. This may be overcome by having the teeth slope in opposite directions on the two halves of the gear, as shown in figs. 6(B) and 6(C).

On ships, for the transmission of power from high-speed turbines to low-speed propellor shafts, double helical gears are almost universally employed.

Helical gears may also be used to connect nonintersecting shafts at any angle to one another. Fig. 7 shows an arrangement for connecting shafts inclined at go°. This is the commonest angle for which such gears are used. If the helices sloped in the opposite direction to that shown, the lower shaft would rotate in the opposite direction.

When the shafts are parallel, the contact between the teeth on mating gears is "line contact" regardless of whether the teeth are straight or helical. When the shafts are inclined, the contact becomes "point contact." For this reason crossed-axis helical gears are never used when the power being transmitted is high. However, they are relatively insensitive to misalignment and are frequently employed in instruments and positioning mechanisms where friction is the only force opposing their motion.

There is another aspect in which gears connecting parallel shafts differ from those connecting nonparallel shafts. When the shafts are parallel, there is always one—and only one—pair of imaginary friction disks which would transmit the power with the same speed ratio as the gears. The diameters of these disks are called the pitch diameters of the gears. These diameters must be proportional to the numbers of teeth and fill the space bttween the shafts, and the gear teeth must be equally spaced on both gears. This spacing is known as the circular pitch and is equal to the circumference of the pitch circle divided by the number of teeth.

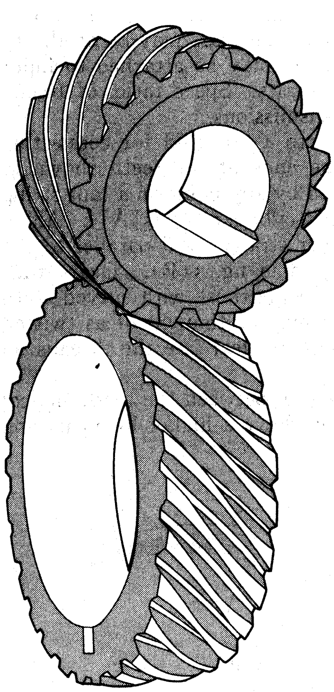

FIG. 7.— CROSSED-AXIS HELICAL GEARS

On crossed-axis helical gears the circular spacing of the teeth need not be the same on both gears of a pair. It follows that the pitch diameters need not be inversely proportional to the speeds. Consequently, if a large speed ratio is required on one pair of gears—say, 100—this large ratio is more easily obtained when the shaft axes are crossed than when they are parallel. With parallel shafts, the pinion pitch diameter would have to be 1/100 of the gear pitch diameter, which is an impractical proportion. With crossed axes, the pinion could have only one helical tooth (called a thread in this case) and be as large as necessary for adequate strength. The pinion would look like a screw, and the gear would have 100 teeth.

In order to achieve line contact and improve the load-carrying capacity of the pair, the gear could be made to partially curve around the pinion in somewhat the same way that a nut envelops a screw. The result would be a worm and gear (fig. 8). It is also possible to make worms of an "hourglass" shape, instead of cylindrical, so that they envelop the gear. This results in a further increase in load-carrying capacity.

Worm gears provide the simplest means of obtaining large ratios in a single pair. However, they are usually less efficient than parallel-shaft gears because when the shafts are parallel there is a sliding movement up and down the teeth only; on crossed-axis gears there is also a sliding movement along the teeth.

On parallel-shaft gears, the friction loss in each pair seldom exceeds 5% of the transmitted power and on helical gears it may be as low as 1%. The losses in worm gears may exceed 75% and are seldom less than 5%. They are greatly affected by the diameter of the worm and the number of threads, single thread worms of large diameter having the highest losses (*i.e.,* the loaest efficiencies). When the efficiency of a worm and gear is more than 50%, the gear can drive the worm. With multiple-thread. hardened and ground steel worms meshing with bronze worm gears, efficiencies exceeding 50% are easily obtained, thus providing compact speed

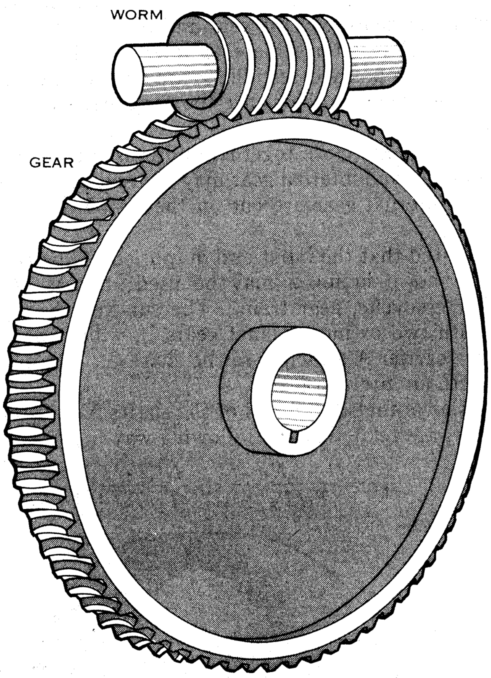

FIG. 8.— WORM AND GEAR

increasers that can be used for driving superchargers on aircraft engines.

For connecting shafts whose axes would intersect if extended, bevel gears are used. The pitch surfaces of bevel gears are frustums of cones, and the teeth, which must be tapered, may be either straight or curved (fig. 9). Although curved-tooth bevel gears are called spiral bevel gears, the curve of the teeth is usually a circular arc. The curvature of the teeth results in overlapping tooth action and creates less noise than straight bevel gears. For the transmission of power at high speeds, spiral bevel gears are superior to straight bevel gears, just as helical gears are superior to spur gears for connecting parallel shafts. Spiral bevel gears are invaluable when power is being transmitted at an angle, as on helicopter transmissions.

When adapted for use on shafts which do not intersect, spiral bevel gears are called hypoid gears (fig. 10). On automobiles they are used to connect the engine drive shaft to the rear axles. The offset permits lowering of the centre of gravity of the body. In some respects, hypoid gears resemble worm gears. There is more sliding movement than on spiral bevel gears, and the pitch surface diameters are not inversely proportional to the speeds. This permits high-speed ratios, since the pinion may be made as large as necessary for adequate strength.

An interesting application of a planetary gear arrangement incorporating bevel gears is found in the differential gears of an automobile (*q.v.*) rear axle. The ring gear, which is driven by the drive shaft pinion, is fixed to the differential carrier which carries the different gears. Bevel pinions are carried on bearings in the carrier and mesh with bevel gears to which the axle shafts are fixed.

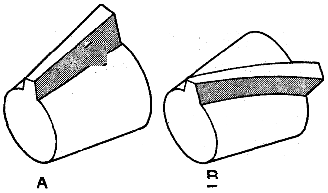

FIG. 9.— BEVEL GEAR TEETH
(A) Straight; (B) spiral

On a straight road, the differential gears revolve as a unit, without meshing action, and the axles revolve as if they were fixed to the ring gear. When turning a corner, the outside wheel (and axle) must turn faster than the inside wheel, and the differential gears rotate relative to one another to permit this. If the angular speeds of the carrier, left axle shaft and right axle shaft are N_C, N_L and N_R respectively, it can be shown that $2N_C = N_L + N_R$. If the rear wheels are jacked up, with the engine stopped. then $N_C = 0$ and $N_L = -N_R$. If the left rear wheel is turned clockwise, the right wheel will turn counterclockwise. Bevel gear differentials are extensively used in computing machines such as adders. If N_L and N_R are the input speeds, N_C will represent one half of their sum. (AR. C.)

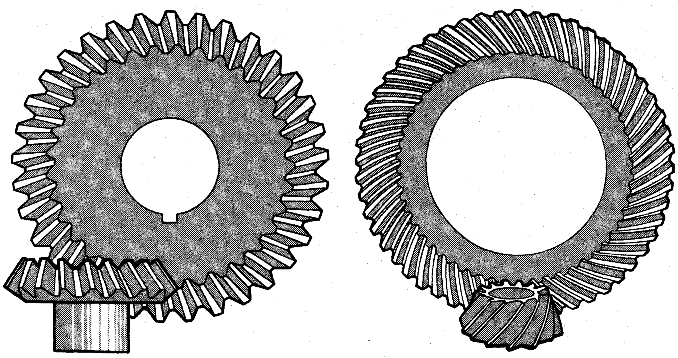

FIG. 10.— SPECIAL GEAR-AND-PINION DESIGNS

GEBER (JABIR; more fully JABIR IBN HAYYAN), was the most celebrated chemist of medieval times. There is reason to believe that he belonged to the famous south Arabian tribe of al-Azd, some members of which settled in the town of Kufa shortly after its foundation by the caliph Omar in A.D. 638. Jabir's father, Hayyan, was a druggist in Kufa and an ardent supporter of the Abbasid family, at that time plotting to secure the caliphate. It is probable that Jabir was born at the town of Tus (near the present Meshed) in the year A.D. 721 or 722, while his father was in Persia as an Abbasid agent. Shortly afterward, Hayyan was arrested and executed by Umayyad officers, and the younger Jabir was sent to Arabia, where he studied under Harbi at Himyari. In later life, Jabir became a friend of Harun al-Rashid's powerful ministers, the Barmakides, and, according to tradition, shared their banishment from Baghdad in 803. Retiring to Kufa, he spent the rest of his life in obscurity, though one authority maintains that he survived until the accession of the caliph al-Ma'mun in 813. His laboratory at Kufa came to light about two centuries later, during building operations in a quarter of the town known as the Damascus Gate.

Jabir was a voluminous writer, and fortunately made a list of the titles of his books, which was reproduced in part by Ibn al-Nadim in his *Kitab al-Fihrist,* a Moslem encyclopaedia of the 10th century A.D. Many of these books are still extant, nearly 100 having been reported as existing in manuscript or native lithographs in various European, Indian and north African libraries. They are, however. for the most part unedited (1928), and it is therefore impossible to express a final conclusion upon Jabir's scientific knowledge.

Jabir's thought is often confused and superstitious, yet he has a twofold importance for the history of chemistry. In the first place he was a skilled and ingenious experimentalist, and describes for the first time the preparation of nitric acid, the method of conducting certain essential chemical operations, and many other things of the same kind. He more clearly than any other early chemist recognized and stated the importance of experiment. Secondly, he suggested the comprehensive theory that all metals are composed of two principles resembling sulfur and mercury. This theory, which was a development of the Aristotelian conception of two "exhalations," persisted for many centuries and was at last modified into the phlogiston theory of Johann Becher and Georg Stahl (17th and 18th centuries). Jabir explained the existence of different varieties of metals by assuming that the sulfureous and mercurial principles are not always pure and that they do not always combine together in the same proportion. If they are perfectly pure, and combine together in the most perfect natural equilibrium, then the product is the most perfect of metals, viz.. gold. Defects in purity or proportion or both result in the formation of silver, lead, tin, iron or copper; but since these metals are all essentially composed of the same constituents as gold, the accidents of combination may be removed by suitable treatment. Such treatment, which Jabir believed could be effected by means of elixirs, was the object of *Alkimia* or alchemy.

Jabir's chemical theory was thus a development of Greek scientific and occult philosophy. Etymological and other evidence renders it likely that his contact with Hellenism was made through Persian channels rather than through Syria and Egypt. The reputation he acquired has never since been equaled in the whole development of chemistry; there is. indeed, scarcely a single later Arabic alchemical work in which he is not quoted, or at least mentioned. When, in the 12th and 13th centuries, Islamic science was transmitted to Latin Christianity, the fame of Jabir went with it; and, at least one of his books was translated into Latin.

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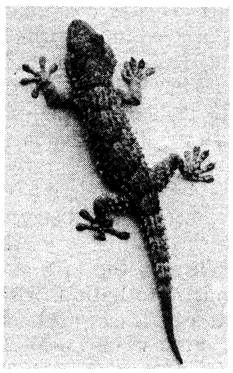
GEBHARD, TRUCHSESS VON WALDBURG (1547–1601), elector and archbishop of Cologne, was born on Nov. 10, 1547, at Cologne, studied at Ingolstadt, Perugia and Louvain, and took orders. He held various positions at the cathedrals of Augsburg, Strasbourg, Cologne, and again at Augsburg, and in Dec. 1577 was elected elector archbishop of Cologne. He became a convert to the Reformed doctrines, but it was suspected that his conversion was due to his desire to marry Agnes, countess of Mansfeld. The marriage was celebrated in Feb. 1583. Gebhard declined to give up his see, and collected an army. In April he was deposed and excommunicated by Pope Gregory XIII. A Bavarian prince, Ernest, bishop of Liège, Freising and Hildesheim. was chosen elector, and war broke out between the rivals. The Lutheran princes of Germany gave no real support to Gebhard, who had Calvinistic leanings, and the only armed assistance he received was from John Casimir, administrator of the Rhenish Palatinate. Early in 1584 he was driven from Bonn. He found refuge in the Netherlands. In 1589 Gebhard went to live in Strasbourg, where he died on May 31, 1601.

GEBHARDT, EDUARD VON (1830–1925), German painter, was born in Estonia, and studied at Diisseldorf, where he became a professor in the academy in 1873. He depicted scriptural subjects, using the German costume of the 15th and 16th centuries for his figures. But his heads were drawn from nature. His art constituted a reaction toward realism after the staged and vapid productions of the Piloty school. Among his more important works are the "Last Supper," and the "Ascension," in the National gallery at Berlin; the "Crucifixion" in the cathedral at Reval. He died at Dusseldorf on Feb. 3, 1925.

GECKO is any lizard of the family Gekkonidae. The names gecko, tokay and cheechak are based on the calls of various species. They are small, usually nocturnal reptiles, rarely over six inches in length, with a soft skin, a short, stout body, large head and weak limbs often equipped with suction-padded digits. Most geckos lack movable eyelids, the eyes, usually large and prominent. being protected by a transparent covering which is probably a modified nictitating membrane. The family is cosmopolitan in distribution, occurring everywhere in warmer climates, even on the remotest oceanic islands, and is adapted to very diverse habitats. All species are insectivorous.

Most geckos have the digits modified for climbing; the fingers and toes are dilated either terminally or at their bases and the lower surface of the dilation is covered with transverse plates whose arrangement is diverse in the various genera; each plate is beset with numerous tiny, hairlike processes which give the whole surface a velvety appearance. When the feet are placed on any surface the velvety pile accommodates itself to the slightest irregularities and pressure forces the air out from between the hairs; the resulting vacuum gives sufficient adhesion to enable many species to climb absolutely smooth and vertical surfaces and even to run across a whitewashed ceiling and even ordinary glass surfaces.



ERIC HOSKING

,,,,, ■, ,, ,,,,, (TARENTOLA MAURITANICA)

Claws are well developed in most species and, in a few, are provided with a special sheath, into which they are retractile. The most remarkable modification of the feet is found in the genus Palmatogecko from the deserts of central South-West Africa; they have no adhesive apparatus but the toes are webbed to their extremities to enable the animal to walk over and partially burrow into the loose sand.

Often the tail is peculiar in shape; it may be long and tapering or short and blunt, or even globular; in one species (*Gymnodactylus* platyurus) it is leaf-shaped. It seems highly probable that in many instances, particularly where it is large and globular, the tail serves as a storehouse of reserve nutriment on which the animal can draw during unfavourable conditions. The tail is extremely fragile and is quickly regenerated, the new one having roughly the same shape and scale pattern as the original.

As a rule the skin is soft and delicate, and covered with minute granules, but frequently there are large tubercles intermixed with these. Teratoscincus, a western Asiatic desert dweller, has. however, developed large, overlapping smooth scales which enable it to slip through the sand with the minimum of friction. Colours as a rule are drab, grays, browns. and dirty whites predominating though one genus, Phelsuma, of Madagascar, comprises the bright green day-active geckos.

Although these curious looking lizards are completely inoffensive, in many regions they have been erroneously regarded as being poisonous, probably from their weird and forbidding appearance. They are actually exceedingly useful because of their insect-eating habit.

Many species have a voice, the call differing with the species and ranging from a feeble click or chirp to a shrill cackle or bark. All species are oviparous, the eggs being white, hard-shelled and usually laid beneath the bark of trees or attached to the under side of leaves. See LIZARD. (H. W. P.; X.)

GED, WILLIAM (1690–1749), Scottish goldsmith, the inventor of stereotyping, was born in Edinburgh in 1690. In 1725 he perfected a system by which printing plates could be cast from type forms but, not being able to interest Edinburgh printers in his venture, he entered into partnership with William Fenner, a London stationer, and Thomas James, a typefounder. They obtained from Cambridge university the privilege of printing Bibles and prayer books by Ged's method, but the partnership was undermined by the typefounder and the process hindered by compositors who saw in it a threat to their trades. Ged returned to Edinburgh where he died on Oct. 19, 1749. A Cambridge prayer book was possibly printed from Ged's plates and certainly an edition of Sallust in Edinburgh. His sons briefly carried on the process but eventually it was abandoned until taken up by others later in the century. (J. C. MN.)

GEDDES, SIR ERIC CAMPBELL (1875–1937), British businessman and administrator remembered for his reforms in economy known as the "Geddes axe," was born at Agra, India, on Sept. 26, 1875. Educated at Merchiston Castle school, Edinburgh, and the Oxford Military college, he went to the United States at 17 and worked in lumber camps, in steel mills and on railways. He also worked on railways in India before returning to England in 1906 to join the North Eastern Railway Co. During World War I Geddes, under Lloyd George as minister of munitions, held several posts in which he brought the British lines of communication in France to a high standard of efficiency. In 1917 he was elected to parliament for the borough of Cambridge and appointed first lord of the admiralty, and in 1919 he became the first minister of transport. Geddes' best-known work was as chairman of the committee on national expenditure, its suggested measures of widespread economy in the nation's finances being called the Geddes axe. In 1922 he left parliament to resume a business career. He died at Hassocks, Sussex, on June 22, 1937.

GEDDES, NORMAN BEL (1893–1958), U.S. designer, particularly influential in the development of theatrical and industrial design, was born in Adrian, Mich., April 27, 1893. Following brief study at the Cleveland Institute of Art and the Art Institute of Chicago, he became interested in the theatre and staged his own first play, Nju, and five others for the Los Angeles Little theatre in 1916. In New York in 1918 he did scenic designs for the Metropolitan Opera. He designed, produced or directed some 200 operas, films: plays and musical comedies. His sets included those for Max Reinhardt's The Miracle (1923); Jeanne *d'Arc*, produced in Paris with Eva Le Gallienne (1925); and Dead End (1935), which were said at the time to have been "more convincing than reality." He changed the whole artistic concept of scenic design from the ornamental to the clean, functional effect—that the audience would "not be conscious of any scenery or background other than the mood in which the characters of the play should move." Toward the end of the 1920s he adapted his ideas to the area of industrial design, gradually building an organization that employed 2,000, and designed such a variety of things as skyscrapers, inkwells, yachts, radios, interiors and refrigerators. He did as much as any U.S. designer to popularize "streamlining" as a style of industrial design (*q.v.*). He designed the General Motors Futurama building and exhibit at the New York world's fair (1939–40), which drew greater crowds than any other exhibit. Geddes also designed theatres all over the world, staged circuses, developed equipment and techniques for the armed services and wrote books on a number of subjects. He died on May 8, 1958, in New York city. One of his daughters, Barbara Bel Geddes, gained fame as an actress. (CD. BN.)

GEDDES, SIR PATRICK (1854–1932), British biologist and sociologist, a pioneer theorist in civic and regional planning, was born at Ballater, Scot., on Oct. 2, 1854, and died at Montpellier, France, on April 17, 1932. He trained in biology in London (under T. H. Huxley) and in France, becoming (1883) professor of botany at University college, Dundee, and (1919) of sociology and civics at Bombay university. His chief biological work is a pioneer study of sex. In sociology his originality is shown by his thesis, based upon surveys in Scotland, India, Israel and elsewhere, that the development of human communities presents essentially biological problems which for solution depend first upon diagnosing the complex interactions between people, their environments and their activities. Novel when first published, Geddes' thesis and many of his ideas for its application were later accepted as fundamental for wise civic and regional planning. His works include The Evolution of Sex (with J. A. Thomson, 1900) and Cities in *Evolution* (1913).

See A. D. Peacock, "Patrick Geddes: Biologist," *Alumnus* Chronicle, St. Andrews (1955); P. Mairet, Pioneer *of* Sociology: *Life* and *Letters* of Patrick *Geddes* (1957). (A. D. P.)

GEDYMIN, or GEDIMINAS (d. 1341), grand duke of Lithuania, was supposed by some to have been the servant of Witen, prince of Lithuania, but more probably he was Witen's younger brother and the son of Lutuwer. Gedymin inherited a vast domain, comprising Lithuania proper and parts of Russia, but these lands were environed by powerful foes, the most dangerous being the Teutonic Knights and the Livonian Knights of the Sword. The systematic raiding of Lithuania by the knights under the pretext of converting it had long since united all the Lithuanian tribes against the common enemy; but Gedymin aimed at establishing a dynasty which should make Lithuania not merely secure but mighty, and for this purpose he began negotiations with the Holy See. At the end of 1322 he wrote to Pope John XXII soliciting his protection against the persecution of the knights, informing him of the privileges already granted to the Dominicans and the Franciscans in Lithuania, and desiring that legates should be sent to receive him also into the church. Gedymin then issued circular letters, dated Jan. 25, 1325, to the principal Hanse towns, offering a free access into his domains to settlers. The immigrants were to choose their own settlements and be governed by their own laws. Similar letters were sent to the Wendish or Baltic cities, and to the bishops and landowners of Livonia and Esthonia. In short Gedymin anticipated Ivan the Terrible and Peter the Great by throwing open the semisavage Russian lands to western culture.

In Oct. 1323 representatives of the archbishop of Riga, the bishop of Dorpat, the king of Denmark, the Dominican and Franciscan orders, and the Grand Master of the Teutonic Order assembled at Vilna, when Gedymin confirmed his promises and undertook to be baptized as soon as the papal legates arrived. A compact was then signed at Vilna confirming the promised privileges. But the christianizing of Lithuania was by no means to the liking of the Teutonic Knights, and they strove to nullify Gedymin's design. Gedymin's chief object was to save Lithuania from destruction at the hands of the Germans. But he was still a pagan reigning over semi-pagan lands; he was equally bound to his pagan kinsmen in Samogitia, to his orthodox subjects in Red Russia, and to his Catholic allies in Masovia. His policy, therefore, was necessarily tentative and ambiguous. Thus his raid upon Dobrzyn, the latest acquisition of the knights on Polish soil, gave them a weapon against him. The Prussian bishops, who were devoted to the knights, at a synod at Elbing questioned the authority of Gedymin's letters and denounced him as an enemy of the faith; his orthodox subjects reproached him with leaning towards the Latin heresy; while the pagan Lithuanians accused him of abandoning the ancient gods. Gedymin then repudiated his former promises; he refused to receive the papal legates who arrived at Riga in Sept. 1323, and dismissed the Franciscans. Gedymin saw that the pagan element was still the strongest force in Lithuania, and could not yet be dispensed with in the coming struggle for nationality. But, through his ambassadors, he privately informed the papal legates at Riga that his difficult position compelled him to postpone his own baptism, and the legates showed their confidence in him by forbidding the neighbouring states to war against Lithuania for the next four years, besides ratifying the treaty made between Gedymin and the archbishop of Riga. Nevertheless in 1325 the Order, disregarding the censures of the church, resumed the war with Gedymin, who by the marriage of his daughter to Casimir, son of Wladislaus Lokietek, king of Poland, had improved his position.

While on his guard against his northern foes, Gedymin from 1316 to 1340 was extending his rule over neighbouring Russian principalities. The principality of Halicz-Vladimir was obtained by the marriage of his son Lubart with the daughter of the Haliczian prince; Kiev seems to have been acquired by conquest. Gedymin also secured an alliance with the grand duchy of Muscovy by marrying his daughter, Anastasia, to the grand duke Simeon. He was strong enough to counterpoise the influence of Muscovy in northern Russia, and assisted the republic of Pskov, which acknowledged his overlordship, to break away from Great Novgorod. His internal administration bears all the marks of a wise ruler. He protected the Catholic as well as the orthodox clergy, encouraging them both to civilize his subjects: he raised the Lithuanian army to the highest state of efficiency then attainable; defended his borders with a chain of strong fortresses; and built numerous towns including Vilna, the capital (1323).

Gedymin died in the winter of 1342 of a wound received at the siege of Wielowa. Married 3 times, he left 7 sons and 6 daughters.

See Teodor Narbutt, *History of the Lithuanian Nation* (Pol.) (Vilna, 1835); Antoni Prochaska, *On the Genuineness of the Letters of Gedymin* (Pol.) (Cracow, 189;); Vladimir Boniiatovich Antonovich, *Monograph concerning the History of Western and South-western Russia* (Rus.) (Kiev, 1885). (R. N. B.; X.)

GEELONG, a city in Victoria, Austr., and second port of the state, is on a land-locked part of Port Phillip bay known as Corio bay. It lies 45 mi. S.W. of Melbourne. Pop. (1954) 20,034. Geelong is a rail junction and manufacturing centre with woollen mills, cement, salt and heavy engineering works; rope is manufactured and there are oil refineries. It is the outlet for the wool-growing area in the state's Western district and wool sales are held several times a year. In the surrounding country agriculture is carried on. Corio bay, a safe and commodious harbour, has a depth of 32 ft. at low water. There is extensive quayage and the largest ships are able to unload at modern wharves, which are connected by rail with all parts of the state. The city is an educational centre and in the mid 1950s contained the only textile college in the commonwealth. Torquay, Lorne, Barwon Heads and Queenscliff are seaside resorts in the vicinity.

GEERTGEN, TOT SINT JANS (*c.* 1465–*c.* 1493), Dutch painter active in Haarlem, one of the most interesting Dutch artists of the 15th century and important as representing a school of which very few works have survived destruction. He was surnamed "tot Sint Jans," as he lived with the knights of St. John at Haarlem. According to K. van Mander, the authority on his life, he was a pupil of Ouwater at Haarlem. Neither the year of his birth nor of his death is known, but only that he was 28 years old when he died. Geertgen painted a large triptych for the high altar of the knights of St. John. The central panel with the Crucifixion and one of the wings were destroyed in religious skirmishes; but the other wing has been identified with the aid of Van Mander's description. This wing is now in the Vienna gallery, sliced into two separate panels, front and back. The front represents the dead Christ being mourned by His friends. The pathos of the scene is expressed with deep feeling. The influence of Rogier van der Weyden is seen in the Magdalen wringing her hands. In the background is a realistic burial scene on Mount Calvary. Here the artist broke away from the traditional symbolical assemblage of emblematic figures on the altarpieces of his time and felt his way toward the more vivid and dramatic style of the next generation of Dutch painters.

The same is true of the other panel (the back of the wing) on which the emperor Julian the Apostate is directing the burial of the bones of St. John the Baptist. In the mid-distance of this panel is an admirable group of portraits of the knights of St. John at Haarlem among whom the artist lived. They are lifelike studies of individual characters and seem to presage those great democratic portrait groups famous in Dutch paintings of the 17th century.

A number of pictures are ascribed to him on stylistic grounds. Among these is the "St. John the Baptist" of the Berlin museum, where the pensive saint is sitting in beautiful parklike scenery. In the same collection is "Virgin and Child." The Louvre contains the "Resurrection of Lazarus," the Amsterdam museum, "The Virgin's Kindred" and the "Adoration of the Magi." The "Man of Sorrows" at Utrecht is a painful but wonderful picture; a triptych at Prague represents the "Adoration of the Magi" in the centre and "Donors and Saints" on the wings. It is distinguished for the original conception of some of its figures and for its animated background. The National gallery, London, has one of his most attractive pictures. It represents "Nativity," a night scene, remarkable for its rendering of chiaroscuro. One of the most striking of Geertgen's achievements is his harmonious fusion of the elements of the landscape.

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GEEZ is the language of an ancient nomadic Semitic race of Ethiopia. *See* Ethiopian Literature; Semitic Languages.

GEFLE (Gavle), a seaport of Sweden on an inlet of the Gulf of Bothnia. chief town of the district of Gavleborg, 112 mi. N.N.W. of Stockholm. Pop. (1950) 46,919. It is the chief port of the district of Kopparberg, with its mines and forests.

The exports consist principally of timber and wood pulp, iron and steel, imports of coal. grain and machinery. The harbour is usually icebound from January to April. There are slips and shipbuilding yards, and a manufacture of sailcloth. The town is an important industrial centre, having tobacco and textile mills, and breweries. At Skutskar at the mouth of the Dal river are wood pulp mills and sawmills, dealing with the timber floated down the river.

The principal buildings are a castle, founded by King John III (1568–92), but rebuilt later, and a council house erected by Gustavus III.

GEGENBAUR, KARL (1826–1903), German anatomist, was born on Aug. 21, 1826, at Wurzburg and was educated at the university there. In 1855 he was appointed professor of anatomy at Jena, and in 1873 at Heidelberg, where he was also director of the Anatomical institute until 1901.

In his best-known work. *Grundriss der vergleichenden Anatomie* (1874, Eng. trans. 1878), Gegenbaur laid stress on the high value of comparative anatomy as the basis of the study of homologies. A distinctive piece of work was effected by him in 1871 in supplementing the evidence adduced by Thomas Huxley in refutation of the theory of the origin of the skull from expanded vertebrae. Huxley demonstrated that the skull is built up of cartilaginous pieces; Gegenbaur showed that "in the lowest (gristly) fishes, where hints of the original vertebrae might be most expected, the skull is an unsegmented gristly brain box, and that in higher forms the vertebral nature of the skull cannot be maintained, since many of the bones, notably those along the top of the skull, arise in the skin."

In 1875 he founded the *Morphologisches Jahrbuch,* which he edited for many years. In 1901 he published a short autobiography under the title *Erlebtes und Erstrebtes.* Gegenbaur died at Heidelberg on June 14, 1903.

See M. Furbringer, "Karl Gegenbaur," in *Heidelberger Professoren aus dem ryten Jahrhundert* (1903).

GEGENSCHEIN (or Counterglow), is a slightly oval patch of faint luminosity just opposite the sun in the night sky. As the sun moves in its apparent annual path among the stars, the gegenschein moves along the ecliptic. always in the region where the sun was six months earlier or will be six months later. The patch of light is so faint that it can be seen only in the absence of moonlight, away from city lights and with the eyes adapted to darkness. Most observers use averted vision in order to utilize the peripheral regions of the retina which are relatively sensitive to very faint light. The gegenschein is lost in the light of the Milky Way in the summer and winter. The best observing periods are February, March, April and August, September, October.

The gegenschein and the zodiacal light (*q.v.*) form a continuous band of light along the ecliptic. The spectrum of the gegenschein is similar to that of the sun, and it is generally believed that it is the result of the back reflection of sunlight from meteoric material located in a region of the solar system opposite the sun and, therefore, outside the earth's orbit. The enhanced intensity in the counter-sun direction may be attributed to an increase in the concentration of particles in that direction, to an increased reflecting efficiency for direct back reflection or perhaps to a combination of these two causes. (F. E. R.)

GEIBEL, EMANUEL (1815–1884), German poet, was born at Lubeck on Oct. 17, 1815. He studied theology, but his real interests lay in classical and romance philology. In 1838 he accepted a tutorship at Athens, where he remained until 1840. His first poems, *Zeitstimmen,* political poems directed against radicalism, appeared in 1841; a tragedy, *Konig Roderich,* in 1843. In the same year he received a pension from the king of Prussia, which he retained until his invitation to Munich by the king of Bavaria in 1851 as honorary professor at the university. Meanwhile he had produced *Konig Sigurds Brautfahrt* (1846), an epic, and *Juniuslieder* (1848, 33rd ed., 1901), lyrics which both in content and in poetic form showed a great advance on his early work. A volume of *Neue Gedichte* (Munich, 1857) mainly on classical subjects, was followed by the *Spätherbstblätter* (1877). His later years were spent in Lubeck, where he died on April 6, 1884. His works further include two tragedies, *Brunhild* (1858, 5th ed.. 1890), and *Sophonisbe* (1869). and translations of French and Spanish popular poetry. Beginning as a member of the group of political poets who heralded the revolution of 1848, Geibel became gradually conservative. He was the chief poet to welcome the establishment of the empire in 1871 and mas one of the early singers of German imperialism. His strength lay not, however, in his political songs but in his purely lyric poetry, such as the fine cycle *Ada* and his still popular love songs.

Geibel's *Gesammelte Werke* were published in 8 vol. (1883, 4th ed. 1906); his *Gedichte* have gone through about 130 editions. An excellent selection in one volume appeared in 1904.

GEIGER, ABRAHAM (1810–1874), Jewish theologian and orientalist, a leader in the Reform movement in Germany, was born at Frankfort-on-Main on May 24, 1810, and educated at the universities of Heidelberg and Bonn. In 1832 he went to Wiesbaden as rabbi of the synagogue, and in 1835 helped to found, and thereafter edited, the *Zeitschrift fur jiidische Theologie.* From 1838 to 1863 he lived in Breslau (being after 1843 first rabbi), where he organized the reform movement in Judaism and wrote some of his most important works. These include *Lehr-and Lesebuch zur Sprache der Mischna* (1845), a translation into German of the poems of Juda ha-Levi (1851), and *Urschrift und Übersetzungen der Bibel in ihrer Abhangigkeit von der innern Entwicklung des Judentums* (1857). In 1863 Geiger became head of the synagogue of Frankfurt, and in 1870 he moved to Berlin, where he took the principal charge of the newly established seminary for Jewish science. His later works included a history of Judaism, *Das Judentum und seine Geschichte* (1865–71). He died on Oct. 23, 1874, at Berlin.

See the memorial volume, *Abraham Geiger, Leben und Lebenswerk,* prepared by his son Ludwig Geiger in collaboration with others on the 100th anniversary of his birth (1910).

GEIGER, THEODOR (1891–1952), German sociologist, outstanding for his studies of social stratification, was born in Munich on Nov. 9. 1891, and received his early training in law and statistics. The upheavals of the 1920s in Germany led him to inquiries into mass behaviour and the sociology of political movements but the coming to power of the Nazi party in 1933 drove him into exile in Denmark. After some years in Copenhagen, he was appointed to the first chair in sociology in the country in the University of Aarhus. During the German occupation of Denmark in World War II he again lived in exile, in Sweden, returning to Aarhus in 1945. He then began a series of studies in social stratification and social mobility, culminating in a detailed work on the social origins of the population of Aarhus. Through UNESCO and the International Sociological association, of which he was a founder member, such studies led him to cross-national comparisons in this field. He died on June 19, 1952, at sea while returning from a visiting professorship in the University of Toronto.

His principal works include *Die Masse und ihre Aktion* (1926), *Die Soziale Schichtung des deutschen Volkes* (1932) and *Soziale Umschichtungen in einer dänischen Mittelstadt* (1951). (J. My.)

GEIJER, ERIK GUSTAF (1783–1847), Swedish historian, poet and phiiosopher, the inspiration of the national movement after the political upheavals in 1809, and of liberal thinking in the 1840s, was born Jan. 12, 1783, at Ransater, Värmland. His father owned a foundry and the home mas musical and sociable. A happy childhood instilled in Geijer an independence and harmony which he retained throughout life. Another important influence was a year's stay in England (1809–10). There he listened to parliamentary debates, through which he gained insight into the political life of a great state, and was impressed by the spirit of national unity and freedom. A collection of his diaries and letters was published as *Geijer i England, 1809–10* (1914; Eng. trans. 1932). Geijer continued to follow political and industrial developments in England in British journals, among them *The Edinburgh Review,* and events there were partly responsible for his famous "defection" in 1838, when, having long been the leading theorist of Swedish conservatism, he went over to the liberal camp. The political defeat which Sweden suffered in 1809 through the loss of Finland to Russia had led him to abandon his earlier liberalism for nationalism. In 1811 he was one of the founders of the *Gotiska förbundet,* which aimed at furthering a deeper national feeling through historical studies. He contributed to its journal *Iduna* (1811) a number of famous poems on national themes, *e.g.,* "Vikingen" and "Odalbonden" ("The Yeoman").

In 1817 Geijer became professor of history at Uppsala. His main historical works are *Svea Rikes Havder* (1825) and *Svenska folkets historia* (3 vol., 1832–36; Eng. trans., abridged, 1845). Geijer's historical writings are objective, sparing in comment! and show both a grasp of each period's special problems and a sense of the inner continuity of Swedish history in the context of events in Europe. In the posthumously published philosophical *Människans historia* (1856), Geijer interprets historical events as a combination of tradition and creation. His reflections on creation reveal kinship with Henri Bergson's philosophy of half a century later, and his ideas on the unpredictability of events and individual responsibility in historical development are echoed in Isaiah Berlin's *Historical Inevitability* (1954). Geijer developed these ideas in his "philosophy of personality," based on the principle of reciprocity: the "I" and "Thou" develop through reciprocal influence. This led to the conclusion that only in a free community can the social character of the individual fully develop; oppression restricts it.

The isolation which followed Geijer's break with conservative friends led to a new flowering of his lyric poetry. Some of his poems written between 1838 and 1841, and set to his own music, belong to the masterpieces of Swedish verse, expressing the feelings of a farmer, a wanderer and a seeker after truth. They were printed in his collected works (1849–55).

Geijer died at Stockholm, April 23, 1847.

The most comprehensive edition of Geijer's works is that edited by J. Landquist, 13 vol. (1923–31).

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GEIKIE, SIR ARCHIBALD (1835–1924), Scottish geologist, was born at Edinburgh on Dec. 28, 1835. He was educated at the high school and University of Edinburgh, and in 1855 was appointed an assistant on the geological survey. His ability at once attracted the notice of his chief, Sir Roderick Murchison, with whom some of his earliest work was done on the complicated regions of the Highland schists; the small geological map of Scotland published in 1862 was their joint work, and a larger map was issued by Geikie in 1892. In 1863 he published his essay "On the Phenomena of the Glacial Drift of Scotland" *(Trans. Geol. Soc. Glasgow)* in which the effects of ice action in that country were for the first time clearly and connectedly delineated. His *Scenery of Scotland* (1865; 3rd ed., 1901), was, he claimed, "the first attempt to elucidate in some detail the history of the topography of a country." In the same year he was elected fellow of the Royal society. At this time the Edinburgh school of geologists — prominent among them Sir Andrew Ramsay, with his *Physical Geology and Geography of Great Britain*—were maintaining the supreme importance of denudation in the configuration of land surfaces, and particularly the erosion of valleys by the action of running water. Geikie's book was an able contribution to the doctrines of the Edinburgh school.

In 1867, when a separate branch of the geological survey was established for Scotland, he mas appointed director. He was the first holder (1871) of the Murchison professorship of geology and mineralogy at Edinburgh. These two appointments he held till 1881, when he succeeded Andrew Ramsay in the joint offices of director general of the geological survey of the United Kingdom and director of the museum of practical geology, London, from which he retired in Feb. 1901. A feature of his tenure of office was the impetus given to microscopic petrography, a branch of geology to which he had devoted special study, by a splendid collection of sections of British rocks. Later he wrote two important and interesting survey memoirs, *The Geology of Central and Western Fife and Kinross* (1900), and *The Geology of Eastern Fife* (1902).

In 1871 Geikie brought before the Geological society of London an outline of the Tertiary volcanic history of Britain. He traveled not only throughout Europe, but in western United States to examine volcanic formations. While the canyons of the Colorado confirmed his long-standing views on erosion, the eruptive regions of Wyoming, Montana and Utah supplied him with valuable data in explanation of volcanic phenomena. The results of his further researches were given in his paper on "The History of Volcanic Action During the Tertiary Period in the British Isles," *Trans. Roy. Soc. Edin.* (1888). His mature views on volcanic geology were stated in his presidential addresses to the Geological society in 1891 and 1892, and afterward in his book, *The Ancient Volcanoes of Great Britain* (1897). Other results of his travels are collected in his *Geological Sketches at Home and Abroad* (1882).

Geikie was president of the British association in 1892 and of the Royal society in 1909; he received the Order of Merit in 1914. He died near Haslemere, Surrey, on Nov. 10, 1924. His experience as a field geologist resulted in an admirable textbook, *Outlines of Field Geology* (5th ed. 1900). His *Text-Book* (1882, 4th ed. 1903), and *Class-Book* of geology are standard works.

His other works include *Memoir of Edward Forbes* (with G. Wilson), and memoirs of his old chiefs Sir R. I. Murchison (1875) and Sir Andrew Crombie Ramsay (1895); *Founders of Geology* (lectures at Hopkins University 1897); *Geological Map of England and Wales, With Descriptive Notes* (1897); *Types of Scenery and Their Influence on Literature,* Romanes lectures (1898); *The Teaching of Geography* (1887); *Scottish Reminiscences* (1904); and *Landscape in History and Other Essays* (1905).

GEILER VON KAISERSBERG, JOHANN (1445–1510), "the German Savonarola," noted as an exceptionally forceful and impressive preacher, was born at Schaffhausen on March 16, 1445, but in 1448 went to live at Kaisersberg in Upper Alsace. He studied at Freiburg university, where he afterward lectured until 1478, when he accepted a call to fill an office as preacher, created for him, at the cathedral of Strasbourg. There his sermons — bold, incisive, denunciatory, abounding in quaint illustrations and based on texts by no means confined to the Bible—won for him a wide fame. Although he was much interested in reform, there is no evidence that he ever considered leaving the church. Geiler died at Strasbourg on March 10, 1510.

See L. Dacheux, *Un Réformateur catholique à la fin du XVe siècle* (1876).

GEISHA, the name of a professional class of women in Japan whose occupation is to entertain men, particularly at businessmen's parties in public restaurants *(ryôri-ya).* The word geisha literally means "art-person," and many of the women sing, dance or play musical instruments, but the majority are merely adept in the art of conversation. The main function of the geisha in society is to provide an atmosphere of chic and gaiety. The women are usually exquisitely dressed, delicately mannered and have a knowledge not only of the past and its elegance but of contemporary gossip. The geisha system is a form of indentured labour, although some girls, attracted by the glamour of the life, volunteer. Usually, a girl at an early age is given by her parents for a sum of money to an organization. She is taught, trained, fed and clothed for a period of years. Then she emerges into the society (known as *karyukai,* the "world of flowers and willows") and begins earning money to repay her parents' debt and her past keep. Inadequate geisha may be hired for the equivalent of a few dollars an hour, while famous ones can command as much as several hundred dollars for a single dance. Geisha are often associated with the theatre (many marry actors), and plays frequently dramatize a geisha as a heroine.

When a geisha marries, she retires from the profession. If geisha do not marry, they usually retire as restaurant owners, teachers of music or dance. or trainers of younger geisha. (F. Bs.)

GEISLINGEN, a town in Baden-Württemberg, on the Thierbach. 38 mi. by rail E.S.E. of Stuttgart. Pop. (1950) 22,535. It has shops for the carving and turning of ivory and wood, besides iron works, machinery factories, glassworks and brewing. The church of St. Mary contains fine wood carving. Above the town lie the ruins of the castle of Helfenstein, which was destroyed in 1552. The town, which passed to Mi'urttemberg in 1810, has chalybeate springs.

GEL. A gel is an elastic coherent mass consisting of a liquid in which ultramicroscopic particles are either dispersed or arranged in a fine network extending throughout the mass. The particles may be, for example, large molecules, such as proteins; or small crystals, such as bentonite; or polymer particles, such as polystyrene. Gels swell in suitable liquids. Depending on the gel and on the liquid, the swelling (that is, the increase in gel volume) may be minute or very large. Extensive swelling results in a gradual transformation of the gel into a colloidal solution. The rheological properties of a gel vary between those of a viscous or elastic liquid and those of a solid. Some gels can be transformed into very fluid colloidal solutions by heat. Others, known as thixotropic gels, can be liquefied by mechanical action. Removal of the liquid phase, *e.g.*, by evaporation, leads to xerogels. Xerogels are often called aerogels if the air-filled capillaries crisscrossing the system are numerous and wide. For a clearer distinction between gel and xerogel, the presence of liquid in the former may be emphasized by use of the term lyogel instead of the term gel. The terms hydrogel, alcogel, etc., may be used instead, if, in addition, the type of liquid is of interest. Gelatine forms typical lyogels. Dry silicagel is a typical xerogel. The term gel is also used even when it may not be certain whether a second phase such as air or a liquid is present in the system prior to swelling. A typical gel of this type is rubber. The ability of such systems to swell extensively and to change to typical lyogels in the course of swelling, and, in addition, their characteristic elastic properties are considered a sufficient justification to classify them as gels. Precipitates from colloidal solutions are also occasionally called gels. This usage is not recommended since the precipitates do not form a coherent mass. If the individual units of a precipitate conform to the definition of a gel, each unit may be called a microgel. A microgel may represent an aggregate of colloidal particles or a crosslinked complex of macromolecules. (WI. H.)

GELA, a town of Sicily on the S. coast, province of Caltanisetta. 74 mi. by rail and 41 mi. direct E.S.E. of Girgenti. Pop. (1951) 43.326 The poorly built modern town stands on a sandhill near the sea, with a fertile plane (the ancient Campi Geloi) to the north of it. It has only an open roadstead. Outside the town to the east are scanty remains of a Doric temple (480–440 B.c.?) which was still standing in the 18th century, of which a single pillar only remains (height about 26½ ft., lower diameter 5⅔ ft.). Between it and the modern town the stylobate of a large and earlier temple was found. This seems to have been constructed toward the end of the 7th century B.C. on the site of a still earlier edifice. The stylobate measures 115 by 58 ft. A large number of decorative terra cottas were found. Both buildings were probably dedicated successively to Athena. On the west of the town. on the Capo Soprano, was the ancient necropolis, where many tombs of the Greek period have been discovered.

The ancient city was founded by Cretan and Rhodian colonists in *c.* 688 B.C., and itself founded Acragas (see AGRIGENTUM) in 582 B.C. It also had a treasure house at Olympia. The town took its name from the river to the east. The Rhodian settlers called it Lindioi (see LINDUS). Gela enjoyed its greatest prosperity under Hippocrates (498–491 B.C.), whose dominion extended over a considerable part of the island. Gelon seized the tyranny on his death, soon became master of Syracuse and transferred his capital there with half the inhabitants of Gela, leaving his brother Hieron to rule over the rest. Its prosperity returned, however, after the expulsion of Thrasybulus in 466 B.C., but in 405 it was abandoned by Dionysius' order (see SYRACUSE). The inhabitants returned and rebuilt the town but it was only refortified in the time of Timoleon. In 311 B.C. Agathocles put to death over 4,000 of its inhabitants; and finally, after its destruction by the Mamertines about 281 B.C., Phintias of Agrigentum transferred the remainder to the new town of Phintias (now Licata, *q.v.*). In Roman times they still kept the name of Gelenses or Geloi in their new abode. The modern town was formerly known as Terranova di Sicilia. It was heavily bombed by the Allies in World War II.

Remains of a temple of Athena of the 6th century B.C. with five terra cottas have been found; also scanty remains of another, a century later (perhaps that of Apollo). (T. A.)

GELADA, a large baboonlike animal, Theropithecus gelada, differing from the true baboons (*q.v.*) by the nostrils being situated some distance from the tip of the muzzle. The gelada, sometimes called lion baboon, resembles the Arabian or hamadryas baboon in having a heavy mantle of long blackish-brown hair covering the forequarters of the old males. with the exception of the bare chest, which is reddish flesh-colour. The gelada inhabits the mountains of southern Ethiopia, where it lives in the steep cliffs of rocky ravines. It seldom climbs trees, preferring to forage for its food — leaves, roots and tubers — on open ground. See also PRIMATES.

GELASIUS, the name of two popes.

ST. GELASIUS I (d. 496), pope from 492 to 496, succeeded Felix III in March 492. The date and place of his birth are not known, though it is probable that he was born a Roman citizen in Africa. His pontificate was devoted mainly to combating the Acacian schism which had arisen in the east during the patriarchate of Acacius (471–489) as a result of the Roman see's refusal to accept the Henoticon, a peace formula designed by the emperor Zeno to reconcile the dissident Monophysites (*q.v.*). During this long bitter struggle with the Eastern Church, Gelasius maintained openly and firmly the primacy of jurisdiction and the apostolic origin of the papacy. This difficult contest, though not settled during his pontificate, earned him the distinction of being one of the great architects of the Roman primacy. His writings, which show clearly the influence of Augustine and Leo I, include various decrees, six theological treatises and some 60 letters, of which the most celebrated is the letter addressed to Anastasius I in 494, in which Gelasius sets forth his understanding of the relation of the church to the empire: "There are two powers by which this world is chiefly ruled: the sacred authority of the priesthood and the authority of kings." Gelasius' doctrine that both sacred and civil power are of divine origin and independent, each in its own sphere, is the most progressive thinking on this subject up to that time and for many centuries afterward. If the Gelasian formula had taken firm root in Christian tradition, it is very likely that the subsequent history of the papacy would have been different. Falsely attributed to Gelasius are the Decretum Gelasianum (on the canonical books of the Bible) and the Sacramentarium Gelasianum. Gelasius died on Nov. 19, 496. His feast is kept in the west on Nov. 21. See also PAPACY : The First Six Centuries. (R. E. McN.)

GELASIUS II (John of Gaeta) (d. 1119), pope from 1118 to 1119, nas called to Rome from Monte Cassino and created cardinal (c. 1082). then papal chancellor (1089). He was elected pope Jan. 24, 1118. at an advanced age, as successor to Paschal II. whom as leader of the moderate cardinals he had defended against his critics. Gelasius had a reign of unending misfortunes; he was grossly maltreated by the pro-imperial Frangipani, and twice driven from Rome by Henry V, who installed the antipope Gregory VIII. Gelasius died in France on Jan. 28, 1119, as he planned for a council at Reims, leaving the close of the struggle to his successor, Calixtus II.

See H K Mann, ***The Lives** of **the Popes in the Middle Ages***, vol. viii, 2nd ed (1925). (J J. RN.)

GELATIN, one of the commoner proteins, is most .familiar as a food; it has, however, many industrial uses which do not require the high purity of the edible grades. Its name is derived from the Lat. gelata, and describes its most characteristic property; *i.e.*, gel formation in water. Contrary to the popular but erroneous concept, gelatin has not been and cannot be prepared from such proteins as horns, hoofs, lungs, muscle tissue and blood. Gelatin is derived from collagen, which is the prime constituent of all white fibrous connective tissue occurring in the animal body. Upon hydrolysis, collagen yields a series of degradation products which are never found in the living animal body and which are called gelatin. This connective tissue is well known in the form of cartilage, sinews, skin or ossein (protein matrix of bone).

Although the relative proportions of constituent amino acids in collagen and gelatin are substantially the same, the physical and chemical properties of these two proteinaceous materials differ widely. Whereas collagen swells and hydrates in dilute acid or alkaline solution, it will not dissolve without hydrolytic cleavage to form the more soluble gelatin. This transformation of collagen into gelatin is rather analogous to the hydrolysis of starch:

$$\text{Collagen} \rightarrow \text{gelatins} \rightarrow \text{proteoses} \rightarrow \text{peptones} \rightarrow \text{peptides} \rightarrow \text{amino acids}$$
$$\text{(high viscosity} \longrightarrow \text{low viscosity)}$$
$$\text{Starch} \longrightarrow \text{dextrins} \longrightarrow \text{glucose.}$$

Gelatin, like dextrin, can vary in molecular size, and therefore a tremendous number of different qualities of gelatin, as of dextrin, are possible. No definite structure or size has been determined for the gelatin molecule since gelatin is a mixture of degradation products resulting from the hydrolytic splitting of the more complex collagen.

Composition. — Both gelatin and its precursor collagen show identical composition when analyzed. The ultimate composition of each is approximately: carbon (50%), nitrogen (18%), oxygen (25%), hydrogen (7%) and sulfur (trace). The constituent amino acids and their relative amounts are approximately: glycine (25%), alanine (9%), leucine (7%), serine (0.5%), phenylalanine (1%), methionine (1%), proline (19%), hydroxyproline (14%), aspartic acid (3%), glutamic acid (6%), histidine (1%), arginine (9%) and lysine (6%). The amino acids valine, isoleucine, tyrosine, tryptophane and cystine are either entirely absent or present only in negligible quantities.

Uses in Foods. — In the food industry advantage is taken of the jellying properties in the manufacture of gelatin desserts, jellied meats and soups, marshmallows, jellied candies and other forms of confectionery. Gelatin exerts a powerful protective colloid action and for this reason is used in commercial ice cream, thereby increasing this product's resistance to "heat shock"; that is, to the formation of ice crystals by sudden changes in temperature. Gelatin has diversified uses in medicine. It is not known to have any therapeutic value beyond that of being a protein food. In pharmacy its most important use is in the manufacture of capsules in which glycerin may be incorporated if a soft capsule rather than a hard one is desired.

Use in Nonfood or Chemical Industries. — Nonfood uses vary from photography to fabric printing. Gelatin is an important ingredient in the preparation of photographic emulsions. For this use it must be particularly free from those impurities which would impair the functions of the silver salts used in the process. Protective colloid uses are found in the dye industry, where gelatin tends to prevent the uneven deposition of colour, and in the manufacture of chemical compounds having a chloramine functional group.

A sheet of flexible jelly, containing seven parts glycerin to one part gelatin, deposited on a paper or fabric back for use as a hectograph or duplicator roll, has the property of absorbing hectograph ink from a master copy and redepositing the impression about 7j times.

Production of Gelatin. — In the United States about 45,000,000 lb. of gelatin are produced annually. Of this 90% is manufactured from hide stock and the remaining 10% is from ossein. According to the U.S. department of commerce the total production is classified as follows: edible (60%–65%); technical (3%–5%); pharmaceutical (15%–20%); photographic (15%–20%).

COMMERCIAL MANUFACTURE OF GELATIN

Preparation of Raw Stock. — The raw material may be hides, skins, bones, sinews or any other suitable collagenous substance. Ran. materials preserved by freezing, such as fresh pork skins, must be defrosted prior to processing. Chrome leather waste or similar material which is not suitable to the production of edible gelatin may be processed for technical or industrial gelatin. The ram material, exclusive of bones, is washed to remove surface soil and water-soluble impurities.

Bones are processed somewhat differently in that, after washing, crushing and rewashing, they are subjected to countercurrent treatment with mineral acid (hydrochloric acid). This process. known as demineralization, serves to decalcify, or leach out the calcium phosphates, and to leave a residue consisting of bone protein (ossein).

This concentrated raw material may be processed directly as is other raw stock, or it may be dried and stored. From this preliminary treatment the stock is put in "cure," which is either acid or alkaline depending upon the ultimate use to which the gelatin is to be put. Acid curing results in gelatin possessing somewhat higher jelly strength but lower viscosity than alkaline curing.

Acid Cure. — In this method the washed hydrated stock is immersed in cold dilute mineral acid (*p*H 1.5–3.0) and held for 8 to 12 hours depending upon the thickness or degree of comminution of the stock. During this period the protein raw material swells to about two or three times its original volume. After curing, the acidulated stock is washed in running water until excess acid has been rinsed away.

Alkali Cure. — Although alkaline agents ranging from caustic soda to soda ash may be used in the curing of hide or bone proteins, it is conventional practice to use saturated limewater (*p*H 12.0) as the curing liquor. The washed stock is placed in pits or vats along with the lime liquor and sufficient hydrated lime to maintain saturation. Temperatures are maintained under 75° F. (24° C.) and occasional agitation is effected by use of poles or other mechanical means. The curing time may be from three to five weeks, depending upon the thickness of the stock and its type.

When curing is completed, the limed stock is washed with water until excess lime is removed. Then this washing is continued with dilute mineral acid until the external areas are acidic. Washing with pure water is then resumed until the whole lot is approximately neutral.

Extraction. — The cured and washed stock is placed in extraction kettles and covered with hot water. Several extractions are made with consecutive lots of water. A series of 8 to 12 extractions, "runs" or "cooks" may be made, each extraction being somewhat hotter than the preceding one; *i.e.*, 110° F. (43° C.), 120° F. (49° C.), 130° F. (54° C.), etc., until the boiling point is reached. Since the extraction depends upon the conversion of collagen to gelatin by hydrolysis, care must be exercised to avoid excessive hydrolytic breakdonn of the gelatin. Highest test gelatin is extracted at the lower temperatures whereas use of higher temperatures produces the lower testing gelatins. At the end of each run all possible grease is removed by skimming. Each run of liquor is then removed prior to the addition of fresh water for the subsequent extraction. These liquors, known as "light" because of low solids (2% to 4%) content, are then allowed to settle for a short time, after which more grease may be skimmed. The various runs are then combined according to the quality of gelatin desired and are processed through filtering equipment whereby grease and foreign suspended material are removed. Active carbon is sometimes used to minimize high colour. The light liquors, which are sparklingly clear and almost water-white, are then continuously evaporated until the increased viscosity makes further evaporation impractical. This situation is reached at concentrations of 8% to 12% in high-test liquors and of 15% to 20% in low-test liquors.

Most film type evaporators tend to break down the jelly strength of gelatin if allowed to concentrate the liquors beyond certain limits. If necessary the heavy liquors from the evaporators may be filtered again and bleached depending upon the quality desired.

Following the evaporating stage the usual drying procedure is based upon the characteristic ·jelling property of the protein. Heavy liquors are run onto a wide endless belt which conveys the gelatin through a refrigerated chamber. The resultant stiff jelly is placed on metal nets and blown with cold air until it has developed a skin. Hot air is then used to finish the drying process and the final clear sheets are comminuted as required. Other methods of drying, making use of sprays, hot rolls, etc., may be employed.

All equipment in the manufacture of gelatin should be so constructed as to avoid contamination by heavy metals. Aluminum for acid-cure processes and nickel or stainless steel for either acid or alkali processes are preferred materials of construction. Certain grades of technical gelatin for industrial use can be processed in equipment made from iron. Extremely pure grades can be made by dialysis (*q.v.*), but this procedure is not commercially practical.

Properties.—The protein gelatin, as manufactured, may be marketed as thin, clear flakes or after grinding to various degrees of fineness. In the U.S. a 30-mesh gelatin is considered standard for most uses. Crystal clarity and slight yellow or amber colour are customary. The dry product normally contains from 85% to 12% of moisture, depending upon atmospheric humidity. Commercial gelatins are substantially free from heavy metal and bacterial contamination. Mineral constituents as represented by ash are less than 2%.

Specifications of the U.S. Pharmacopoeia are satisfactory in general although additional specifications may be required for certain uses (photography, hectography).

Gelatin is insoluble in pure cold water, but will absorb moisture, with swelling. The swollen gel will pass completely into solution when warmed to about 120° F. (49° C.), forming a gel again when cooled. The swollen gel will dissolve in hot water, hot aqueous glycerin, hot acids, alkalies and salts. It is insoluble in all organic solvents other than the water-soluble phenols and carboxylic acids. In dilute mineral acid (0.5N HCl) and in dilute alkali (0.15N NaOH), a 1% solution of gelatin can be formed at room temperature. Concentrated mineral acids or alkalies will dissolve larger amounts of gelatin, considerable hydrolysis taking place. Concentrated acetic and formic acids will dissolve gelatin in the cold as will concentrated aqueous solutions of urea, thiourea, calcium chloride, calcium nitrate and other peptizing agents. Aqueous glycerin will swell gelatin slowly in the cold and will dissolve it when heated. The viscous mass will set to a stiff gel when cooled and is the basis for manufacture of printer's rollers, hectograph jellies and capsules.

The isoelectric point of a given gelatin is 4.85 or 7.8 depending upon whether it is derived from acid- or alkaline-cured material. Any gelatin at its isoelectric point exhibits minimum solubility, minimum viscosity, minimum electroconductivity and minimum swelling. Similarly to other water-soluble proteins, gelatin will swell or puff like popcorn when heated dry. At a temperature of 300° F. (149° C.), it will polymerize with corresponding increase in viscosity and decrease in solubility.

Tanning agents normally used in leather manufacture will act upon gelatin to produce insolubility in water. Heavy-metal salts, aldehydes and sugars having active aldehydic functions act in the same way. In such cases water insolubility does not mean moisture resistance, since insolubilized gelatin will absorb almost as much water as will the untanned gelatin from the same source.

Two forms of gelatin are believed to exist. These differ only in the specific rotation of their solutions. Form A has a specific rotation $[\alpha]_D$ of $-313°$ and is stable above 95° F. (35° C.). Form B has a specific rotation $[\alpha]_D$ of $-141°$ and is stable only below 59° F. (15° C.). Outside the range of 59°–95° F. (15°–35° C.) the specific rotation does not vary with changes in temperature. These two forms are believed to be the sol, 95° F. (35° C.), and gel, 59° F. (15° C.), forms.

For detailed accounts of the more specific physical and chemical properties of gelatin, see the references at the end of this article.

Commercial Grades and Tests of Gelatin.—As emphasized, many different qualities of gelatin can be prepared from a given collagenous raw material. The less vigorous the hydrolytic treatment used in its preparation, the higher is the quality of the resulting gelatin.

Uniformity in gelatin of commerce is maintained through process control and by the blending of selected lots of gelatin so that the over-all average molecular weight and other properties remain quite constant.

As a general rule, the product is evaluated on the basis of two colloidal properties, viscosity of solution and stiffness of gel. Viscosity is measured at 6.67% concentration (anhydrous basis) and is expressed in millipoises. Stiffness of gel, or "jelly strength," is determined for the same concentration by the Bloom test; it is expressed as the weight in grams required at 50° F. (10° C.) to impress the jelly surface a given distance. Both determinations are necessary for commercial evaluation since it is quite possible to produce extractions of gelatin of different qualities from the same lot of raw material, one having higher jelly strength and lower viscosity than the other; for instance, 300 g. and 50 millipoises or 240 g. and 60 millipoises. The end use of the gelatin determines which characteristic is of more importance.

High jelly strength is obviously needed for the production of gels. Gelatins are primarily blends of individual lots or extractions. These blends have a jelly strength from 75 g. to 300 g. The higher the Bloom test the greater is the utility, since proportionally less of a high jelly-strength gelatin is required for producing a gel under a given set of conditions.

The United States government specifications issued in Jan. 1945 listed the following limits for dessert gelatin:

1. Ground to pass 90-mesh sieve.
2. Hot aqueous solution should be clear, of light colour and free from foreign odour or taste.
3. Free from chemical preservatives, grit, dirt and foreign matter.
4. Jelly strength not less than 220 g.
5. Total bacteria count not exceeding 5,000 per gram.
6. Free of the organism *E. coli*, gas-forming anaerobes and liquefiers.

Additional specifications covering heavy metals and other impurities in foods must be met by all gelatin sold for edible purposes.

(See *U.S.P. XIII Standards*, 1942.)

In addition to gelatin for desserts or sweets, there are the edible ice cream, marshmallow, confectionery and capsulating gelatins. Hectographic, photographic and other technical gelatins are not required to meet food specifications.

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GELDER, AERT (Arent) **DE** (1645–1727), Dutch painter, who, except for a stay in Amsterdam where he became Rembrandt's pupil around 1661, lived at Dordrecht. De Gelder is remarkable in Dutch art as the only artist who kept to the Rembrandt tradition in the late 17th and early 18th century. His biblical scenes especially are full of strong colours and fantastic light effects. He varies Rembrandt's compositional ideas in a personal way (series of the Passion c. 1715, Amsterdam and Munich). As a portrait painter he is equally unconventional and the broad character of his painting contrasts strongly with the polished and refined surface paint of his contemporaries.

See K. Lilienfeld, *Arent de Gelder, sein Leben und seine Kunst . . .* (1914). (H. K. Gn.)

GELDERLAND (*Guelders*), a province of the Netherlands, bounded south by North Brabant, west by Utrecht and South Holland, northwest by the Ijselmeer, north by Overysel and southeast by North Rhine-Westphalia. It has an area of 1,932 sq.mi. and a pop. (1957 est.) of 1,223,434, the density per square mile being 633.

The main portion of Gelderland north of the Rhine and the Old Ysel forms an extension of the province of Overysel and is composed of diluvial sand and gravel, covered with heaths and patches of fen. South of this line, however, the soil consists of fertile river-clay. The northern portion is divided by the New (or Gelders) Ysel into two distinct regions, namely, the Veluwe ("bad land") on the west, and the former countship of Zutphen on the east. In this last division the ground slopes downward from southeast to northwest (131 to 26 ft.) and is intersected by several fertilizing streams which flow in the same direction to join the Ysel. The extreme eastern corner is occupied by older Tertiary loam, which is used for making bricks, and upon this and the river banks are the most fertile spots, woods, cultivated land, pastures, towns and villages. The highlands of the Veluwe lying west of the Ysel really extend as far as the Crooked Rhine and the Vecht in the province of Utrecht, but are slightly detached from the Utrecht hills by the Gelders depression, which forms the boundary between the two provinces. This extends from the Rhine along the Grift, the Luntersche Beek and the Eem to the Zuider Zee, and would still offer an outlet in this direction to the Rhine at high water if it were not for the river dikes. The two main ridges of the Veluwe hills (164 and 360 ft.) extend from the neighbourhood of Arnhem northwest to Harderwyk and north to Hattem. In the south they stretch along the banks of the Rhine, forming a strip made up of sandhills and trees, claylands and pastures. All over the Veluwe are heaths, scantily cultivated, with fields of rye and buckwheat, cattle of inferior quality and sheep, and a sparse population. There is also a considerable cultivation of wood, especially of fir and copse, while tobacco plantations are found at Nykerk.

The southern division of the province is watered by three large rivers, the Rhine, the Waal and the Maas, and has a level clay soil, varied only by isolated hills and a sandy, wooded stretch between Nijmegen and the southern border. The region enclosed between the Rhine and the Waal and watered by the Linge is called the Betuwe ("good land") and gave its name to the Germanic tribe of Batavians. There is here a denser population, occupied in the cultivation of wheat, beetroot and fruit, the breeding of excellent cattle, shipping and industrial pursuits. The principal centres of population, such as Zutphen, Arnhem (the chief town of the province), Nijmegen and Tiel, as well as smaller old towns, lie along the rivers. (X.)

History.— It was formerly a duchy of the empire, bounded by Friesland, Westphalia, Brabant, Holland and the Zuider Zee, part of which has become the province of Holland. The territory of the later duchy of Gelder formed part of the Frankish kingdom of Austrasia. In 843, by the treaty of Verdun, it became part of Lotharingia (Lorraine), and in 879 was annexed to the kingdom of East Francia by the treaty of Mersen. The nucleus of the later county and duchy was the district surrounding the town of Gelder or Gelre, lying between the Meuse and the Niers, and after 1715 included in Rhenish Prussia.

There were in the 11th century a number of counts ruling in various parts of what was afterward known as Gelderland. Toward the close of that century Gerard of Wassenburg acquired a dominant position and is generally reckoned as the first hereditary count of Gelder (d. 1117–18). His son, Gerard II (d. 1131), married Irmingardis, daughter and heiress of Otto, count of Zutphen, and their son, Henry I (d. 1182), inherited both countships. His successors, Otto I (1182–1207) and Gerard III (1207–29), were lovers of peace and strong supporters of the Hohenstaufen emperors, through whose favour they were able to increase their territories by acquisitions in the districts of Veluwe and Betuwe. Otto II (1229–71) became a person of so much importance that he was urged to be a candidate for the dignity of emperor, but he preferred to support the claims of his cousin, William II of Holland. In return for the loan of a considerable sum of money William gave to him the city of Nijmegen in pledge. His son Reinald I (d. 1326) married Irmingardis, heiress of Limburg, and in right of his wife laid claim to the duchy against Adolf of Berg, who had sold his rights to John I of Brabant. War followed, and on June 5, 1288, Reinald was defeated and taken prisoner at the battle of Woeringen and surrendered his claims to John of Brabant. In 1310, Reinald received from the emperor Henry VII the exemption of his subjects from the liability to be sued before any court outside his jurisdiction, and in 1317 he was made a prince of the empire.

Reinald II., his son (1326–43), was one of the foremost princes in the Netherlands of his day. He married (1) Sophia, heiress of Mechlin, and (2) in 1331 Eleanor, sister of Edward III of England. By purchase or conquest he added considerably to his territories. He did much to improve the condition of the country, to foster trade, to promote the prosperity of the towns and to maintain order and security in his lands by wise laws and firm administration. In 1338 the title of duke was bestowed upon him by the emperor Louis the Bavarian, who at the same time granted to him the fief of East Friesland. He died in 1343, leaving three daughters by his first marriage, and two sons, Reinald and Edward, by Eleanor of England. His elder son was ten years of age and succeeded to the duchy under the guardianship of his mother, Eleanor. Declared of age two years later, Reinald III found himself involved in a struggle between two rival factions which ended only after his death in 1374, with the recognition as duke of his nephew William of Julich, son of his younger sister, Maria.

Duke William was able, restless and adventurous. He took part in no less than five crusades with the Teutonic order against the heathen Lithuanians and Prussians. In 1393 he inherited the duchy of Jiilich and died in 1402. He was succeeded by his brother, Reinald IV (d. 1423), in the united sovereignty of Gelder, Zutphen and Jiilich. On his death Gelder passed to the young Arnold of Egmont, grandson of his sister Johanna, whose daughter Maria (d. 1415) was wife of John, count of Egmont (d. 1451). Arnold was recognized as duke in 1424 by the emperor Sigismund, but in the follo ing year the emperor revoked his decision and bestowed the duchy upon Adolf of Berg. Arnold in retaliation laid claim to the duchy of Jiilich, which had likewise been granted to Adolf by Sigismund, and a war followed which ended in Arnold's retaining Gelder and Zutphen, and Gerard, the son of Adolf (d. 1437), being acknowledged as duke of Julich. To gain the support of the estates of Gelder in this war, Arnold had made many concessions limiting the ducal prerogatives and granting large powers to a council consisting of representatives of the nobles and the four chief cities; his extravagance and exactions led to continual conflicts, and in his later years a conspiracy was formed against him, headed by his wife and his son Adolf, which gave an opportunity of intervention to Charles the Bold of Burgundy. For 92,000 golden gulden, Arnold sold the reversion of the duchy to Charles (1471). On Feb. 23, 1473, Arnold died and Charles became duke of Gelder. His succession was not unopposed. Nijmegen offered an heroic resistance and only fell after a long siege. After Charles's death in 1477 Adolf was released from the captivity in which he had been held and placed himself at the head of a party in the powerful city of Ghent, which sought to settle the disputed succession by forcing a match between him and Mary, the heiress of Burgundy. On June 29, 1477, however, he was killed at the siege of Tournai; and Mary gave her hand to the archduke Maximilian. Catherine, Adolf's sister, made an attempt to assert the rights of his son, Charles, but by 1483 Maximilian had crushed all opposition and established himself as duke of Gelder.

Charles of Egmont, however, did not surrender his claims, but with the aid of the French collected an army, and in the course of 1492 and 1493 succeeded in reconquering his inheritance. 'In 1507 he invaded Holland and Brabant, captured Harderwijk and Bommel in 1511, threatened Amsterdam in 1512 and took Groningen. It was undoubtedly a great and heroic achievement for the ruler of a petty state like Gelder thus to assert and maintain his independence against the overwhelming power of the house of Austria. It was not till 1528 that the emperor Charles V could force him to accept the compromise of the treaty of Gorinchem, by which he received Gelder and Zutphen for life as fiefs of the empire. In 1534 the duke, who was childless, attempted to transfer the reversion of Gelder to France, but was compelled by the estates in 1538 to appoint as his successor William V of Cleves (d. 1592). Charles died the same year. William, with the aid of the French, succeeded in maintaining his position in Gelder for several years, but was forced to cede the duchy to Charles V by the treaty of Venlo (Sept. 7, 1543).

Gelder was definitely amalgamated with the Habsburg dominions in the Netherlands, until the revolt of the Low Countries led to its partition. In 1579 the northern and greater part, comprising the three "quarters" of Nijmegen. Arnhem and Zutphen, joined the Union of Utrecht and became the province of Gelderland in the Dutch republic. Only the quarter of Roermond remained subject to the crown of Spain, and nas called Spanish Gelderland. By the treaty of Utrecht (1713) this was ceded to Prussia with the exception of Venlo, which fell to the United Provinces, and Roermond, which with the remaining Spanish Ketherlands passed to Austria Of this, part was ceded to France at the peace of Basle in 1795, and the whole by the treaty of Lunéville in 1801, uhen it received the name of the department of the Roer By the peace of Paris of 1814 the bulk of Gelderland mas incorporated in the United Netherlands, the remainder falling to Prussia, where it formed the circle of Dusseldorf

The rise of the towns in Gelderland began in the 13th century, river commerce and markets being the chief cause of their prosperity, but they never attained to the importance of the larger cities in Holland and Utrecht, much less to that oi the great Flemish municipalities. They differed also from the Flemish cities in the nature of their privileges and immunities, since they did not possess the rights of communes but only those of "free cities" of the Rhenish type. The power of the feudal lord over them was much greater. The states of Gelder first became a considerable pouer in the land during the reign of Arnold of Egmont (1423–73). From this time the absolute authority of the sovereign in Gelder was broken The states consisted of two members—the nobility and the towns. The towns were divided into four separate districts or "quarters" named aiter the chief town in each—Kijmegen, Arnhem, Zutphen and Roermond Each quarter had peculiar rights and customs, and their representatives met together in a separate assembly before taking part in the diet of the states. The nobility possessed great influence in Gelder and retained it in the time of the republic. (G E.; X.)

GELIMER or GEILAMIR (*fl.* 530–534), last king of the Vandals in Africa. a great grandson of Gaiseric, succeeded when Hilderic was deposed in 530. Justinian, who invited him to allow the old king to remain sovereign in name and to content himself with the actual power, was in reality desirous of an excuse for interference in Africa. In j33 Justinian sent against him a great expedition under Belisarius (*q.v.*). Gelimer was defeated and in 534 taken prisoner. He was then permitted to settle in Galatia.

GELLERT, CHRISTIAN FÜRCHTEGOTT (1715–1769). German poet, born at Hainichen. Saxony, on July 4, 171j, studied at Leipzig became *Privatdozent* there in 1745 and in 1751 extraordinary professor. He died at Leipzig on Dec. 13. 1769. His best work is to be found in the admirable Fnbeln und *Erzählungen* (1746–48), for which he took La Fontaine as his model. His Geistliche Oden und Lieder (1757) were among the great religious poems of their time. Some of them mere set to music by Beethoven. Gellert also wrote a few comedies.

GELLERT or KILLHART, in Welsh traditional history, the dog of Llewellyn, prince of Wales. The dog, a greyhound. is left to guard the cradle in which the infant heir sleeps. A wolf enters and is about to attack the child, when Gellert flies at him. In the struggle the cradle is upset and the infant falls underneath. Gellert kills the wolf, but when Prince Llewellyn arrives and sees the empty cradle and blood all around, he thinks Gellert has killed the baby. He at once stabs him and then finds his son safe under the cradle and realizes the dog's bravery. Gellert is supposed to have been buried near the village of Beddgelert ("grave of Gellert"), Snowdon. uhere his tomb is pointed out to visitors. The date of the incident is traditionally given as 1205. The story is only the Welsh version of a tale which is traced to the Indian Panchatantra and perhaps as far back as 200 B.C.

GELLIGAER, a town and urban district in the Caerphilly parliamentary division of Glamorgan, Wales, in the heart of the south Wales coal fields Pop (1961) 34.572. Area 26 2 sq mi. The chief town of the district is Bargoed. about 16 mi. N of Cardiff by road, which contains a large public park. Gelligaer takes its name from the Roman fort which lies northwest of the 8th-century parish church of St. Cattwg and is 780 ft. above sea level. Many of the relics found when the fort was excavated are in the National Museum of Wales in Cardiff. Charles I stayed at the 16th-century manor house of Llancaiach when he visited Glamorgan in 1645.

The three coal mining valleys of Taff Bargoed, Deri and Rhymney lie nithin the district which is bounded on the east by the river Rhymney, there the boundary between Glamorgan and Monmouthshire. and on the west by the river Taff Bargoed. Besides coal mines there are automobile and rubber works.

GELLIUS, AULUS (b. c. A.D. 130), Latin author, who composed a miscellany entitled Noctes Atticae in which are preserved many fragments of lost works. He is an interesting source of information about the knowledge and studies of his own day. Both in Rome, where he received instruction in literature (*grammatica*) and rhetoric, and in Athens, where he studied philosophy, his teachers and friends included many distinguished men. He was appointed a judge in private cases in Rome. It was in Athens, during the long winter evenings, that he began his practice of excerpting from authors, and after his return to Rome he continued this work which led to the publication of his Noctes *Atticae*. Written partly for the benefit of his children it comprised 20 books. The beginning of the preface and the end of the last book are lost and of the eighth book only the chapter headings have survived. It is a miscellany with no systematic order touching on the most diverse matters of language, literature, dialectic, philosophy, arithmetic, geometry, antiquities, law, history and other subjects. Gellius' aim was to provide interesting but not exacting reading. He seems to have been a modest and amiable man. He had neither a profound mind nor much critical power, but he was a diligent and accurate student whose delight was in books and learning.

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GELLIVARA (GÄLLIVARE), a mining town of Sweden in the district (lan) of Norrbotten, 815 mi. N. of Stockholm by rail. It lies in the well-nigh uninhabited region of Swedish Lapland, 43 mi. N. of the Arctic circle. Pop. (1960) 10.159. There are iron mines in the mountain hfalmberget $4\frac{1}{2}$ mi. to the north, rising to 2.024 ft. above sea level (830 ft. above Gellivara town). After the mines: which had been previously begun and abandoned, were reopened late in the 19th century a provisional railway was built from Malmberget to Luleå at the head of the Gulf of Bothnia (127 mi. S.S.E.). In 1891 the Swedish government bought the railway. The output of ore was insignificant until about 1892 but later increased considerably. (See KIRUNA.)

GELNHAUSEN, a town formerly in the Prussian province of Hesse-Nassau, after 1945 in Hesse, Federal Republic of Germany, 27 mi. E.N.E. of Frankfurt-on-Main, on the railway to Bebra. Pop. (1959 est.) 7,739. Gelnhausen became an imperial town in 1169. and diets of the empire were frequently held there. In 1803 the town became the property of Hesse-Cassel and in 1866 passed to Prussia. Ancient walls still stood in modern times.

On an island in the river are ruins of the palace built by Frederick I (Barbarossa) before 1170 and destroyed by the Swedes in the Thirty Years' War. The beautiful Marien Kirche, with four spires was built in the 13th century and restored in 1876–79; among other ancient buildings are the town hall, the Fiirstenhof (later administrative offices) and the Hexenthurm.

GELON, son of Deinomenes, tyrant of Gela and Syracuse. On the death of Hippocrates, tyrant of Gela (491 B.C.), Gelon, who had been his commander of cavalry, succeeded him, and in 485, his aid having been invoked by the Gamori (the oligarchical landed proprietors) of Syracuse, who had been driven out by the populace: he seized the opportunity of making himself despot. From this time Gelon paid little attention to Gela and devoted himself to the aggrandizement of Syracuse, which attained extraordinary wealth and influence. When the Greeks solicited his aid against Xerxes. he refused it, since they would not give him command of the allied forces (Herodotus vii, 171). In the same year the Carthaginians invaded Sicily, but were totally defeated at Himera, the result of the victory being that Gelon became lord of all Sicily. After he had thus established his power, he made a show of resigning it; but his proposal was rejected by the multitude. and he reigned without opposition till his death (478).

See also SICILY: *History* and SYRACUSE.

GELSEMIUM (YELLOW JASMINE ROOT), a drug consisting of the dried root of Gelsemium sempervirens (family Loganiaceae). The plant is a woody twining shrub having a milky juice; opposite, lanceolate, shining leaves; and clusters of from one to five large, funnel-shaped, fragrant yellow flowers. It is native to the southeastern United States, where it is known as wild, yellow or Carolina jasmine; it is not related in any way, however, to the true jasmine, which is a member of the family Oleaceae. Commercial supplies are collected in Virginia, North and South Carolina, Tennessee and Georgia. The roots and underground stems are dug up in the autumn, washed and dried. The plant was first described in 1640 but was not used medicinally until about 1821.

Three alkaloids have been isolated in crystalline state, gelsemine, gelsemicine and sempervirine. All three have similar pharmacologic properties, gelsemicine being the most potent and toxic. Gelsemium depresses the motor nerve cells of the brain and spinal cord, resulting in generalized muscular weakness. Death from action of this drug is caused by respiratory failure resulting from paralysis of the respiratory muscles. The drug is little used medicinally, though formerly it was used in treating various neuralgic conditions. (V. E.)

GELSENKIRCHEN, an industrial town in the Land North Rhine-Westphalia in the German Federal Republic. Pop. (1950) 315,460. In the mid-19th century Gelsenkirchen was a village with only about 650 inhabitants. It developed as a mining and industrial town only after 1870. Early in the 20th century the towns of Buer and Horst were amalgamated nith Gelsenkirchen. Buer, north of the river Emscher which bisects the tonn, is surrounded by a 1,000-ac. green belt; at Horst there is a Renaissance palace, built in 1558, which survived the heavy bombing of World War II in which 38% of the public buildings in Gelsenkirchen were destroyed. The Hans Sachs house and the Buer tonn hall are the seats of the municipal administration. The town possesses a museum, a zoological garden (opened in 1949), a number of public gardens and two race-courses. The Institute of Hygiene for the Ruhr is situated in Gelsenkirchen. The railway connecting Hamburg uith the south and Cologne with the east, the Cologne-Berlin *Autobahn* and two federal highways, and the Rhine-Herne canal all pass through the town. At Gelsenkirchen is a port on the canal. To the south is the large conglomeration of mines which made Gelsenkirchen one of the largest coal mining and coking centres of Germany. There is also a variety of industries of considerable importance; the chief of these are the iron and steel works. chemical, glass and clothing industries. (P. Z.)

GEM, a mineral used for adornment. The true gem stone is a product of nature and is often referred to as a natural gem to distinguish it from synthetic gems and artificial gems. A synthetic gem is a man-made product which has the same chemical composition, crystallographic and physical properties as the mineral occurring in nature. It differs from the true gem only in its origin and in those features which reflect the different environment of its growth. An artificial gem is a man-made product whose composition and properties are different from the gem stone it imitates but which simulates its appearance. The term manufactured gem not only includes any man-made product but also treated gems. A mineral which has been heated, subjected to the influence of radioactive material, dyed or has had its appearance changed by some other process is properly called a treated gem. Most gems are inorganic minerals, but pearl, amber, coral and jet originate in life processes. The diamond, ruby. sapphire. emerald and sometimes chrysoberyl are commonly designated as precious, and all others as semiprecious stones. This distinction, in general, denotes the relative value of the respective gems. but there is a wide variation in the quality and, therefore, in the value of different specimens of the same gem. Because the finer qualities of amethyst, opal, topaz and zircon may be more valuable, weight for weight, than the inferior qualities of the so-called precious stones, this classification has lost much of the significance formerly attached to it.

The desire to wear gems has been characteristic of all ages and all groups of mankind. For generations the diamond has been preeminent in the western world. the ruby in India and the jade in China. Custom or fashion has influenced the relative popularity of other gems. While fashion plays an important role in their use, changes are measured in decades rather than in seasons. The gems of lesser importance often achieve an extensive use locally in the districts in which they are produced, such as turquoise in southwestern United States.

This article discusses gems under the following main headings: Natural Gems, Synthetic Gems, Imitation Gems and Gems in Art.

NATURAL GEMS

Of the approximately 2,000 inorganic minerals, only the following 16 achieved importance as gems: beryl, chrysoberyl, corundum, diamond, feldspar, garnet, jade, lazurite, olivine, opal, quartz, spinel, topaz, tourmaline. turquoise and zircon. The quasi mineral pearl completes the list of important gems. All except zircon, which gained widespread popularity in the 1930s, have been worn for centuries.

When the same mineral is found in two or more colours, a specific gem name is commonly given to each variety; hence, two gems may be identical in every respect except in the small amount of impurity that acts as a pigmenting agent. Emerald is the green, aquamarine the blue variety of beryl; ruby the red, sapphire the blue variety of corundum. However. in the case of diamond and topaz, individual gem names are not given to the variously coloured stones.

Because wealth can be conveniently concentrated in gems, for which there is a ready market in all parts of the world, persons of wealth have commonly invested portions of their fortunes in gems. Centuries ago, this motive was more compelling than in modern times, but this practice was again demonstrated during the invasion of the Netherlands, Belgium and France in World War II.

The general properties and characteristics of minerals, which are fully discussed in the article MINERALOGY, are applicable to gems. Only those properties which have special significance when attached to gems will be considered here. Gem minerals have certain characteristics that set them apart from nongem minerals—beauty, durability and rarity. No mineral lacking in any of these characteristics has ever achieved distinction. However, beauty only is essential in a gem. Some gem minerals of minor importance, such as satin spar and malachite, are too soft to be durable. and others like rock crystal and pyrope are not uncommon. Among those qualities that give beauty to gems, colour is the most important.

Colour.—Only a few gems are idiochromatic; that is, with a colour which is distinctive and inherent in the chemical constitution of the mineral. Most gem minerals are allochromatic; that is, they are colourless when pure, and their colour is dependent upon impurities which act as pigmenting agents. In most instances, allochromatic gems are also transparent or translucent.

Gem minerals generally occur in well-developed crystals (*see* CRYSTALLOGRAPHY). Such crystals are apt to be pure and, therefore, transparent. Opal is the only important gem mineral which is amorphous, that is, not found in the crystalline state. An even distribution of pigment is desirable in transparent gems, but in some translucent stones, such as agate and heliotrope (bloodstone), their mottled appearance, caused by an uneven distribution of pigment, is characteristic.

Because of its other unusual properties, diamond is the only gem which is valuable when colourless. Those varieties which are coloured red, green or blue are, however, much more valuable and are called fancies, bringing a higher price than any other gem. But a trace of yellow pigment will lower the value to one-half or one-third of that of the diamond devoid of colour. Such diamonds are called Capes. Conversely, the colourless variety of topaz is worth little more than the cost of cutting, while the most highly prized topaz possesses a distinct yellow colour faintly tinged with wine. In 1956 the U.S. Federal Trade commission ruled that any colour term, such as blue-white, could not be used in describing a diamond unless the stone had a tinge of the colour mentioned. The so-called blue-white diamond contains no blue pigment.

The play of colours characteristic of opal and labradorite is caused by the interference of light waves reflected from successive layers within the stone. It is analogous to the coloured reflections from thin films of oil on water. Similarly, the asterism of star rubies and sapphires and the chatoyancy of cat's-eye, satin spar and tiger's-eye are structure phenomena.

Asterism in the ruby and sapphire is produced by minute inclusions oriented with respect to the hexagonal crystal structure of the mineral; hence, the six-pointed star. Chatoyancy, a single band of light which moves across the surface of the stone as its position is changed, is produced by the parallel orientation of inclusions. The flashes of red and blue which one observes on properly cut diamonds, zircons, rutile, sphenes and demantoid garnets when held in a beam of parallel light are called fire. Like the rainbow, fire is caused by dispersion (see LIGHT).

As recovered from the earth, few gem stones are attractive. Only after the gem cutter has given the stone proper proportions and a high polish to emphasize its pleasing characteristics may it be called a gem. All types of cutting are classified either as (1) cabochon, curved surfaces; (2) faceted, flat surfaces; or (3) carved, cameo (relief), intaglio (engraved). The styles and methods of cutting are described below under *Gems* in ***Art*** and under LAPIDARY AND GEM CUTTING; and SEALS.

Colour Improvement.——Proper treatment often improves the colour of a gem. This was practised in India centuries ago by heating faintly coloured chalcedony to produce the attractive yellow-red of carnelian. Similarly, amethystine to smoky-coloured quartz may be changed to the yellow citrine, which then is commonly but improperly sold as topaz. The colours of many amethysts and aquamarines and some rubies and tourmalines are the result of heat treatment.

Zircon, when mined, is commonly reddish-brown. Many zircons develop a fine blue colour when heated in a reducing atmosphere at 900° C. to 1,000° C.; an occasional stone becomes red or green, others colourless. Practically all of the zircons marketed are the result of heat treatment.

X-rays, cathode rays, radium emanations and cyclotron bombardment induce many colour changes in gems. Of these, the production of a green colour in diamonds by radium or cyclotron bombardment is the most important. This green colour is only skin deep, and may be removed by heating the diamond at 900° C. Diamonds treated with radium develop a similar green colour and also a secondary radioactivity, which persists for years and serves to distinguish them from diamonds treated in the cyclotron.

Nearly any colour can be produced in chalcedony, agate and onyx by staining with appropriate chemicals or dyes. Agates were first dyed in the Idar-Oberstein district, Germany, in the early part of the 19th century by soaking them in sugar or honey solutions and subsequently placing them in concentrated sulphuric acid. The acid chars the absorbed sugar to carbon, staining the various layers of agate from light brown to black, depending on their porosity. The nonporous layers remain colourless, accentuating the banded structure of the agate.

Red hues are commonly produced by ferric oxide; greens by chromium and nickel compounds; blue by ferric ferrocyanide. Solutions of other inorganic compounds and organic dyes may be used. Practically all agate and onyx of gem quality have been artificially coloured.

Brilliancy.— This depends upon the amount of incident light that is reflected from the surface and the interior of the stone. The amount of light reflected by surfaces with equal polish varies with the indices of refraction of the gem. The index of refraction of rock crystal (quartz) is 1.55; sapphire 1.76; zircon 1.95; and diamond 2.42. The percentage of normally incident light reflected from the polished surfaces of these gems is roughly in the ratio of 1 : 1.5 : 2 : 4.

If a gem has been properly cut, the light which enters the stone will be twice totally reflected by the back facets, and will emerge at the front surface. The stone will appear to have a silvered back. The amount of totally reflected light increases with the index of refraction and, therefore, a greater amount of light will be reflected from the interior of the diamond than from any other natural gem; hence, it is the most brilliant.

Identification of Gems.--Uncut gem stones may be identified by crystal form, hardness, cleavage, fracture, structure or chemical tests. When cut, many of these properties are not visible, or their determination would damage the gem, though, under the microscope, minute cleavages or fractures and the presence of characteristic inclusions and their distribution may give evidence as to the stone's identity. However, a positive identification is made only after one or more of the physical constants have been determined. In most instances, the determination of the density (specific gravity) and the index of refraction will suffice.

Various methods of determining density are described under the article DENSITY. The Jolly balance is unsatisfactory, except for the larger stones. Accurate determinations can be made on very small stones by suspending the gem in water from the arm of a chemical balance in a spiral coil at the end of a fine wire.

The index of refraction can be conveniently measured by the method of total reflection. Several small, hand-sized refractometers have been specially designed for this purpose. They consist of either a hemisphere or prism of high-index glass, upon which the gem is placed. A beam of light is directed from the undersurface toward the gem. The totally reflected rays fall upon a calibrated ground-glass scale. A numerical value is directly read which is the refractive index of the gem. It is essential that the film of air between the high-index glass and the gem be displaced by a liquid the refractive index of which is greater than that of the gem. A solution of sulphur in methylene iodide with a refractive index of 1.793 is commonly used. Diamond, titanite, zircon, rutile and some garnets have greater indices than this liquid and, consequently, cannot be differentiated by this method.

A determination of the density and refractive index will give a positive identification of an unknown gem, except in those rare instances, such as ruby and almandite, where the values are the same for both gems. However, almandite crystallizes in the cubic system and hence is optically isotropic (singly refractive). while ruby is hexagonal and anisotropic (doubly refractive). Two convenient instruments! the polariscope and the dichroscope. were designed for differentiating gems on the basis of these optical properties. Their use in the determination of gems is discussed under the article CRYSTALLOGRAPHY: *Optical Crystallography.* It has been noted that the refractive indices of diamond, titanite. zircon, rutile and some garnets cannot be determined on the refractometer. However, because garnet and diamond are optically isotropic. and zircon and titanite are strongly anisotropic, a positive determination can be made by using the polariscope in conjunction with density determinations.

Of all the diagnostic properties, the determination of the index of refraction is the most useful and, at the same time, the most readily determined. Satisfactory readings may often be obtained from the curved surfaces of a cabochon-cut stone by carefully adjusting the position of the stone on the refractometer so that the point of contact with the high-index glass is at the optical centre of the instrument.

Trade.—Because of their nearly indestructible character, gems are sold and resold from generation to generation. The available supply is not greatly affected by the production of newly mined gems in any year. However, as with other luxury items, demand fluctuates markedly with business conditions. Hence, price variations are determined largely by demand.

Science and modern industrial processes have had but slight influence on the gem-cutting industry. In the gem-cutting centres of Europe, the family is still the basic business unit. Knowledge and skills are passed on from father to son, and the traditions of the guild survive in many forms. The fine craftsman combines both mechanical and artistic skills.

The Gemmological Association of Great Britain (1931) and the Gemological Institute of America (1931) instituted courses of study based on a scientific approach to gemology. The American Gem society (1934) was organized to maintain and raise professional standards and to promote education and research in its field. The Gemmological Association of Australia (1946) was established for similar purposes. These organizations were founded in the retail trade with which their efforts are primarily concerned, but their influence extends to the producers, manufacturers and wholesalers.

(See also JEWELLERY; LAPIDARY AND GEM CUTTING.)

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PRECIOUS AND SEMI-PRECIOUS STONES

1, Turquoise, China; 2, turquoise, Egypt; 3, demantoid garnet, Chudóvaya river, Urals, Russia; 4, garnet (pyrope), Gallup, New Mexico; 5 and 6, kunzite, Pala, San Diego County, Calif.; 7, tourmaline, Paris, Maine; 8, tourmaline (tricoloured), Minas Gerais, Brazil; 9 and 10, aquamarine, Minas Gerais, Brazil; 11 and 12, quartz amethyst, Ural Mountains, Asiatic Russia; 13 and 14, topaz, Ouro Preto, Brazil; 15 and 16, malachite, Russia; 17, opal on ironstone, Queensland, Australia; 18, opal, New South Wales

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DIAMONDS AND OTHER HARD STONES

1, **Sapphire, crystal,** Ceylon; 2, **sapphire,** blue, Ceylon; 3, chrysoberyl, Ceylon; 4, **ruby,** Burma; 5, star **sapphire,** Ceylon; 6, ruby; 7. diamonds, **ıatural** round bort (white, **grey,** black); 8, diamond, crystal in blue ground matrix, Kimberley, S. Africa; 9, diamond. Brazil; 10, emerald in limestone, Muzo Mine. Colombia; 11, emerald. East Indian carving. Muzo Mine, Colombia; 12, jade (Jadeite) **Mogaung,** Burma; 13, jade (Nephrite), Jew **Zealand**

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PRECIOUS ORGANIC SUBSTANCES

1, Pearl in Unio, common fresh-water mussel; 2, Pearl from Unio, fresh-water mussel; 3, Oriental pearl, black, Gulf of Mexico; 4, Pearl in shell of common clam (*Venus mercenaria*), Long Island Sound; 5, ambergris, concretion from whale; 6, coral, precious, Japan; 7, amber, Chinese carving, Burma; 8, *Corallum rubrum*, precious coral, Mediterranean; 9, amber, enclosing insect, Samland, Baltic coast

GEM

BY COURTESY OF (1–18, 21–25, 27–31) THE METROPOLITAN MUSEUM OF ART, NEW YORK; FROM (19, 26) THE E. T. NEWELL COLLECTION, (20) THE W. G. BEATTY COLLECTION; ARRANGED BY MISS G. M. RICHTER

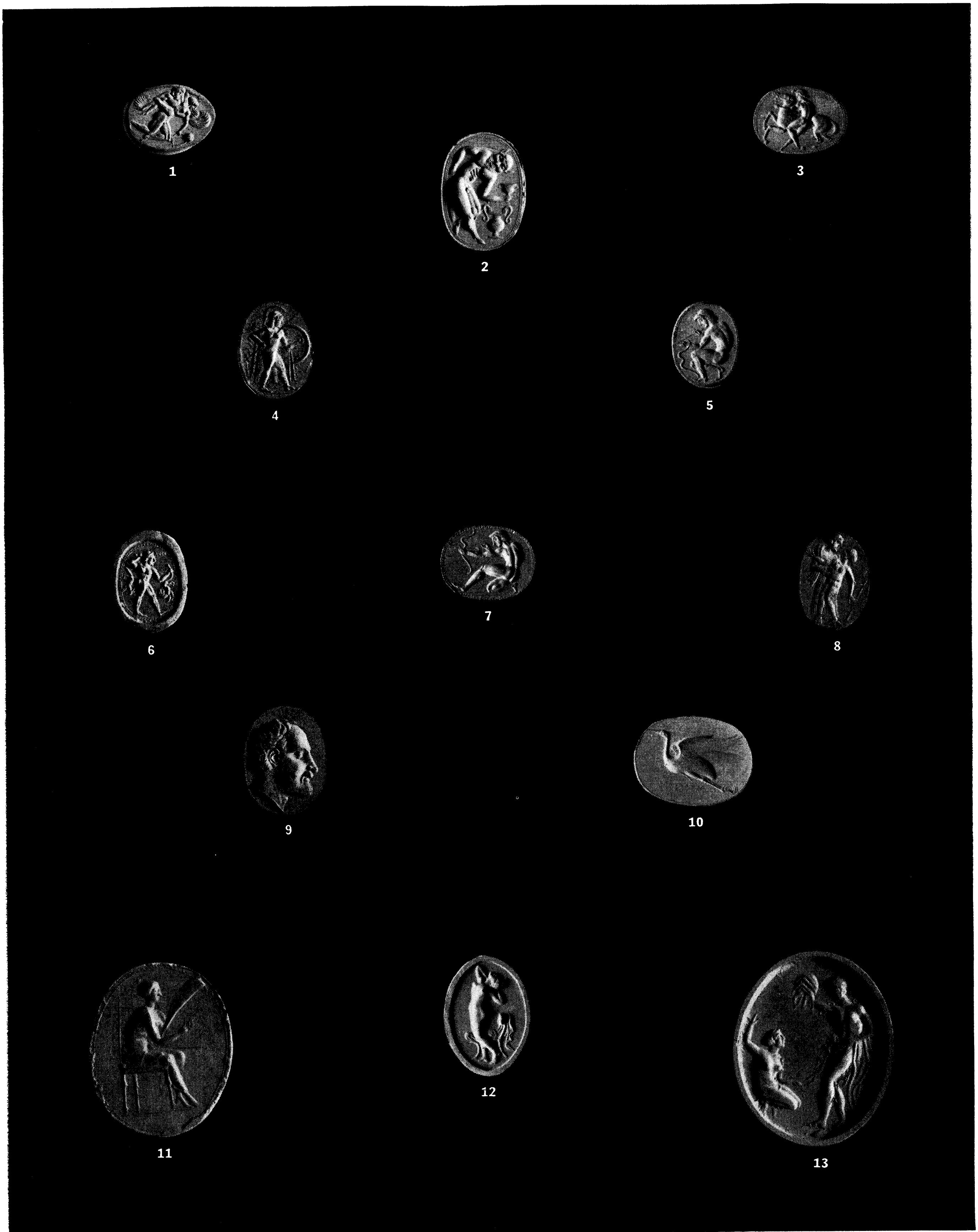
ANCIENT GEMS AND THEIR MATERIALS

1. Carnelian. 2. Sard. 3. Chalcedony. 4. Plasma. 5. Nicolo. 6. Moss agate. 7. Banded agate. 8. Peridot. 9. Heliotrope. 10. Black jasper. 11. Green jasper. 12. Red jasper. 13. Yellow jasper. 14. Rock crystal. 15 and 20. Amethyst. 16 and 17. Garnet. 18 and 30. Glass pastes. 19. Hematite. 21. Beryl. 22. Emerald. 23. Topaz. 24. Sardonyx, 25. Turquoise. 26. Lapis lazuli. 27. Onyx. 28. Porphyry. 29. Serpentine. 31. Steatite.
1, italic, 2nd century B.C.; 2, 4, 5, 7, 8, 9, 12–18, 20, 21, 23, 28, Roman, 1st century B.C. to 2nd century A.D.; 3, 6, 11, Greek, 6th–5th century B.C.; 10, 22, 24, 18–19th century A.D.; 19, Hittite, 2nd millennium B.C.; 25, 30, Hellenistic, 3rd–1st century B.C.; 26, Ephthalite (North Indian), 5th–6th century A.D.; 27. 29, 31 Minoan, 3rd–2nd millennium B.C.; 8, 24, 25, 30 are cameos and the rest intaglio seals

BY COURTESY OF (7, 11-15, 17) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (8, 16, 19) THE TRUSTEES OF THE BRITISH MUSEUM, (18) STAATLICHE MUSEEN, BERLIN; FROM (1) THE G. M. BRETT COLLECTION, (2, 3, 4, 5, 6, 9, 10) THE E. T. NEWELL COLLECTION

ORIENTAL, CRETAN AND OTHER GEMS, FROM 4000–500 B.C. (PLASTER IMPRESSIONS, EXCEPT FIG. 14)

1. Elamite, 4th millennium, marble. 2. Sumerian, 4th millennium, shell. 3. Akkadian, 1st half of 3rd millennium. 4. Sumero-Akkadian 2nd half of 3rd millennium; marble. 5. Amorite c. 2100–1800; hematite. 6. Hittite, North Syrian, c. 1400–1000 hematite. 7. Kassite, c. 1800; rock crystal. 8. Persian seal of Darius, c. 500; chalcedony. 9. Hittite c. 1400–1000 showing Egyptian influence; hematite. 10. Assyrian, c. 700; carnelian. 11. Early Minoan, c. 3500–2200; serpentine. 12. Middle Minoan, I. and II.; serpentine. 13. Late Minoan, I.–II.; red jasper. 14. Egyptian scarab, 13th dynasty; glazed steatite. 15. Graeco-Phoenician scarab, Bes with lions; green jasper. 16. Middle Minoan, III.; chalcedony. 17. Late Minoan, I.–II., onyx. 18. island gem, sea horse; steatite. 19. Geometric stone, chariot; steatite



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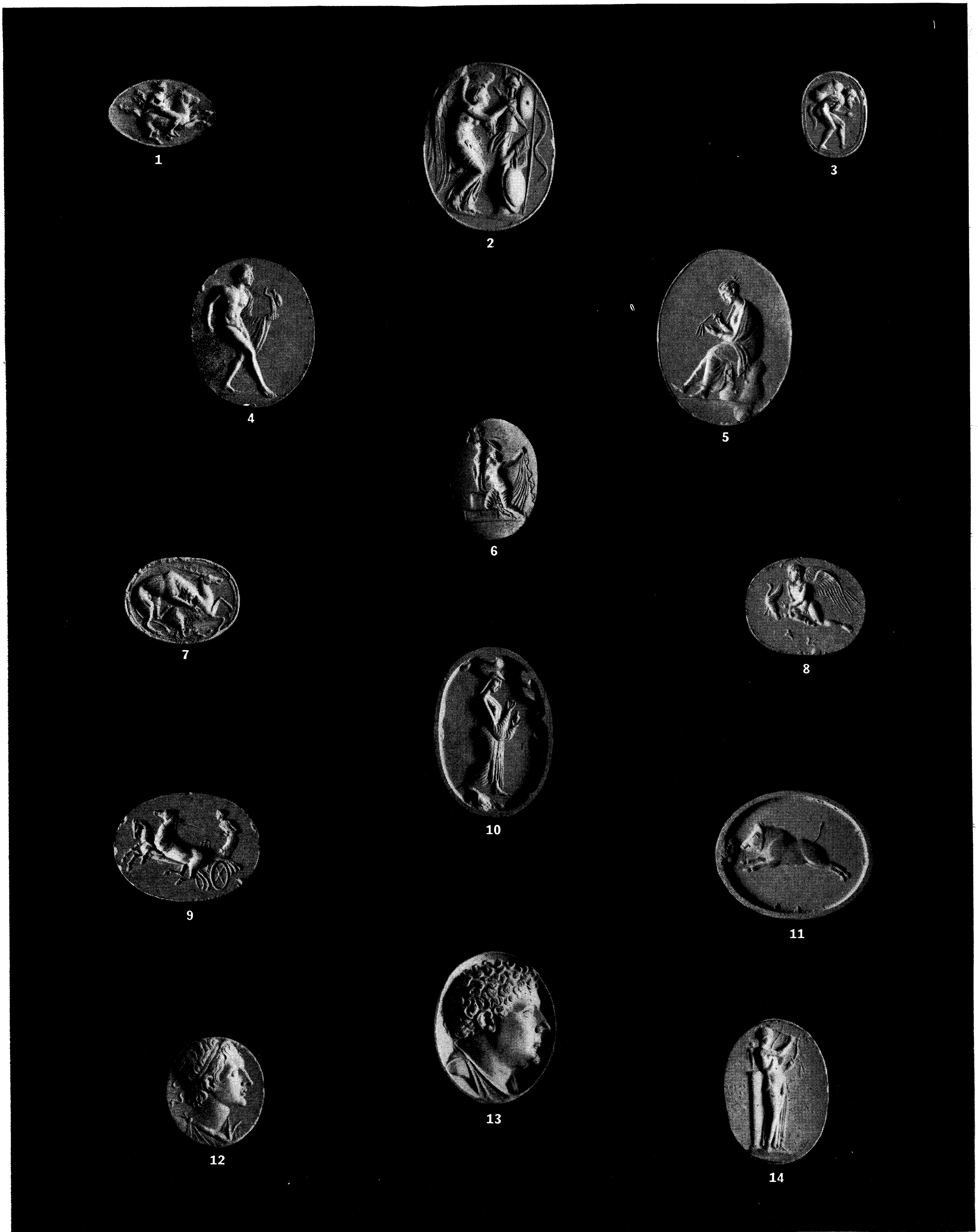
GREEK GEMS, 6TH AND 5TH CENTURIES B.C.
(ACTUAL SIZE. FROM PLASTER IMPRESSIONS)

1. Eros and girl. Carnelian, early 5th century. 2. Satyr dancing. Agate, late 6th century. 3. Youth with horse. Chalcedony; signed by Epimenes, *c.* 500. 4. Athena. Chalcedony, end of 6th century. 5. Archer. Chalcedony, *c.* 500. 6. Herakles. Carnelian, early 5th century. 7. Archer. Chalcedony, *c.* 500. 8. Hades and Persephone. Chalcedony, *c.* 460. 9. Portrait. Yellow jasper; signed by Dexamenos, 3rd quarter of 5th century. 10. Heron. Chalcedony; signed by Dexamenos, 3rd quarter of 5th century. 11. Woman playing harp. Rock crystal, 2nd half of 5th century. 12. Dancer. Gold ring, middle of 5th century. 13. Youth and woman. Burnt Carnelian, 2nd half of 5th century



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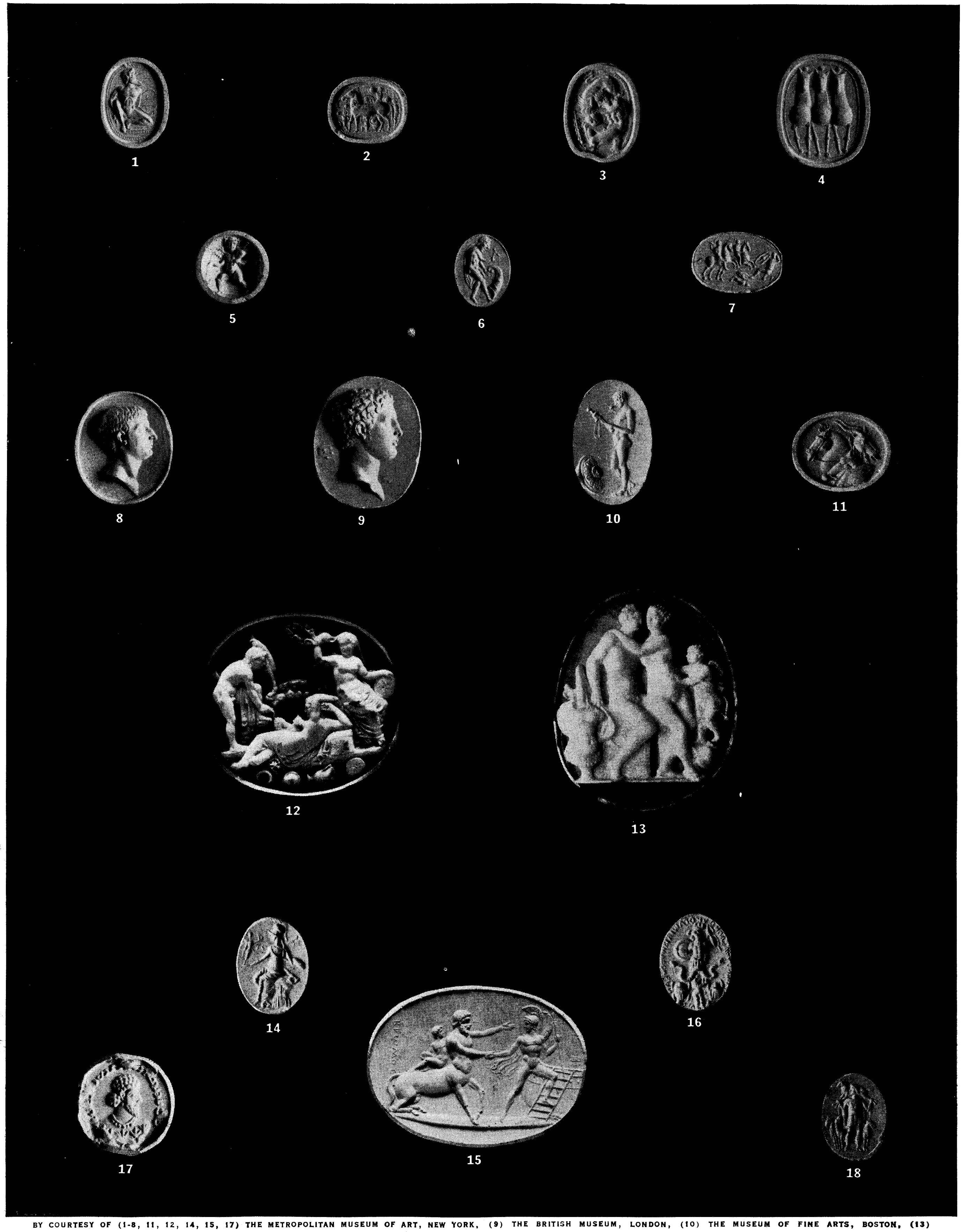
GREEK GEMS, 5TH TO 4TH CENTURY B.C., AND HELLENISTIC. GRAECO-PERSIAN GEMS
(ACTUAL SIZE. FROM PLASTER IMPRESSIONS)

1–9. GREEK, 5th–4th CENTURY B.C.: 1. Horseman. Gold ring, 4th century. 2. Nike and trophy. Chalcedony, signed by Onatas, 2nd half of 5th century. 3. Silenus with wins skin. Sard, 2nd half of 5th century. 4. Diomedes. Chalcedony, 1st half of 4th century. 5. Girl writing. Chalcedony, late 5th century. 6. Cassandra. Sard, 4th century. 7. Lion seizing deer. Rock crystal, late 4th century. 8. Eros with goose. Chalcedony, c. 400. 9. Two-horse chariot. Chalcedony, c. 4W. 10–11. GRAECO-PERSIAN: 10. Persian lady. Chalcedony, 2nd half of 5th century. 11. Boar. Chalcedany, 2nd half of 5th century. 12–14. HELLENISTIC: 12. Portrait of Alexander. Carnelian. 13. Portrait of Philetairos. Chalcedony sprinkled with jasper. 14. Muse with lyre. Yellow glass paste

GEM



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ETRUSCAN, ROMAN, EARLY CHRISTIAN, GNOSTIC, SASSANIAN, RENAISSANCE AND 19TH CENTURY GEMS
(ACTUAL SIZE, FROM PLASTER IMPRESSIONS, EXCEPT FIGS. 12–13)

1–4. **ETRUSCAN:** 1. Satyr. Banded agate, early 5th century. 2. Greeks emerging from the wooden horse of Troy. Carnelian scarab, early 5th century. 3. Herakles and Nemean lion. Banded agate, 5th century. 4. Horses. Carnelian, probably 4th century. 5–7. **ROMAN, 3rd–1st CENTURY B.C.:** 5. Eros. Brown glass paste. 6. Man working on prow of ship. Carnelian. 7. Dioskouroi at battle of Regillus. Carnelian. 8–11. **ROMAN, 1st CENTURY B.C.–1st CENTURY A.D.:** 8. Portrait. Carnelian. 9. Head of Herakles, signed by Gnaios. Blue beryl. 10. Theseus. Sard. 11. Gryllos. Carnelian. 12–13. **CAMEOS:** 12. Bacchic scene. Roman, Sardonyx. 13. Mars and Venus with cupid. Onyx, Renaissance, middle of 16th century. **LATE ROMAN, 2nd CENTURY A.D.:** 14. Roma holding a victory. Red jasper. **19TH CENTURY:** 15. Jason and Cheiron, inscribed Kromos. Carnelian. **GNOSTIC:** 16. Abraxas. Heliotrope. **SASSANIAN:** 17. Portrait. Carnelian. **EARLY CHRISTIAN:** 18. The Good Shepherd. Jasper

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SYNTHETIC GEMS

In the U.S. the Federal Trade commission has restricted the use of the adjective synthetic when applied to gem stones. to manufactured materials that possess the same chemical, physical and optical properties as the naturally occurring stone.

In the earliest recorded attempts to produce gems. natural stones were planted in the ground in the hope that they mould either reproduce or grow larger. Later, the alchemists attempted to imitate the processes of nature. Microscopic crystals of rubies were produced in 1857 by Marc Antoine Augustin Gaudin by fusing alum to which a little chromium sulphate was added to give the proper red color. Edmond Fremy and Charles Feil in 1878 produced crystals from which small gem stones were cut by fusing aluminum oxide (Al_2O_3) and lead oxide (PbO). In 1895 Michaud fused fragments of natural rubies to produce larger stones known as reconstructed rubies. For a short time this was a commercially successful process. The method of August Victor Lewis Verneuil (1902) of producing synthetic rubies and sapphires by an oxyhydrogen flame was highly successful and is used today with only slight modification.

This process is also known as the flame-fusion method and is used to produce not only rubies and sapphires but also variously coloured synthetic spinels ($MgO.Al_2O_3$), rutile (titania TiO_2) and the imitation gem, strontium titanate. Chrysoberyl ($BeO.Al_2O_3$) crystals large enough to cut into gems have also been made by this process but it has not been commercially successful.

Jaeger and H. Espig of the I. G. Farbenindustrie, Bitterfeld, Ger., synthesized emerald ($3BeO.Al_2O_3.6SiO_2$) in 1930 and made crystals, by fusion. large enough to be cut into small gems. The same year Carrol F. Chatham of San Francisco, Calif., also synthesized emerald and in 193j succeeded in producing crystals large enough to be cut and marketed.

Because of its greater value, many attempts have been made to synthesize diamond. It was generally accepted prior to the 1930s that several of the experimenters had made diamond. Of these, J. B. Hannay (1880) in England, Henry Moissan (1893) in France and Sir William Crookes (1906) in England were most widely credited with success. Hannay heated organic material with water in sealed glass tubes. Moissan dissolved carbon in molten iron in an electric furnace and plunged the molten iron into a brine solution. The cooling and shrinking of the outside layer while the interior was still molten created terrific pressures which supposedly produced diamonds in the interior. Crookes exploded cordite containing excess carbon in a cylinder and momentarily attained calculated pressures of 100,000 lb. per square inch at a temperature of 5,100° C.

In attempts to duplicate the processes no diamonds have ever been produced. Microscopic crystals of metallic carbides which resemble diamond in many ways have been obtained and identified by modern scientific methods not available to those earlier scientists. Edward G. Acheson, while attempting to make diamonds in 1891, produced and identified SiC (carborundum), the second hardest known crystal.

The first synthetic diamonds were produced by the General Electric company at Schenectady. N.Y. The discovery was announced in Feb. 195j but the details of the process were not released.

Verneuil or Flame-Fusion Process. — Originally developed to manufacture synthetic rubies and sapphires! this method with only slight modifications is used to produce spinel. rutile (titania) and strontium titanate, an imitation gem. It consists essentially of an inverted oxyhydrogen torch (fig. 1j which opens into a ceramic muffle and forms the "boule" on a support which can be lowered as the boule grows.

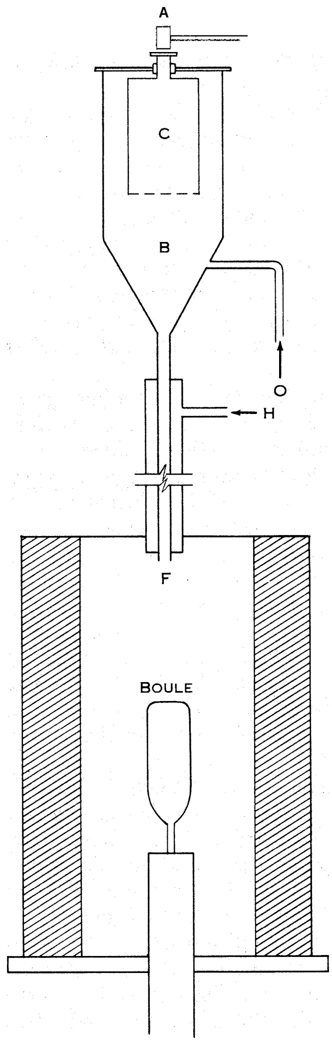

FIG. 1.—THE VERNEUIL, OR FLAME-FUSION, PROCESS FOR MANUFACTURING SYNTHETIC GEM STONES. (SEE TEXT FOR EXPLANATION OF SYMBOLS AND THE PROCESS)

For the formation of a clear single crystal boule it is essential to start with a highly purified alumina. This is prepared by repeated crystallization of ammonium alum and subsequent calcination which leaves pure alumina (Al_2O_3). The alumina is placed in the container C (fig. 1) which has a fine sieve at the base. When the container is tapped by the mechanically actuated hammer, A, the alumina sifts down into the enclosed chamber. B. Oxygen passes into this chamber at O and carries the finely divided alumina down to the tip of the torch. F, where it burns with the hydrogen which enters at H. the larger tube which encloses the central tube. The oxygen carries the fine alumina particles into the intense heat of the central part of the flame where they fuse and fall on the molten upper surface of the boule as droplets.

To start the operation a sintered mass of alumina is built up on a fire-clay support using a low heat and a high rate of powder flow. The flame temperature is raised. the rate of powder flow adjusted and the sintered mass lowered at the proper rate until the spine at the base of the boule grows. By controlling the powder flow and the rate of lowering the boule the boule begins to form with a mushroomlike top. When the desired diameter is reached flame characteristics and the rate of powder feed and boule lowering are adjusted to produce a boule of uniform diameter. The temperature of the upper surface of the boule is held just above the melting point, which for colourless sapphire is 2,030° C.

To initiate boule growth the continuous attention of the operator is required. Once started, the boule growth proceeds under automatic control and one operator can attend several furnaces. When a boule reaches the desired size. normally 150–200 carats, the operator shuts off the furnace and allows the boule to cool. During the cooling process the boule develops internal strains nhich would eventually cause the boule to crack. These are relieved by splitting the boule longitudinally. which is induced by snapping off the elongated stem of the boule. Some residual strain ahich is not disadvantageous for gem and most industrial uses is left in the half-boule developed by splitting. Strain free whole boules may be produced by annealing at 1,950° C.

The strain develops during cooling because the outer surface cools faster than the interior, and causes considerable loss from cracking during the manufacturing process. Most successful boule growth takes place when the principal axis of the crystal lies 60° from the vertical axis.

For many scientific and technical uses it is desirable to have boules oriented crystallographically. In the U.S., the Linde Air Products company developed the use of an oriented seed crystal on which boule growth was started. The boule then has the same crystallographic orientation as the seed crystal. The company also developed a semiautomatic process of making rods by continuing the uniform growth of the spine at the base of the boule. Rods 18 in. long and 0.1–2.0 in. in diameter are commercially available. They are ground to uniform diameters and flame polished in an oxyhydrogen flame. Short mushroomlike boules up to 4 in. in diameter are also grown from which circular transparent disks up to 0.2 in. thick are cut and polished.

Corundum (Rubies and Sapphires). — Prior to 1940 all synthetic boules were made in Switzerland, Germany and France. For several years after the discovery of the process of manufacture all of the production was used for gem stones. Synthetic ruby was the chief product and was produced by adding chromium sulphate to the purified alum before calcining (at 1,000° C.) in fused quartz dishes, yielding an intimate mixture of aluminum and chromium oxide. Five per cent of Cr_2O_3 gives a pale pink boule and 6% a deep red boule. The higher the percentage of chromium oxide the more difficult it is to control boule growth and the greater the loss from boules cracking on cooling.

Blue sapphire was produced by adding iron and titanium, green by cobalt and yellow by nickel and magnesium oxides. Various other colours were produced from mixtures of these oxides.

Star rubies and sapphires, first developed in the U.S. in 1947, are made by adding 1% of titanium oxide to the starting powder and forming the boules in the usual manner. The boules are then heat treated at temperatures between 1,100° C. and 1,500° C. depending on the colour of the "star" to be made. The titanium oxide develops small needlelike crystals of rutile (TiO_2) which are oriented along the hexagonal crystal planes within the boule similar to the same needlelike crystals in natural "stars." After cutting en cabochon with the principal crystal axis normal to the base the finished gem has a centred six-ray star. The synthetic gems have sharper and more distinctly developed stars than the natural crystals.

Identification. — It is very difficult to distinguish between natural colourless sapphires and synthetic colourless sapphires, but this determination is rarely necessary because these stones have little value. The natural crystals have microscopic irregularly shaped gas and liquid inclusions while the synthetic gems may have minute spherical gas bubbles. The cut synthetic gems usually show microscopic cracks along and normal to the intersection of facets. Coloured gems may be differentiated under the microscope by characteristics of the pigmentation inherent in the processes of growth in addition to the above features present in the colourless gems.

Synthetic coloured boules are purer than the coloured natural stones. The only inclusions seen in synthetics are spherical gas bubbles of microscopic size and rutile needles in "stars." Under the microscope, natural stones show irregular cavities filled with gas or liquid inclusions with both often present in the same cavity. Impurities such as iron or titanium oxide may be segregated in hexagonal plates or elongated needles respectively.

Synthetic stones show curved lines parallel to the upper growth surface of the boule. They represent uneven distribution of pigmentation caused by minor fluctuations in the rate of growth. Occasionally, especially in blue sapphire, this banding is visible to the unaided eye. In cut stones they should not be confused with the polishing striations on the surface of the facets often visible under the microscope. Structure lines are only seen when viewing the stones nearly parallel to their plane, and can be followed by focusing the microscope down into the interior of the stone. Unlike polishing striations they are continuous beneath adjacent facets. Some natural stones show straight parallel twinning striations, often in a hexagonal pattern in three directions, which may be confused with the structure lines of synthetics.

On examining faceted gems, reflections from the facets hide the interior features of the stone. It is usually necessary to rotate the stone under the microscope and view it in several directions before evidence of the true nature of the stone is found.

About 1920 the industrial use of synthetic rubies and sapphires began to be of more importance than the gem use when they began to replace the natural stones for jewel bearings in watches and electrical instruments. By 1935 synthetics had replaced natural jewels in both Europe and the United States. Every household electric meter had at least two bearings jeweled with synthetics. Although colourless sapphire is easier to grow, ruby is preferred for industrial jewels because of the greater ease in handling it.

The Linde Air Products company pioneered in the U.S. in other industrial uses uhich take advantage of the superior hardness of Al_2O_3, second only to diamond. Colourless sapphire rods were introduced as thread guides in the textile industry, followed by the sapphire stylus for phonograph needles. Drilled blanks are used as orifices for injection nozzles in oil-fired furnaces because they resist wear and maintain a constant diameter. Small spherical balls of clear sapphire are superior to metal spheres in ball-point pens.

Other industrial uses of sapphire take advantage of its high dielectric constant for electronic devices and of its high melting point for heat resistant windows. Because sapphire transmits not only visible light but ultra-violet and infra-red (heat) waves with little absorption loss, it has been used in optical systems needing such characteristics. It resists corrosion by both alkalis and acids. The combination of these properties in a single material has made possible the development of many specialized scientific and technical instruments for high temperature and pressure control and regulation.

Spinel. — Spinel boules have a square cross section with round corners but otherwise are like A1203 boules in manufacture, size and appearance although they do not develop internal stresses during manufacture. Spinel has a hardness on Mohs's scale of 8 (Al_2O_3 has a hardness of 9; diamond, 10) which gives it adequate durability for gem stone use. Spinels are easier to cut and polish than synthetic rubies and sapphires which can only be worked with diamond powder. They are made in all colours by adding appropriate pigments. The popular "aquamarine" blue is made by adding small amounts of cobalt, nickel, and titanium and vanadium oxides

The problem of differentiating between natural and synthetic spinels rarely arises because the natural gem is not a popular or valuable one. The natural gems are usually red or blue in colour and have irregular cavities with liquid or gas inclusions and microscopic crystalline inclusions similar to those of natural rubies and sapphires, while the synthetic have only spherical gas bubble inclusions.

Because it is singly refractive, spinel is preferred for some industrial uses but for most the greater hardness of sapphire is desirable.

Rutile (Titania). — Synthetic rutile, first produced in 1948 by the Verneuil process, is far superior to the natural crystals as a gem because natural rutile is dark in colour and was only occasionally cut as a gem stone. The pure synthetic boules have a faint tinge of yellow colour but may be produced in nearly any colour by the addition of appropriate colorants. The pure titanium oxide used in the flame-fusion process is prepared by calcining hydrolyzed titanium tetrachloride at 500° C. in an oxygen atmosphere for several hours.

The furnace is the same as that used in the manufacture of synthetic rubies, sapphires and spinel although it is sometimes modified by adding a third outer tube through which oxygen passes. The single crystal boules are tetragonal with the principal axis parallel to the boule axis. They have a square cross section similar to the spinel boules but rarely exceed 100 carats in weight. When removed from the furnace they are black in colour and semiconductors of electricity because some titanium is still unoxidized On heating in an oxygen atmosphere oxygen is slowly absorbed, the colour decreases until only a faint yellow tinge is left and the boules become nonconductors

Because synthetic rutile has a higher index of refraction and greater dispersion than diamond, cut gem stones are more brilliant and show more fire. Its double refraction $\omega_D = 2.616$, $\epsilon_D = 2.903$ exceeds that of any other known substance. Nearly all the titania boules produced are used for cutting into gem stones They can be readily distinguished from diamond because of the strong double refraction and the prismatic flashes of red and blue due to the strong dispersion. The hardness, 6.5, is much inferior to the diamond.

Emerald. — The details of the Chatham process for synthesizing emerald is a closely guarded secret. From the character of the crystals it is thought that the process depends on fusing appropriate chemicals under pressure in the presence of water. Only a small percentage of the emeralds made are suitable for cutting into gems but several hundred carats are marketed annually. Synthetic emeralds may be distinguished from the natural gems because they fluoresce with a deep red colour under ultra-violet rays while natural emeralds do not.

Diamonds. — No synthetic diamonds suitable for gems have been made Not only is the possible production of crystals suitable for gems fraught with serious technical difficulties, but experience indicates that the public will not buy such synthetic gems unless they are cheap in price.

For industrial purposes, quality and perfection of crystal growth are not important because a major market ior abrasive grits and powder is available which needs only the superior hardness of the diamond. At the time diamond was first synthesized, abrasive diamond grits and powder sold for $3 per carat (nearly $7,000 per pound). The better qualities of synthetic diamond are suitable for wheel dressers and for the manufacture of diamond drill bits used in the mining and oil industries.

IMITATION GEMS

Prior to World War II most imitation gems were made from glass. Usually a special high lead glass was used which was often referred to as paste. The word paste was applied to such glasses because the components of the mixture—silica, lead oxide, potassium carbonate, borax and arsenic oxide with appropriate pigmenting materials—were mixed wet to ensure a thorough and even distribution of each.

These glasses were softer than ordinary or crown, glass but had a higher index of refraction and dispersion which gave them greater brilliancy and fire. "Fire" is the flashes of red and blue seen in cut stones with the proper prismatic distribution of facets. The cheaper imitations were pressed or moulded gems but on the better qualities the facets were cut and polished. Moulded glass imitations can be identified with a hand lens because the edges between the iacets are rounded while cut glass has sharp edges.

Glass imitations can be readily identified because they are singly refractive, and the index oi reiraction and specific gravity, both of which vary with the composition of the glass, are unlike those of the gems they imitate. Most gem stones are doubly reiractive. Usually small spherical bubbles are visible in the interior of glass imitations when examined with a lens. Because of the inferior hardness, glass is easily scratched with a file. This test can be applied along the girdle where it will do little damage. Because glass is a poorer heat conductor than natural gems it feels warmer to the touch. Glass imitations that have been worn show under the lens fine scratches on the facets and small conchoidal chips along the edges between the facets.

The finer qualities of imitation gems are made irom variously coloured synthetic sapphires or spinels. The superior hardness of these materials makes them much more durable than glass. A new imitation of the diamond was introduced in 1955 that closely resembles diamond in all properties except hardness. Strontium titanate produced in boules by the Verneuil process has an index of refraction of 2.40 while diamond is 2.42. Like diamond it is singly refractive. It has considerably more dispersion which is not noticeable to the layman but which to the trained observer serves to distinguish it from the diamond. Its hardness of only 5.5 as against 10 ior a diamond keeps it from being a serious competitor of the diamond as a gem stone.

Before World War II most costume jewelry was made with glass imitations. After World War II glass was displaced by the many newly developed plastics. which are of two kinds. Thermosetting plastics, such as Bakelite, permanently harden when moulded and will not soften on reheating. Thermoplastics, such as Lucite and Plexiglas, soften on heating and can be moulded and remoulded. With proper pigmenting agents both types of plastics can be given any desired colour. Plastic jewelry can be readily identified because it is light in weight and is easily scratched with a knife. Because of their cheapness and easy workability the many new plastics profoundly changed the market for the cheaper forms oi jewelry.

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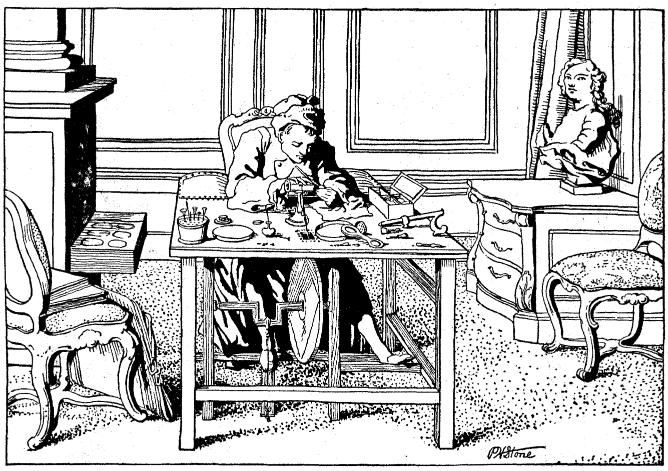
GEMS IN ART

Gems engraved with designs for sealing (intaglio) or for decoration (cameo) exist in large numbers from the early Sumerian period to the decline of the Roman civilization and again irom the Renaissance to modern times They exercise a strong appeal in many ways. The inherent beauty of the material, with its rich and varied colours, its lustre and brilliance. gives pleasure at first sight The hard and durable quality oi the stones has made for unusually good preservation, so that we can appreciate in many cases the artist's work in its original state—a rare opportunity in ancient art Moreover, the smallness and preciousness of the gems invited exquisite workmanship, and in certain periods, when art was at a high level, the achievements in this field mere very notable. The best ancient gem engravers combined minuteness and accuracy of detail with a largeness of style that is indeed remarkable. A gem engraving of this class possesses the nobility and dignity of a marble or bronze sculptural work, though it is often confined to the space of less than half a square inch.

The Technique of Gem Engraving.—Only soft stones and metals can be worked ireehand with cutting tools, the harder stones require the wheel technique. This technique was known in Mesopotamia



FROM MARIETTE TRAITE DES PIERRES *GRAVEES*

FIG 2—A GEM ENGRAVER OF THE 18TH CENTURY AT WORK IN HIS SHOP SURROUNDED BY THE VARIOUS TOOLS OF HIS TRADE

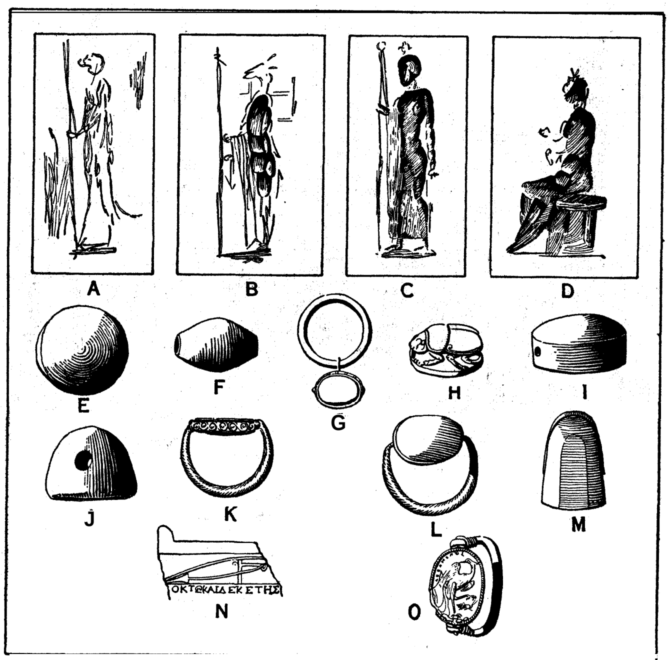
as early as c. 4000–3000 B.C., as well as to the Minoans from the middle Minoan 111 period (c. 1800–1600 B.C.). The method of work seems to have been similar to that in use in the 20th century, to judge by the references we have in classical literature, especially in the writings of Pliny and Theophrastus, and an examination of the stones themselves (fig. 3, A, B, C, D). By this method the stones were worked with variously shaped drills ending in balls, disks, cylinders, etc., which were made to rotate by the help of the wheel (fig. 2). In modern practice the stone to be engraved is fastened to a handle and held to the head of the rotating drill and moved as the work requires. It has been suggested that the ancients reversed the process and held the stone stationary while the rotating tools were guided by the hand, as in modern dentistry. The cutting is not actually done by the drills but by the powder which is rubbed on the stone with the drill. This is in modern practice diamond powder, mixed with oil; it was known also to the Romans, but in the period beiore Alexander emery powder was probably used. The wheel used in the 20th century either worked by the foot (fig. 2) or by an electric motor lathe. The iormer, though more cumbersome, has the advantage of giving the artist more direct control over the speed. On the gravestone of a gem cutter of the Roman empire found at Philadelphia in Asia Minor (fig. 3, N) a tool is represented which looks like the bow used by modern jewelers and which, by being drawn back and forth, could impart a rotating movement similar to that of the wheel. But since we know that the rotating wheel was used by the ancients in the making of pottery, it is probable that they made use oi it in gem engraving also. After the cutting oi the gem was complete the suriace was often polished, a practice especially popular among the Etruscans and in the later Greek and Roman periods. Naxian stone (*naxium*) mas used for polishing, according to Pliny.

We do not know definitely whether the ancient gem cutters made use of the magnifying glass but it is probable that they did. The general principle of concentrating rays was known to Aristophanes. Pliny several times mentions the use of balls of glass or crystal brought in contact with the rays oi the sun to generate heat, and Seneca speaks more specifically of this principle applied for magnifying objects.

What seem to he ancient lenses, some going back to the 2nd millennium B.C., were found in Egypt and Crete.

HISTORY

Mesopotamia.—The art of engraving stones probably originated in south Mesopotamia. There it attained a high degree oi proficiency as early as the 4th millennium *E.C.; i.e.,* during the Elamite and Sumerian civilizations. The engravings were worked on stones mostly of cylindrical shape which were suspended by a string and used as seals. The materials were petrified shell and marble, and the subjects are chiefly heroes fighting animals, deities with worshippers and decorative motives. Aiter the Akkadian invasion (c. 2800 B.C.) the art of seal engraving reached its greatest height, and such semiprecious stones as rock crystal were cut in masterly fashion. The mythical King Gilgamesh (see GILGAMESH, *EPIC OF*) performing his great exploits was the favourite representation, and cuneiform inscriptions began to appear. After the decline of the Akkadian empire the representations become more and more conventionalized. Hematite gradually became the prevailing material. The most frequent subjects were the "Introduction Scene"—a seated goddess toward whom a second deity leads a worshipper, the Gilgamesh legend and other mythical representations. During the Amorite dynasty (c. 2100–1800 B.C.), to which belonged the famous King Hammurabi, there was a highly artistic period, hut probably one of short duration. The representations were mostly the same as during the preceding epoch, and the use oi cuneiiorm inscriptions became important, until in the Kassite period (c. 1800 B.C.) it constituted the most conspicuous feature.



BY COURTESY OF (A, B, C, D, H, I, J & N) FURTWÄNGLER, "ANTIKE GEMMEN," (E, F, G, K, L & M) THE METROPOLITAN MUSEUM OF ART. NEW YORK

FIG. 3.— SPECIMENSOF GEM ENGRAVER'S ART AND CHIEF FORMS USED (A, B, C, D.) **Four-sided stone with** unfinished **engravings; (E, F.)** Minoan **stone forms—lentoid and glandular;** (G.) **Ring with pendant;** (H.) **Scarab;** (I.) **Scaraboid;** (J.) Dome; (K, L, O.) **Swivel rings;** (M.) **Cone form;** (N.) **Part of a grave stone of a gem engraver;** (O.) **Heron and grasshopper, signed by Dexamenos**

After the downfall of the Amorites in Babylonia (1758 B.C.), southern Mesopotamia no longer played an important part politically. serving only as a cultural centre. The other oriental countries which now came into prominence naturally profited by the older civilization, and the Hittites (2nd millennium B.C.), the Assyrians (first half of 1st millennium B.C.) and other peoples of Asia Minor all became conversant with the art of gem engraving. They carried on the southern Mesopotamian tradition with some contributions of their own. The favourite subjects were adoration scenes and heraldic groupings oi deities and animals. Decorative motives were popular. The cylinder form remained in vogue, but conical and dome-shaped seals with a flat base for the intaglio were the most popular (fig. 3, J, M). The coloured quartzes were the favourite material. When the power of Assyria gave, way to that of Persia, the Persian gem engravers followed in the footsteps oi their predecessors in both technique and style; but the favourite theme became the exploits of Darius the Great, king of Persia (d. 486 B.C.).

Egypt.— The Egyptians early adopted the art of engraving, employing first the cylinder form, then, from about the 9th dynasty on, the scarab or beetle and kindred shapes. As subjects for their engravings they used chiefly symbols, script and ornaments, only occasionally pictorial scenes. Though historically, thereiore, these scarabs are oi great importance—especially as they have been found in great numbers and form a continuous series—the artistic value is frequently secondary. The great majority lack the interest of subject treatment, though the finish of their execution is remarkable. The commonest materials were glazed steatite and faïence, but the coloured quartzes—carnelian, amethyst, jasper, etc.—were also employed.

Crete.— From the earliest times we find Greece treading an independent path influenced but not conditioned by its oriental neighbours. In Crete gem engraving occupied an important place. The stones of the early Minoan period (c. 3500–2200 B.C.) show a great variety of shapes—including cylindrical, pyramidal, conoid, quadrilateral and three-sided rounded beads—and are engraved with rude pictographs, consisting of primitive renderings of human beings, animals, ships and floral and linear patterns. It was clearly an experimental stage without traditional forms. The stone was invariably of a soft variety, *i.e.*, steatite oi different colours worked by hand. As time went on—during the first arid second middle Minoan periods (c. 2000–1800 B.C.)—the three-sided elongated bead became the standardized shape and the pictographs were transformed into less rude, more conventionalized forms. Several symbols now generally occur together, showing that from mere ideographic meaning they had acquired a phonographic value as syllables or letters. In other words, the primitive pictographs had evolved into hieroglyphs. The material was still the soft steatite. During the middle Minoan III period (c. 1800–1600 B.C.) the hieroglyphic script reached its full development, the symbols appearing in highly systematized form, executed often with great nicety. The stones were no longer steatite but hard varieties, such as carnelian, chalcedony and green jasper. They mere worked with the wheel, the use of which was apparently learned from the orient.

In the next period (late Minoan, *c.* 1600–1100 B.C.) we note a great change. The Minoan written language had finally evolved into a linear script and concurrently it disappeared from the seal stones. In its stead we find naturalistic designs—animals, cult and sacrificial subjects, deities and demons, hunting and war scenes; *i.e.*, the stock subjects of Cretan art, executed with amazing spirit and vivacity. The stones are now regularly the hard quartzes, of lentoid and glandular forms (fig. 3, E, F). Similar engraved gems as well as gold rings with engraved bezels have been found at Mycenae and other places within the range of Cretan influence. Toward the end of the late Minoan period the art deteriorated. The soft steatite again took the place of the harder stones, and the subjects became merely conventionalized representations. Gradually there was established the geometric style in which linear designs were engraved by hand on soft stones of the prevalent oriental forms. In the 7th century B.C. a revival in artistic conceptions is noticeable. Highly decorative animals were carved with considerable feeling for liie on steatites of glandular and lentoid forms. This was the prelude to several centuries of a flourishing output, lasting throughout the classical civilizations.

Greece.— The study of Greek and Roman gems is the study of classical art in miniature; for the gems reflect faithfully the styles of the various periods to which they belong, so that they represent an accurate picture of the development, the prime and the decadence of classical art. In the gems of the 6th and early 5th century B.C. the dainty charm of archaic Greek art found a happy expression. The chief iorms were the scarab and the scaraboid (fig. 3, H, I) regularly set in swivel rings (fig. 3, K, L, O). The subjects were the same as in other branches of archaic art. At the beginning oi the period the human figure in kneeling posture was the most popular, but soon a greater variety was attempted. Representations of gods and goddesses are comparatively rare, but Herakles was a favourite: and various demons, the Silenus, the Siren and the Sphinx were also common subjects. Among the figures without mythological significance, the commonest were warriors, archers, athletes and horsemen; and among the animals the lion, bull, boar, deer, ram, cock and horse were favoured. The coloured quartzes, such as the carnelian, chalcedony and agate, are the chiei materials used.

The second half of the 5th and the 4th centuries mark another climax in the history of Greek gem engraving. We find the same conception oi serene beauty in the minute products of the gem cutters as in the contemporary statues. The favourite shape employed is no longer the scarab but the scaraboid (fig. 3, I), generally large and thick, and perforated to be worn on a swivel (fig. 3, L, O) or as a pendant (fig. 3, G). With regard to the choice of suhjects the chief theme was now the daily life of the people, especially of the women. A woman taking a bath, making music, playing with animals, etc., were all favourite representations; animals were likewise common subjects; mythological subjects were less popular. The favourite deities were Aphrodite, Eros and Nikē. By far the commonest stone of this period was the chalcedony. Less irequently used were the carnelian, agate, rock crystal, jasper and lapis lazuli.

The inscriptions which occur on Greek gems form an interesting study. They generally give the name of the owner, often only the beginning oi his name being recorded. Occasionally they refer to the people represented or they contain a greeting. Sometimes the name of the artist is given. Of the latter the most prominent are Epimenes and Dexamenos (fig. 3, O). Their works rank among the best which have been produced in Greek gem cutting.

The Greek gems of the Hellenistic period, about 323–30 B.C., reflected the heterogeneous styles of contemporary sculpture; but there were also some notable representations, including a portrait of Philetairos. A change took place in the shape of the stones used. Instead of the perforated scarabs and scaraboids the unperforated ringstone, generally flat on one side and convex on the other, became the accepted form. The stones were often of considerable size and many of the large rings in which they were mounted are preserved. The favourite stones were the hyacinth, garnet, beryl, topaz, amethyst, rock crystal, carnelian, sard, agate and sardonyx, many of them introduced into the Greek world from the east after the conquests of Alexander the Great. Glass, as a substitute for more precious material, was often used. Among the subjects represented the most important is the portrait, which acquired great popularity. Scenes from daily life and mythology both were represented.

A great technical innovation introduced in this period is the cameo, in which the representation instead of being engraved in the surface of the gem is carved in relief. It is therefore the converse of the intaglio. These cameos naturally did not serve as seals, as did the intaglios, but were used purely ior decorative purposes. In such work the coloured quartzes were generally employed, their various layers being skilfully and effectively utilized; but imitations in glass paste also occur. The technique was popular in Roman times.

Graeco-Phoenician and Graeco-Persian Gems.—A class of gems in which the influence of Greek art is shown is that of the Graeco-Phoenician scarabs, chiefly found in the Carthaginian cemeteries of Sardinia, Carthage and Iviza. The stones discovered there show that at first Phoenician art was strongly subjected to Egyptian influence, but from the 6th century B.C. onward both the Greek style and Greek subjects were adopted. The archaic Greek style prevailed in the Phoenician stones throughout the 5th century and into the 4th, long after a freer style had been introduced in Greece itself—a phenomenon with which we are familiar from Carthaginian coins. The shape of stone used is regularly the scarab and the favourite material green jasper. The representations consist chiefly of the favourite Greek types of youths and men, and of mythological creatures. Fantastic combinations of heads and masks probably had significance as a means of averting evil.

The Graeco-Persian gems illustrate the influence of Greek art in the east. In Persia the gems of purely Persian style are followed in the second half of the 5th and the first half of the 4th century by gems in which Persian and Greek elements commingled. They were evidently made by Greeks for Persians. The subjects were taken from the daily life of the Persian nobles, preferably contests of Persians and Greeks, or hunting scenes, or single figures of Persian nobles or ladies. Animals were also favourite subjects. These representations were executed in a broad, spirited style, chiefly on chalcedony stones of scaraboid form. A rectangular shape with one faceted side was also popular.

Etruria.—Etruscan gems made their appearance toward the end of the 6th century B.C. and remained in vogue until the 4th. They closely copied Greek styles, forms and subjects. At times their execution was excellent, but there is always a certain dryness and stiffness which serve to distinguish even their best products from pure Greek work. The shape used is invariably that of the scarab, worked often with minute care, while to the Greek artist the backs of the engraved gems were of secondary interest. Moreover, the edge of the base on which the beetle stands, which in the Greek examples is left plain, is ornamented in the Etruscan gems, except in the earliest period and in the more careless specimens. By far the commonest material is the carnelian. The subjects chosen are chiefly taken from Greek mythology. Homeric and Theban heroes predominate (Peleus, Achilles, Odysseus, Ajax, Tydeus and Kapaneus). Inscriptions sometimes occur; they do not, as in the Greek gems, give the name of the owner or of the artist but of the figure represented.

At the end of the 5th century another class of scarab became prevalent, lasting until the beginning of the 3rd century B.C. It was not confined to Etruria but occurred also elsewhere in Italy. The distinguishing characteristic is that it is roughly worked with the round drill, evidently merely for decorative effect, which is heightened by the brilliant polish. Herakles, Silenus and animals were popular subjects.

Roman Gems.—The Etruscan scarabs were superseded in Italy in the 3rd and 2nd centuries B.C. by ringstones in which we can distinguish two styles, according as they imitate Etruscan or Hellenistic art. There are no great artistic achievements among them but they are nevertheless of interest in that they form an important source of knowledge for the Roman art of the earlier republican period. In the 1st century B.C. the two styles became merged, with Greek elements predominating and growing gradually into the classicist style of the Augustan age.

Engraved gems enjoyed a great popularity in Rome during the late republican and early imperial periods. We know this not only from the large number of examples which have survived, but also from literary sources. Gem collecting became a passionate pursuit. Wealthy men vied with one another in procuring fine specimens and paid enormous prices for them. The keenness of this rivalry can be gauged by the story that the senator Nonius was exiled from Rome because he refused to give a certain gem (valued at 20,000 sesterces) to Mark Antony. Public-spirited men, then as nowadays, after having formed their collections would deposit them in the temples for all to enjoy. Scaurus, the son-in-law of Sulla, is said to have been the first Roman to have a collection of gems. Julius Caesar was an eager and discriminating collector and deposited as many as six separate collections in the temple of Venus Genetrix. The style of the representations is that of the classicist art of the early imperial period which we encounter in other contemporary products. Its dominant characteristic is a quiet, cold elegance. The subjects have a wide range comprising mythological and everyday themes, including portraits of distinguished men, copies and adaptations of famous statues, symbols and grylli—fantastic combinations of heads and figures, probably with superstitious import. The prevalent form throughout is the ringstone. The variety of stones used is large, for at this time of Roman world dominion and increased commercial facilities a wide range of stones could be obtained from all parts of the empire. The commonest were the carnelian, sard, sardonyx, chalcedony and amethyst; especially fine engravings are often found on garnets, hyacinths, beryls, topazes and peridots, more rarely on emeralds and sapphires. The nicolo and red jasper, which occurred only occasionally in former periods, now enjoyed great popularity. The Roman enthusiasm for this wealth of beautiful stones can be gauged from the remarks of Pliny who declared that some gems are considered "beyond any price and even beyond human estimation, so that to many men one gem suffices for the contemplation of all nature."

Cameos continued in use throughout this period, chiefly of sardonyx, onyx and glass paste. The favourite subjects are portraits and mythological scenes. Among the former are valuable representations of emperors and princes.

Signatures of artists are found not infrequently on both the intaglios and cameos. In fact, by far the majority of ancient gem cutters known to us belong to early imperial times. The most distinguished artist was Dioskourides, of whom we know from Pliny that he made the imperial seal-ring of Augustus. Other well-known names are Gnaios, Aspasios, Eutyches, Aulos, Apollonios and Agathangelos. (*See* ROMAN ART.)

Late Roman Period.—By the 2nd century A.D. the art of gem engraving was on the decline. Of the large number of gems of that period which have survived very few have any artistic value. The majority show hasty, careless workmanship and the representations are lifeless and monotonous. The shape of the gems used is always the ringstone and the materials are very much the same as those in use during the preceding period. Nicolo and jasper became specially common, probably on account of supposed magical properties.

The same deterioration is noticeable in the early Christian and Gnostic gems. The commonest materials were hematite and jasper. More important artistically are the Sassanian gems (3rd to 7th century A.D.) which indeed represent the last important product yet found of gem engraving in the ancient world. The representations are a mixture of oriental traditions and late Roman forms. Especially fine are some of the portraits.

In north India the Ephthalites (White Huns) established a civilization about A.D. 475 which lasted until about A.D. 550. That they too practised the art of gem engraving was ascertained by the discovery of a stone with the portrait of an Indian king.

Postclassical Times.—In postclassical times there are two epochs in which the art of gem engraving again flourished, the Renaissance and the 18th and early 19th centuries. The artists of both periods borrowed freely from the antique. Those of the Renaissance were too individual to keep very closely to the ancient spirit, and Renaissance works are therefore seldom difficult to distinguish from ancient gems. The gem engravers of the 18th and 19th centuries, on the other hand, consciously tried to copy ancient work as exactly as possible in style and in subject. And though at first this copying was done out of admiration for the antique, it soon developed with unscrupulous people into an extensive output of forgeries. At times it is extremely difficult to tell definitely whether a certain piece is ancient or a faithful copy. Mostly, however, the copyist betrayed himself by a slight innovation characteristic of the spirit of his own time rather than that of the antique; and in a large number of cases, notably in the famous Poniatowski gems, including a representation of Jason and Cheiron inscribed Kromos, the spirit and composition are so far removed from ancient work that few people would be deceived by them.

An interesting feature of the gems of this period is presented by the inscriptions which often appear and give the signatures of the artist or would-be artist. For besides signing their own names, often in Greek or Roman letters, artists inscribed their works with names of famous ancient artists. Generally such forged inscriptions are easily detected, but sometimes they are cut with great care and present a difficult problem. Moreover, at times genuine ancient gems are supplied with forged signatures. The best-known gem cutters of this period are the famous Johann Lorenz Natter, the three Pichlers (Giovanni, Giuseppe and Luigi), Nathaniel Marchant and Edward Burch.

In modern times the art has a certain limited vogue, not comparable, however, with the great periods we have described.

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Classical Gems.—O. M. Dalton, *Catalogue of the Post-Classicat Gems in the British Museum* (Oxford, 1915). (G. M. A. R.; X.)

GEMBLOUX, a town in the province of Namur, Belgium, 25 mi. S.E. of Brussels on the main line to Namur. Pop. (1947) 5,350. There on Jan. 31, 1578, Don John of Austria defeated the army of the provinces under Antony de Goignies. In 1860 the State Institute of Agriculture was founded there. Gembloux became a busy railway centre with engine works.

GEM CUTTING: *see* LAPIDARY AND GEM CUTTING.

GEMINI (the Twins; *i.e.,* Castor and Pollux), in astronomy, the third sign in the zodiac) denoted by the symbol II. By the Egyptians this constellation was symbolized as a couple of young kids; the Greeks altered this symbol to two children, variously said to be Castor and Pollux, Hercules and Apollo or Triptolemus and Iasion; the Arabians used the symbol of a pair of peacocks. The two brightest stars are known as Castor and Pollux; Pollux (β Geminorum) is slightly brighter than Castor (a Geminorum). The latter is a remarkable multiple system consisting of at least six stars. The two brightest members are each spectroscopically double and the faint, distant component (Castor C) is an orange-coloured dwarf eclipsing system in which the two stars revolve about each other once in every 19 hours. The system of Castor is located at a distance from the sun of about 45 light-years. The two brightest stars form an interesting double for a small telescope. Pollux is a yellow giant located at a distance of the order of 30 light-years from the sun. There are two bright variable stars in the constellation: the Cepheid variable. ζ Geminorum, whose light varies in a period of about ten days, and the red irregular variable star. η Geminorum. At the time of its discovery (1930) the planet Pluto was in the neighbourhood of the star δ Geminorum.

GEMINIANI, FRANCESCO (*c.* 1667–1762), Italian violinist. was a native of Lucca. and studied the violin under Carlo Lunati (Gobbo) and afterward under Ancangelo Corelli. He may also have had lessons in composition from Scarlatti. In 1714 he arrived in London, where he found a patron in the earl of Essex. In 1715 he played his violin concertos with George Frederick Handel at the English court and later spent much time in Dublin: where he had a fine house in which he gave private concerts.

Geminiani brought to England great improvements in the technique of violin playing. His chief contribution was his *Art of Playing the Violin,* the first book on the subject, which he wrote in English. He died Sept. 1:, 1762.

GEMISTUS PLETHO, GEORGIUS (*c.* 1355–1452), the leading scholar and philosopher of the last century of the Byzantine empire, is chiefly notable for his influence upon the Renaissance in western Europe and for the attempt that he made in his principal work, the *Laws* (*Nomoi*), to establish a new polytheistic religion based upon Platonic and Neoplatonic principles, which, he hoped, mould supersede both Christianity and Islam. He was born and trained in Constantinople but spent the most important years of his life in Mistra, then an important citadel in the Peloponnese.

During the Council of Ferrara-Florence (1438–39), which, despite his hostility to the proposed union between the Greek and Roman churches, he attended as lay adviser to the Greek delegation, he fired the humanists with new interest in Plato (who had been ignored in the west during the middle ages because of the preoccupation with Aristotle) and inspired Cosimo de' Medici with the project of founding the Platonic Academy of Florence.

More momentously, in his talks with the astronomer Paolo del Pozzo Toscanelli and others and by his *Excerpts fsom Strabo,* Pletho introduced the *Geography* of Strabo to the west (where it had hitherto been unknown) and led the way to the overthrow of Ptolemy's erroneous geographical theories. He thus greatly affected the Renaissance conception of the configuration of the earth and so played an important, if indirect, role in the discovery of America by Christopher Columbus, who cites Strabo among his principal authorities.

Besides the *Laws,* he composed orations, two memoirs advocating social and economic reform for the defense of the Peloponnese numerous excerpts from ancient Greek authors and essays on the differences between Plato and Aristotle, on Zoroaster, on the *Oracula Chaldaica* and on astronomy, music, history, rhetoric, the virtues and various theological subjects. Nearly all his writing is marked by passionate devotion to Greece and a desire to restore its ancient glory.

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GEMSBOK (GEMSBUCK), African antelope of the genus *Oryx* (*see* ANTELOPE; ORYX); also German for chamois (*q.v.*).

GENE. Gene is the unit of heredity, first exactly demonstrated in J. Gregor Mendel's experiments in plant breeding (1865). The word gene (in the form "gen") was applied to this unit by Wilhelm W. Johannsen in 1909. The method of reappearance of diverse characters in successive generations, following crosses between two contrasting parental types, was found by Mendel to conform to certain laws, of "segregation" and "random assortment" (*see* HEREDITY; GENETICS). According to these laws, the characters must be determined by definite units that persist, multiply and enter into various combinations, from generation to generation, without themselves becoming changed thereby. Later in the 19th century, though Mendel's laws were forgotten, microscopic observations of chromosomes—small bodies of characteristic number and shape in the nuclei of all cells—led several biologists independently to the conclusion that these are transmitted as self-reproducing units, or rather as collections of units of diverse kinds, both in the process of multiplication of cells occurring during development, and also in heredity. Soon after 1900, when Mendel's laws were rediscovered, evidence was obtained that the chromosomes are probably to be identified with, or contain, the Mendelian units. And gradually, through a comprehensive series of studies on normal and abnormal hereditary transmission, coupled with observations of the chromosomes and chromosome parts in question, the case for this conclusion became convincingly established (*see* CYTOLOGY).

The newer work showed that the chromosomes are in reality exceedingly fine, relatively long filaments that are almost invisible in the ordinary nucleus. For cell division, or mitosis, (*see* CYTOLOGY) each filament coils up into a dense helix which, covered by a pellicle, assumes the sausagelike shape formerly thought of as characteristic of a chromosome. The filament, or "chromonema," consists of, or contains, hundreds or thousands of diverse genes connected permanently in line, single file, in a given order, either by direct attachment to one another or possibly joined together by a fine fibre. Before each ordinary cell division, each filament has doubled, by virtue of the reproduction of each gene within it, to form two identical filaments, and at cell division one of each of these "sister chromosomes," now in its sausagelike form. is pulled into one daughter cell, the other into the other cell. Thus both cells come to contain all the chromosomes and genes which the "mother cell" possessed.

In an immature germ cell which is about to undergo its last divisions (those of "meiosis") prior to becoming a mature egg or sperm, each chromosome derived originally from one parent of the individual becomes attached side by side to the nearly identical "homologous" chromosome derived from the other parent. This process, called "synapsis,)' is undoubtedly due to some kind of attraction or attachment mechanism exerted between like genes. In an ensuing cell division the synapsed chromosomes are pulled apart again, to opposite daughter cells, in such a way that each mature germ cell comes to contain one but not both of each of the previously paired genes (*see* CYTOLOGY). The separation of these corresponding genes fulfils Mendel's first law, segregation. The fact that a given gene, whether of maternal or paternal origin, lying in a chromosome of one pair, is equally likely to be pulled into either the same or a different daughter cell from any given gene of another pair of chromosomes, results in the fulfilment of Mendel's second law, random assortment.

But for the relations of the genes lying at different places in the same chromosome (or homologous chromosomes), a new principle of heredity emerges. All genes of the same chromosome are not always pulled into the same daughter cell, and so are not always inherited together, though they do tend to be. For two homologous filaments, during their synapsis with one another, are apt to break, at identical points, and to become joined up again with their corresponding pieces interchanged, a process called "crossing over." Thus a given gene of paternal origin may in the mature germ cell find itself in the same chromosome with some other gene of maternal origin, instead of with its former associate gene. The proportion of germ cells in which this separation of two previously connected genes will have happened will depend largely upon how far apart the two genes considered are from one another in the chromonema. For they can become separated only if the breakage occurs at some point lying between them, and since breakage may occur at any point it will be more apt to happen between them if they are located far apart in the thread than if they are near together. So by studying just how often the different genes that tend to be inherited together actually separate in heredity, an estimate may be made of the relative distances apart, or positions, of these genes in the chromonema. The validity of these "chromosome maps" has in recent years been verified by observations of chromosomes that were visibly broken in various ways. In addition to the genes of the chromosomes there are also self-reproducing hereditary units, genes, in some of the plastids of plants, and in some other cell constituents. They have not been found in higher animals, unless we include infectious agents ("viruses"). Lacking the precise Mendelian method of distribution, they appear to have played but a minor role in evolution. Apparent derivatives of chromosomal genes, having a limited power of self-reproduction themselves, have recently been found to exist in the protoplasm of some micro-organisms, but they appear to be subject to vicissitudes of cell functioning, and liable to loss and replacement by fresh derivatives of the chromosomal genes.

The "self-reproduction" of a gene is in reality self-copying. That is, each gene must have such an effect upon materials of the medium around it as to cause them to become rearranged into another particle, identical in its internal configuration with the original gene, and lying next to it. Whatever configuration the old gene has to start with, that configuration is caused to be repeated in the new gene. On rare occasions, to be sure, a gene, subjected to some unusual stress, undergoes a sudden permanent change, a "mutation," in it: inner constitution, or, alternatively, the new gene may be fashioned with some "mistake" in its pattern. Yet after a mutation of either of these kinds has occurred, the gene of modified type, whenever it reproduces, accurately incorporates the new feature into its own daughter gene. A gene may thus be defined as a particle having a capacity of self-copying of such a nature as to be retained despite the occurrence of any number of permanent changes in its configuration. In a chromonema, a single gene would, theoretically, be a portion too small to be divided without the loss of this property by one or both pieces. This unique property of self-copying, conformable with change, is known for no other substance or particle than the hereditary unit, It is this which makes the gene not only the unit of heredity and the material out of which all biological evolution is fashioned, but the foundation of growth, development and reproduction, and even, according to the growing conviction of many biologists, the primordial basis of life itself.

Chemical investigations of the gene indicate that, whether in chromosome, plastid or precellular micro-organism, it consists of a combination of protein with nucleic acid. As yet, however, these studies have not led to a satisfactory explanation of the gene's fundamental property, self-copying. This property may, however, be related to the chromosomal gene's second most distinctive peculiarity: that of exerting a specific attraction, or power of attachment, at synapsis, for a second gene of like configuration. For if this force were exerted even between like gene parts, then a given gene might attach, next to its own parts, corresponding pieces that lay scattered in unorganized fashion in the medium, and so cause them to become placed in an integrated arrangement identical with that existing in itself. Unfortunately, as little is known about the mechanism of gene synapsis as about that of self-copying.

A gene appears to be a large molecule, or closely connected group of different molecules, the whole of ultra-microscopic size, and a "gene-mutation" to be a largely fortuitous chemical change within it. This change is ordinarily caused by localized, individually uncontrollable microchemical accidents, such as may result from thermal agitation, reactions of metabolism that get out of control, the incidence of high-energy radiation like X-rays, and the impact of certain special foreign substances. The direction taken by mutation seldom, if ever, depends upon the type of environment or physiological state experienced by an individual; still less is the mutation an adaptive response to such a situation. Nevertheless, given conditions, including those brought about by the presence of given genes, may greatly influence the over-all frequency of mutations.

In this conception, there is no room for evolution through the inheritance of acquired characters. Being accidental, most mutations are harmful to the organism, but the smaller their effects, the less harmful they are apt to be. Hence the very rare ones which chance to be useful, and so to survive and take part in the evolution of a species, usually represent small steps. Evolution thus tends to proceed by slow accretions, under the guidance of natural selection, as Darwin thought. In any particular gene, mutations are very few and far between, with intervals of thousands of years between them, but the individual contains so many different genes, and the species so many individuals, that sufficient "building blocks" are nevertheless provided for evolution. And the rate of their accumulation is increased by the processes of Mendelian recombination and crossing over that form the essence of sexual reproduction. Besides the mutations in individual genes ("gene-mutations"), there are inheritable changes caused by the addition, subtraction or rearrangement of groups of genes en bloc. The rearrangements sometimes occasion changes in the functioning of the genes tnat have acquired new neighbour genes ("position effect"). Because of hindered interchange with normal chromosomes, the rearranged ones may facilitate the divergence of new varieties. More important, perhaps, the rearrangement sometimes involves the insertion of a group of genes that is the duplicate of a group already present and thus increases the total number of genes. In later evolution the inserted genes often mutate differently from their duplicates, and so the organization increases in complexity.

So effective does this process of duplication followed by differential mutation appear, that the view has gained ground that by the continuation of this process a single "naked" archetypal gene may in the course of ages have given rise to all the complex chromosomal systems of today. On this conception, protoplasm first appeared as a series of by-products of mutated genes that were naturally selected because of the usefulness of these by-products in furthering the survival and multiplication of the genes that produced them. The nucleoprotein molecules of virus that cause some plant diseases seem to be the nearest existing counterparts of these hypothetical primordial genes.

The relation of the genes to the protoplasm, and to the characters of the organism "determined" by them, are highly complex as well as disputatious. Suffice it here to say that there are many genes which affect several or many characters at once and, conversely, that all morphological characters and physiological processes depend upon the combined action of numerous genes, together with environmental factors, any one of which, if not held constant, can produce a change in the final result (see HEREDITY; GENETICS). And since all parts of the body have, by mitosis, been allotted the same genes, it is evident that this lot of genes must have reacted very differently in producing the different parts. (H. J. M.)

GENEALOGY, a pedigree or list of ancestors, or the study of family history (from the Gr. γένος, family, and λόγος, theory).

Biblical Genealogies. — The aims and methods of ancient genealogists require to be carefully considered before the value of the numerous ancestral lists in the Bible can be properly estimated. Many of the old "genealogies," like those of Greece, have arisen from the desire to explain the origin of the various groups which they include. The subdivision of tribes, their relation to each other, the intermingling of populations and the like are thus frequently represented in the form of genealogies. The "sons" of a "father" often stand for the branches of a family as they existed at some one period, and since in course of time tribal relations would vary, lists will present discrepancies. Many of the Biblical names are nothing more than personifications of nations, tribes, towns, etc., grouped together to convey some idea of the bond by which they were believed to be connected. Thus we find among the "sons" of Japhet: (the nations) Gomer, Javan, Tubal; Canaan "begat" Sidon and Heth; the "sons" of Ishmael include the well-known tribes Kedar and Jetur; Jacob, or the synonym Israel, personifies the "children of Israel." The recognition of this usage often furnishes an ethnological interpretation to those genealogical stories which obviously do not relate to persons, but to tribes or peoples personified. The Edomites and Israelites are regarded as "brothers" and since Esau (Edom) was born before Jacob (Israel) it would appear that the Edomites were held to be the older nation. The union of two clans is expressed as a marriage, or the wife is the territory which is dominated by the husband (tribe); see CALEB. If the woman is not of noble blood, but is a handmaiden or concubine, her children are naturally not upon the same footing as those of the wife; consequently the descendants of Ishmael, the son of Hagar (Sarah's maid), are inferior to Isaac and his descendants, while the children of Keturah, Abraham's concubine, are still lower—from the Israelite point of view. This application of the terms of relationship is characteristic of the Semites. The "father" of the Rechabites is their head or founder and a common bond, not necessarily physical, unites all "sons," whether they are "sons of the prophets" (members of prophetic guilds) or "sons of Belial" (worthless men).

Every case has to be judged upon its own merits, and allowance made both for the ambition of the weaker to claim or to strengthen an alliance with the stronger, and for the desire of clans or individuals to magnify the greatness of their ancestry. The first step must always be the careful comparison of related lists in order to test the consistency of the tradition. Next, these must be critically studied in the light of all available historical material, though indeed such evidence is not necessarily conclusive. Finally, (a) literary criticism must be employed to determine if possible the dates of such lists, since obviously a contemporary register is more trustworthy than one which is centuries later; (b) a critical estimate of the character of the names and of their use in various periods of Old Testament history is of importance in estimating the antiquity of the list—for example, many of the names in Chronicles attributed to the time of David are indubitably exilic or post-exilic; and (c) principles of ordinary historical probability are as necessary here as in dealing with the genealogies of other ancient peoples, and attention must be paid to such features as fluctuation in the number of links, representation of theories inconsistent with the growth of national life, schemes of relationship not in accordance with sociological conditions, etc. G. B. Gray's Hebrew Proper *Names* (1896), with his article in the Expositor (Sept. 1897), pp. 173–190, should be consulted for the application and range of Hebrew names in O. T. genealogies and lists.

The Biblical genealogies commence with "the generations of the heaven and earth," and by a process of elimination pass from Adam and Eve by successive steps to Jacob and to his sons (the tribes), and finally to the subdivisions of each tribe. According to this theory every Israelite could trace back his descent to Jacob, the common father of the whole nation. Such a scheme, however. is full of manifest improbabilities. It demands that every tribe and every clan should have been a homogeneous group which had preserved its unity from the earliest times, that family records extending back for several centuries were in existence, and that such a tribe as Simeon was able to maintain its independence in spite of the tradition that it lost its autonomy in very early times (Gen. xlix, 7). The whole conception of the unity of the tribes cannot be referred to a date previous to the time of David. and in the older writings a David or a Jeroboam was sufficiently described as the son of Jesse or of Nebat. The genealogical zeal as represented in the Old Testament is chiefly of later growth, and the exceptions are due to interpolation (Josh. vii, 1–18, contrast v. 24), or to the desire to modify or qualify an older notice. This, in the case of Saul (1 Sam. ix, 1), has led to textual corruption; a list of such a length as his should have reached back to one of the "sons" of Benjamin (*cf. e.g.* Gen. xlvi, 21), else it were purposeless. The genealogies, too, are often inconsistent amongst themselves and in contradiction to their object. They show, for example, that the population of southern Judah, so far from being "Israelite" was half-Edomite (see JUDAH), and several of the clans in this district bear names which indicate their original affinity with Midian or Edom. Moreover, there was a free intermixture of races. and many cities had a Canaanite (*i.e.* pre-Israelite) population which must have been gradually absorbed by the Israelites (cf. Judg. i). That spirit of religious exclusiveness which marked later Judaism did not become prominent before the Deuteronomic reformation and it is under its influence that the writings begin to emphasize the importance of maintaining the purity of Israelite blood, although by this time the fusion was complete (see Judg. iii 6) and for practical purposes a distinction between Canaanites and Israelites within the borders of Palestine could scarcely be discerned.

Many of the genealogical data are intricate. Thus, the interpretation of Gen. xxxiv is particularly obscure (see LEVITES ad *fin.*; SIMEON). As regards the sons of Jacob, it is difficult to explain their division among the four wives of Jacob; viz. (a) the sons of Leah are Reuben, Simeon, Levi and Judah (S. Palestine), Issachar and Zebulun (in the north), and Dinah (associated with Shechem); (b) of Leah's maid Zilpah, Gad and Asher (E. and N. Palestine); (c) of Rachel, Joseph (Manasseh and Ephraim, *i.e.*, central Palestine) and Benjamin; (d) of Rachel's maid Bilhah, Dan and Naphtali (N. Palestine). It has been urged that (b) and (d) stood upon a lower footing than the rest, or were of later origin; or that Bilhah points to an old clan associated with Reuben (Gen. xxxv 22) or Edom (Bilhan, Gen. xxxvi 27), while Zilpah represents an Aramaean strain. Tradition may have combined distinct schemes, and the belief that the wives were Aramaean at least coincides with the circumstance that Aramaean elements predominated in certain of the 12 tribes. The number "12" is artificial and can be obtained only by counting Manasseh and Ephraim as one or by omitting Levi, and a careful study of Old Testament history makes it extremely difficult to recover the tribes as historical units. See, on these points, the articles on the several tribes, B. Luther, *Zeit.* d. alttest. *Wissens.* (1901), pp. 1 sqq.; G. B. Gray, Expositor (March 1902), pp. 225–240, and in Ency. Bib., art. "Tribes"; and H. W. Hogg's thorough treatment of the tribes in the last-mentioned work.

The ideal of purity of descent shows itself conspicuously in portions of Deuteronomic law (Deut. vii, 1–3, xxiii, 2–8), and in the reforms of Nehemiah and Ezra. The desire to prove the continuity of the race, enforced by the experience of the exile, gave the impetus to genealogical zeal, and many of the extant lists proceed from this age when the true historical succession of names was a memory of the past. This applies with special force to the lists in Chronicles which present finished schemes of the Levitical divisions by the side of earlier attempts, with consequent confusion and contradiction. Thus the immediate ancestors of Ethan appear in the time of Hezekiah (2 Chron. xxix, 12), but he with Asaiah and Heman are contemporaries of David, and their genealogies from Levi downwards contain a very unequal number of links (1 Chron. vi). By another application of genealogical method the account of the institution of priests and Levites by David (1 Chron. xxiv) presents many names which belong solely to post-exilic days, thus suggesting that the scribes desired to show that the honourable families of their time were not unknown centuries previously. Everywhere we find the results of much skill and labour, often in accordance with definite theories, but a thorough investigation reveals their weakness and often quite incidentally furnishes valuable evidence of another nature.

The intricate Levitical genealogies betray the result of successive genealogists who sought to give effect to the development of the hierarchal system. The climax is reached when all Levites are traced back to Gershon, Kehath and Merari, to which are ascribed respectively Asaph, Heman and Ethan (or Jeduthun). The last two were not originally Levites in the later accepted sense of the term (see 1 Kings iv, 31). To Kehath is reckoned an important subdivision descended from Korah, but in 2 Chron. xx, 19 the two are distinct groups, and Korah's name is that of an Edomite clan (Gen. xxxvi, 5, 14, 18) related to Caleb, and thus included among the descendants of Judah (1 Chron. ii, 43). Cases of adjustment, redistribution and "Levitizing" of individuals are frequent. There are traces of varying divisions both of the singers (Neh. xi, 17) and of the Levites (Num. xxvi, 58; Ezr. ii, 40, iii, 9; 1 Chron. xv, 5–10, xxiii), and it is noteworthy that in the case of the latter we have mention of such families as Hebroni (Hebronite), Libni (from Libnah)—ethnics of south Judaean towns. In fact, a significant number of Levitical names find their analogy in the lists of names belonging to Judah, Simeon and even Edom, or are closely connected with the family of Moses; *e.g.* Mushi (*i.e.*, Mosai'te), Gershon and Eleazar (cf. Gershom and Eliezer, sons of Moses). The Levites bear a class-name, and the genealogies show that many of them were connected with the minor clans and families of South Palestine which included among them Moses and his kin. Hence. it is not unnatural that Obed-edom, for example, obviously a southerner, should have been reckoned later as a Levite, and the work ascribed by the chronicler's history to the closing years of David's life may be influenced by the tradition that it was through him these mixed populations first attained importance.

In the time of Josephus every priest was supposed to be able to prove his descent, and perhaps from the time of Ezra downward lists were carefully kept. But when Anna is called an Asherite (Luke ii, 36), or Paul a Benjamite (Rom. xi, 1), family tradition was probably the sole support to the claim, although the tribal feeling had not become entirely extinct. The genealogies of Jesus prefixed to two of the gospels are intended to prove that He was a son of David. But not that alone, for in Matt. i He is traced back to Abraham the father of the Jews, while in Luke iii He, as the second Adam, is traced back to the first man. The two lists are hopelessly inconsistent; not because one of them follows the line of Mary, but because they represent independent attempts. That in Matthew is characteristically arranged in three series of fourteen generations each through the kings of Judah, while Luke's passes through an almost unknown son of David; in spite of this, however, both converge in the person of Zerubbabel.

See A. C. Hervey, *Genealogies of Our Lord;* H. von Soden, *Ency. Bib.* ii col. 1666 *sqq.;* B. W. Bacon, Hastings' *Dict. Bib., ii* pp. 138 *seq.;* J. F. M'Lennan's *Studies* (2nd ser., ch. ix); S. A. Cook, *Ency. Bib.* ii col. 1657 *sqq.* (with references); W. R. Smith, *Kinship and Marriage* (2nd ed., especially ch. i). (S. A. C)

Modern.—Two forces have combined to give genealogy its importance during the period of modern history: the laws of inheritance, particularly those which govern the descent of real estate, and the desire to assert the privileges of a hereditary aristocracy. But it is long before genealogies are found in the possession of private families. The succession of kings and princes is in the chronicle book; the line of the founders and patrons of abbeys is recorded by the monks with curious embellishment of legend. But the famous suit of Scrope against Grosvenor will illustrate the late appearance of private genealogies in England. In 1385 Sir Richard Scrope, lord of Bolton, displaying his banner in the host that invaded Scotland, found that his arms of a golden bend in a blue field were borne by a knight of the Chester palatinate, one Sir Robert Grosvenor. He carried the dispute to a court of chivalry, whose decision in his favour was confirmed on appeal to the king. Grosvenor asserted that he derived his right from an ancestor, Sir Gilbert Grosvenor, who had come over with the Conqueror, while an intervening claimant, a Cornish squire named Thomas Carminowe, boasted that his own ancestors had borne the like arms since the days of King Arthur's Round Table. It is remarkable that in support of the false statements made by the claimants no written genealogy is produced. The evidence of tombs and monuments and the reports of ancient men are advanced, but no pedigree is exhibited in a case which hangs upon genealogy. It is possible that the art of pedigree-making had its first impulse in England from the many genealogies constructed to make men familiar with the claims of Edward III to the crown of France, a second crop of such royal pedigrees being raised in later generations during the contests of York and Lancaster. But it is not until after the close of the middle ages that genealogies multiply in men's houses and are collected into volumes. The mediaeval baron, knight or squire, although proud of the nobility of his race, was content to let it rest upon legend handed down the generations. The exact line of his descent was sought only when it was demanded for a plea in the king's courts to support his title to his lands. From the first the work of the genealogist in England had that taint of inaccuracy tempered with forgery from which it has not yet been cleansed. The mediaeval kings, like the Welsh gentry of later ages, traced their lines to the household of Eden garden, while lesser men, even as early as the 14th century, eagerly asserted their descent from a companion of the Conqueror. Yet beside these false imaginations we find the law courts, whose business was often a clash of pedigrees, dealing with genealogies centuries long which, constructed as it would seem from worthy evidences, will often bear the test of modern criticism.

Genealogies in great plenty are found in manuscripts and printed volumes from the 16th century onward. Remarkable among these are the descents recorded in the Visitation Books of the heralds, who, armed with commissions from the crown, the first of which was issued in 20 Hen. VIII, perambulated the English counties, viewing arms and registering pedigrees. The notes in their register books range from the simple registration of a man's name and arms to entries of pedigrees many generations long. To the heralds these visitations were rare opportunities of obtaining fees from the visited, and the value of the pedigrees registered is notably unequal. Although it has always been the boast of the College of Arms that visitation records may be produced as evidence in the law courts, few of these officially recorded genealogies are wholly trustworthy. Many of the officers of arms who recorded them were, even by the testimony of their comrades, of indifferent character, and even when the visiting herald was an honourable and industrious man he had little time to spare for the investigation of any single genealogy. Deeds and evidences in private hands may have been hastily examined in some instances—indeed, a herald's summons invites their production—and monuments were often viewed in the churches, but for the most part men's memories and the hearsay of the countryside made the backbone of the pedigree. The further the pedigree is carried beyond the memory of living men the less trustworthy it becomes. The principal visitations took place in the reigns of Elizabeth, James I, Charles I and Charles II. No commission was issued after the accession of William and Mary, but from that time onward large numbers of genealogies have been recorded in the registers of the College of Arms, the modern ones being compiled with a care which contrasts remarkably with the unsupported statements of the Tudor heralds.

Outside the doors of the College of Arms genealogy has now been for some centuries a favourite study of antiquaries, whose researches have been of the utmost value to the historian, the topographer and the biographer. County histories, following the example of Dugdale's Warwickshire folios, have given much space to the elucidation of genealogies and to the amassing of material from which they may be constructed. Dugdale's great work on the English baronage heads another host of works occupied with the genealogy of English noble families, and the second edition of "G.E.C.'s" *Complete Peerage* shows the mighty advance of the modern critical spirit. Nevertheless, the 20th century has not yet seen the abandoning of all the genealogical fables nourished by the Elizabethan pedigree-mongers, and the ancestry of many noble houses as recorded in popular works of reference is still derived from mythical forefathers. Thus the dukes of Norfolk, who, by their office of earl marshal are patrons of the heralds, are provided with a 10th century Hereward for an ancestor; the dukes of Bedford, descendants of a 15th century burgess of Weymouth, are traced to the knightly house of Russell of Kingston Russell, and the dukes of Westminster to the mythical Gilbert le Grosvenor who "came over in the train of the Conqueror."

Genealogical research has, however, made great advance during the last generation. The critical spirit shown in such works as Round's *Studies in Peerage and Family History* (1901) has assailed with effective ridicule the methods of dishonest pedigree-makers. Much raw material of genealogy has been made available for all by the publication of parish registers, marriage-licence allegations, monumental inscriptions and the like, and above all by the mass of evidences contained in the volumes issued by the Public Record office.

Within a small space it is impossible to set forth in detail the methods by which an English genealogy may he traced. But those who are setting out upon the task may be warned at the outset to avoid guesswork based upon the possession of a surname which may be shared by a dozen families between whom is no tie of kinship. A man whose family name is Howard may be presumed to descend from an ancestor for whom Howard was a personal name: it may not be presumed that this ancestor was he in whom the dukes of Norfolk have their origin. A genealogy should not be allowed to stray from facts which can be supported by evidence. A man may know that his grandfather was John Stiles who died in 1850 at the age of 45. It does not follow that this John is identical with the John Stiles who is found as baptized in 1795 at Blackacre, the son of William Stiles. But if John the grandfather names in his letters a sister named Isabel Nokes, while the will of William Stiles gives legacies to his son and daughter John Stiles and Isabel Nokes, we may agree that reasonable proof has been given of the added generation. A new pedigree should begin with the carefully tested statements of living members of a family. The next step should be to collate such family records as Bible entries, letters and diaries, and inscriptions on mourning rings, with monumental inscriptions of acknowledged members of the family. From such beginnings the genealogist will continue his search through the registers of parishes with which the family has been connected; wills and administrations registered in the various probate courts form, with parish registers, the backbone of most middle-class family histories. Court rolls of manors in which members of the family were tenants give, when existing and accessible, proofs which may carry back a line, however obscure, through many descents. When these have been exhausted the records of legal proceedings, and notably those of the court of chancery, may be searched. Few English households have been able in the past to avoid an appeal to the chancery court, and the bill and answer of a chancery plaintiff and defendant will often tell the story of a family quarrel in which a score of kinsfolk are involved; the pleadings may contain the material for a family tree of many branching generations. Coram Rege and De Banco rolls may even, in the course of a dispute over a knight's fee or a manor carry a pedigree to the conquest of England, although such good fortune can hardly be expected by the searcher out of an undistinguished line. In proving a genealogy it must be remembered that in the descent of an estate in land must be sought the best evidence for a pedigree.

At the present time the study of genealogy grows rapidly in English estimation. It is no less popular in the United States, where societies and private persons have of late years published a vast number of genealogies, many of which combine the results of laborious research in U.S. records with extravagant and unfounded claims concerning the European origin of the families dealt with. A family with the surname of Cuthbert has been known to hail St. Cuthbert of Lindisfarne as its progenitor, and one surnamed Eberhardt has incorporated in its pedigree such German princes of old times as were found to have Eberhardt for a Christian name.

Genealogy in modern France has, with a iew honourable exceptions, fallen into the hands of the popular pedigree-makers, whose concern is to gratify the vanity of their employers. Italy likewise has not yet shaken off the influence of those venal genealogists who sold pedigrees cheaply to all comers. But much laborious genealogical inquiry had been made in Germany since the days of Hubner, and even in Russia there was some attempt to apply modern standards of criticism to the chronicles of the swarming descendants of the blood of Rurik.

In no way is the gap made by the dark ages between ancient and modern history more marked than by the fact that no European family makes a serious claim to bridge it with its genealogy. The unsupported claim of the Roman house of Massimo to a descent from Fabius Maximus is respectable beside such legends as that which made Lévis-Mirepoix head of the priestly tribe of Levi, but even the boast of such remote ancestry has now become rare. The ancient sovereign houses of Europe are, for the most part, content to attach themselves to some ancestor who, when the mist that followed the fall of the western empire begins to lift, is seen rallying with his sword some group of spearmen.

BIBLIOGRAPHY.—Genealogical works have been published in such abundance that the bibliographies of the subject are already substantial volumes. Amongst the earlier books from the press may be noted Benvenuto de San Georgio's *Montisferrati marchionum et principum regiae propagium successionumque series* (1515); Pingonius's *Arbor gentilitiae Sabaudiae Saxoniaeque domus* (1521); Gebweiler's *Epitome regzi ac vetustissimi ortus Caroli V. et Ferdinandi I., omniumque archiducum Austriae et comitum Habsburgiensium* (1527); Meyer's work on the counts of Flanders (1531), and Du Boulay's genealogies of the dukes of Lorraine (1547). Later in the same century Reineck of Helmstadt put forth many works having a wider genealogical scope, and we may cite Henninges's *Genealogiae Saxonicae* (1587) and *Theatrum genealogicum* (1598), and Reusner's *Opus genealogicum catholicum* (1589–1592). For the politically inconvenient falseness of François de Rosières's *Stemmata Lotharingiae ac Barri ducum* (1580), wherein the dukes of Lorraine were deduced from the line of Charlemagne, the author was sent to the Bastille by the *parlement* of Paris and his book suppressed.

The 17th century saw the production in England of Dugdale's great *Baronage* (1675–1676), a work which still holds a respectable place by reason of its citation of authorities, and of Sandford's history of the royal house. In the same century André Duchesne, the historian of the Montmorencys, Pierre d'Hozier, the chronicler of the house of La Rochefoucauld, Rittershusius, Imhoff, Spener, Lohmeier and many others contribute to the body of continental genealogies. Pierre de Guibours, known as Pbre Anselme de Ste Marie, published in 1674 the first edition of his magnificent *Histoire généalogique de la maison royale de France, des pairs, grands officiers de la couronne et de la maison du roy et des anciens barons du royaume*. Of this encyclopaedic work a third and complete edition appeared in 1726–1733. A modem edition under the editorship of M. Potier de Courcy began to be issued in 1873, but remains incomplete. Among 18th-century work Johann Hubner's *Bibliotheca genealogzca* (1729) and *Genealogische Tabellen* (1725–1733), with Lenzen's commentary on the latter work (*c.* 1756), may be signalized, with Gatterer's *Handbuch der Genealogie* (1761) and his *Abriss der Genealogie* (1788), the latter an early manual on the science of genealogy. Hergott's *Genealogia diplomatica augustae gentis Habsburgicae* (1737) is the imperial genealogy compiled by the emperor's own historiographer.

Modern peerages in England may be said to date from that of Arthur Collins, whose one-volume first edition was published in 1709. The fifth edition appeared in 1778, in eight volumes, to be republished in 1812 by Sir Egerton Brydges, the "Baptist Hatton" of Disraeli's novel, who corrected many legendary pedigrees, besides inserting his own forged descent from a common ancestor with the dukes of Chandos. From this work and from the Irish peerage of Lodge (as re-edited by Archdall) most of the later peerages have quarried their material. With these may be named the baronetages of Wotton and Betham. Of modern popular peerages and baronetages that of Burke has been published since 1822 in many editions and now appears yearly. Most important for the historian are the *Complete Peerage* of G. E. C[ockayne] (2nd ed., 1910), and the *Complete Baronetage* of the same author. The *Peerage of Scotland* (1769) of Sir Robert Douglas of Glenbervie came to a second edition in 1813, edited by J. P. Wood, and the whole work has been revised and re-edited by Sir James Balfour Paul (1904, etc.). Of the popular manuals of English untitled families, Burke's *Genealogical and Heraldic Dictionary of the Commoners* (1833–1838) is now brought up to date from time to time and reissued as the *Landed Gentry*.

Lists of pedigrees in English printed works are supplied by Marshall's *Genealogist's Guide* (1903), while pedigrees in the manuscript collections of the British Museum are indexed in the list of R. Sims (1849). Valuable genealogical material will be found in such periodicals as the *Genealogist*, the *Herald and Genealogist*, the *Topographer and Genealogist, Collectanea topographica et genealogica, Miscellanea genealogica et heraldica* and the *Ancestor*. In Germany the *Deutscher Herold* is the organ of the Berlin Heraldic and Genealogical Society. The *Nederlandsche Leeuw* is a similar publication.

Modern criticism of the older genealogical methods will be found in J. H. Round's *Peerage and Pedigree*, 2 vols. (London, 1910), and in other volumes by the same author. The Harleian Society has published many volumes of the Herald's Visitations; and the British Record Society's publications, supplying a key to a vast mass of wills, chancery suits and marriage licences, are of still greater importance. The *Victoria History of the Counties of England* includes genealogies of the ancient English county families still among the land-owning classes. English pedigrees before the Conquest are in W. G. Searle's *Anglo-Saxon Bishops, Kings and Nobles* (1899).

Genealogical dictionaries of noble French families include Victor de Saint Allais's *Kobiliaire universel* (21 vols., 1872–1877) and Aubert de la Chenaye-Desbois' *Dictionnaire de la noblesse* (15 vols., 1863–1876). A sumptuous work on the genealogy and heraldry of the ancient duchy of Savoy by Count Amédée de Foras began to appear in 1863. Spain has Lopez de Haro's *Nobiliario genealogico de los reyes y títulos de España*. Italy has the *Teatro araldico* of Tettoni and Saladini (1841–1848), Litti's *Famiglie celebri* and an *Annuario della nobilità*. Such annuals are now published more or less intermittently in many European countries. Finland has a *Ridderscap och Adels Kalender*, Belgium the *Annuaire de la noblesse*, the Dutch Netherlands an *Adelsboek*, Denmark the *Adels-Garbog* and Russia had the *Annuaire* of Ermerin. But chief of all such publications is the ancient *Almanach de Gotha*, containing the modern kinship oi royal and princely houses, and now accompanied by volumes dealing with the houses of German and Austrian counts and barons, and with houses ennobled in modern times by patent. A useful modern reference book for students of history is Stokvis's *Manuel d'histoire et de généalogie de tous les états du globe* (1888–1893). The best manual for the English genealogist is Walter Rye's *Records and Record Searching* (1897). G. Gatfield's bibliography (1892) is helpful. (O.B.)

Data for American genealogies may be found in the *New England Historical and Genealogical Register; New York Genealogical and Biographical Record; Genealogical Magazine of New Jersey; Publications of the Genealogical Society of Pennsylvania; Mayflower Descendant: New Haven Genealogical Magazine; William and Mary College Quarterly; Maryland Historical Magazine; Virginia Magazine of History and Biography; South Carolina Historical and Genealogical Magazine; Nebraska and Midwest Genealogical Record; Utah Genealogical and Historical Magazine; National Genealogical Society Quarterly; Americana; Vineland Historical Magazine; Magazine of American Genealogy; Lineage Books of the Daughters of the American Revolution.*

GENÉE, ADELINE (1878–), Danish dancer, was born at Aarhus, Jutland, and began to study her steps when a child. After appearing in Berlin, Copenhagen and Paris, she went to London. The precision and technical perfection of her dancing made her a great favourite. For many seasons she was *première danseuse* at the Empire, London.

Adeline Genée was in America in 1908–13.

GENERAL, a high military rank. Army officers holding this rank usually command units larger than a regiment or its equivalent or units consisting of more than one arm of the service *(see* OFFICERS). This applies also to officers commanding comparable units of air forces. In many instances, however, a general is a staff officer who does not command troops but who plans their operations in the field. General, lieutenant general and major general are the first, second and third grades of general officers in most armies. The U.S. army, air force and marines have a fourth grade, brigadier general. The highest U.S. army rank, that of general of the army, was created during World War II and is the equivalent of the rank of field marshal in the British and other armies. Its counterpart in the U.S. air force is general of the air force. *(See* INSIGNIA, MILITARY.)

The term is also included in the titles of various civil offices of high responsibility such as postmaster general, attorney general and governor general. (LN. Ms.)

GENERAL AGREEMENT ON TARIFFS AND TRADE (G.A.T.T.): *see* TARIFFS AND TRADE, GENERAL AGREEMENT ON (G.A.T.T.).

GENERAL AVERAGE: *see* AVERAGE.

GENERAL ELECTRIC COMPANY, one of the largest electrical manufacturers in the world, designs, produces and sells thousands of diversified products. General Electric participates actively in most of the basic industries possible in manufacturing and its products afford power for all basic industries. An important pioneer in industrial research, General Electric also contributed much to fields not directly allied with the electrical industry through research in physics, metallurgy and chemistry.

The General Electric company was established on April 15, 1892, by the consolidation of the Edison 'General Electric company and the Thomson-Houston company, with Charles A. Coffin as the first president. The Edison Electric Light company had been formed in 1878 by Thomas A. Edison for the purpose of developing an electric light. After the organization of the Thomson-Houston company in 1883, a merger of the two companies was effected since the parallel developments of each tended to result in infringement upon individual patent rights. The company contributed not only to the extensive electrification of all industry in the three primary fields—lighting, electric railways and power—which was its initial aim but also to the discovery of hundreds of new applications for electricity.

In 1879 Edison had demonstrated his first successful incandescent lamp, to which he won all patent rights in 1891 by court order. Contingent upon this first main step, progress in lighting advanced, after the merger, with the first practical demonstration of the mercury vapour arc lamp and the magnetic arc lamp (1903). General Electric subsequently began the manufacture of the metalized-carbon filament lamp (1905); the tantalum-filament lamp (1906); the tungsten lamp (1911); the water-cooled lamp (1931); and the fluorescent light (1938).

Other improvements included the development of lamp bulbs without tips (1919) and the use of inside frosting for lamp bulbs (1924)—later improved by the white, inside-finish lamp which diffused light with almost perfect uniformity.

Edison's first electric railway was tested in 1880. In 1895 a General Electric locomotive pulled the first trains through the Baltimore and Ohio railway tunnel in Baltimore. General Electric operated the first fully automatic substation for the Elgin and Belvidere Electric railway in 1914. The Great Northern railway's Cascade tunnel, which traverses the Cascade mountain range in Oregon for the length of three miles, was placed under General Electric operation in 1929, and in 1934 the company equipped the "Zephyr," a new type of streamlined diesel-electric train.

General Electric. moreover, made vast progress in the comprehensive field of power In 1903 the company tested the first steam turbine and in 1926 produced the largest turbine-generator in the world, a 208.000-kw. unit. The U.S.S. "Jupiter," the first electrically driven ship of the U.S. navy, was launched in 1912, powered by General Electric engines.

Other major accomplishments include the demonstration of the hot-cathode X-ray tube (1913); the first domestic refrigerator with a sealed mechanism (1925); the introduction of the oil furnace and air conditioner (1932); a mobile two-way radio system (1934); the manufacture of metal radio tubes and the first sets to use them (1935); and the electric blanket (1936). In 1952 General Electric became the largest manufacturer of jet aircraft engines in the U.S.

During World War II General Electric mobilized its facilities for the production of war weapons. Among the defense products which the company manufactured were propulsion units to drive navy and merchant marine ships; turbosuperchargers for the air force; radar and radio equipment; electrical control apparatus; and electric motors.

General Electric also participated in research aimed at the development of atomic weapons and of peaceful applications of atomic energy. General Electric was among the first firms to volunteer its services for research in nuclear power.

GENERAL MOTORS CORPORATION, the world's leading producer of motor vehicles, also manufactures a wide variety of household appliances and commercial products such as electric refrigerators, ranges, clothes washers and dryers; oil burners; diesel locomotives. diesel engines for highway, marine and stationary use; turbo-jet and prop-jet aircraft engines; and earth-moving equipment.

When called upon, the company has undertaken major assignments for the armed forces, including production of complete tanks, guns and airplanes; ammunition and military vehicles; gun-bomb-rocket sights, bombing navigational computers and guidance systems for missiles.

General Motors also makes many of the special smaller parts and accessories for its principal products, such as starting, lighting and ignition systems, spark plugs, fuel pumps, shock absorbers, car radios, heaters, locks, horns, headlights, ball and roller bearings, carburetors, etc.

Research in General Motors has been emphasized since the GM Research laboratories were founded in 1920. Company research has contributed a number of pioneering developments in fields such as fuels, refrigerants, quick-drying lacquers, internal combustion engines of all types and metallurgy. It developed the lightweight two-cycle diesel engine, which after the mid-1930s all but completely replaced steam on U.S. railroads.

The General Motors company (New Jersey) was incorporated on Sept. 16, 1908. Buick was the nucleus company but was soon joined by Oldsmobile, Oakland (now Pontiac) and Cadillac. Chevrolet joined the by then reorganized General Motors corporation (Delaware) in 1918. In that reorganization General Motors changed from a holding to an operating company. Subsequently, the corporation pioneered in the development and application of a decentralized concept of management. Under this concept, since widely emulated by other major industrial enterprises. the various operating units, called divisions. have a substantial degree of autonomy within a framework of over-all policy.

In Nov. 1954 General Motors produced its 50,000,000th motor vehicle in the United States and the following year attained the highest annual sales ever reported by any company—more than $12,000,000,000. In the late 1950s General Motors was employing about 600,000 persons world-wide, and was owned by well over 750,000 shareholders. In the United States alone, General Motors company purchases goods and services from more than 26.000 suppliers, who receive approximately 50 cents out of each sales dollar.

General Motors scholarship programs aid 350 colleges and 1.600 students annually. (H. H. C.)

GENERAL STAFF, a military term denoting the staff of officers who assist a commander by performing detailed duties of administration. planning, supply and co-ordination. The general staff concept emerged in European armies during the 19th century, the first and most successful being the general staff of the Prussian army.

The U.S. army created a general staff in 1903, largely resulting from the efforts of the secretary of war, Elihu Root. Soon thereafter, in 1906, the British army also formally established a general staff. In most air forces the counterpart of the army general staff came to be known as the air staff.

See STAFF, MILITARY.

GENERAL STRIKE. A general strike does not necessarily imply a strike of all workers in *every* industry, but the term does mean that a substantial proportion of workers in each of a number of industries have ceased work in a common endeavour to achieve a certain objective, which may be economic or political. While the description may not be properly applied to a strike covering only one industry, there may be considerable variations in the degree of generality of such a strike.

Early Radicals and Chartists.—The idea of the strike as a means of influencing conditions of employment is as old as civilized man and antedates the trade-union movement by centuries. However, as a deliberate part of the tactics of collective bargaining the strike came into regular use with the growth of the trade unions in Great Britain in the late 18th century. The history of the general strike also seems to begin in Great Britain. When the term was first used is not clear. but both the idea and the expression were brought into popular currency at the time of the Chartists. John Doherty, one-time leader of the cotton spinners, used the term in 1834 in a newspaper which he edited. and again when giving evidence before a parliamentary committee in 1838 on the cause of the strikes which had occurred after the repeal of the Combination acts in 1824. Doherty, however. seems to have meant nothing more than a strike which was not confined to a single district, but embraced the whole cotton trade.

In the 1820s and 1830s the idea of a general stoppage of work was canvassed by radical orators as a means of securing the reform of parliament and achievement of the "rights of labour." The first conception was that of a "national holiday" or "sacred month." In Jan. 1832 William Benbow published a pamphlet entitled *Grand National Holiday and Congress of the Productive Classes*, describing how the workers, if they would act with unity of "thought and action." could by ceasing to work for one month secure "equal rights, equal liberties. equal enjoyments, equal toil, equal respect. equal share of production." The national holiday or sacred month was to be a peaceful affair and achieve its objectives by the simple process of the workers remaining "at leisure."

There was much talk of the sacred month by the Chartists at the time of the great convention in 1839. and a great deal of dispute as to whether it should take the form of a national holiday or an armed insurrection. In the event. little came of the agitation, though it caused considerable apprehension to the government. In 1842 the Chartist executive tried to turn an outbreak of strikes in Lancashire into a general strike for the charter. They were successful in spreading the stoppage to neighbouring counties. but the strike eventually collapsed in the face of the show of force organized by the government.

Syndicalism.—After the failure of the Chartist agitation interest in the general strike declined in Britain until the early years of the 20th century. Discussion of the theory of the general strike as a method of social revolution was mainly conducted in France, and the doctrines of Syndicalism (*q.v.*) subsequently developed there gave it a philosophic basis. The question was discussed at the Geneva congress of the International Association of Workingmen in 1866, but it was not until 1893 that the next significant manifestation of the general strike occurred. On the refusal of the Belgian parliament to agree to universal manhood suffrage the Labour party issued orders calling on the workers to stop work immediately, and more than 200,000 workers went on strike. the stoppage only being called off when parliament relented and agreed in a modified form to the workers' demands. Again in 1902 there mas another general strike in Belgium which led to riots and the shooting of some strikers.

In the same year, a large-scale strike took place in Sweden in support of universal suffrage and the reform of parliament, and in 1909 there occurred the most complete general strike for economic ends which had, up to that date. ever taken place in any country. The 1909 general strike in Sweden was largely the result of the high degree of organization and centralized control of both workpeople's and employers' federations. Falling profits had led the employers to agree betneen themselves on a nation-wide basis not to raise wages and in some instances to cut them. This policy was resisted by the unions, which had also other scores to settle, and they eventually decided to attempt to defeat the employers by calling a general strike.

The stoppage lasted a month and more than 300,000 workers out of a total of 800,000 ceased work. Industry was brought almost completely to a standstill, but the railway workers did not join the strike, though road and river transport stopped. The strike was entirely peaceful and aroused world-wide interest, large sums of money being subscribed by unions in other countries to assist the striking Swedish workers.

Though the results of the Swedish general strike could not be described as either failure or success, it encouraged the growth of the idea in other countries that major economic reforms could be achieved thus nithout violence necessarily being involved.

Widespread support for the general strike began to develop in Great Britain after the return from Australia of Tom Mann—one of the leaders of the great 1889 dock strike. (*See* also STRIKES AND LOCKOUTS). Mann came back to Britain inspired by the doctrines of Syndicalism which had spread from France to America, later being adopted by the Industrial Workers of the World (founded in Chicago in 1905), and re-exported to Europe and Australasia. Mann established in 1911 the Revolutionary Syndicalist league and had a hand in most of the large-scale strikes which occurred in 1910, 1911 and 1912.

The essence of the Syndicalist belief was that the workers could not achieve social revolution by democratic political means, but only by the direct overthrow of the capitalist owners of industry through a general strike. Once the power of the capitalists had been destroyed any re-emergence of centralized authority could be prevented by the unions taking over the control of industries and running each of them for the benefit of the norkers. To attain these ends the first essential step was the reorganization of the trade unions on the pattern of industry, since combinations based on craft or occupational differences only weakened the power of the working class.

These ideas were perhaps most brilliantly expressed in the pamphlet published by the south Wales miners in 1913 entitled The *Miners' Next Step*. Between 1910 and 1914 industrial Syndicalism secured a considerable following, and on the eve of World War I the road transport, railway and miners' unions came together to form the "triple alliance," with the object of securing, by strike action if necessary. major improvements in wages and working conditions.

The progress of Syndicalism was arrested by the war, and the changes wrought by the conflict were such that the Syndicalist movement was never able to recapture its pre-1914 attraction. However, the upheaval in social conditions and the problems of social and economic readjustment left by the war to some extent promoted militant ideas. There was much talk of "the day" among shop stewards and other radical elements in the trade-union movement, and when Ernest Bevin organized the councils of action it is almost certain that there would have been a complete stoppage of work throughout the country had not David Lloyd George changed his policy of sending troops to Poland. It was this easily earned victory of 1920 that perhaps led Bevin astray when weighing up the situation in 1926.

The General Strike of 1926 in Britain.—The British general strike of 1926 stemmed from the background of developments already sketched and from the conditions of employment in the coal industry. It was not a deliberately planned strike and the policy of the leaders of the trade-union movement was not determined by theoretical considerations, but they and the rest of the active workers did believe that the mineowners and the government could be coerced by a show of peaceful force.

Much had been expected of the triple alliance by militant members of the unions immediately after the end of the war. However, the miners were persuaded not to call upon its aid by the appointment of the Sankey commission, and then, when this proved abortive from their point of view, disagreement between the members of the alliance prevented action. The end of the alliance came when in 1921 the railwaymen and transport workers refused to strike with the miners.

The fundamental weakness of the triple alliance lay in the refusal of each organization to give up final autonomy. The result was that the miners struck alone against wage reductions and a long struggle followed after which they eventually returned to work, bitter at their defeat. The problems faced by the coal industry grew no easier, and with the return of the German. Polish and Belgian coal fields to full production the export market grew even more difficult. The coal owners sought to bring down costs by again reducing the standards of employment of the miners. The conflict came to a head in 1925 and the government staved off another stoppage by granting a temporary subsidy while another royal commission under Herbert Samuel made a further investigation of the industry's sickness.

The report of the commission, which made a number of compromise proposals to tide the industry over its difficulties, was published in March 1926. It was immediately rejected by both sides and a strike appeared inevitable when the government subsidy came to an end on April 30. Meanwhile, the Industrial committee of the Trades Union congress had met the prime minister and explored the possibility of getting negotiations restarted. Nothing was achieved. houever, in the face of the intransigence of both the miners and the owners. On April 29 the T.U.C. pledged its support to the miners and called a national conference of trade-union executives. The general council then took a roll call of its affiliated unions; 3,653,000 votes were cast in favour of giving the council full powers to act on behalf of the whole movement, and 49,911 against.

Further attempts were made by the Trades Union congress to negotiate with the government, which had invoked the Emergency Powers act passed in 1920 to meet just such a situation as this. Some progress seemed to have been made. but while the general council of the T.U.C. was meeting the miners' executive a summons was received from Downing street. and when the T.U.C. delegates arrived they were handed a letter stating that negotiations could not be continued since the machine operators at the Daily Mail had refused to print the leading article of the following day's issue. Despite the fact that this action had been taken spontaneously without the knowledge of the T.U.C., the government held it sufficient reason for refusing further discussions and insisted that all strike notices be withdrawn before any further talks could be held. Faced with this situation the general council decided that there was nothing further it could do but give the order for the strike to commence.

The unions had talked about making preparations, but in fact little had been done, and a hurriedly improvised organization had to be created. The only possibility of winning the strike lay in frightening the government and so persuading it to intervene, in order to get talks going once again, by the offer of some compromise solution.

The government, however. had long made preparations to meet an emergency of this kind, and it was determined to force the unions to capitulate. In spite of the calling out of troops, arming of special constables and the arrest of hundreds of strikers, the whole affair was remarkably peaceful and very few serious incidents were reported.

At this time there were about 5,000,000 trade-union members out of a total wage-earning population of 15,000,000; about 3,000,000 were eventually involved in the strike. The main industries to be stopped included railways, road transport, iron and steel. building and printing; the rest were to be called out later if necessary. The closing of the press led to the government's producing its own paper, the *British Gazette,* and the T.U.C. published a strike newspaper called the *British Worker.* In the absence of the daily press many rumours circulated and the effect nas to weaken the resolution of the workers and increase the fears of the middle class.

The general council rapidly realized that the government was not likely to be stampeded and began to look for a way of ending the strike. Sir Herbert Samuel, who had returned posthaste from the continent. acted as an intermediary on his own initiative, and made certain suggestions to the T.U.C. The miners, however, refused to consider them, and therefore the general council decided to call off the strike as it felt that no solution was possible if the miners would not compromise at all. The general council believed that the miners had violated their agreement with the T.C.C. when it accepted the responsibility of calling the strike, since in their view this also implied the right of the general council to decide on the settlement.

The general strike was thus brought to an end on May 12, having lasted nine days. But the miners refused to return and remained on strike throughout the summer until they were starved into submission.

The Legal Issue.—The general strike raised many important issues. How far is it possible for a strike to go before it in fact becomes a revolutionary action directed against the state? Lord Simon held that the strike was illegal since it was not a trade dispute but an attempt "to make the public and parliament and the government do something," and this was not legally permissible under the trade-union acts.

On the other hand Arthur Lehman Goodhart challenged this interpretation of the law, holding that the fact that the T.U.C. did not have a trade dispute with the government was irrelevant. The real question was whether the trade unions on strike were furthering a trade dispute, which obviously existed so far as the miners were concerned, in which case the sympathetic strikers were acting legally.

This legal dispute has never been resolved. The government tried to clarify the issue by passing the Trade Disputes and Trade Unions act in 1927, but since this act was repealed in 1946 the position became as it was in 1926.

Later Tendencies—The effect of the general strike was to make both sides realize the danger to themselves in allowing industrial relations to become so strained. During the following years industrial relations improved considerably and this was to a great extent the result of wise leadership shown by both sides of industry. The *modus vivendi* which unions and employers gradually worked out for themselves in Britain was not achieved in France, which went through a period of bitter industrial unrest involving general stoppages in the 1930s. At the end of World War II there were several instances of general strikes in a number of European countries for both political and economic reasons; however, the Syndicalist notion had long been abandoned in most western European countries. So long as there is free trade unionism, with the right to bargain, a general strike is always possible. but it is extremely unlikely to occur if political democracy flourishes and prosperous economic conditions are sustained. When a general strike does occur, however, whatever the legal situation may be, it does constitute a challenge to the authority of the state and no government could in fact refrain from taking drastic action to bring it to an end.

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(B. C. R.)

UNITED STATES

American labour has accepted in principle the inviolability of the collective contract and consequently it has in general always opposed the general strike. A general strike would lead to universal breaches of existing agreements, and would expose weaker unions to reprisals from employers. This kind of opposition by union leaders, based upon pragmatic grounds, has been reinforced by their strong opposition to the use of what is essentially a revolutionary weapon.

There have, nevertheless, been a number of local general strikes, all of which were opposed by the national officers of many of the participating unions. In the period folloning World War I, mounting radicalism as well as the belief that the employers of the shipyards were out to destroy the newly built unions in their plants led to a strike on Feb. 6, 1919, involving virtually all labour in Seattle, Wash. The walkout lasted five days, and the opposition of the national officers of many of the unions mas an important factor in ending the general strike. Local general strikes later took place in Terre Haute. Ind., in July 1935; in Pekin, Ill., in Feb. 1936; and in Oakland, Calif., in 1946; but the most important local general strike took place in San Francisco. Calif.. in July 1934. This was caused by the attempt of the stevedores and shipowners to break the maritime strike for union recognition. Violence against the strikers, followed by efforts to carry on stevedoring operations by strikebreakers and the use of the national guard to protect them, precipitated the general walkout. It lasted four days, and the national heads of a number of unions as well as the American Federation of Labor disclaimed any support for this walkout.

General strikes are to be distinguished from industry-wide strikes, which are general as far as the affected industry is concerned. In the period after World War II, there were a number of industry-wide strikes in the bituminous coal and steel industries, but no general strikes of even the local variety. The reason is that local general strikes can only be called when there is widespread conviction among the organized workers in a community that an attack is being made upon the right of a large body of workers to organize and that united action is necessary to frustrate the employer's effort. With the acceptance of unions as a normal part of the industrial scene, the possibility for local general strikes are sharply reduced.

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GENERATOR, ELECTRIC, a device in which mechanical power is converted into electrical power, utilizes the principle that a voltage is induced in the turns of a coil of wire while the number of magnetic lines (the flux) linking the turns of the coil are changing. The principle can be illustrated with a horseshoe magnet, a coil of perhaps 50 turns of wire and a galvanometer. Connect the ends of the coil to the terminals of the galvanometer. Then observe the galvanometer pointer as the magnet, is placed so that its legs enclose one side of the coil. A pointer deflection in one direction occurs while the magnet is moved toward the coil; a deflection in the opposite direction occurs while the magnet is moved away from the coil. Moving the magnet more rapidly increases the deflection. With the magnet held stationary in any position relative to the coil no pointer deflection is observed. If the magnet is held stationary and the coil moved, it is found that a deflection occurs only while the coil is moving. If the coil is placed about a leg of the magnet and both are held stationary, and if a piece of steel is now moved to make and break contact with the poles, galvanometer deflection occurs when the steel is being moved —in one direction as the steel approaches the poles and in the opposite direction as it leaves the poles. In some generators the coils are stationary and the magnetic lines are moved across them, in others the coils are moved across the magnetic lines, and in still others both the coils and the source of the magnetic lines are stationary and steel in the magnetic path is moved.

History. — In 1831 Michael Faraday rotated a copper disk edgewise between the poles of a horseshoe magnet and obtained a continuous (direct) voltage between two rubbing contacts, one on the periphery and the other on the shaft of the disk. In this first electric generator the electromotive force was obtained by moving the conductors (*i.e.,* the elements of the disk) across the magnetic flux, not by a change in the amount of flux linking a turn. In this disk generator, of the type now called homopolar or acyclic, the electromotive force generated in any element of the disk maintains a fixed direction with respect to the element for a given direction of disk rotation. Homopolar generators are low-voltage machines; they are not of commercial importance because their efficiencies are lower and their costs of construction are higher for a given power output than for other types of generators.

In 1832 Hippolyte Pixii constructed a generator using permanent magnets and wire armature windings. This type, in which alternate poles have alternate magnetic polarities, is known as heteropolar. In Pixii's generator the electromotive forces generated in the windings are alternating in sign. To obtain a direct current output he contrived the first commutator, a device using moving contacts to reverse the connections at the ends of an armature coil at the instant the voltage in the coil is reversing.

In 1845 Charles Wheatstone replaced the permanent magnets with electromagnets excited with direct current from a battery. In 1857 he added the feature of self-excitation, whereby the field windings received current from the armature terminals. The ring winding of Antonio Pacinotti (1860) and Zénobe Théophile Gramme (1870) made it possible to add the voltages of many conductors of a multipolar generator and thus obtain higher voltages than were feasible earlier. The winding method was such that the conductors were held in place on the surface of the revolving armature. Ring windings were superseded by the more cheaply constructed barrel or drum-type winding of Friedrich von Hefner-Alteneck (1872), a development from the earlier shuttle winding of Ernst Werner von Siemens (1856). Placing an armature winding in slots (first proposed by Pacinotti in 1860) made possible a reduction in the effective length of the air gap in the path of the magnetic lines and a consequent increase in the strength of the magnetic field produced by a given field winding. Rotation of the armature structure causes alternating voltages to be generated not only in the conductors but also in the steel, where circulating or eddy currents cause losses. Eddy current losses were reduced by laminating the armature steel.

Edward Weston and Thomas A. Edison were among the first to recognize all the factors contributing to generator losses, and the latter's bipolar generator raised the standard of generator efficiency from about 50% to the then unheard of value of 90%. This machine had a much greater ratio of steel to copper weight than earlier ones and had the first mica-insulated commutator. In 1886 John and Edward Hopkinson devised the first rational method of generator design. Edison's bipolar generator in 1878, the incandescent lamp in 1879 and the Edison system of central station power production in 1882 gave commercial impetus to electric generator and power development.

In 1881 Charles F. Brush added a second field winding—about the field poles and connected in series with the armature circuit—to form a compound generator. The voltage of this generator automatically remained at a nearly constant value regardless of the amount of current drawn by connected loads.

Brushes used on early generators were of strap copper, copper mesh and metal alloy. Enough sparking occurred to cause burning of the commutator bars and the brushes in addition to friction wear. In 1888 Charles J. Van Depoele invented the carbon brush, which greatly reduced the sparking and the wear on the commutator. In the early 1890s parallel operation of compound generators by means of external equalizer connections was devised, and in 1896 Benjamin Garver Lamme invented internal equalizer connections, which ensure an equal division of the current between parallel armature paths, and made really large generators practical. Thereafter larger and larger multipolar generators, directly connected to reciprocating steam engines, came into use, reaching a peak of development about 1900.

The invention of the first A.C. (alternating current) system of power generation and distribution by Lucien Gaulard and John Dixon Gibbs in Europe and by William Stanley in the U.S. (1885), and of the induction motor by Kikola Tesla (1888), led to A.C. generator developments. Steam engines and, occasionally, water wheels were the early prime movers.

Among the earliest developments was Stanley's inductor generator with stationary field and armature windings which generated voltages from pulsations in a unidirectional magnetic field caused by revolving a toothed rotor. Elihu Thomson's A.C. generator of 1878 was similar to D.C. (direct current) generators, except that a commutator was not required and collector rings were connected to the armature winding in a manner such that alternating voltages were obtained between brushes riding on the rings. Ultimately the advantages of having the armature winding stationary, avoiding high voltages between collector rings, led to universal use of the modern revolving field structure for a synchronous generator.

The frequency of the voltage delivered by early A.C. generators was probably determined by the number of poles that could be readily constructed and the speed of an available prime mover. During the early years of alternating current, installations were made using frequencies ranging from $16\frac{2}{3}$ to $133\frac{1}{3}$ c p.s. (cycles per second). Changes in the application of alternating current led to changes in the frequencies. The need for a restriction in the number of frequencies led to the almost universal adoption of 60 c.p.s. for lighting and power purposes in the U.S., although 25 and 50 c.p.s. remained in use in some installations.

For a given number of poles and a given speed of rotation, an inductor generator delivers twice the frequency of the present common types of A.C. generators. In the early years of radio telegraphy the inductor generator was the best source of the frequencies required. Generators with a frequency of 100,000 c.p s. and capacities up to 100 kw. were built. The advent of the electronic tube and the discovery that it could be used to produce a high-frequency output from a D.C. source enabled it to supplant the inductor generator. New applications requiring frequencies ranging from 1,000 to 10,000 c.p.s. for inductive heating and the use of 400-c.p.s. control equipment and motors for aircraft created a demand for which the inductor generator was an economic answer.

Among the first polyphase generators were the three-phase, 100-kw. Lauffen generators designed by C. E. L. Brown (1891) and the two-phase, 5.000-kw. Niagara generators built by the Westinghouse company (1894), both vertical shaft machines with external revolving fikld structures.

In the late 1890s, when polyphase alternating current was replacing D.C. supply, and before the advent of the steam turbine, steam-reciprocating-engine-driven A.C. generators were built with ratings up to several thousand kilowatts.

The first large steam-turbine-driven A.C. generator in the U.S. was built by the American General Electric company and installed in Chicago. Ill., in 1903. It was of the vertical shaft type and rated at 5,000 kw. Its satisfactory operation led to the almost universal adoption of steam-turbine-driven polyphase generators for central stations. After a few years, turbine-driven generators were designed almost entirely with horizontal shafts and internal revolving field structures. Improved materials and design refinements enabled larger and larger machines to be built, ratings up to 50,000 kw. at 13,200 v. and 3,600 r.p.m. being common. Two-hundred-thousand-kilowatt single-shaft generators at 3,600 r.p.m. have been built, and up to 33,000 v. have been used.

Modern water-wheel generators are almost universally of the salient-pole, revolving field structure type, with drum windings in open slots and welded steel frame structures. Typical of the large machines in modern hydroelectric projects are the 77,500-kva., 88-r.p.m. Dnieprostroi generators, the 82,500-kva., 180-r.p.m. Hoover dam generators and the 108,000-kva., 120-r.p.m. Grand Coulee dam generators.

Some power plants have diesel or other oil engines as prime movers. A.C. generators for this service must have damper or amortisseur windings and often extra flywheels to limit the electric oscillations set up by the pulsating torque of the engine.

Hydrogen cooling of synchronous machines was introduced first in 1928. By the 1950s almost every steam-turbine-driven generator with a rating above 20,000 kw. was hydrogen cooled. An innovation of 1952 was to make the armature conductors hollow so that they could be cooled by blowing hydrogen through them.

DIRECT-CURRENT GENERATORS

A D.C. generator consists of a field structure, a series of alternate north and south magnetic poles equally spaced around a circular periphery and an armature structure built up of laminated steel sections (laminations) with slots in its surface in which a system of electrical conductors (a winding) is placed. A common lamination thickness is 0.025 in. Although either the field or the armature structure can be made the moving part, mechanical considerations cause a D.C. generator to be built with the armature structure as the moving part. An elementary D.C. generator is represented in fig. 1. Here a battery is represented as the source of direct current that flows through the turns of the field winding surrounding the field poles. In this manner the magnetic lines are established in the paths as shown. That the magnetic lines pass through the pole pieces from left to right is determined from the principle that if one coils the fingers of the right hand about an iron core in the direction current flows in turns about the core, the extended thumb is parallel to the lines in the core. The enlarged portions of the poles near the armature are the pole shoes, and the areas facing the armature are the pole faces. The spaces between the pole faces and the armature are the air gaps.

In fig. 1 the number of magnetic lines passing through the armature coil varies from zero when the plane of the coil is horizontal to a maximum when it is vertical. The voltage generated in the coil at a given instant depends not upon the number of lines through the coil but upon the rate at which the number of lines is changing. Just before the plane of the coil reaches the horizontal position the lines are passing through it in one direction; just after it passes that position the lines are passing through it in the opposite direction. At the horizontal position the rate of change of the lines is the greatest and the voltage generated is a maximum. When the plane of the coil is vertical the rate of change of the number of lines through it is zero and no voltage is generated in it at that instant. For nearly one-half revolution, one brush is in contact with the commutator bar attached to one end of the coil and the other brush is in contact with the commutator bar attached to the other end of the coil. Note that the brushes are set so that the left-hand brush makes contact through the commutator bar to a coil side when it is on the left side of the vertical and the right-hand brush makes contact through a commutator bar to a coil side when it is on the right side of the vertical. As soon as a coil side moves from one side of the vertical to the other it ceases contact with one brush and establishes contact with the other. Thus the polarity of a brush remains fixed even though an alternating voltage is being generated in the coil.

The polarities of the brushes in fig. 1 are determined by Fleming's right-hand rule. Place the thumb, the first finger, and the second finger of the right hand mutually at right angles, thereby forming the axes of a three-co-ordinate system. Now, while pointing the first finger toward the right in the direction of the magnetic

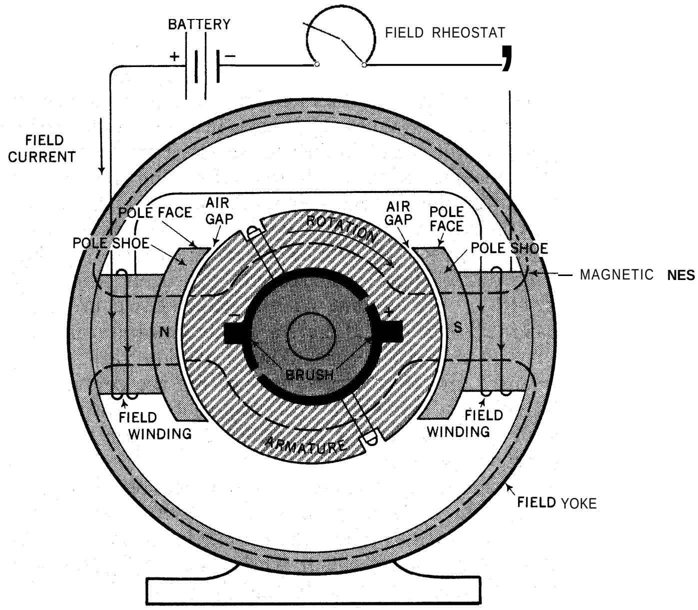

FIG. 1.— ELEMENTARY D.C. GENERATOR WITH ONE-TURN ARMATURE COIL AND TWO COMMUTATOR BARS

lines from the N pole, turn the hand until the thumb points upward in the direction the left-hand coil side moves in front of the N pole face. Then the second finger points into the page as the direction of the generated voltage in the left-hand side of the coil. The right-hand coil side moves downward in front of the S pole through magnetic lines directed from right to left, so the voltage generated in that coil side is directed out of the page. The right-hand brush is the positive one since it is the one toward which the voltage generated in a coil side acts.

The time variation (wave form) of the voltage between brushes in fig. 1 depends upon the length of the air gap, the contour of the pole face and the percentage of the armature surface covered by a pole face. A D.C. voltmeter between brushes in fig. 1 would read the average value of the voltage. This would probably be more than one-half the maximum voltage, although the exact value would depend upon the wave form.

The voltmeter reading would increase in direct proportion if the speed of rotation were increased. The current in the field circuit could be changed by adjusting the setting of the field rheostat shown. Increasing the field current would increase the voltmeter reading, not in direct proportion with the current but in direct proportion with the number of magnetic lines. Starting with zero current, as the current is increased, the number of lines at first increases approximately in direct proportion. As higher values of current are reached, the rate of increase of lines becomes less than

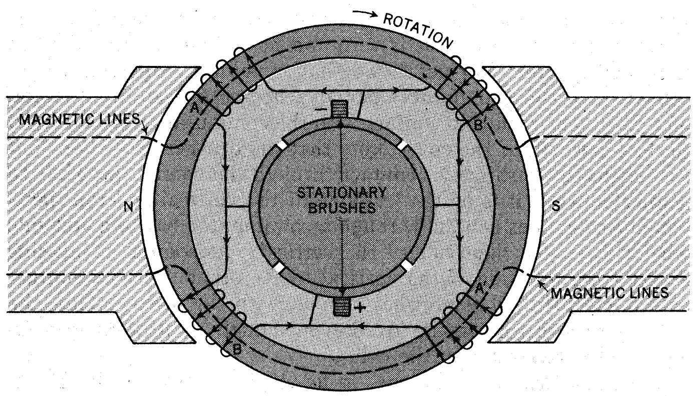

FIG. 2.— RING WINDING FOR D.C. GENERATOR

that of the current because of magnetic saturation in steel.

If the brushes in fig. 1 were shifted 90° from the position shown, a brush would make contact with a coil side while the side moves from the centre of one pole to the centre of the other. The voltage between brushes would be alternating with an average value of zero, as would be proved by a zero reading on a D.C. voltmeter.

Ring Winding. — If the one-turn coil of fig. 1 were replaced by a coil of more turns wound in the slots and the coil ends connected to the commutator bars, the voltage between brushes would be increased in proportion with the number of turns. For most applications of D.C. generators it is desired that the percentage variation with time of the voltage delivered from the brushes be small. The one-coil generator of fig. 1 would have too great variation for most applications. To reduce the variation, the number of coils and commutator bars is increased. An early means of doing this was with a ring winding such as that shown in fig. 2. This winding has four sections and there are four commutator bars. Here the number of magnetic lines linking a section varies from zero when the centre turn of a section is opposite the centre of a pole to a maximum when the centre turn is opposite a brush. The voltage generated in a section is a maximum in the first position and zero in the second position.

The voltages in the four sections have identical wave forms. The voltage in section A' is zero when that in A is zero, and the voltage in A' is a maximum when that in A is a maximum. The voltage in section B' is zero when that in B is zero, and the voltage in B' is a maximum when that in B is a maximum. However, the voltages in A and A' differ in time position from those in B and B' by the time for one-quarter revolution. Note that the four sections form a closed circuit. In that circuit the voltage of A is always equal to and opposed to that of A', and the voltage of B is always equal to and apposed to that of B'. As a result, no current flows in the windings when no external connections are made to the brushes.

During the part of a revolution that the brushes are in contact with the commutator bars that they touch in fig. 2, the voltages of sections A and B add in one path between the brushes, and the voltages of sections A' and B' add to an exactly equal value in the other path. Hence there are two paths in parallel as far as the brushes are concerned.

The voltage between brushes varies from a minimum at one position of the armature to a maximum at another position. When the armature has turned about one-eighth revolution from the position shown, two commutator bars touch one brush and the other two touch the other. Then section A is short-circuited by one brush and section A' is short-circuited by the other. At this instant the voltage between brushes is that of section B in one path and that of section B' in the other path. As the armature turns on beyond this position, coil A comes under the influence of the S pole, its voltage reverses from the previous direction and now adds to that of section B'in the right-hand path. At the same time section A' comes under the influence of the N pole, its voltage reverses from the previous direction and it now adds to that of section B in the left-hand path. As rotation continues the transfer of sections from one path to another continues. By using more winding sections and more commutator bars than are shown in fig. 2, the percentage time variation in the voltage between brushes can be reduced to a relatively small value.

When a load (a conducting element) is connected between brushes in fig. 2, the total current drawn divides equally between the two paths, entering the armature at the negative brush and leaving it at the positive brush. As a winding section is being transferred from a path on one side of a brush to a path on the other side, the current in it reverses direction. This reversal occurs during the time a section is short-circuited by a brush, an interval called the time of commutation. Although the generated voltage in a section becomes zero and then reverses during the time of commutation, the current in the section does not become zero and reverse simultaneously. The self-inductance (electrical inertia) of the section causes the current to decrease more slowly to zero than the voltage does.

After the current in the section has become zero, the reversed generated voltage causes the current to increase in the reversed direction. This rate of growth is limited by the self-inductance of the section. If, by the end of the time of commutation, the current in a section has not had time to reverse to a magnitude equal to that of the current in the path in which it is inserted, a spark occurs between a brush and the commutator bar from which it has just parted contact. Some sparking can be tolerated, but excessive sparking causes objectionable heating and pitting of the commutator bars. Most modern D.C. generators have one or more interpoles (commutating poles), which are located midway between the main poles. The winding on an interpole is connected in series with a lead from a brush in order that the number of magnetic lines passing from the interpole to the armature will vary in approximate proportion with the current in the armature coils. The location of an interpole is such that its magnetic lines generate a voltage in an armature coil during the time of commutation. The direction of the voltage is that required to reduce the current in a coil to zero and then establish it in the reverse direction.

Drum Winding. — For economic and mechanical reasons, the ring winding has been superseded by the drum winding. In fig. 3 are represented the form and the connections of coils in a lap type of drum winding. One coil with sides numbered 1 and 10, respectively, is placed so that side 1 occupies the upper half of one slot and side 10 occupies the lower half of another four slot pitches distant. This coil may consist of one or more turns of insulated copper wire taped together as shown. The ends of the coil are connected to adjacent commutator bars. A second coil with sides numbered 3 and 12 is displaced one slot pitch from the first with connections to the commutator being advanced by one bar. With this arrangement of coils continued around the armature a closed winding results, having as many commutator bars as there are coils. The ends of each coil connect to adjacent commutator bars.

With a drum winding the number of magnetic lines linking a coil is a maximum when the centre of the coil is opposite the centre of a pole. At that instant the rate of change of lines is zero and

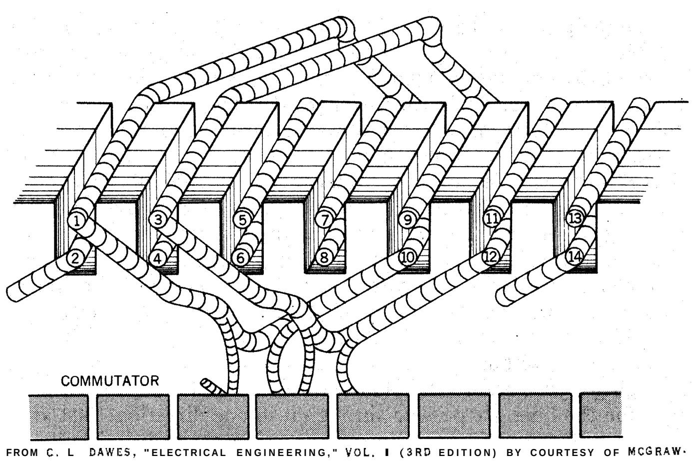

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FIG. 3. —LAP WINDING ON ARMATURE OF D.C. GENERATOR

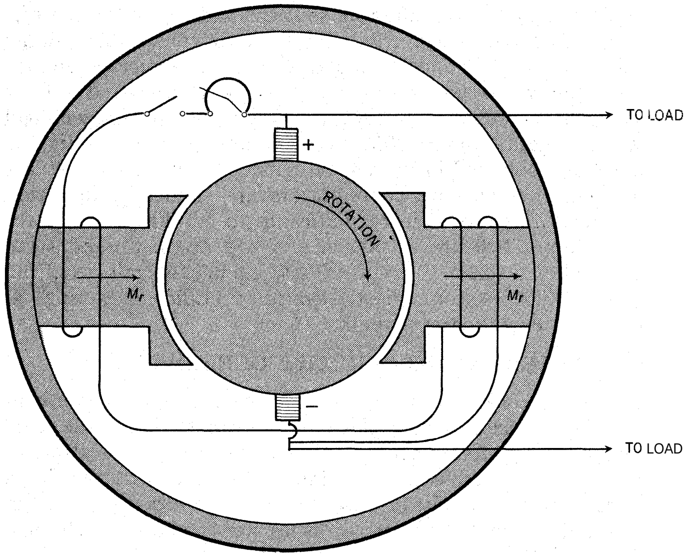

FIG. 4.— CONNECTIONS OF A SHUNT-WOUND GENERATOR

the generated voltage is zero. The maximum number of lines would be all those entering or leaving a pole if the span of a coil is equal to the distance from the centre of one pole to the centre of the next. The number of lines linking a coil is zero when the centre of the coil is midway between the centres of two adjacent poles. At that instant the rate of change of lines is a maximum and the generated voltage is a maximum.

Self-Excited Generators.— The generator of fig. 1 is separately excited since its field winding receives current from a source other than the armature terminals. Although the source is represented here as a battery, most separately excited generators receive their field current from a smaller D.C. generator known as an exciter. An exciter is often mounted on a shaft extension from the generator, both being driven by the same prime mover.

After current has been sent through the field winding of a D.C. generator and then removed. some residual magnetic lines remain in the magnetic circuit. As a result, when the generator is driven at rated speed a voltage that may be of the order of 5% of the rated voltage appears between the armature terminals. This voltage is used to produce a build-up to a higher value in a self-excited generator by using it to send current through the field winding.

In fig. 4 are represented the connections of a shunt-type self-excited generator. Normally no load is connected to the leads coming from the brushes until the voltage has been adjusted to a desired value. With the switch in the field winding circuit open and the armature driven at rated speed, it is assumed that the residual magnetic lines are from left to right as indicated by M_r and that the low voltage between brushes has the polarity indicated. When the switch is closed, current out of the positive brush flows through the field winding in such a direction as to produce an increased number of magnetic lines. This increase causes an increase in the voltage between brushes, which in turn causes a further increase of current. Saturation in the steel in the magnetic circuit prevents the voltage from increasing indefinitely. The value attained can be varied over a wide range by varying the resistance of the field rheostat. When the resistance is a maximum, the voltage may be only slightly greater than that with no current in the field winding. When the resistance is zero, the voltage is likely to be of the order of 50% above rated value. The value of field current required to produce rated voltage is likely to be of the order of 5% of the current rating of the generator.

If in fig. 4 the connections of the field windings to the brushes were to be interchanged and if the switch were closed, the current would flow in the field windings in such a direction as to reduce the number of magnetic lines below the residual value. As a result the voltage would reduce.

Consider a shunt generator Chat is being driven at rated speed with the field rheostat set so that rated voltage is obtained between brushes when no current is being drawn by a load. Under that condition the only current delivered by the brushes is that to the field windings. This is obtained equally from the various paths in the armature winding. When a load is connected it draws additional current from the brushes and the currents in the armature winding paths increase. These currents cause a magnetic action that in turn causes a reduction (usually small) in the number of magnetic lines and a corresponding reduction in the voltage produced in the winding. In addition, some of the voltage produced is used in sending the current through the resistance of the winding. These two factors cause the voltage between brushes to be reduced below its value when no load is connected. This reduction in voltage causes a reduction in the field current and a further reduction in the number of magnetic lines. Hence the voltage reduces more than it would have if the generator had been separately excited. With a given load current being delivered, it would be possible to bring the voltage back to its no-load value by cutting resistance out of the field rheostat. Because the percentage variations in its output voltage are rather great when changes in the load current occur, a shunt generator is best suited to applications where the load current required is nearly constant.

The connections of a series D.C. generator are shown in fig. 5. Here, if there is no connected load there is no current in the field winding. Under that condition, with the generator driven at rated speed, the residual magnetic lines cause the voltage between brushes to be about 5% of rated value. If a load is connected, the current drawn flows through the field winding and produces a magnetic action to cause voltage build-up just as in a shunt generator.

Because all the load current flows through it, the series winding needs fewer turns and a larger cross section of wire than the shunt winding to deliver an equal rated voltage at rated speed. The output voltage of a series generator varies from a low value with a small load current to rated value when rated current is delivered. Since most applications require a generator whose voltage output is nearly constant, regardless of the amount of current delivered, the series generator is not widely used.

A cumulative compound D.C. generator has both a shunt and a series field winding, connected as in fig. 6. With the proper connections of the shunt winding to the brushes, the generator builds up with no load connected, just as a shunt generator does. The rheostat can be adjusted so that rated voltage is obtained. When a load is connected, the current drawn through the series field winding causes a magnetic action that may increase the number of magnetic lines and consequently the voltage between lines to the load, even though the magnetic action of the current in the armature windings tends to reduce the number of magnetic lines, and some

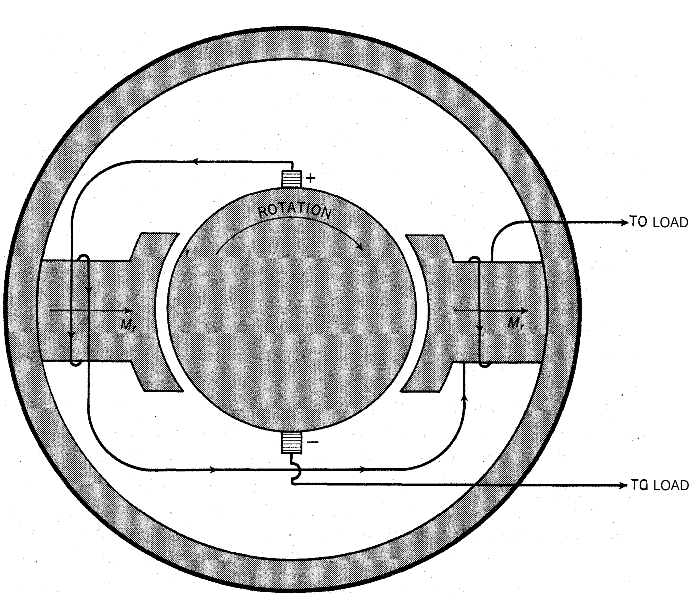

FIG. 5.— CONNECTIONS OF A SERIES-WOUND D.C. GENERATOR

of the voltage produced in the armature windings is used in sending current through the resistance of the armature and series field windings. If the magnetic action of the series field winding is

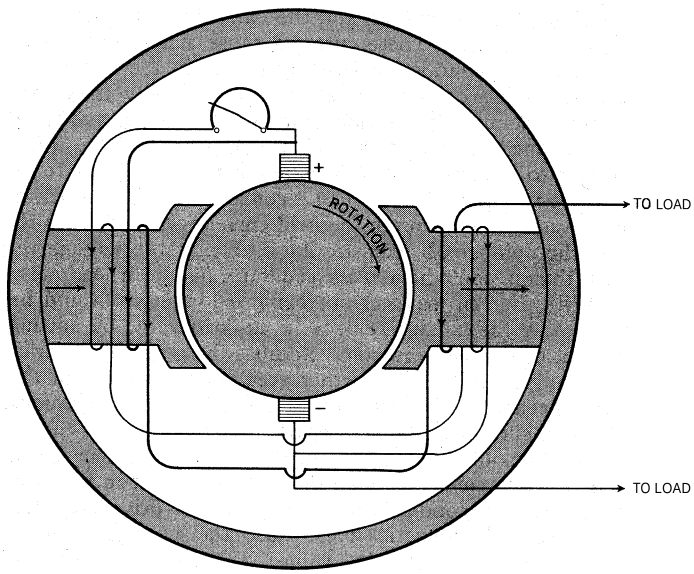

FIG. 6.— CONNECTIONS OF CUMULATIVE COMPOUND D.C. GENERATOR

enough to cause a rise in the voltage between brushes when the load current is increased, a rise in the shunt field winding current occurs. As a result the voltage rises more than it would have if no change in the shunt field current had occurred. If the voltage delivered to a load by a generator is greater when rated current is being delivered than with no current, the generator is overcompound If the magnetic action of the series field winding is such that the voltage delivered at rated current is equal to that with no current, the generator is flat compound.

D.C. Generator Construction.— A typical armature for a D.C. generator has a shaft on which are mounted two spiders, one to support the armature core and the other the commutator. The core is built up of thin steel laminations, insulated from each other and held together by end flanges. In the slots in the core are placed copper conductors which are insulated from the core with treated fabric or paper materials, or pasted mica flakes, and held in the slots by insulating wedges. The portions of the conductors that extend beyond the slots at each end are held down on the end flanges by steel wire. The commutator is made of a number of copper segments, insulated from each other and from the spider and clamping flanges by pasted mica flakes. In small machines the ends of the armature coils may be connected directly to the segments. In large machines the ends are connected to risers which are copper strips extending outward from the segments.

The field structure is composed of a steel ring to the inside of which are bolted the main and the commutating poles. The main poles are built up of steel laminations, thicker than those in the armature core. The lower portion of the pole is broadened to spread the magnetic lines over most of the armature surface. Above the pole shoe and around the pole core are placed the field coils. The shunt field coils, consisting of a large number of turns of insulated wire, are usually connected in series with a field rheostat between the brushes. The series field coils, consisting of a few turns of heavy copper wire, are usually supported with the shunt coils.

Graphitized carbon brushes are used with an area such that the normal current density is about 40 amp. per square inch. These are arranged in axial rows, one row for each main pole, equally spaced around the commutator periphery. The brushes fit into metal brush holders and are held against the commutator by spring pressure. The holders are bolted to brackets that are supported by a brush yoke. The centrifugal forces present limit the permissible peripheral speeds of an armature and a commutator to about 10,000 and 6,000 ft. per minute, respectively. The terminal voltage is limited by the commutator segment width and the permissible voltage between segments. Mechanical construction limits the minimum segment width to about 0.1 in. The average voltage between segments is limited to about 20 v. by the sensitivity of the commutator to arcing between brushes at times of sudden load current changes. About 2,000 v. from one commutator is the highest value obtained in normal designs. When higher voltages are needed, two or more commutators are connected in series. D.C. generators are built in capacities up to 300 kw. at 12 v. for electroplating, 5,000 kw. at 600 v. and 240 r.p.m. for industrial power. 1,500 kw. at 1,500 v. and 400 r.p.m. for railways, and 100 kw. at 15,000 v. for radio transmitters. Efficiencies range as high as 94% on the largest units.

ALTERNATING-CURRENT GENERATORS

Let the two commutator bars of fig. 1 be replaced by two continuous rings mounted side by side on, but insulated from, the shaft that rotates the armature coil. Let one end of the coil be attached to one ring and the other end be attached to the other ring. With this arrangement the voltage between rings is alternating and can be obtained externally between brushes riding one on each ring. Few modern generators are constructed in this manner. It is cheaper to brace and insulate the armature winding when the armature structure is stationary and the field poles are rotated. Windings on the poles are attached to collector rings mounted on and insulated from the shaft and separately excited with direct current from an exciter connected to brushes that ride on the rings.

In an A C. generator it is desired that the wave form of voltage produced be a sine wave. This can be approximated closely by shaping the contour of the pole pieces and by the proper connections of the armature coils. Most A.C. generators are of the three-phase type with three armature terminals. The armature windings are divided into three distinct sections that generate voltages that are one-third cycle apart in time phase. The magnitude of the voltage produced can be varied by varying the field current, usually by means of a rheostat in the exciter field circuit. Let the voltage be set at rated value when no current is being delivered by the armature. Now let a load be connected that draws equal currents from the three terminals. The magnetic action of the currents depends upon the nature of the connected load. If it has a lagging power factor, such as is characteristic of induction motors, the action is to reduce the number of magnetic lines. This reduction, plus the fact that some voltage is used in sending the current through the windings, causes a decrease in the voltage between a pair of terminals. If the load has a leading power factor, the magnetic action may increase the number of magnetic lines enough to cause an increase in the voltage between terminals.

Steam-Turbine-Driven Generators.— High turbine efficiency requires high speed, and high speed produces centrifugal stresses that make it necessary to construct a generator with a large output so that the rotating part (rotor) is long compared with its diameter. To make them rigid, large rotors are usually made from solid steel forgings. In European practice, only the rotor body is made from a forging, and the separate, laminated teeth are inserted in dovetailed slots cut in this body. The field windings are concentric coils of strip copper, insulated with mica and laid in deep radial slots in the rotor. The coil ends are usually held in place by shrunk-on retaining rings of forged nonmagnetic steel. Fans attached to the end of the rotor blow the cooling medium—air or hydrogen—along the rotor surface and out through radial ducts in the stationary portion (stator). Small channels are provided below the rotor slots, or adjacent to the slot walls, through which the cooling medium is driven, leaving the rotor through radial openings. When air is used for cooling, about 100 cu.ft. per minute are required for each kilowatt of loss, or about 200,000 cu.ft. per minute for a 100,000-kva. generator of 98% efficiency. To prevent excessive dirt accumulation, large generators are completely enclosed and the air is recirculated after passing through finned water tube coolers.

Hydrogen has seven times greater thermal conductivity and 30% lower surface temperature drop for a given transfer rate than air and permits about 25% greater output rating for a given machine. The lower density of hydrogen reduces the windage loss to about 10% of that with air and yields about 1% gain in the generator efficiency. Automatic devices control the hydrogen pressure and purity, replacing gas lost by leakage to avoid a possible explosion by admixture of air. Shaft seals hold the loss of hydrogen to low values, usually by means of lubricating oil pumped through the small shaft clearance, the entrapped air and hydrogen being continuously removed by a pumping system through which the oil is circulated.

The stator frame that supports the segmental armature punchings is usually built up of steel plates and ribs welded together. Machines are sometimes made with split frames, or with separate inner and outer frames, to facilitate shipment. The outside of the frame is covered with steel sheeting. The interior space serves as a ventilating passage. The armature punchings are of 2% to 4% silicon steel, 0.025 in. or less in thickness and insulated from each other by thin paper or enamel. Because of the great core length, armature windings usually are made of half coils or bars that are soldered together at the ends after insertion in the slots. To reduce the eddy current losses in them, the armature conductors are made of several insulated strands transposed at regular intervals throughout the length of the core so that each strand occupies each of the possible positions in a slot for equal portions of the length.

Armature winding insulation usually is made of mica flakes cemented to paper tape or sheets, a number of layers being taped or wrapped on the conductors and bonded with varnish. The varnish solvent is removed later by vacuum treating and baking processes. Asphalt-base varnishes are commonly used. A layer of asbestos tape and conducting varnish is applied to coil exteriors to prevent damage from electrical discharges that might otherwise occur between a coil surface and slot edges.

Armature coil end connections must be well braced to withstand the forces that may act on them when a short circuit occurs on the system supplied from the generator. The force beween two adjacent coil ends is proportional to the square of the current in the coils. The not unusual short-circuit current of 10 times normal value results in 100 times the normal force. The magnitude of the short-circuit current is limited not only by resistance of the winding but also by what is called its reactance. High reactance is undesirable insofar as it affects the change in generator voltage with change in armature current, but it is necessary to hold short-circuit currents to values that can be tolerated. Armature slots are very deep in proportion to their width to increase the reactance and to provide large cooling surfaces.

A steam-turbine-driven generator has a cylindrical or non-salient pole rotor, in contrast to the salient (or projecting) pole rotor used on slower speed generators.

Water-Wheel-Driven **A.C.** Generators. — Both horizontal and vertical shaft machines are used as water-wheel-driven A.C. generators. In the vertical shaft machine, the weight of the rotor and the downward thrust of the water are carried by a thrust bearing at the upper end of the shaft, while guide bearings above and below hold the rotor in a central position. A thrust bearing carries a load of about 400 lb. per square inch and is cooled by oil. The field structure is usually revolved inside the stationary armature structure. The armature frame ordinarily is built up of welded steel plates. As a water wheel may attain nearly double normal speed before the water can be shut off after a full load is dropped, the generator rotor must pass severe overspeed tests. A pilot exciter at the top supplies the field current of the main exciter below it. That in turn supplies the field current of the generator. As water may leak through closed turbine gates, brakes are provided to stop and hold the rotor when it is taken out of service. These are mounted below the rotor. The generator is cooled by air drawn in between the poles from the ends and blown out through radial ducts in the stator.

In Europe, and to an increasing extent in the U.S., amortisseur windings are used. These consist of copper bars passing through slots in the pole faces and solidly connected by short-circuiting rings at both ends. If a momentary oversupply of water to the wheel should cause the generator frequency to tend to exceed that of the system with which it is connected, currents are induced in the windings in a direction to produce braking action on the rotor. If a momentary undersupply of water should cause the generator frequency to tend to be less than that of the system, the induced currents produce an accelerating force on the rotor.

Water-wheel-driven generators, except for small ones, have a full-load efficiency ranging from 95% to 98%. The Kaplan propeller turbine with adjustable pitch blades yields higher generator speeds in low-head installations than was feasible with fixed blade turbines. These turbines have runaway speeds that may be as great as 280% of rated speed.

Water-wheel generators are so constructed as to make the inertia of the rotating structure high. The high inertia is necessary to reduce to a value that can be tolerated the fluctuations in the speed that accompany sudden changes in the load or the water supply.

Engine-Driven **A.C.** Generators. — This type of machine is similar to a water-wheel generator. The main differences are that engine-driven generators have horizontal shafts and amortisseur windings (unless the poles are solid). Most of them operate at low speeds and have cast-iron spiders and bolted poles. Some are made with the revolving field structure outside the stationary armature to increase the inertia or flywheel effect. Since the engine torque varies during a revolution, it produces oscillations above and below the uniform speed desired, a phenomenon known as "hunting."

When a generator operates alone, hunting may cause flickering of connected lights or undesirable surges in the speeds of connected motors. When two or more generators are in parallel, it may be that one engine is accelerating at an instant when another is decelerating; and this may cause a large interchange of current between the generators.

In an extreme case, continued parallel operation may be impossible because of the tripping of overcurrent devices in the connecting circuits.

Special Types of Generators. — Although the homopolar generator was the first developed and is the only one that generates direct current without a commutator, it is of no commercial importance because it costs more and has a lower efficiency than a commutator machine of equal rating.

A generator with permanent magnet field poles has some application in measuring speed, for control purposes and as a magneto for an ignition system.

On the automobile, a special type of D.C. generator or control is required so that sufficient current is delivered at low driving speeds and yet not too much is delivered at high speeds. Early third-brush generators made use of a differential magnetizing effect of the armature current to limit it to a permissible value. Modern generators have only two brushes and have a regulator that automatically limits the voltage and current output to permissible values. However, even the most efficient small D.C. generators proved incapable of meeting the demand of many added electrical accessories, and by the 1960s automotive manufacturers were resorting to A.C. generators coupled with converters to provide direct current for ignition and battery charging *(see* AUTOMOBILE: *Modern Automobiles: Mechanical Operation: Electrical System).*

A D.C. generator mounted under a railway car and belt-connected to a wheel axle is subjected not only to a wide range of speeds but also to a reversal of rotation when the direction of car travel is reversed. One type of generator for this application has the brushes attached to a rigging that will permit the brushes to be shifted through an arc equal to that from the centre of one pole to that of another. When the car is moved in one direction, the friction between them causes the commutator to shift the brushes to one extreme position at which the generator produces the proper polarity at the armature terminals. If the car is stopped and then started in the opposite direction, the commutator shifts the brushes to the other extreme position, and the generator produces the same polarity at the armature terminals as before.

If an induction motor, when connected to A.C. lines, is driven by a prime mover in the direction it would rotate if the prime mover were not connected, but faster than its synchronous speed, it becomes an induction generator and delivers electrical energy to the lines. This type of generator has only limited applications since another source of A.C. energy is always required.

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(G. V. M.)

GENESEE, a river rising in the hilly Allegheny plateau of northern Pennsylvania and southwestern New York, flows northward 158 mi. through Rochester, N.Y., to Lake Ontario. North of Mt. Morris it crosses flat to rolling plains and the New York Barge canal. The valley was the home of the Seneca Indian tribe of the Iroquois confederacy until after the Revolutionary War. The steep waterfalls produce hydroelectric power and the Genesee gorge, a meandering canyon 17 mi. long and nearly 600 ft. deep with numerous waterfalls (the highest 107 ft.), is preserved for tourists in Letchworth State park. The 205-ft, falls at Rochester early made it a flour-milling centre. (A. S. CN.)

GENESIS, the name of the first book in the Bible, derives its title from the Septuagint rendering of ch. ii, 4. It is the first of the five books (the Pentateuch) which cover the history of the Hebrews to their occupation of Canaan. The "genesis" or "becoming" (*i.e.*, coming into being) of history begins with records of antediluvian times: the creation of the world, of the first pair of human beings, and the origin of sin (i–iii), the civilization and moral degeneration of mankind, the history of man to the time of Noah (iv–vi, 8), the flood (vi, 9–ix), the confusion of languages and the divisions of the human race (x–xi). Turning next to the descendants of Shem, the book deals with Abraham (xii–xxv. 18), Isaac and Jacob (xxv, 19–xxxv), the "fathers" of the tribes of Israel, and concludes with the personal history of Joseph! and the descent of his father Jacob (or Israel) and his brethren into the land of Egypt (xxxvii–l). The book of Genesis, as a whole. is closely connected with the subsequent oppression of the sons of Israel, the revelation of Yahweh the God of their fathers (Ex. iii, 6, 15 scq., vi, 2–8), the "exodus" of the Israelites to the land promised to their fathers (Ex. xiii, 5, Deut. i, 8, xxvi, 3 sqq., xxxiv, 4) and its conquest (Josh. i, 6, xxiv); cf. also the summaries Neh. ix, 7 sqq., Ps. cv, 6 sqq.

Its **Compositeness.**—Only on the assumption that the book of Genesis is a composite work is it possible to explain the duplication of events, the varying use of the divine names Yahweh and Elōhīm, the linguistic and stylistic differences, the internal intricacies of the subject matter and the differing standpoints as regards tradition. chronology, morals and religion. The cumulative effect of the whole evidence is too strong to be withstood, and already in the 17th century it was recognized that the book was of composite origin. Immense labour has been spent upon the critical analysis of the contents, but it is only since the work of Karl Graf (1866) and Julius Wellhausen (1878) that a literary hypothesis has been found which explains the most obvious intricacies. According to the Graf-Wellhausen theory, Genesis is a postexilic work composed of a postexilic priestly source (P) and nonpriestly earlier sources which differ markedly from P in language, style and religious standpoint, but much less markedly from one and another. These sources can be traced elsewhere in the Pentateuch and Joshua, and P itself is related to the postexilic works Chronicles, Ezra and Nehemiah. In its present form Genesis is an indispensable portion of the biblical history, and consequently its literary growth can not be viewed apart from that of the books which follow. On internal grounds it appears that the Pentateuch and Joshua, as they now read, virtually come in between an older history by "Deuteronomic" compilers (easily recognizable in Judges and Kings), and the later treatment of the monarchy in Chronicles, where the influence of the circle which produced P and the present Mosaic legislation is quite discernible. There have been stages where earlier extant sources have been cut down, adjusted or revised by compilers who have incorporated fresh material, and it is the later compilers of Genesis who have made the book a fairly knit whole. The technical investigation of the literary problems (especially the extent of the earlier sources) is a work of great complexity. and. for ordinary purposes, it is more important to obtain a preliminary appreciation of the general features of the contents of Genesis.

Value.—That the records of the prehistoric ages in Gen. i–xi are at complete variance with modern science and archaeological research is unquestionable. But although it is impossible to regard them any longer either as genuine history or as subjects for an allegorical interpretation (which would prove the accuracy of any record) they are of distinct value as human documents. They reflect the ideas and thoughts of the Hebrews, they illustrate their conceptions of God and the universe, and they furnish material for a comparison of the moral development of the Hebrews with that of other early races. Some of the traditions are closely akin to those current in ancient Babylonia, but a careful and impartial comparison at once illustrates in a striking manner the relative moral and spiritual superiority of our writers.

The records of the patriarchal age, xii–l, are very variously estimated, although the great majority of scholars agree that they are not contemporary and that they can not be used as they stand, for pre-Mosaic times. Apart from the ordinary arguments of historical criticism, it is to be noticed that external evidence does not support the assumption that the records preserve genuine pre-Mosaic history. There are no grounds for any arbitrary distinction between the prehistoric pre-Abrahamic age and the later age. External evidence, which recognizes no universal deluge and no dispersal of mankind in the third millennium B.C., throws its own light upon the opening centuries of the second. It has revealed conditions which are not reflected in Genesis, and important facts upon which the book is silent—unless, indeed, in Gen xiv, there is a passing allusion to the great Babylonian monarch Hammurabi in the name Amraphel. A perusal of modern attempts to recover historical facts or historical outline from the book will show how very inadequate the material proves to be, and the reconstructions will be found to depend upon an interpretation of the narratives which is often liberal and not rarely precarious, and to imply such reshaping and rewriting of the presumed facts that the cautious reader can place little reliance on them. Whatever future research may bring, it can not remove the internal peculiarities which combine to show that Genesis preserves, not literal history, but popular traditions of the past. External evidence has proved the antiquity of various elements. but not that of the form or context in which they now appear; and the difference is an important one. We have now a background upon which to view the book, and, on the one hand, it has become obvious that the records preserve (as is only to be expected) oriental customs. beliefs and modes of thought. But it has not been demonstrated that these are exclusively pre-Mosaic. On the other hand, a better acquaintance with the ancient political, sociological and religious conditions has made it increasingly difficult to interpret the records as a whole literally, or even to find a place in pre-Mosaic Palestine for the lives of the patriarchs as they are depicted. Nevertheless though one can not look to Genesis for the history of the early part of the second millennium B.C., the study of what was thought of the past is more instructive than the facts of the past, and it is more important to understand the thought of the ages immediately preceding the foundation of Judaism in the jth century B.C. than the actual history of many centuries earlier.

Characteristics.—A noteworthy feature is the frequent personification of peoples, tribes or clans. (See GENEALOGY.) Midian (*i.e.*, the Midianites) is a son of Abraham; Canaan is a son of Ham (ix, 22); and Cush, the son of Ham, is the father of Raamah and grandfather of the famous south Arabian state Sheba and the traders of Dedan (x, 6 sq., *cf.* Ezek. xxvii, 20–22). Bethuel, the father of Rebecca, is the brother of the tribal names Uz and Buz (xxii. 21 seq., *cf.* Jer. xxv, 20, 23). Jacob is otherwise known as Israel and becomes the father of the tribes of Israel; Joseph is the father of Ephraim and Manasseh, and incidents in the life of Judah lead to the birth of Perez and Zerah, Judaean clans. This personification is entirely natural to the oriental, and though "primitive" is not necessarily an ancient trait (cf. 1 Chron. iv, 10). It gives rise to what may be termed the "prophetical interpretation of history" (S. R. Driver, *Genesis,* p. 111), where the character, fortunes or history of the apparent individual are practically descriptive of the people or tribe which, according to tradition, is named after or descended from him. The utterance of Noah over Canaan, Shem and Japheth (ix, 25 seq.), of Isaac over Esau and Jacob (xxvii), of Jacob over his sons (xlix) or grandsons (xlviii), would have no meaning for Israelites unless they had some connection mith and interest for contemporary life and thought. Herein lies the force of the description of the wild and independent Ishmael (xvi, 12), the "father" of certain well-known tribes (xxv, 13–15); or the contrast between the skilful hunter Esau and the quiet and respectable Jacob (xxv, 27), and between the tiller Cain who becomes the typical nomad and the pastoral Abel (iv, 1–15). The interest of the struggles between Jacob and Esau lay, not in the history of individuals of the distant past, but in the fact that the names actually represented Israel and its near rival Edom. These features are in entire accordance with oriental usage and give expression to current belief, existing relationships, or to a poetical foreshadowing of historical vicissitudes. But in the effort to understand them as they were originally understood, it is very obvious that this method of interpretation can be pressed too far. It would be precarious to insist that the entrances into Palestine of Abraham and Jacob (or Israel) typified two distinct immigrations. The separation of Abraham from Lot (cf. Lotan, an Edomite name), of Isaac from Hagar-Ishmael, or of Jacob from Esau-Edom scarcely points to the relative antiquity of the origin of these non-Israelite peoples who, to judge from the evidence, were closely related. Or, if the "sons" of Jacob had Aramaean mothers, to prove that those derived from the wives were on a higher level than the "sons" of the concubines is more difficult than to allow that certain of the tribes must have contained some Aramaean blood (*cf.* 1 Chron. vii. 14, and see TWELVE TRIBES OF ISRAEL; GAD; MANASSEH, TRIBE OF). Some names are clearly not those of known clans or tribes (*e.g.,* Abraham, Isaac), and many details of the narratives obviously have no natural ethnological meaning. Stories of heroic ancestors and of tribal eponyms intermingle; personal, tribal and national traits are interwoven. The entrance of Jacob or Israel with his sons suggests that of the children of Israel. The story of Simeon and Levi at Shechem is clearly not that of two individuals, sons of the patriarch Israel; in fact the story actually uses the term "wrought folly in Israel" (cf. Jud. xx, 6, 10), and the individual Shechem, the son of Hamor, can not be separated from the city, the scene of the incidents. Yet Jacob's life with Laban has many purely individual traits. And, further, there intervenes a remarkable passage mith an account of his conflict with the divine being who fears the dawn and is unwilling to reveal his name. In a few verses the "wrestling" (ʿ-b-k) of Jacob (*yăʿăkōb*) is associated with the Jabbok (*yabbōk*); his "striving" explains his name Israel; at Peniel he sees "the face of God," and when touched on his vulnerable spot (the hollow of the thigh) he is lamed, hence "the children of Israel eat not the sinew of the hip which is upon the hollow of the thigh unto this day" (xxxii, 24–32). Other examples of the fusion of different features can be readily found. Three divine beings appear to Abraham at the sacred tree of Hebron, and when the birth of Isaac (from ṣāḥaḳ, "laugh") is foretold, the account of Sarah's behaviour is merely a popular and trivial story suggested by the child's name (xviii, 12–15; see also xvii, 17, xxi, 6, 9). An extremely fine passage then describes the patriarch's intercession for Sodom and Gomorrah, and the narrative passes on to the catastrophe which explains the Dead sea and its desert region and has parallels elsewhere (*e.g.,* the Greek legend of Zeus and Hermes in Phrygia). Lot escapes to Zoar, the name gives rise to the pun on the "little" city (xix, 20), and his wife, on looking back, becomes one of those pillars of salt which still invite speculation. Finally the names of his children Moab and Ammon are explained by an incident when he is a cave-dweller on a mountain.

To primitive minds which speculated upon the "why and wherefore" of what they saw around them, the narratives of Genesis afforded an answer. They preserve, in fact, some of the popular philosophy and belief of the Hebrews. They furnish what must have been a satisfactory origin of the names Edom, Moab and Ammon, Mahanaim and Succoth, Bethel, Beersheba, etc. They explain why Shechem, Bethel and Beersheba were ancient sanctuaries (*see* further below); why the serpent writhes along the ground (iii, 14); and why the hip sinew might not be eaten (xxxii, 32). To these and a hundred other questions the national and tribal stories (of which no doubt only a few have survived, and of which other forms, earlier or later, more crude or more refined, were doubtless current) furnish an evidently adequate answer. Myth and legend, fact and fiction, the common stock of oral tradition, have been handed down, and thus constitute one of the most valuable sources for popular Hebrew thought.

The book is not to be judged from any one-sided estimate of its contents. By the side of much that seems trivial, and even nonmoral (for the patriarchs themselves are not saints) it is noteworthy how frequently the narratives are didactic. The characteristic sense of collective responsibility, which appears more incidentally in xx, 7, is treated with striking intensity in a passage (xviii, 23–33) which uses the legend of Sodom and Gomorrah as a vehicle for the statement of a familiar problem (cf. Ezek. xviii, Ps. lxxiii, Job). It will be observed that interviews with divine beings presented as little difficulty to the primitive minds of old as to the modern native; even the idea of intercourse of supernatural beings with mortals (vi, 1–4) is to-day equally intelligible. The modern untutored native has a not dissimilar undeveloped and childlike attitude towards the divine, a naïve theology and a simple cultus. The most circumstantial tales are told of imaginary figures, and the most incredible details clothe the lives of the historical heroes of the past. So abundant is the testimony of modern travellers to the extent of which Eastern custom and thought elucidate the interpretation of the Bible, that it is very important to notice those features which illustrate Genesis. "The oriental," writes S. I. Curtiss (*Bibl.* Sacra, Jan. 1901, pp. 103 *sqq.*), "is least of all a scientific historian. He is the prince of story-tellers; narratives, real and imaginative, spring from his lips, which are the truest portraiture of composite rather than individual oriental life, though narrated under forms of individual experience." There are, therefore, many fundamental facts which combine to show that the critical student can not isolate the book from oriental life and thought; its uniqueness lies in the manner in which the material has been shaped and the use to which it has been put.

Questions of Date.—The Book of Jubilees (not later than *c.* 100 B.C.) presents the history in another form. It retains some of the canonical matter, often with considerable reshaping; it omits many details (especially those to which exception could be taken), and adds much that is novel. The chronological system of the latest source in Genesis becomes an elaborate reckoning of heavenly origin. Written under the obvious influence of later religious aims, it is especially valuable because one can readily compare the two methods of presenting the old traditions. The Book of Jubilees (*q.v.*) also enables the student to test the arguments based upon any study restricted to Genesis alone. Thus it shows that the "primitive" features of Genesis afford a criterion which is sociological rather than chronological. This is often ignored. For example, the conveyance of the field of Machpelah (xxiii) is conspicuous for the absence of any reference to a written contract in contrast to the "business" methods in Jer. xxxii. This does not prove that Gen. xxiii is early, because writing was used in Palestine about 1400 B.C., and, on the other hand, the more simple forms of agreement are still familiar after the time of Jeremiah (*e.g.,* Ruth, Proverbs). Similarly, no safe argument can be based upon the institution of blood-revenge in Gen. iv, when one observes the undeveloped conditions among the Trachonites of the time of Herod the Great (Josephus, *Ant.* xvi, 9, 1), or the varying usages among modern tribes. In the Book of Jubilees there is the same kind of personification; there are fresh examples of the "prophetical interpretation of history," and by the side of the older "primitive" thought are ideas which can only belong to this later period. In each case we have merely a selection of current traditional lore. For example, Gen. vi, 1–4 mentions the marriage of divine beings with the daughters of men and the birth of Nephilim or giants (cf. Num. xiii, 33). Later allusions to this myth (*e.g.,* Baruch iii, 26–28, Book of Enoch vi, sqq., 2 Peter ii, 4, etc.) are not based upon this passage: the fragment itself is all that remains of a more complete written myth. Old myths underlie the account of the Creation and the garden of Eden, and traces of other versions or forms appear elsewhere in the Old Testament. Again, the Old Testament throws no light upon the redemption of Abraham (Is. xxix, 22), although the Targums and other sources profess to be well informed. The isolated reference to Jacob's conquest of Shechem in Gen. xlviii, 22, must have belonged to another context, and later writings give in a later and thoroughly incredible form allied traditions. In Hosea xii, 4, Jacob's wrestling is mentioned before the scene at Bethel (Gen. xxxii, 24 *sqq.,* xxviii, 11 sqq.). The overthrow of Sodom and Gomorrah is described in Genesis (xviii, seq.), but Hosea refers only to that of Admah and Zeboim (xi, 8, cf. Deut. xxix, 23, Gen. x, 19)—different versions of the great catastrophe were doubtless current. Consequently investigation must start with the particular details which happen to be preserved, and these not necessarily in their original or in their only form. Since the antiquity of elements of tradition is independent of the shape in which they appear before us, a careful distinction must be drawn between those details which do not admit of being dated or located and those which do. There is evidence for the existence of the names Xbram, Jacob and Joseph in early times, but this does not prove the antiquity of the present narratives encircling them.

Historical Backgrounds.—Popular tradition often ignores events of historical importance, or, as repeated experience shows, will represent them in such a form that the true historical kernel could never have been recovered aithout some external clue. The absence of definite references to the events of the Israelite monarchy does not necessarily point to the priority of the traditions in Genesis or their later date. Nevertheless, some allusion to national fortunes is reflected in the exaltation of Jacob (Israel) over Esau (Edom), and in the promise that the latter should break the yoke from his neck; later writers (in the Targums) bring this up-to-date. Israelite kings are foreshadowed (xvii, 6, xxxv, 11 P), and Israel's kingdom has the ideal limits as ascribed to Solomon (xv, 18, see I Kings iv, 21; but cf. art. SOLOMON). Judah is promised a world-wide king (xlix, 8–10), though elsewhere the supremacy of Joseph rouses the jealousy of his "brothers" (xxxvii, 8). Different dates and circles of interest are thus manifest. The cursing and dispersion of Simeon and Levi (xlix, 5–7) recall the fact that Simeon's cities were in the territory of Judah (Josh. xix, 1, 9), and that the Levitical priests are later scattered and commended to the benevolence of the Israelites. But the curse obviously represents an attitude quite opposed to the blessing pronounced upon Levi by Moses (Deut. xxxiii, 8–11). The Edomite genealogies (xxxvi) represent a more extensive people than the references in the popular stories suggest, and the latter by no means indicate that Edom had so important a career as we actually gather from a few allusions to its kings (xxxvi, 31–39). The references to Philistines are anachronistic for the pre-Mosaic age, and it is clear that the tradition of a solemn covenant with a Philistine king and his general (xxi, 22 seq., xxvi, 26 seq.) does not belong to the age or the circle which remembered the heavy oppressions of the Philistines. Similarly, the treatment of the covenant by the author of Jubilees (xxiv, 28 sqq.) is only intelligible when one recalls the attitude of Judah to the Philistine cities in the and century B.C. Finally, the thread of the tradition unmistakably represents a national unity of the 12 sons (tribes) of Israel; but this unity was not felt at certain periods of disorganization, and the idea of including Judah among the sons of Israel could not have arisen at a time when Israel and Judah were rival kingdoms. Thus in the original text of II Sam. xix, 43, the men of Israel claim to be the first-born rather than Judah; cf. also I Chron. v, 1 sq., where Joseph obtains the birthright. Insofar as the traditions can be read in the light of biblical history it is evident that they belong to different ages and represent different national, tribal or local standpoints.

Religious **Interests.**—Noteworthy is the interest taken in sacred sites. Certain places are distinguished by theophanies or by the erection of an altar (literally "place of sacrificial slaughter"). Mizpah in Gilead is the scene of a covenant or treaty between Jacob and his Aramaean relative commemorated by a pillar (*Maṣṣēbah*). It was otherwise known for an annual religious ceremony, the traditional origin of which is related in the story of Jephthah's vow and sacrifice (Judg. xi), and its priests are denounced by Hosea (v, 1). Shechem, the famous city of the Samaritans ("the foolish nation," Ecclus i, 50, 26), where Joseph was buried (Josh. xxiv, 32), had a sanctuary and a sacred pillar and tree. It was the scene of the coronation (a religious ceremony) of Abimelech (Judg. ix), and Rehoboam (I Kings xii, 1). The pillar was ascribed to Joshua (Josh. xxiv, 26 seq.), and although Jacob set up at Shechem an "altar," the verb suggests that the original object was a pillar (Gen. xxxiii, 20). The first ancestor of Israel, on the other hand, is merely associated with a theophany at an oracular tree (xii, 6). The Benjamite Bethel was especially famous in Israelite religious history. The story tells how Jacob discovered its sanctity (it was the gate of heaven), made a covenant with its God, established the sacred pillar and instituted its tithes (xxviii). The prophetess Deborah dwelt under a palm tree near Bethel (Judg. iv, 5), and her name is also that of the foster mother of Rebekah who was buried near Bethei beneath the "oak of weeping" (xxxv, 8). Bochim ("weeping") elsewhere receives its name when an angel appeared to the Israelites (Judg. ii, 1, Septuagint adds Bethel). To the prophets Hosea and Amos the cultus of Bethel was heathen and immoral, even though it was Yahweh himself who was worshipped there (see BETHEL). South of Hebron lay Beersheba, an important centre and place of pilgrimage, with a special numen by whom oaths were taken (Amos viii, 14, see Sept, and cf. the commentaries). Isaac built its altar, and Isaac's God guarded Jacob in his journeying (xxxi, 29, xlvi, 1). This patriarch and his "brother" Ishmael are closely associated with the district south of Judah; both are connected with Beer-lahai-roi (xxiv, 62, Sept. xxv, 11), whose fountain was the scene of a theophany (xvi). Their traditions are thus localized in the district of Kadesh, famous in the events of the Exodus (*cf.* xvi, 14, xxi, 21, xxv, 18, Ex. xv, 22). Abraham planted a sacred tree at Beersheba and invoked "the everlasting God" (xxi, 33). But the patriarch is more closely identified with Hebron, which had a sanctuary (*cf.* II Sam. xv, 7 seq.), and an altar which he built "unto Yahweh" (xiii, 18). The sacred oak of Mamre was famous in the time of Josephus (B. J. iv, 9, 7), it was later a haunt of "angels" (Sozomen), and Constantine was obliged to put down the heathenish cultus. The place still has its holy tree. Beneath the oak there appeared the three divine beings, and in the cave of Machpelah the illustrious ancestor and his wife were buried. There is a distinct tendency to emphasize the importance of Hebron. Taken from primitive giants by the non-Israelite clan Caleb (*q.v.*), it is predominant in the patriarchal traditions. Jacob leaves his dying father at Beersheba (xxviii, 10), but according to the latest source he returns to him at Hebron (xxxv, 27), and there, north of Beersheba, he continues to live (xxxvii, 14, xlvi, 1–5). The cave of Machpelah became the grave of Isaac, Rebekah and Leah (but not Rachel); and though Jacob appears to be buried beyond the Jordan, it is the latest source which places his grave at Hebron (1, 1–11 and 12 *seq.*). So, in still later tradition, all the sons of Jacob with the exception of Joseph find their last resting place at Hebron, and in Jewish prayers ior the dead it is besought that their souls may be bound up with those of the patriarchs, or that they may go to the cave of Machpelah and thence to the Cherubim. The increasing prominence of the old Calebite locality is not the least interesting phase in the comparative study of the patriarchal traditions.

The association of the ancestors of Israel with certain sites is a feature which finds analogies even in modern Palestine. There are old centres of cult which have never lost the veneration of the people; the shrines are known as the tombs of saints or *welis* (patrons) with such orthodox names as St. George, Elijah, etc. Traditions justify the reputation ior sanctity, and not only are similar stories told of distinct figures, but there are varying traditions of a single figure. Genesis preserves a selection of traditions relating to a few of the old Palestinian centres of cult. We cannot suppose that these first gained their sacred character in the pre-Mosaic "patriarchal" age; there is in any case the obvious difficulty of bridging the gap between the descent into Egypt and the Exodus; and it is clear that when the Israelites entered Palestine they came among a people whose religion, tradition and thought were fully established. It is only in accordance with analogy if stories were current in Israel oi the institution of the sacred places, and closer study shows that we do not preserve the original version of these traditions.

A venerated tree in modern Palestine will owe its sanctity to some tradition, associating it, it may be, with some saint; the Israelites in their turn held the belief that the sacred tree at Hebron was one beneath which their first ancestor sat when three divine beings revealed themselves to him. But it is noteworthy that Yahweh alone is now prominent; the tradition has been revised, apparently in writing, and, later, the author of Jubilees (xvi) ignores the triad. At Beer-lahai-roi an El ("god") appeared to Hagar, whence the name of her child Ishmael; but the writer prefers the unambiguous proper name Yahweh, and, what is more, the divine being is now Yahweh's angel—the Almighty's subordinate (xvi). The older traits show themselves partly in the manifestation of various Els, and partly in the cruder anthropomorphism of the earlier sources. Later hands have by no means eliminated or modified them altogether, and in xxxi, 53, one can still perceive that the present text has endeavoured to obscure the older belief that the God of Abraham was not the God of his "brother" Nahor *(see* the commentaries). The sacred pillar erected by Jacob at Bethel was solemnly anointed with oil, and it (and not the place) was regarded as the abode of the Deity (xxviii, 18. 22). This agrees with all that is known of stone cults. but it is quite obvious that this interesting example of popular belief is far below the religious ideas of the writer of the chapter in its present form. There were many places where it could be said that Yahweh had recorded his name and would bless his worshippers (Ex. xx, 24). They were abhorrent to the advanced ethical teaching of prophets and of those imbued with the spirit of Deuteronomy *(cf.* II Kings xviii, 4 with *v.* 22), and it is patent from Jeremiah, Ezekiel and Is. lvi–lxvi that even at a late date opinion varied as to how Yahweh was to be served. It is significant, therefore, that the narratives in Genesis (apart from P) reflect a certain tolerant attitude; there is much that is contrary to prophetical thought, but even the latest compilers have not obliterated all features that, from a strict standpoint, could appear distasteful. Although the priestly source shows how the lore could be reshaped, and Jubilees represents later efforts along similar lines, it is evident that for ordinary readers the patriarchal traditions could not be presented in an entirely new form, and that to achieve their aims the writers could not be at direct variance with current thought.

Southern Interests. — There is relatively little tradition from north Israel; Beersheba, Beer-lahai-roi and Hebron are more prominent than even Bethel or Shechem, and there are no stories of Gilgal, Shiloh or Dan. Yet in the nature of the case there must have been a great store of local tradition accessible to some writers and at some periods. Interest is taken not in Phoenicia, Damascus or the northern tribes, but in the east and south, in Gilead, Ammon, Moab and Ishmael. Particular attention is paid to Edom and Jacob, and there is good evidence for a close relationship between Edomite and allied names and those of south Palestine (including Simeon and Judah). Especially significant, too, is the interest in traditions which affected the south of Palestine, that district which is of importance for the history of Israel in the wilderness and of the Levites. It is noteworthy therefore, that while different peoples had their own theories of their earliest history, the first-born of the first human pair is Cain, the eponym of the Kenites, and the ancestor of the beginnings of civilization (iv, 17, 20–22). This "Kenite" version had its own view of the institution of the worship of Yahweh (iv, 26); it appears to have ignored the Deluge, and it implies the existence of a fuller corpus of written tradition. Elsewhere, in the records of the Exodus, there are traces of specific traditions associated with Kadesh, Kenites, Caleb and Jerahmeel, and with a movement into Judah, all originally independent of their present context. Like the prominence of the traditions of Hebron and its hero Abraham, these features are not fortuitous, though the problems they bring cannot be discussed here (see *Camb. Anc. History,* ii, 359 *sqq.,* iii, 472 *sqq.,* vi, 185 *seq.).*

BIBLIOGRAPHY.—S. R. Driver's commentary ("Westminster Series") deals thoroughly with all preliminary problems of criticism, and is the best for the ordinary reader ; Dillmann (6th ed., Eng. trans.) is technical, Ryle *(Cambridge Bible)* and Bennett *(Century Bible)* more popular. Spurrell, *Notes on the Text of Genesis,* and Ball (in Haupt's *Sacred Books of the O. T.)* appeal to Hebrew students. Addis, *Documents of the Hexateuch,* Carpenter and Harford-Battersby, *The Hexateuch,* and C. F. Kent, *Beginnings of Hebrew History,* are important for the literary analysis. J. Wellhausen's sketch in his *Proleg. to Hist. of Israel* (Eng. trans., pp. 259–342) is admirable, as also is the general introduction (trans. by W. H. Carruth, 1907) to Gunkel's commentary. Fuller bibliographical information mill be found in the works already mentioned, in the articles in the *Ency. Bib.* (G. F. Moore) and Hastings' *Dict.* (G. A. Smith), and in the volume by J. Skinner in the "International Critical Series." (S. A. C.)

GENET, EDMOND CHARLES (1763–1834), French minister plenipotentiary 'to the United States in 1793, was born on Jan. 8, 1763, at Versailles. He was for a time attached to the embassy at Berlin and later to the embassy at Vienna; and at the age of 18, following his father's death, succeeded him as secretary interpreter at the ministry of foreign affairs. In 1787 he was sent to the embassy at St. Petersburg where he remained until July 1792, when his liberal views made him *persona non grata.* After a brief stay in Paris. where he came more fully under the influence of the Revolution, "citizen" Genet was sent as French minister to the congress of the United States. He was assuming a position which would require much tact, but his impetuous nature, combined with the ovations accorded him by the Democratic-Republicans, led him into misjudging public opinion regarding U.S. neutrality. His activities in instigating military operations against the Spanish possessions of Florida and Louisiana and against Canada. the fitting out of privateers in U.S. ports, his acrimonious debates with the federal government and his caustic attacks on the president demonstrate conclusively his lack of diplomacy. Genet's threat to override the executive by appealing to the people caused Washington to ask the French republic to recall its representative. His successor, "citizen" Fauchet, brought orders to arrest him and send him back to France for trial, but Washington refused to permit the extradition. He subsequently became a naturalized U.S. citizen. In 1794 he married Cornelia Tappen Clinton, daughter of the governor of New York and in 1814, four years after the death of his first wife, married Martha Brandon Osgood, daughter of the first postmaster general. He died on July 14. 1834.

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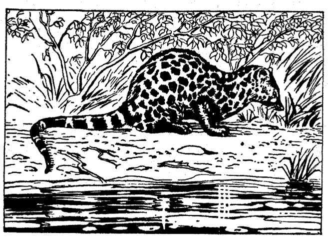
GENET, a catlike mammal belonging to the family Viverridae *(see* CARNIVORA), found chiefly in Africa. The common genet *(Genetta genetta)* occurs throughout Africa and also in southern Europe and Palestine; it is about the size of a cat, but more slender and longer of leg. The fur is dark gray. thickly spotted mith black and having a dark streak along the back, while the tail, which is nearly as long as the body, is ringed with black and white. It frequents the banks of streams and feeds on small mammals and birds. It differs from the true civets in that the anal pouch is a mere depression and contains only a faint trace of the characteristic odour of the former. (J E. HL.)


GENET (GENETTA SERVALINA) OF THE CONGO, AFRICA

GENETICS, the scientific study of heredity and variation, was so named by William Bateson in 1906, although its origins trace to the discovery by Johann Gregor Mendel *(q.v.)* (1866) of the first general laws of heredity. The experiments of Mendel, which lay unremarked by biologists until 1900, gave the first indication that an organization of living elements. the genes, constitutes the main transmission mechanism of heredity by which the generations of sexually reproducing organisms are connected. Following the experimental proof that genes are subelements within the visible system of chromosomes within the nucleus of each cell, including the sex cells (egg and sperm) through which the chromosomes with their genes pass to descendants, genetics could be more simply defined as the study of the gene in reproduction, heredity, development and evolution. The activities of the genes in these several processes may best be understood by considering them under three headings, which represent not divisions of the science, since all are concerned with the nature and activity of genes, but rather facets of gene activity in the processes of heredity, development and evolution.

Under *Transmission Genetics,* below. will be found a description of the mechanism of heredity, evidence for the existence and spatial arrangement of genes in the living cell, Mendel's first principles of segregation and independent assortment of genes, linkage of genes in groups each corresponding to a pair of chromosomes, linear arrangement of the genes in each linkage group, transmission of genes in the sex chromosomes with consequent proof of the genetic determination of sex, and the ways in which genes reproduce. giving rise to a continuous succession of like elements and occasionally to new gene forms by mutation.

Under *Physiological Genetics* (sometimes called phenogenetics or developmental genetics) the causal relations will be discussed which connect particular genes or systems of genes (genotypes) with the effects produced on the characters of the mature or embryonic individual. This division is essentially a study of the gene in the processes of life.

Under *Evolutionary Genetics* will be treated the forces which play upon the arrays of genes as they are transmitted and function in successive populations of animals or plants, leading to evolutionary changes. The understanding of this historical process is based upon the principles of population genetics.

Finally the applications of genetics in forms of special interest to man (human genetics, medical genetics, genetics of microorganisms, genetics of crop plants and of domestic animals) will be pointed out.

GENERAL VIEWS

Before dealing with any of these special features of genetics, it is necessary to have a clear view of certain general principles and assumptions which underlie the whole subject. The most important of these is the meaning of the terms heredity and hereditary. We may start from the fact that all organisms, considered as individuals or as populations distribute'd in space or in time, represent the outcomes of interaction between factors intrinsic to the organism and factors external to it. The usual way of stating this is to say that any individual is a joint product of his heredity and his environment. The intrinsic factors consist of an assemblage of genes derived from the parents. In cross-breeding populations like man, most higher animals and plants such as maize, every individual gets a unique assemblage derived from ancestors who are largely unrelated or distantly related, although some part of the system of genes which he inherits are those which he shares with all members of his species (since derived from a common ancestry) and by virtue of which he develops the distinguishing marks of his species. This array of genes which each individual receives is known as his "genotype." The same array of genes may produce different characters if the individuals carrying them develop in different environments. Thus the expression of a genotype which produces diabetes in the absence of insulin treatments fails to do so when regular injections of insulin become a part of his environment.

The sum total of the physical and behavioural characters of an individual is known as his "phenotype." The phenotype is, on the above view, the outcome of the interplay between the genotype and the environments in which development occurs. The genes appear to act as the regulators or modulators of this interplay. Each individual's response to his environment is thus determined by his genotype, but obviously not irrevocably or without some latitude in the range of responses. The range (or norm of reaction) varies with the character under consideration and may in some cases be very wide, as in the case of size, in which the same genotype may result in small size if some essential food requirement is withheld, or in much greater size if all essentials for maximum growth are freely available. On the other hand, a genotype which includes a gene or genes for dwarf size can respond within narrower limits unless the particular metabolic limitations due to the gene can be discovered and made good by special diet or other treatment. It is from such considerations that the general principle is derived which states that what is inherited is the potentiality of response during development to a range of environmental conditions. Heredity is thus to be viewed as the transmission of patterns of development. It is a corollary of this rule that all structures and functions of living organisms are inherited, and that all, in greater or lesser degree, are responsive to their environments. One task of genetics is thus to elucidate the relationships between genotypes and phenotypes. Results of studies directed to this end will be discussed further under *Physiological* Genetics.

A second important general view arises from considering the origins of hereditary variety. Variations in general are departures from the common or normal characteristics of the species. They may arise from encounters of the usual or established genotypes with new or unusual conditions, but if they are to add something which is both novel and hereditary in the above sense, they must involve new, transmissible modes or levels of response to the environments of the species, since in the course of sexual reproduction over many generations, the existing genes will be shuffled and reshuffled so that all possible genotypes and the responses that they make possible will have been exposed to a variety of environments.

A new potentiality will in general arise only when a new genotype arises and this will depend upon the occurrence of a new form of one or more genes. The change in the form of a gene, as deduced from its changed effects, is known as mutation and will be discussed under *Evolutionary Genetics*. It is this event which makes new gene forms available for recombination into a variety of genotypes, which may subsequently be winnowed by the environment in the process known as natural selection. Mutation and natural selection are the essential factors of evolution.

TRANSMISSION GENETICS

The **First Law of** Mendel.—The rules by which genes are transmitted to descendants all relate to the behaviour of these elements during reproduction. The system, revealed mainly since 1900 by breeding experiments combined with studies of the cell and its parts (cytology, *q.v.*), is referred to as the mechanism of heredity. The existence of this system was first indicated by Mendel's experiments (1856–65; published 1866). He collected from seedsmen varieties of the garden pea (*Pisum sativum*) differing in colour of flowers, height, form and colour of seeds and other sharply different characters which occur in alternative forms (such as white or coloured flowers) in different races. Each of these alternative forms bred true to its own type, and since the pea plant reproduced by self-fertilization, it could be assumed that all the descendants of a single plant (known as a pure line) receive the same heredity and exhibit only the variations due to variable environmental factors such as temperature, amount of water, fertilizer, etc. In crosses between different pure lines, however, Mendel found that the first generation plants (known as F,) showed the alternative character or characters of only one of the parents, whereas when the F_1 plants produced seed by self-fertilization some of the plants of the second generation (known as F_2) showed one of the alternative characters (such as coloured flowers) while other plants showed the other alternative (white flowers). When the numbers of plants of the two types in F_2 were counted in large experimental populations it was found that about three-fourths of them showed the alternative character of one grandparent while one-fourth of them showed the alternative character of the other grandparent. Mendel's actual results for the seven pairs of alternatives which he studied are shoan in Table I.

TABLE I.—*F_2 Results for Seven Alternative Characters* (*Mendel*)

Structure	Property	Characters		Ratio
		Dominant	Recessive	
Seed . . .	Form	5,474 round	1,850 wrinkled	2·96:1
Reserve material in cotyledons .	Colour	6,022 yellow	2,001 green	3·01:1
Seed-coats . .	Form	882 inflated	299 ivrinkled	2·95:1
Seed-coats . .	Colour	705 grey	224 white	3·15:1
Unripe pods .	Colour	428 green	152 yellow	2·82:1
Flowers . .	Position	651 axial	207 terminal	3·14:1
Stem . . .	Length	787 tall	277 dwarf	2·84:1
		14,949 (74·90%)	5,010 (25·10%)	2·98:1 or 3:1

The essential feature of these results was the proof of the existence of sharp discontinuous alternatives in inheritance, and of the particulate character of the hereditary material. Although the alternatives were revealed by the discontinuous, differentiating characters which could be observed in the plants at the end of development, Mendel's great contribution was to show that the essential discontinuity was in the invisible elements contained in the reproductive cells, ovum and pollen grain, or, as we shall subsequently refer to them, in the single pairs of cells, egg and sperm, "gametes," which unite at fertilization to form the new individual. He did this by showing, in further breeding of the F_2 plants, that the three-fourths of them which externally resembled one grandparent actually consisted of two genetically different kinds of individuals of which one duplicated the behaviour of the grandparental pure line by producing only progeny like itself, while the other resembled the F_1 by producing both of the altemative grandparental forms. If we represent the essential entities of inheritance by alternative forms of the same letter, we may symbolize the whole experiment as in Table II.

TABLE 11.—Representation of *Mendel's* Experiment

Parental generation P_1	*AA*	×	*aa*
Gametes of P_1	*A*		*a*
First filial generatioh (hybrid) F_1 . .	*Aa*	×	*Aa*
Gametes (sex cells) of F_1 (with random combinations at fertilization)		*A*----+*A* *a*——→*a*	
Second filial generation F_2	¼ *AA*	½ *Aa*	¼ *aa*
Third filial generation F_3	all *AA*	¼ *AA* ½ *Aa* ¼ *aa*	all *aa*

The assumptions involved in the representation are:

1. Each element of heredity (now called gene) exists in alternative forms called alleles. Where the parents have the same allelic form of the gene (technically known as being homozygous for this form, or as homozygotes *AA, aa)*, this form is transmitted in each gamete to each offspring. Where a parent contains two different alleles, such as *A* and *a*, each gamete receives, by chance, either one or the other but never both, so that half of the gametes transmit *A* and half *a*.

2. Each union of a male gamete with a female gamete is at random with respect to the allele which it contains; which is to say that where the parents form two different kinds of gametes with respect to *A*, all combinations, *AA, Aa, aA* and *aa,* are equally frequent.

These assumptions have been validated, since 1900, by observations of this process in all forms of life from bacteria and other fungi through green plants to higher animals including man. The principle involved is known as the first law of Mendel, or the principle of segregation, since its essential feature is the separation or segregation of alternative forms (alleles) of a gene into different sex cells (gametes). In the period before its general applicability was recognized, the operation of this system and the second, less general, rule discovered by Mendel was known as Mendelism.

The Second "Law" of Mendel.—By observing the results of crossing pairs of pure parents differing in two sets of altemative characters at the same time (such as parents homozygous for coloured flowers and tall growth crossed with parents homozygous for white flowers and dwarf growth), Mendel showed that each pair of alleles behaved as though independent in inheritance of each other pair. Thus parents *AABB* × *aabb* or *AAbb* × *aaBB* produce F_1 offspring *AaBb*. These produce gametes *AB, Ab, aB* and *ab* in equal numbers, and random union among these produces the array of genotypes shown in Table III.

TABLE III.—*Mendel's* Second "Law"

Eggs	Sperms			
	AB	Ab	aB	ab
AB.	**AABB**	**AABb**	**AaBB**	**AaBb**
Ab.	**AaBb**	Ahhb	**AaBb**	Aahb
aB	**AaBB**	***AaBb***	aaBB	aaBb
ah	**AaBb**	Xahh	aaBb	*aabb*

If a single allele A is sufficient to produce the character A (say coloured flowers) and a single allele B results in the character B (say tall growth) as Mendel found, then the F_2 from the above cross should consist of phenotypes as follows: 9/16 **AB** (bold face), 3/16 Ab (Roman face), 3/16 aB (Roman), and 1/16 *nabb* (italic). The resemblance of the actual proportions found by Mendel in F_2 to those expected on the above assumptions was sufficiently close to validate the above theory.

This is known as the principle of independent assortment of allele pairs; its essential feature is that segregation of one pair of alleles is independent of the segregation of other pairs, all possible combinations being formed at random by this process of recombination. If two independent pairs of alleles are observed, of which one produces three genotypes such as *AA, Aa* and *aa,* the other *BB, Bb* and *bb,* then the combinations of these should be 3 × 3 or 9. If a third pair (C-c) is observed at the same time, the numbers of different combinations should again be multiplied by 3 to produce 27 different genotypes. If *n* is the number of pairs of alleles observed, the number of independently different gene combinations (genotypes) should be 3^n. For 10 pairs of alleles (a small part of the existing number which for most organisms is in the thousands) $3^{10} = 59{,}049$ different combinations. This is obviously the cause of much of the genotypic variety found in crossbreeding species of animals and plants. Its sources trace to the occurrence of different forms of the same gene which arise by mutation, such as *A* giving rise to *a* or vice versa.

The principle of independent assortment is subject to the important limitation that it applies only to pairs of alleles belonging to different linkage groups *(see* below), that is, to genes located in different pairs of chromosomes. Since in man there are 24 pairs of chromosomes there can be 24 pairs of alleles showing independent assortment, and this alone would lead to 3^{24} random combinations or genotypes, a very large number indeed.

Dominance.—One of the "rules" discovered by Mendel turned out not to be of general applicability. This was his observation that in the case of all seven of the differentiating pairs of characters which he studied, one of the pair was dominant in the sense that it produced its phenotypic effect in the offspring when received from one parent only. Thus *AA* and *Aa* individuals showed character *A, aa* individuals character *a*. We know now that dominance is not a property of the transmission mechanism by which alleles are distributed to gametes and progeny but is affected by circumstances which intervene between the origin of the individual at fertilization and the time when his characters are observed. This is to say, dominance is decided during development. It is, therefore, discussed under *Physiological Genetics.*

Linkage and Crossing Over of Genes.—The period immediately follou-ing the rediscovery of Mendel's principles (they were independently arrived at by three different botanists in 1900 and this led to the unearthing of his forgotten publication of 1866) saw the confirmation of his genera1 theory by the results of experiments and observations on a wide variety of animals and plants, including man. In the decade 1910–20 several new principles were discovered, chiefly through the work of T. H. Morgan and his coworkers. C. B. Bridges, A. H. Sturtevant and H. J. Muller. The first new principle came to light through the discovery of exceptions to the principle of independent assortment. In experimental breeding of the vinegar fly, *Drosophila rnelanogaster,* it was found that certain genes tended to remain associated in the progeny more frequently in the same combinations in which they had been present in the parents. Thus parents *SSTT* × *sstt* gave rise to F_1 progeny *ST*, and those produced gametes *ST*, *sT*, *St* and *st*, as assumed by Mendel. but not in equal numbers as called for by his theory. The parental combinations *ST* and *st* in these cases always exceeded the new combinations *St* and *sT*. In fact, in male heterozygotes *ST/st,* only *ST* and *st* gametes were formed, and no recombinations *sT* or *St* at all. This led to the supposition that S and *T* were linked together in some common element which held them in association. In females *ST/st,* this association was only partial, and the linkage was occasionally broken, so that gametes *sT* and *St* were occasionally formed. These breaks in the linkage revealed by separation of the partners in the gametes and progeny were called crossovers, and the process of exchange, crossing over. In many animals and plants crossing over occurs in both sexes; its failure to occur in male *Drosophila* was a special feature of such species which greatly facilitated the detection of four groups of linked genes corresponding to the four pairs of chromosomes characteristic of *Drosophila,* and this led to the discovery of a new general principle, the limitation of the linkage groups, which states that the number of linkage groups is equal to the number of pairs of chromosomes. This has been confirmed for many species. Only genes belonging to different linkage groups show independent assortment. Members of the same linkage group which undergo recombination by crossing over also eventually enter into all possible combinations, but this process is retarded, in numbers of generations, by the associations between linked genes.

A third new principle was discovered when it was found that the frequency of recombination between linked genes was a measure of the relative "distance" between genes in the linkage group. Linked genes which infrequently recombine by crossing over are assumed to be closer together than genes which recombine more frequently. By use of these relations, as determined from breeding experiments, linkage "maps" can be constructed indicating the order in which the genes are arranged. The data for *Drosophila* and a number of other species in which many genes can be identified and studied together can be reconciled only by assuming a linear order so that for adjacent genes, the recombination "distance" ***A-B*** plus the distance B-C gives the "distance" (per cent of recombination) between A and C. This is the principle of linear arrangement of the genes in the linkage group. It appears to be of general application.

Subsequently, it was found that each linkage map corresponds to one particular chromosome and that linkage order expresses the actual order of succession of genes in the chromosome. Linkage distance also corresponds in a rough way to the actual distance of one gene from another in the physical structure of the chromosome, although apparent "distance" is affected by local peculiarities of structure and function within the chromosome, and by factors external to the chromosome (age, temperature, humidity, etc.) which influence the likelihood of occurrence of recombination and crossing over in different segments along the chromosome (see CYTOLOGY). The proof that a chromosome Consists of a linearly arranged succession or thread of genes, like beads on a string, was greatly facilitated by the discovery that the threads can break and recombine, a process that can'be influenced experimentally by exposure to radiations, including thermal effects.

Sex Linkage and Sex Determination.—In most animals and in some plants in which male and female gametes are produced by different individuals (separate sexes or dioecism), one of the chromosomes is differentiated from the others by carrying a set of genes which show sex-linked inheritance, and by having a preponderant influence on the determination of sex by affecting the development of the primary sex characters (ovary or testis). Consequences of this difference in the sex chromosomes are seen in the development of secondary sex characters (male or female habitus) associated with the primary difference. In man, for example, the female has two sex chromosomes, designated as X, while the male has one X chromosome (always derived from the mother) and one chromosome not exactly equivalent to its X partner which is known as the Y chromosome. Half of the spermatozoa, therefore, transmit the Y chromosome and half the X chromosome. The transmission of these chromosomes is diagrammed below:

Female XX by male XY
Gametes X→X fertilization gives XX female
↘
Y fertilization gives XY male

The sex-linked genes are borne in the X and pass from mother to both sons and daughters; the genes in the Y chromosomes pass only from father to sons. Genes in the X for which no equivalent alternatives (alleles) exist in the Y (which contains very few active genes) therefore exhibit their full effects in the sons only, as in the cases of red-green blindness, haemophilia and a number of other sex-linked peculiarities which generally go from mother to sons only.

Many such genes have been mapped in linear fashion in the X chromosomes of man and other animals. The X chromosomes also carry many other genes which influence early development to take place either in a female direction (in man and many other animals) or in a male direction (in birds and some other animals in which the male is XX and the female XY). Ordinarily, this early influence is decisive in determining the sex of the individual, so that sex appears to be inherited according to the same principle of segregation which governs inheritance generally; but the early influence of the sex chromosomes may be modified or even reversed by subsequent events in development, such as disease or aberrations in other chromosomes (see SEX).

In summary, the transmission system of genetics consists of an orderly arrangement of genes, or loci, at which elements within each chromosome may assume different alternative forms or alleles by which they may be identified. Each chromosome consists of hundreds or thousands of such loci, depending on size and other variables, each capable of mutating to forms having different physiological effects. This system is coextensive with the mechanism known as meiosis by which the chromosomes and their elements are distributed to the reproductive cells. The principles of transmission genetics are, therefore, consequences of the behaviour in reproduction of elementary particles—genes—and the integrated systems in which they are organized.

PHYSIOLOGICAL GENETICS

After the genes reach the new individual via the transmission system, their effects on that individual will be determined by three main contingencies. First is the contribution which the particular gene makes (or fails to make) to the physiological or metabolic processes of the individual; second is the physiological effect of the combination of genes or genotype of which the particular gene is a part; third is the set of circumstances, environmental and other, which the gene and the genotype encounter during development. The effects of a gene on development are outcomes of interactions among such influences as these.

Each gene affects some living process or processes, its several forms or alleles having different degrees of effectiveness. Thus the process leading to the development of dark pigment (melanin) in the hair and skin of vertebrates is dependent upon the condition of a gene, one allele of which permits completion of this process resulting in normal pigmentation. But if another form is present the conversion of a colourless substance, tyrosine, to melanin is interrupted at some point, and defective or no coloration (such as albinism) results. From studies of microorganisms it is known that certain individual genes exert a controlling influence on the synthesis of particular organic molecules such as amino acids and proteins from simpler compounds. One way in which the genes do this is by influencing the rate or efficiency of catalytic (enzyme) reactions which promote such processes. (See BIOCHEMISTRY.) Other genes produce antigens, molecular groupings which have specific relations (reactions) with antibodies. Genes affecting the blood group status of human beings have such effects. The first or primary effects of genes are unknown since the effects are recognized by measurement of secondary substances such as pigments or enzymes or antigens. It is suspected that substances given off by genes during their reproduction, or absorbed from the cell during this process, are responsible for their specific effects.

Since the essential feature of heredity is the self-reproduction of copies of the parental organisms, a primary question of physiological genetics concerns the mechanism of the copying process. This must require the self-reproduction or copying of each of the elements of heredity. How each element does this is not known and the ultimate solution of this problem would involve understanding the physics and chemistry of the synthesis of organic molecules in patterns determined by antecedent molecules such as genes. On the level of biological observation, however, it can be said that at each cell division, each gene produces a copy or replica of itself out of materials present in the cell. A demonstrable result of this is the replication of each chromosome which is an organized aggregation of genes in linear order. This operation lies at the bottom of all reproduction and of the continuity of living substance.

Some clues as to the copying process are obtained when slight imperfections in it occasionally occur. Mutation, the origin of a new and different gene form from an antecedent one, may be looked upon as due to defective gene copying. If the daughter gene is capable of further reproduction, then its changed character will be transmitted to its descendants, and a new pattern of development becomes possible, and this may be detected in changed characters of the embryo or the developed organism. If the defect in the daughter gene interferes with its subsequent replication, this gene uill not be found in the descendant cells, and this may prevent successful development from occurring at all. and the gene and its possessor are lost from the species. Studies of altered functions of particular mutated genes consequently provide information on the normal processes controlled by those genes. These are known to include the synthesis of certain chemical groupings such as amino acids, nucleic acids, proteins and carbohydrates on which living functions depend.

The products synthesized under the influence of particular genes react with each other in complex ways, so that different combinations of genes have different effects on the cells, thence on the individual. One result of the interaction of gene products is that under certain conditions, one member of a pair of alternative gene forms, such as *A*, may exert its effect on a character, even when the other member is different, such as *a*. This is the relation known as dominance. Thus the normal parents of an albino are of genotype *Aa*, yet are able to carry out the synthesis of pigment (melanin) in much the same way as persons with two normal genes *AA*. Albinos *aa*, with two recessive forms of this gene, are unable to carry out this synthesis in a normal way.

Both the elaboration of gene products and the reactions between them are influenced by the amount and kind of nutrients available, by heat, light and many other environmental variables. Thus it has been repeatedly shown that effects resembling those due to change in the form of a gene by mutation can be produced by altering the environment. Such imitations of the effects of mutations are known as phenocopies. Since the genes and the transmission system may remain unchanged after such treatments, the changed effects are not transmitted by inheritance.

Different forms of genes are known which influence key processes in the differentiation of the structures of the embryo or adult organism. It is through such channels that defective forms of certain genes lead to absence or abnormality of a part of the body. For normal development of the parts to be accomplished certain combinations of normal gene forms are required. When any of these change by mutation, abnormality may result, which may in some cases he corrected by supplying the missing or defective substance from the environment. Thus mutation in a gene may lead to a defect in a normal process, to cessation of development and death. (See HEREDITY.) Such mutant gene forms are known as lethals. Occasionally development of such organisms may be permitted to proceed under different environmental conditions or when the defective gene is combined in a different genotype.

EVOLUTIONARY GENETICS

The system by which genes are transmitted and the rules governing their physiological effects (which thus influence the kinds of structures and functions which the organisms exhibit) are obviously of primary importance in the historical process by which the succession of organisms become adapted to the environments in which they live. The principles by which genotypes change and adapt are those of population genetics. The elementary steps are the origin of new gene forms by mutation and the winnowing of the gene forms and combinations by natural selection.

In general, a population of crossbreeding animals or plants constitutes an integrated system (sometimes called a Mendelian population), consisting of a variety of genotypes which reproduces itself and remains in equilibrium as long as all effective factors remain constant. These factors are those which influence the relative frequencies of different gene forms in the population referred to as the gene pool. The conditions affecting equilibrium are: (1) mutation of alleles such as *A* to *a* and *a* to *A*; (2) migration into and out of the population; (3) the size of the population and its mating pattern (presence or absence of inbreeding, preferential or assortative mating, etc.); (4) selective forces acting on the population, tending to affect viability, fecundity and fertility of different genotypes. Changes in any one or more of these primary factors will give the opportunity for change in the frequency of one of the alleles relative to the other and thus lead to a change in the gene pool of the population. This constitutes an evolutionary change. The conditions of maintenance or change in the equilibrium are discussed under GENETICS OF POPULATIONS.

In general, if mutation occurs more frequently from *A* to ***a*** than the reverse, this will create a mutation pressure in favour of A and, other conditions being equal, will lead to replacement of *a* by *A* in the population. If more individuals with *A* enter or leave the population this will favour (or oppose) the spread of *A* in that population. If the population is very small. then by chance *A* or *a* gametes may fail to be included in those passed to the next generation. and either *A* or *a* will tend toward fixation to the exclusion of the other. Change in frequency by such accidents of sampling is known as random drift. If any genotype such as *AA* tends to leave more offspring by reason of some selective advantage, then the alternative genotype such as *aa* will tend, unless balanced by other factors, to be replaced by the more fit type. If *Aa* is superior to both *AA* and *aa* then both alleles *A* and *a* will tend to be retained in the population even though AA and *aa* are disadvantageous, and an equilibrium between *A* and *a* will be established, other things being equal.

Evolutionary changes by one or more of these methods have been observed in experimental populations. In nature, most populations are of limited size, have some mobility and inhabit environments which are subject to spatial and temporal variation. The normal state of crossbreeding populations is thus one of flux equilibrium among a variety of genotypes, and this is subject to change by one or more of the agencies mentioned above. Populations reproducing by self-fertilization are subject to somewhat different equilibriums, since new mutations (*A* to *a*, for example) are quickly resolved to homozygous states, *AA* and *aa,* and thus exposed promptly to natural selection which preserves the pure lines adapted to the given environment.

Populations reproducing by clonal (asexual) reproduction are subject to change by a variety of other factors. Since in the latter two methods no intercrossing and, hence, no recombination of genes is possible, the populations are likely to be more fixed in special environments and lack the plasticity associated with bisexual reproduction. (See also EVOLUTION, ORGANIC; GENETICS OF POPULATIONS; SELECTION.)

APPLICATIONS OF GENETICS

Although the principles of genetics appear to be coextensive with living matter, their consequences assume human or economic values which vary with different forms of life. Thus human genetics is especially concerned with the interplay of hereditary and environmental factors in determining the physical and mental characters of man, with the effects of heredity on diseases, abnormalities and special abilities, with the biological differentiation of interbreeding groups of man, such as races or subgroups separated by geographical or cultural factors such as language, religion or tradition.

Medical genetics is especially concerned with the influence of heredity on conditions of medical importance, and eugenics (*q.v.*) with means for the eradication of deleterious genes and for the improvement of human genotypes. Animal breeding and plant breeding utilize genetic principles in programs for improvement of livestock and useful plants. Genetics of microorganisms (bacterial genetics. genetics of fungi, of viruses and of protozoa) has assumed special importance both as an applied science concerned with control of pathogenic and parasitic forms, and with the utilization of microorganisms in fermentation, production of antibiotics and of food factors, and also as an avenue of approach to the understanding of such fundamental processes as mutation and the manner of effect of genes on metabolic processes, since these are more accessible to study in organisms with less complicated life cycles.

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GENETICS OF POPULATIONS. Many of the pioneer geneticists to whom is due the extraordinary development of knowledge of heredity after 1900 entered the field because of interest in the theory of evolution or in practical problems of animal and plant breeding. It seemed to them that the simple rules that were found for the heredity of many conspicuous variations, and the parallel behaviour of the threadlike chromosomes, visible in the nuclei of cells, provided keys that would rapidly reveal the solutions of their problems. To some extent their expectations were directly realized. But the harmonious combination of many subtle differences by which one species usually differs from its closest allies, and which similarly characterizes a successful strain of livestock or crop plant, continued to present difficult problems.

It became necessary to consider the statistical properties of populations in which many genetic differences are present simultaneously as the cumulative result of past mutation and recombination.

The reader must be referred to the articles **HEREDITY; GENE;** and GENETICS for presentation of the principles upon which the intelligibility of the following discussion rests.

Gene Frequency.— The basic concept of the genetics of populations is that of gene frequency. Let A_1 represent a particular autosomal gene and A_2 its array of alleles. Let $(x_mA_1A_1+y_mA_1A_2+z_mA_2A_2)$ represent the array of genotypes and their relative frequencies $(x_m+y_m+z_m=1)$ in mature males and assume a similar array with subscript f in mature females. The frequencies of gene A_1 in gametes of males and females respectively may be written: $q_m=[x_m+(\frac{1}{2})y_m]$, $q_f=[x_f+(\frac{1}{2})y_f]$. Since there is equal inheritance of autosomal genes from both parents, the gene frequencies become the same in males and females in the next generation. In symbols, $q_m=q_f=(\frac{1}{2})(q'_m+q'_f)$, using primes to designate the preceding generation. In general we may write $q=(\frac{1}{2})(q_m+q_f)$ as the effective gene frequency of a population, irrespective of the absolute numbers of males and females. It is obvious from the symmetry of the Mendelian mechanism, and the absence of any contaminating influence of alleles on each other in heterozygotes, that gene frequencies tend to remain constant in populations $(q=q')$.

In the important special case of sex-linked genes, one sex (to be taken as male in what follows) has only one chromosome (transmitted to half the gametes) that carries the locus in question, while the other sex has the usual pair. As males inherit such genes only from their mothers, while females inherit equally from both parents, $q_m=q'_f$, $q_f=(\frac{1}{2})(q'_m+q'_f)$. The effective gene frequency of the population is here $q=(\frac{1}{3})(q_m+2q_f)=(\frac{1}{3})(q'_m+2q'_f)=q'$. While the frequencies of sex-linked genes tend to remain the same generation after generation in the population as a whole, the frequencies in the males and females separately do not come to immediate equilibrium. There are rapidly damped oscillations about the mean, $(q_m-q)=(-\frac{1}{2})(q'_m-q')$. In polyploids, also, the frequencies of the various genotypes (*e.g.*, $A_1A_1A_1A_1$, $A_1A_1A_1A_2$, $A_1A_1A_2A_2$, $A_1A_2A_2A_2$ and $A_2A_2A_2A_2$ in a tetraploid) approach equilibrium only gradually, while gene frequency tends to remain constant.

Departures from random mating do not affect gene frequencies, provided that all genotypes contribute proportionately to the next generation. The frequencies of genotypes are, however, affected. Thus the random union of the array of sperms $[qA_1+(1-q)A_2]$ with a similar array of eggs produces a population with the genotypic array $q^2A_1A_1+2q(1-q)A_1A_2+(1-q)^2A_2A_2$, which is stable in large populations as long as mating continues at random. But if the system of mating is changed to universal self-fertilization, the homozygotes, A_1A_1 and A_2A_2, produce only their own kind while the heterozygotes, A_1A_2, produce 25% of each of the homozygous classes and only 50% of their own kind. With a 50% reduction in the frequency of heterozygotes in each generation it requires only a small number of generations to convert the population practically wholly into a mixture of homozygous lines $[qA_1A_1+(1-q)A_2A_2]$. Gene frequency has not changed but the aspect of the population has changed enormously. Recessives that are manifested in only 0.01% of the individuals of the random bred population become fixed in 1% of the inbred lines. Random mating would, however, immediately restore the initial genotypic composition (assuming, of course, that there has been no selection).

The tendency toward indefinite persistence of variability under random mating and its rapid elimination within each closely inbred line, shown above to be immediate consequences of the Mendelian mechanism, are not expected under blending heredity, under which variability should fall off 50% in every generation of random mating unless replenished by mutation at this enormous rate. Comparative data from random bred and inbred lines, and from crosses between inbred lines, indicate the practical universality of Mendelian heredity.

The extension of these principles to systems of multiple alleles is obvious. Under random mating, the frequencies of genotypes are given by the appropriate terms in the expansion of the square of the gene array, $(\Sigma q_iA_i)^2$.

Recombination.—We must next consider the frequencies of combinations of genes at different loci. Suppose that a population produces gametes with combinations of alleles at the A and B loci in the array $[wA_1B_1+xA_1B_2+yA_2B_1+zA_2B_2]$. Let c_m and c_f be the frequencies of recombination in the reduction division in eggs and sperms respectively, with c the unweighted average. The quantity $D(=wz-xy)$ is a measure of the departure from random combination. This falls off at the rate c per generation under random mating. Thus if A and B are in different chromosomes, D is halved in every generation. With 1% crossing over it is halved every 69 generations. Randomness of combination is not only approached with respect to any two loci, it is approached with respect to all loci simultaneously. It is sometimes suggested that a correlation between two characters in a population may be due to genetic linkage. This may be true in a population that has arisen recently from a mixture of two strains that differ in both respects but there can be no appreciable correlation of this sort in a population that has bred within itself at random for many generations unless linkage is complete or the approach to random combination is hampered by severe selection.

The most probable genotypic frequencies under long continued random mating are given by the appropriate terms in the expansion of $\prod_{i=1}^{n}\left[\sum_{j=1}^{k} q_{ij} A_{ij}\right]^2$ where A_{ij} is used for the j'th of k alleles at the i'th of n loci and q_{ij} is used for its frequency. Actually all potential genotypes cannot be realized in a finite population. With only 4 alleles (10 combinations) at each of only 100 loci, the number of potential genotypes is the inconceivably great number 10^{100}. A very limited number of mutations thus provides a virtually infinite field of potential variability. It is probable that no two individuals in a species with exclusive sexual reproduction ever have exactly the same genetic constitution.

Systematic Changes in Gene Frequency.— The immediate causes of change of gene frequency may be grouped into three categories by degree of determinacy. (1) Systematic processes (wholly determinate in principle) include recurrent mutation, recurrent immigration and selection (a comprehensive term for all modes of disproportionate contribution by genotypes to following generations). (2) Random processes (determinate only in variance) include the effects of fluctuations in the coefficients describing the systematic processes, and also those of accidents of sampling. (3) Unique events such as a nonrecurrent mutation, a unique hybridization or a unique selective incident.

Recurrent mutation, immigration and selection exert directed pressures on each gene frequency. The rate of change per generation due to these will be symbolized by Δq. Random processes give rise to undirected changes in gene frequency that may be symbolized by δq. There may be a question whether gene mutations are ever more than superficially recurrent. In the case of structural mutations, which usually involve two chromosome breaks, exact recurrence must certainly be a very rare event. Nonrecurrent mutation is undirected, but in a different sense from the accidents of sampling. The former extends the number of alleles at the expense of a very slight reduction in the frequency of those already present, while the latter produces random changes within the group present.

Recurrent mutation from A_1 to A_2 at the rate u per generation with reversal at the rate v per generation obviously tends to change the frequency of A_1 at the net rate $\Delta q = v(1-q) - uq$. There is equilibrium, in the absence of other factors of change, at the value $\hat{q} = v/(u+v)$. If, however, A_2 represents an array of multiple alleles of A_1, v is the weighted average of the rates of mutation from these to A_1 and is thus a function of their varying frequencies. If all mutations are unique, $v=0$.

The effect of immigration depends on the extent (m) to which the immigrants displace the native population in each generation and on the difference between the gene frequency (q_I) of the immigrants and that of the natives (q). $\Delta q = m(q_I - q)$. The theory of immigration pressure may be identified with that of mutation pressure in the case of two alleles by substituting mq_I for v and $m(1-q_I)$ for u.

The effect of selection on gene frequency depends on the frequencies (f) of the genotypes and their selective values (w), defined as the net rates of reproduction per generation on taking account of mortality, emigration, rates of attainment of maturity, duration of reproductive period, success in mating and fecundity. Letting $\bar{w}$ $(=\Sigma wf)$ be the average selective value for the whole population and $\bar{w}_1$ that for gene A_1 (giving all combinations which involve A_1A_1 full weight and those involving heterozygosis of A_1 half weight), the frequency q_1 becomes $q_1\bar{w}_1/\bar{w}$ in the next generation and we may write $\Delta q_1 = q_1(\bar{w}_1 - \bar{w})/\bar{w}$ as the general expression for selection pressure.

Some of the special cases are instructive. We shall assume random mating and consider a pair of alleles with mean selective values w_{11} for A_1A_1, w_{12} for A_1A_2, and w_{22} for A_2A_2, and let q be the frequency of A_1. It may easily be verified that under these conditions $\Delta q = q(1-q)[w_{11}q + w_{12}(1-2q) - w_{22}(1-q)]/\bar{w}$, which may be written in the form $\Delta q = q(1-q)\Sigma w\frac{df}{dq}/2\bar{w}$. If the w's are constants this reduces to $\Delta q = q(1-q)\frac{d\bar{w}}{dq}/2\bar{w}$.

Assume that A_1A_1 has the selective disadvantage s relative to the heterozygote, and A_2A_2 the selective advantage t over the latter, $(w_{11}=1-s, w_{12}=1, w_{22}=1+t)$. Then $\Delta q = q(1-q)[q(t-s)-t]/\bar{w}$. An unfavourable gene may be maintained in the population by recurrent mutation. If A_1 is semidominant $(s=t)$, the net pressure may be represented approximately by $\Delta q = v(1-q) - sq(1-q)$, with equilibrium at $\hat{q} = v/s$. If recessive $(t=0)$, we have $\Delta q = v(1-q) - sq^2(1-q)$, approximately, with equilibrium at $\hat{q} = \sqrt{v/s}$, much higher than for a more or less dominant gene with the same values of v and s (see fig. 1).

The net effects of selection and immigration can be investigated similarly. In a population in which s (case of semidominance) is smaller than m, local differences in conditions of selection are largely swamped by crossbreeding $(\hat{q} = q_I - (s/m)q_I(1-q_I)$, approximately). Local selection dominates the situation, however, if s is larger than m, $\hat{q} = mq_I/s$, approximately, in localities in which selection is adverse.

Two alleles may both be kept at high frequencies if the heterozygote has an advantage over both homozygotes. Letting $w_{11} = 1-s_1$, $w_{12}=1$, $w_{22} = 1-s_2$ $\Delta q = -q(1-q)(q-\hat{q})$, approximately, where $\hat{q} = s_2/(s_1+s_2)$. If there are multiple alleles, and all heterozygotes have the same selective value, $w_{ij}=1$, while all homozygotes are selected against, $w_{ii} = 1-s_i$, $\Delta q_i = q_i[1-s_iq_i-\bar{w}]/\bar{w}$. Thus $s_1\hat{q}_1 = s_2\hat{q}_2$ etc., $\hat{q}_i = (1/s_i)/\Sigma(1/s)$. Each allele is maintained at a frequency inversely proportional to the selective disadvantage of its homozygote relative to the heterozygotes. There is reason to believe that complementary effects of alleles, somewhat of this sort, are not uncommon.

This is not, however, the only mechanism by which two or more alleles may all be maintained at high frequencies within a random breeding population. The territory occupied by the population may contain diverse ecological niches for each of which one allele is superior to the others. Each allele is favoured when rare, but selected against when abundant, assuming that the individuals that carry it can exercise some choice of abode. Suppose that $w_{11} = 1+s-tq$, $w_{12}=1$, $w_{22} = 1-s+tq$. The heterozygote is always exactly intermediate but $\Delta q = q(1-q)(s-tq)/\bar{w}$, giving stable equilibrium at $\hat{q} = s/t$. Multiple alleles may, of course, more easily be kept at high frequencies in a heterogeneous territory in which the effects of different local conditions of selection are not swamped by too much crossbreeding.

If selective values are constant, selection tends to drive the gene frequencies to a set of values at which the reproductive rate of the population as a whole is at a peak. This may not be true where the selective values are, as in the preceding case, functions of the frequency of the gene in question. As a more striking example, consider a case in which at all times A_2A_2 has a selective advantage s over A_1A_2 and 2s over A_1A_1. But assume on the other hand that increase in the frequency (q) of A_1 has a favourable effect (term $a+bq$) on the rate of increase of all individuals in the population through some product or activity of those that carry it. $w_{11} = (a+bq)(1-s)$, $w_{12} = (a+bq)$, $w_{22} = (a+bq)(1+s)$. In the formula for Δq in a random breeding population any factor such as $(a+bq)$ that is common to all w's, cancels leaving the result the same as if there were no such term. Thus a gene with effects that are of advantage to the population but disadvantageous to individuals cannot be fixed by selection within the group. It may be fixed, however, by intergroup selection in a population divided into small partially isolated groups.

So far we have disregarded the effects of other series of genes that may interact with the one under consideration. But selection applies to the organism as a whole (or to a group of organisms), not to separate genes. Most characters are affected by many genes and since the best-adapted grade may be expected to be near the mid-grade in a population that has lived long under about the same conditions, a gene that has a favourable effect in combinations below the mid-point should have unfavourable effects in combinations above the mid-point. Moreover if the mean selective values $(\bar{w})$ of populations are imagined to be plotted against locations in the many-dimensioned system of gene frequencies, it is to be expected that these will form a surface with a large number of distinct peaks, each centring about a different harmonious combination of genes. In the case cited above all of these give the same character, the optimum, but there may also be harmonious combinations that represent different ways of life open to the species in question and these peaks may differ greatly in height.

If random combination is assumed, the rate of change of a given gene A is given by the formula $\Delta q_A = q_A(1-q_A)\left(\Sigma w\frac{\partial f}{\partial q_A}\right)/2\bar{w}$, where the w's are the selective values of the combinations of all pertinent pairs of alleles, the j's the corresponding compound frequencies, and the summation has 3^n terms if n loci are involved. The w's may be functions of any or all of the gene frequencies. If constant, however, the rate formulas reduce to the type $\Delta q_A = q_A(1-q_A)\frac{\partial\bar{w}}{\partial q_A}/2\bar{w}$. Under this assumption, the mean selective value of the population tends to move toward its peak value in the surface $\bar{w}$ at the rate $\Delta\bar{w} = \Sigma\left(\frac{\Delta q\partial\bar{w}}{\partial q}\right)$, the summation applying to all pairs of alleles. The peak value toward which it moves is not necessarily the highest. On the other hand, as noted in the one-factor case, selection may carry the population to lower values of $\bar{w}$, if the w's are functions of the gene frequencies.

It should be pointed out that the assumption that all series of alleles are combined at random can only be an approximation, since selection itself disturbs the randomness of combination in the parental generation and the return among the offspring is not complete. It can be shown, however, that the effect is slight if the selective disadvantage of genotypes at one step from a mid-grade optimum is less than the proportion of crossing over.

While models based on pairs or finite numbers of alleles are convenient mathematically, the probability that all loci may, in the long run, evolve through an indefinitely extended branching series of alleles must not be forgotten. In this situation, all selection coefficients are subject to undefinable changes.

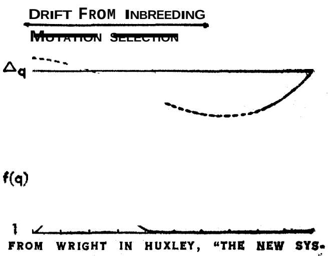
Random Changes in Gene Frequency.— We will illustrate this category by discussing the case of accidents of sampling. The composition of a population of N diploid individuals depends on $2N$ gametes produced by the preceding generation. If these are a random sample from the array $[qA_1+(1-q)A_2]$, the array of probabilities for the next generation is $[qA_1+(1-q)A_2]^{2N}$. The variance of q is $\sigma^2_{\delta q}=q(1-q)/2N$. In a k-ploid population $\sigma^2_{\delta q}=q(1-q)/kN$, approximately. For sex-linked genes, it is approximately $2q(1-q)/3N$ if there are equal numbers of males and females.

It might seem that these random deviations would be negligible in any reasonably large population; but the variance of the array of probabilities for later generations increases approximately linearly with the number of generations until damped by approach to the limiting value, $q(1-q)$, of complete fixation one way or the other. Moreover, the effective value of N should often be much smaller than its apparent value. It obviously applies only to individuals that reach maturity. If there is cyclic variation in population size, effective N is the harmonic mean of the numbers in the generations of the cycle, which is largely dominated by the population minimum. The sampling effect is, however, much more important in connection with a population structure in which there are numerous small partially isolated local strains than in a homogeneous random breeding population.

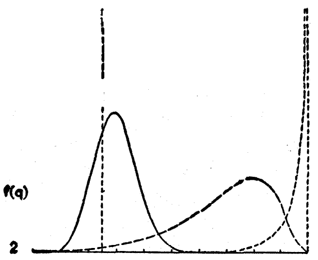
The tendency toward a stable equilibrium in gene frequency due to opposing systematic pressures and the tendency to drift away from the point of equilibrium due to the random processes result in a distribution of probabilities which one might expect to find realized by the values taken by the frequency of the gene in question over a long period of generations in the ideal case in which all conditions remain constant. Even if never actually realized, the distribution formula is important in reaching an appreciation of the degree of control by the systematic pressures.

The formula for this distribution must satisfy the conditions of persistence of the mean, $\Sigma(q+\Delta q+\delta q)f=\Sigma qf$, and of all higher moments $\Sigma(q+\Delta q+\delta q-\bar{q})^n f=\Sigma\ (q-\bar{q})^n f$. It can be shown that these conditions are satisfied to a first approximation by the differential equation $\frac{d}{dq}\ \sigma^2_{\delta q}\varphi(q)-2\,\Delta q\varphi(q)=0$, the solution of which is the probability curve $\varphi(q)=(C/\sigma^2_{\delta q})\ \exp\ [2\int(\Delta q/\sigma^2_{\delta q})\ dq]$, $\int_0^1\varphi(q)dq=1$. Since there are $(2N+1)$ possible values of q among $2N$ gametes, the frequency of a given class is approximately $f(q)=\varphi(q)/2N$. The formula gives good approximations even for the subterminal classes $f(1/2N)$ and $f[(2N-1)/2N]$ but the frequencies of fixation must in general be determined from the subterminal classes by consideration of the balance between loss of the gene in question or its allele by accidents of sampling (approximately half the subterminal class per generation) and reintroduction by mutation or immigration. Thus, $f(0)=f(1/2N)/(4N[mq_1+v])$.

As an illustration, consider a case in which there is systematic pressure from reversible mutation, immigration and selection measured by $\Delta q=v(1-q)-uq-m(q-q_1)+q(1-q)\frac{d\bar{w}}{dq}/2\bar{w}$ and accidents of sampling measured by $\sigma^2_{\delta q}=q(1-q)/2N$. Substitution yields $\varphi(q)=C\bar{w}^{2N}q^{4N(mq_1+v)-1}(1-q)^{4N[m(1-q_1)+u]-1}$. Examples are given in figs. 1 and 2.



FROM WRIGHT IN HUXLEY, "THE NEW SYSTEMATICS" (CLARENDON PRESS)



FROM WRIGHT IN THE BULLETIN OF THE AMERICAN MATHEMATICAL SOCIETY, VOL. 48

FIG. 1.—ABOVE: SYSTEMATIC RATE OF CHANGE (Δq) OF THE FREQUENCY (q) OF A DELETERIOUS RECESSIVE GENE FOR WHICH S=25V, AND RE. (U) IS NEGLIGIBLY LOW. THE SCALE OF Δq IS GREATLY EXAGGERATED. BELOW: DISTRIBUTION OF RELATIVE FREQUENCIES, F (q), OF THE VALUES OF q OVER A LONG PERIOD OF TIME IF V=1/N. FIG. 2.—DISTRIBUTION OF GENE FREQUENCIES q FOR GENE A IN THREE SUBGROUPS OF A POPULATION OF MEAN GENE FREQUENCY .25. THESE SUBGROUPS ARE ASSUMED TO BE OF THE SAME EFFECTIVE SIZE (N=1,000) AND SUBJECT TO THE SAME SELECTION PRESSURE ($W_{AA}=1$, $W_{Aa}=.9975$, $W_{aa}=.995$) BUT TO DIFFERENT DEGREES OF ISOLATION (SHORT DASHES AT .25: NO ISOLATION: SOLID LINE: $m=.01$; LONG DASHES: $m=.001$; SHORT DASHES TO RIGHT: $m=.001$)

This formula can be extended to the case of a finite number of multiple alleles, assuming that mating is at random and that the rate of mutation to each allele from each of the others, is the same (a severe restriction), $\varphi(q_1, q_2 \ldots q_n)=C\bar{w}^{2N}\Pi q^{4N(mq_1+v)-1}$, where the product includes terms for all alleles. This is also the frequency distribution for all series of alleles considered simultaneously, if the product term includes all loci. This formula describes a frequency surface in a space of $\sum^{n}(k_i-1)$ dimensions where k_i is the number of alleles per locus and n is the number of loci. There are in general a large number of peak frequencies, corresponding roughly to the peaks in the surface $(\bar{w})$ of selective values. Under certain conditions there is an appreciable chance of drifting from control by one peak value to control by a higher one.

The number of alleles that may be carried by a population under various conditions is important. Consider first a series in which each mutation yields a new allele and assume that alleles that are completely neutral, as regards selection, are arising at a constant rate u. The distribution for such alleles is $f(q)=Cq^{-1}(1-q)^{4Nu-1}$ with $f(0)$ infinite. The number of new alleles of the above sort per generation is $2Nu$. The number lost by accidents of sampling is approximately $(n/2)f(1/2N)$ where n is the number present. Putting $\Sigma f(q)=1$ in this case, there is equilibrium between mutations and loss if $n=2u\Sigma q^{-1}\ (1-q)^{4Nu-1}$ with summation including values of q from $1/2N$ to 1. With $u=10^{-6}$, a population of 250,000 may be expected to carry an average of 13.7 alleles. In larger populations, there should be a somewhat less than proportional increase, *e.g.*, 132 alleles if N is increased tenfold. These results are not changed appreciably for mutations that are slightly selected against.

Most of the alleles in these cases are present at very low frequencies. The chance that a single completely neutral mutation will reach approximate fixation is $1/2N$. Even if selected against, there is specifiable chance of displacing the type allele, $2s/(e^{4Ns}-1)$, in case the selective disadvantage of heterozygotes is s, of homozygotes 1s. With a corresponding selective advantage, the chance is approximately $2s$. It is approximately $\sqrt{s/2N}$ for a completely recessive mutation with an advantage s when homozygous.

Population Structure.—Departures from random mating have important consequences which it is now desirable to consider. A population has a structure in time that consists of a 'complicated network of paths of descent. An adaptation of the theory of multiple correlation, the method of path coefficients, is convenient in dealing with such networks.

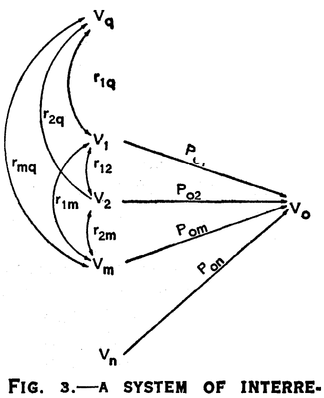
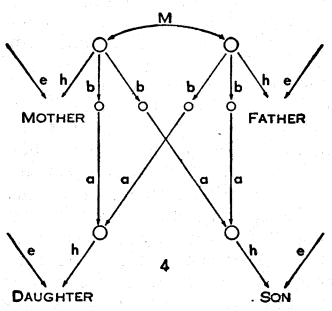


FIG. 3.—A SYSTEM OF INTERRELATED VARIABLES

The basis for application of this method is a diagram which represents a point of view as to which variables in a system of linear relationships are to be treated as immediate functions of which others. Fig. 3 is a simple diagram of this sort. A single-headed arrow indicates the direct effect of one variable upon another while double-headed arrows are used for residual relations tracing to unrepresented factors which may be considered as located at the mid-points of such "arrows." Assume that x_o, x_1, etc., are variables measured in standard form, $x_o=(V_o-\bar{V}_o)/\sigma_o$, where V_o is the original variable, $\bar{V}_o$ its mean and σ_o its standard deviation. Assume that x_o is a linear function of known variables x_1 *to* x_m and that the array of factors is made formally complete by addition of a hypothetical variable x_n, independent of the others. In the expression $x_0=p_{o1}\ x_1+p_{o2}\ x_2+\ldots p_{om}\ x_m+p_{on}\ x_n$, the coefficients are path coefficients. The correlation (r) between two variables is defined as their average product when expressed in standard form. Thus $r_{oq}=\sum_{i=1}^{n}p_{oi}\ r_{iq}$. The special case of self-correlation $r_{oo}=1$ yields the equation $\sum_{i=1}^{n}p_{oi}\ r_{oi}=1$. This may be analyzed into two components, $p_{on}\ r_{on}(=r^2_{on})$ which measures the portion of the variance (σ^2_o) determined by unknown factors and $\sum_{i=1}^{m}p_{oi}\ r_{oi}$ expressing that due to known factors. The latter is the squared coefficient of multiple correlation.

Factors xi, x_2, x_q, etc., may in turn be represented as linear functions of variables a step farther back in this network, making possible analysis of the correlation terms, in the above equations. However extensive the network, the following principle holds. Any correlation between variables in a network of directed linear relations can be analyzed into contributions from each of the paths by which the two variables are connected through a common factor. The value of each contribution is the product of the coefficients (of which only one may be a correlation coefficient) pertaining to the elementary paths.

Fig. 4 represents the relations between parents and offspring in the network of descent in the case of an autosomal factor. Variations in the characters of individuals are represented as determined by additive effects of environmental and genotypic variations (path coefficients e and h respectively, $e^2 + h^2 = 1$. The path coefficient a relates genotype to one of the gametes that produced it. Assume that each allele at the locus under consideration is assigned a value and that the value of a genotype is the sum of the values of the two gametes that produced it. As there is complete determination $2a(a + aF) = 1$, where F represents the correlation between uniting gametes. Thus, $a = \sqrt{(1/2)/(1+F)}$. The path coefficient b relates gamete to the genotype that produced it. This is also the correlation coefficient since there is only one connecting path. This correlation must be the same as



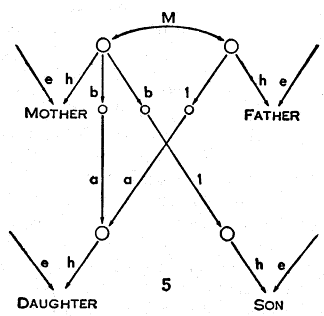


FIG. 4.—RELATIONS AMONG GENOTYPES AND CHARACTERS OF PARENTS AND OFFSPRING, AS DETERMINED BY AUTOSOMAL GENES. FIG. 5.—RELATIONS AMONG GENOTYPES AND CHARACTERS OF PARENTS AND OFFSPRING AS DETERMINED BY SEX-LINKED GENES

that between parental genotype and one of the gametes that produced it, with respect to the series of alleles in question. Thus, $b = a + a'F' = \sqrt{(1+F')/2}$ where primes are used to indicate the preceding generation. The compound path coefficient relating a gamete to one of those back of it a generation earlier is $ba' = 1/2$.

It may readily be seen by tracing the connecting paths that the correlation between parent and offspring is $h^2 ab(1+M)$ relative to a locus and that between brothers is $2h^2a^2b^2(1 + M)$ where $M (= F/b^2)$ is a correlation coefficient that sums up all possible connections between the parental genotypes. These results apply to the combined effects of multiple loci, provided that these are associated at random and that effects are throughout additive. In a random breeding population ($M = F = O$) both of the above correlations reduce to $.50h^2$.

Sex-linked genes can be treated similarly, noting that the coefficient relating male genotype to egg must equal 1 and that relating X-bearing sperm to genotype producing it must also be 1 since there is complete determination in both cases (fig. 5). Coefficients a and b in other cases have the same values as with autosomes. The correlation between any relatives can be found from a diagram that shows all of the ancestral connections.

In actual cases, nonadditive relations are likely to be involved in the relations between genotype and character (as a consequence of dominance or factor interactions) and there may he nonadditive relations between genotype and environment. These introduce complications which can not be discussed in the scope of this article.

The structure of a population is perhaps best expressed in terms of F, which, as the correlation between uniting gametes, is the most appropriate coefficient of inbreeding. The array of genotypes relative to a pair of alleles may be expressed as follows in terms of the frequency, q, of one of the alleles (A_1), and the proportion of heterozygotes p:

$$[(q - \tfrac{1}{2}p)A_1A_1 + pA_1A_2 + (1 - q - \tfrac{1}{2}p)A_2A_2].$$

It may easily be verified that the correlation between the gametes whose union is here indicated is $F = (p_o - p)/p_o$ where p_o $(= 2q(1-q))$ is the proportion of heterozygosis under random mating. It may be shown that with multiple alleles as well as with mere pairs the frequencies of homozygotes are of the type $[(1-F)q^2_1 + Fq_1]$ for A_1A_1 and of heterozygotes of the type $[2(1-F)q_1q_2]$ for A_1A_2. The correlation between uniting gametes comes out $F = (p_o - p)/p_o$ where p is the total frequency of all heterozygous classes, irrespective of the values assigned the various alleles.

The value of F can be obtained from inspection of the appropriate diagram in simple cases. Thus for the progeny of an isolated brother-sister mating it is one-fourth and for progeny of a first-cousin mating one-sixteenth. Recurrence formulas can be obtained in cases of regular systems of mating. Thus if a population is broken up into lines of exclusive brother-sister mating, $F = b^2a'^2(2F' + 2b'^2) = \tfrac{1}{4}(1 + 2F' + F'')$; $p = (\tfrac{1}{2})p' + (\tfrac{1}{4})p''$. Putting $p/p' = p'/p''$, $p/p' = (\tfrac{1}{4})(1 + \sqrt{5}) = .809$, indicating that heterozygosis decreases about 19.1% per generation under continued brother-sister mating. In populations of size N with completely random union of gametes $F = \frac{1}{N}b^2 + \frac{N-1}{N}F' = \frac{1}{2N} + \left(\frac{2N-1}{2N}\right)F'$, $p = \frac{(2N-1)}{2N}p$, indicating fixation at the rate of $1/2N$ per generation in this case. With N_m males and N_f females similar analysis gives $p = p' - \left(\frac{N_m + N_f}{8N_mN_f}\right)(2p' - p'')$ with fixation at rate $[(1/8N_m) + (1/8N_f)]$ if the N's are large.

A case of great importance is that in which a population has a uniform distribution over a large area but dispersion is limited to small neighbourhoods. The ancestors of any given individual are drawn from ever widening circles as one goes back in time. With random union of gametes within neighbourhoods of size N, the value of F relative to a population of size KN (that from which the Kth ancestral generation was drawn) is $[\Sigma t/(2N - \Sigma t)]$ where Σt is the sum of K-1 terms of the series $\left[1 + \tfrac{1}{2}\left(\frac{N-1}{N}\right) + \tfrac{1}{3}\left(\frac{N-1}{N}\right)\left(\frac{2N-1}{2N}\right)\ldots\right]$ which can be evaluated. Its limiting value is N and that of F is thus 1. If the effective value of N is less than 100 there is considerable differentiation not only of neighbourhoods but also of large territories. If on the other hand, N is more than 1,000, the situation differs little from universal random mating. If there is continuity along only a narrow strip such as a shore line or a river instead of over an extensive area, there is, however, enormously more differentiation with a given size of neighbourhood.

It can readily be seen that the general formula for the inbreeding coefficient, F, applicable to irregular pedigrees is $\Sigma[(\tfrac{1}{2})^{n+n'+1}(1 + F_A)]$ where n and n' are the numbers of generations from sire to dam respectively to a common ancestor with inbreeding coefficient F_A, and the summation applies to all connecting paths which include only one common ancestor. By taking random lines of ancestry back of the sires and dams of animals chosen at random and noting the proportion (T) of cases in which those include the same animal, it is possible to estimate $F(= (\tfrac{1}{2})T(1 + F_A))$ for a whole breed. This has been done for several breeds of horses, cattle, sheep and hogs with rather similar results. The inbreeding coefficient rises at rates between 0.2% and 1.2% per generation, indicating that concentration on the sons and grandsons of noted animals has given a system equivalent to the use of only 10 to 60 sires in the whole breed. (Rate $= 1/8N_m$, assuming N, males and indefinitely many females.)

The inbreeding coefficient measures inbreeding relative to a certain foundation stock. Thus the coefficient 26.0% in Shorthorn cattle of 1920 implies that heterozygosis was 26.0% less than expected from random mating within the cattle population of northern England of about 1780, the period to which the pedigrees trace. The correlation between random pedigree lines of 1920 was 24.6%, indicating that the departure from random mating within the breed in 1920 was not great. The extensive loss of heterozygosis indicated by the value 24.6% applies to the breed as a whole. If we let $F_{I \cdot T}$ be the inbreeding coefficient of individuals relative to some comprehensive population, $F_{I \cdot G}$ that of individuals relative to groups within the latter and $F_{G \cdot T}$ the correlation between random gametes within the groups, $(1 - F_{I \cdot T}) = (1 - F_{I \cdot G})(1 - F_{G \cdot T})$. The structure of a population may be analyzed by application of this formula.

The subdivision of a population into numerous partially isolated groups leads to differentiation of these in gene frequencies, measured by $\sigma^2_q = q_T(1 - q_T)F_{G \cdot T}$ where q_T is the gene frequency of the comprehensive population. The differentiation with respect to characters is, of course, closely related. The variance of a character due to semidominant genes in a population breeding at random is $\sigma^2_R = 2\Sigma[q(1-q)(\alpha^2)]$ where α is the effect of replacement of a gene by its allele and the summation relates to all pertinent series of alleles. If the population is divided into partially isolated groups, breeding at random within themselves ($F_{I \cdot G} = 0$, $F_{G \cdot T} = F_{I \cdot T} = F$), the variance of group means is $2F\sigma^2_R$, the variance within groups is $(1-F)\sigma^2_R$ and the variance of individuals in the total is $(1 + F)\sigma^2_R$.

The primary consequence of subdivision of a population into more or less isolated groups is, of course, that differences in the conditions of selection may bring about direct differentiation. But even if the conditions of selection are everywhere the same, such groups may be expected to drift apart as a result of the accidents of sampling. This would not be likely to go far by itself but may initiate trends toward diverse ways of meeting the conditions and thus create differences in direction of selection. In terms of the mathematical model, the systems of gene frequencies of different groups may come under the control of different peak adaptive values. If isolation is not complete, the stage is set for selection at the group level. The localities, in which the most successful genetic systems have been arrived at, become the principal sources of migrants to other regions. In a random breeding population selection operates merely according to the net effects of the genes in all combinations. In a population of vegetatively reproducing clones, the genotype as a whole is the object of selection. This process may be very effective, especially in a form capable of rapid multiplication under favourable conditions if associated with occasional crossbreeding to provide new clones for trial more rapidly than by the slow process of mutation. In a large population divided into numerous partially isolated groups the object of selection is the entire genetic system and the situation is that most favourable for an indefinitely continuing evolutionary process. (See EVOLUTION, ORGANIC.)

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GENEVA, a canton of southwest Switzerland situated between the Jura and the Alps and consisting mainly of the city of Geneva.

With an area of 108.9 sq.mi. of which 11½ sq.mi. are lake, it is, except for Zug, the smallest canton in the Swiss confederation. In the extreme north it borders on the Swiss canton of Vaud for 3½ mi., but is otherwise surrounded by French territory, the *département* of Haute Savoie to the south, and that of the Ain west and north. The Rhbne flows through it from east to west and then along its southwest edge. The turbid Arve which flows from the snows of the chain of Mont Blanc is its largest tributary and joins the Rhbne within the city of Geneva. The climate is healthful, the vicinity of the lake regularizing the temperature. Market gardens, orchards and vineyards occupy a large proportion of the soil, the apparent fertility of which is largely due to the unremitting industry of the inhabitants. In 1956 there were 10,620 cattle, 1,108 horses, 8,719 swine, 296 goats and 6,605 sheep. Besides building materials, such as sandstone and slate, the only mineral to be found within the canton is bituminous shale.

Geneva was admitted into the Swiss confederation in 1815 and ranks as the junior of the 22 cantons. In 1815–16 it was increased by adding to the old territory belonging to the city 16 communes (to the south and east, including Carouge and Chêne) ceded by Savoy and 6 communes (to the north, including Versoix) from the French district of Gex. Geneva made an important contribution to the confederation in the person of General Guillaume Henri Dufour (*q.v.*), who defeated the seceding league of conservative cantons, the Sonderbund. Democratic agitation in the 19th century against a reactionary government resulted in the constitution of 1842, which set up the *conseil d'état* as the executive authority and the grand *conseil* as the legislative body, and established municipal autonomy. In 1847 James Fazy instituted a radical régime; his failure to obtain re-election to the *conseil d'état* led to disturbances in 1864.

The radical party returned to power under Antoine Carteret, and supported the church iounded by Père Hyacinthe Loyson against the Catholics. The Catholic prelate Gaspard Mermillod, who later became a cardinal, was exiled in 1873. A later radical leader, Henri Fazy, was more in sympathy with thr Catholics. The separation of church and state was voted in 1907. The conservative party, known as the Democrats, introduced certain reforms such as the referendum, the popular initiative and proportional representation. The Socialist party and other party formations later came into existence.

In 1960 the population of the canton was 259,234; in 1950 it was 202,918. As to religion the 19.50 population was divided as follows (1941 figures for the canton are within brackets): Roman Catholic 85,856 (75,448), Protestants 102,625 (95,373) and Jews 2,897 (2,439).

Nationality was as follows: 83,751 (65,040) were Genevese citizens, and 76,856 (82,543) Swiss citizens of other cantons. In 1919 the canton contained 62.611 foreigners, but by 1930 the number had fallen to 51,727 in consequence of the emigration during and after World War I, and fell to 40,888 as a result of World War II; in 1950 foreigners numbered 42,311 of whom 12,366 were French, 12,357 Italians, 1,492 Germans and 16,096 citizens of various other countries.

In point of language, among a population of 202,918 in 1950 (174,855 in 1941), 138,627 (140,909) inhabitants were French-speaking, French being the mother tongue of the Genevese, the official language of the State; 24,983 (23,716) were German-speaking, while there were also 215 (176) Romansch-speaking. (G. VR.)

GENEVA, a city of Switzerland and capital of the canton of Geneva, lies in the Rhône valley at the extreme southwestern corner of the Lake of Geneva or Lac *Léman*. To the west of the canton boundary is the range of the Jura mountains while to the south and east are the steep limestone slopes of Mont Salève. Pop. (1950) 145,473, (1960) 176,183.

, The river Rhône, spanned by eight bridges, flows south from the lake and divides the city into two parts. On the left bank, to the south, is the hill where Geneva first stood, surmounted today by the town's civic buildings and at the highest point by the cathedral of St. Pierre. This picturesque area of the old city is reached by a long and narrow street bearing several names, Rue de la Cité, Grand' Rue and Rue de l'Hôtel de Ville, which winds uphill from the Pont de l'Ile. In this street there are some beautiful 17th- and 18th-century houses and the very simple house where Jean Jacques Rousseau was born. The hôtel de ville itself is a Renaissance building with 17th-century frontage and cloistered courtyard. An unusual feature is the 16th-century paved slope serving instead of a staircase and leading up to a square tower. Inside are the room of the council of state with its 15th-century paintings, and the "Salle de l'Alabama" where the arbitration between Great Britain and the United States was awarded in 1872 and where the first international convention for the relief of wounded soldiers (Red Cross) was signed in 1864. Parallel with the Grand' Rue is the aristocratic Rue des Granges with its line of beautiful 18th-century mansions built by rich Genevese bankers. The Rue du Puits St. Pierre, facing the town hall, runs along a former corn granary. In it stands the Tavel house, decorated with amusing carved heads, one of the oldest houses of the city. It has a lovely turret and 12th-century cellars. Nearby in the Rue Calvin is the site, now built on, of the house where the reformer lived and died (1564). This street leads toward the spacious Cour St. Pierre where the former cathedral stands. This 12th- to 13th-century building has a classical frontage added in the 18th century with a columned portico by Benoît Alfieri (1749). Next to St. Pierre, on the Place de la Taconnerie, is the Temple de l'Auditoire (the former 14th-century church of Notre Dame-la-Neuve) where John Knox preached and where John Calvin and Theodore Beza used to teach; to the south is a chapel in Aamhoyant Gothic style, the Chapelle des Macchabees, built by the cardinal of Brogny, bishop of Geneva (c. 1404). East of the cathedral is the Place du Bourg-de-Four, a picturesque and irregular square, which was once the Roman forum. Below are the law courts, a fine classical building (1707), iormerly a hospital. The Collège de Geneve, founded by Calvin in 1559, is nearby. Farther east is the Musée d'Art et d'Histoire, a large white neoclassic building (1910) housing, in particular, remarkable collections of Genevese and Swiss paintings (C. Witz, J. E. Liotard, A. Calame, F. Diday, F. Hodler), collections of laces, watches, ancient vases, enamels and art relics of the old city. Below the hill to the north and close to the lake is the Place du Molard which, in ancient times, was a harbour. The medieval tower formerly standing at its entrance has been restored.

Toward the southern part of the city overlooking the river Arve is the Promenade des Bastions with its monument of the Reformation (1909–17) and the statues of the great reformers. In this promenade are the university buildings (1863–72). Founded by Calvin in 1559, the old academy acquired university status in 1872. Within its walls are the natural history museum and the public and university library containing many valuable books and illuminated mss. There are rooms housing the Calvin and Rousseau collections.

West of the Promenade is the Place Neuve, the finest square in Geneva. In the centre is the equestrian bronze statue of General Guillaume Henri Dufour, commander of the federal army in the Sonderbund mar (see SWITZERLAND: History). Among buildings in the square are the Conservatoire, the Grand Theatre (1879) inspired by the opera house in Paris, and the Musée Rath (1824), once the home of the International Agency for Prisoners of War. From the Place Neuve, the Rue de la Corraterie, once flanked by the city wall where the famous escalade took place (1602), leads down to the river and the Pont de l'Ile.

On this bridge is the Tour de l'Ile, the remnants of a bishop's castle of the 13th century; across the river is the Place de Coutance in the district of St. Gervais, where the workers and the craitsmen of the watchmaking, enamel and jewelry industries established themselves in the 18th and 19th centuries. The 15th-century church of St. Gervais containing wall paintings of the same period has a monument to those Genevese killed during the *escalade*. The Quai drs Bergues leads along the river bank toward the lake with the Pont des Rergues and the Ile Rousseau with Pradier's statue of the philosopher (1835) on the right.

In the Quai du President Wilson along the northern shore is the former Hôtel National which was the first home of the League of Nations. The International Labour office, a massive building completed in 1925, stands in the wide Avenue de la Paix. This road mounts to the Palais des Nations which is the European office of the United Nations and the headquarters of the World Health organization. Built originally for the League of Nations (1929–1937), the Palais des Nations has imposing frontages facing the lake. The interior of the Palais is decorated with contributions from various nations (stone, wood, carpets, paintings, et~.).Among its chief rooms are the pillared assembly hall and the council chamber, adorned with a fresco by the Spanish painter José Maria Sert. Next to the Palais is the Musée Ariana housing a ceramic collection. Across the road is the headquarters of the International Red Cross society which was founded at Geneva in 1864 by Henri Dunant. On the right bank of the lake, in a district which in the 18th century lay outside the city walls, is the house where Voltaire lived 1755–58. This house, called "Les Delices" (now the name of the district), has been restored and contains the Musée et Institut Voltaire where Voltaire's first publications and manuscripts are kept.

Among Geneva's beauties are its parks, which form a green belt around the citp; along the shore of the right bank are the Parc Mon Repos, the Parc de la Perle du Lac and the Parc Barton which extends as far as the grounds of the International Labour office On this bank, too, are the Botanic gardens and the Conservatoire Botanique. On the opposite shore of the lake is the Jardin Anglais or Promenade du Lac with the monument erected in 1864–69 commemorating the entrance of the canton into the Swiss confederation; the Parc der Eaux-Vives and the adjoining Parc de la Grange with its beautiful 18th-century house and rose garden. Offshore on the Jetée des Eaux-Vives there is a fountain the jet of which rises nearly 330 ft. To the east of the old city is the extensive Parc Bertrand.

Celebrated Residents. — In the 16th century besides Calvin and Bonivard there were in Geneva the printers Robert and Henri Estienne and the scholars Isaac Casaubon and Joseph Scaliger, the latter only for a short time from 1572 to 1574. J. J. Rousseau is, of course, the great Genevese of the 18th century. Voltaire, Rousseau's rival, made the chbteau of Ferney, not far from Geneva, a centre of European intellectual society. In the 18th and 19th centuries Geneva was an acknowledged centre of scientific study. Scholars in this field include the botanists A. P. de Candolle and P. E. Boissier; the geologists Alphonse Favre and L. A. Necker; J. C. G. de Marignac, the chemist, J. A De Luc, the physicist, E. Plantamour, the astronomer, and Horace Bénédict de Saussure (*q.v*), best known for his conquest of Mont Blanc in 1787. In the arts, too, many famous names are linked with that of the city: the sculptor J. Pradier and the artists J. A. Arlaud, F. Diday and A. Calame On her exile, Madame de Stael transferred to the chbteau at Coppet, near Geneva, the salon she had held at Paris.

Trade and Communications. — Geneva, known primarily as a centre of Swiss cultural life and as the headquarters of international movements, is also an industrial city. Jewelry, watches and enamels are the chief manufactures: others include electrical machines and water turbines, medical instruments and precision tools. There are important clothing, food, chemical and printing industries and a prosperous banking business. The hotel trade also contributes largely to the city's income Geneva is linked by rail with the rest of Switzerland and with France (Lyons, Paris, Marseilles). The station is at Cornavin. The station of Eaux-Vives on the left bank connects Geneva with Savoy. The airport is at Cointrin, 3 mi. N.W. of the city. Served by international airlines, it is one of the largest airports in Switzerland. The Swiss and French sides of the lake can be reached by lake steamers.

HISTORY

In prehistoric times (4th or 5th millennium B.C.) a great lake city built upon piles, some of which may still be seen, existed at the western end of the lake where the waters narrow into the channel of the Rhône. After the period of the lake dwellings, the inhabitants established themselves on the hill on the left bank of the lake and of the river.

Caesar states that Genua was a walled town (*oppidum*) in the extreme north of the country of the Gallic people of the Allobroges; the Rhône separated it from the territory of another Gallic people, the Helvetii, whose invasion Caesar repelled. Later inscriptions refer to Geneva as a *vicus* (community) of the Viennese province. It had temples, aqueducts, ports and ships and was evidently of some importance judging by the many Roman remains found on the original site of the city (in the vicinity of the cathedral). About A.D. 400 it is described as a *civitas*. This rise in status was probably connected with the establishment of a bishop's see there. A letter of St. Leo in 450 states that the see was then a suffragan of the archbishopric of Vienne.

In the mid-jth century A.D. Geneva came into the possession of the Burgundians; in 534, however, Gundibald was defeated by Clovis, king of the Franks. After the barbarian invasions the city shrank to half its former size. It was then concentrated on the high ground During the feudal period the Burgundian kings had more to fear from the hereditary counts of Geneva than from the elected bishops; Rudolf III, therefore, conferred estates on the bishops, favouring them at the expense of the counts. The kingdom of Burgundy was bequeathed by Rudolf III (d. 1032) to the emperor Conrad II. Temporal sovereignty of the city was finally granted to the bishop, who, in 1162, was raised to the rank of a prince of the Holy Roman empire. Like many other prince-bishops, the ruler of Geneva had to defend his rights: against powerful neighbours without, and against the rising power of the citizens from within.

The Genevese attempted toward the end of the 13th century to create a municipal organization for themselves. They were able to play off against one another the rival rulers of the district. In Maurienne, a remote district of the country, there presently came to the fore a count assuming the title of count of Savoy. He tried to win land and power at the expense of both the count of Geneva and the bishop. It was natural, therefore, that the citizens should invoke the aid of Savoy against their bishop. But the count of Savoy, Amadeus V, not merely seized the castle of the bishops, but also the office of vidomne, the official through whom the bishop exercised his minor judicial rights. By calling in the count of Savoy, the Genevese had succeeded in freeing themselves from the count of Geneva and in defying the bishop; they soon discovered, however, that their "protector," not content with the office of vidomne, intended to make himself "prince" of the citp.

In 1401 Amadeus VIII of Savoy bought the county of the Genevois, the dynasty of its rulers having become extinct, and then attempted to purchase the bishopric of the city. This move was rejected, but Amadeus VIII achieved his object. Having been elected pope under the name of Felix V, he named himself to the vacant see of Geneva in 1444. Until 1522 the see was almost continuously held by a cadet of the house of Savoy.

Geneva might soon have become an integral part of the realms of the house of Savoy had it not been for the appearance of a new protector–the Swiss confederation. Early in the 15th century the town of Fribourg negotiated with Geneva for commercial purposes, as the cloth manufactured at Fribourg found a market in the long-established fairs of Geneva. This took on a political significance in the treaty of combourgeoisie (1526) which included not only Fribourg and Geneva but Berne also.

The Genevese, wishing to rid themselves now of domination by the duke of Savoy, the self-appointed "protector" of the city, turned to the Swiss for help. Their armed intervention (1530) forced the duke to sign the treaty of St. Julien by which he engaged not to trouble the Genevese any more, agreeing that if he did so the two towns of Fribourg and Berne should have the right to occupy his barony of Vaud. A legal tie was thus established between Geneva and two of the Swiss cantons. The municipal authorities of the city greatly developed and included a grand conseil and petit conseil.

The Reformation and Independence. — The situation was complicated by the Reformation, in which Fribourg remained loyal to the old faith, while Berne supported the Reformation. In 1535 Geneva formally adopted the Protestant faith. The bishop, Pierre de la Baume, had already left the city (July 14, 1533), never to return. The syndics and the council assumed authority and claimed the sovereign powers of the bishop The Fribourgeois, who had come to the help of Geneva in 1530, remaining Catholics, now seceded from the alliance. The bishop joined forces with the duke of Savoy to attack Geneva. The Genevese were on the point of succumbing in the unequal struggle when, in Jan. 1536, the Bernese at last came to their aid, acquiring the barony of Vaud and the bishopric of Lausanne. They seized the Gex district, the Chablais, and, in combination with the Genevese, took the castle of Chillon, from which they delivered Bonivard, the prior of St. Victor. Meanwhile, Guillaume Farel had been advancing the cause of religious reform, which was definitively adopted on May 21, 1536.

In July 1536 a French refugee, John Calvin (*q.v.*), came to Geneva and was persuaded by Farel to remain. He was not immediately successful, however, and was obliged to leave the town. Later recalled by his partisans (1541), he undertook the task of imposing on the Genevese, intoxicated with their newly won freedom, a severe moral discipline. One of his most lasting achievements was the foundation of the Academy of Geneva, which he set up with the assistance of Théodore Beza (1559). It was virtually a training school for Protestant missionaries and Geneva became the acknowledged stronghold of Protestantism and the city of refuge for the persecuted from Italy, England and France. Calvin was the virtual ruler of the city, and from that fastness, through his emissaries and a voluminous correspondence, he directed his disciples in all parts of Europe.

The gains of the war of 1536 were not lasting. Emmanuel Philibert of Savoy recovered his lands; Berne only retained the Vaud; Geneva was once more encircled by enemies; and finally, Calvin died in 1564. On the other hand, Berne renewed the treaty of combourgeoisie and Zurich entered the alliance in 1584. Some time before this Henry III of France had made an alliance with Berne and Solothurn for the "conservation" of Geneva (1579). When civil war broke out in France, Henry III's envoy N. H. de Sancy brought a Swiss contingent to his aid, and Geneva entered the struggle. Sometimes in concert with Sancy's troops and the Bernese, sometimes alone, the Genevese fought and held their ground. Henry of Navarre, the former Huguenot leader, presently succeeded Henry III. Despite his former friendship with Geneva, he deprived the Genevese of the Gex district, which they had conquered, when he made peace with Savoy (1601).

With complete disregard of treaties, Duke Charles Emmanuel made a final attempt to take Geneva by surprise by scaling the walls with ladders (night of the escalade, Dec. 12, 1602). He was repelled with considerable losses, while only 17 Genevese perished. Overjoyed at this victory, the citizens crowded into their cathedral; they sang the 124th psalm which has ever since been sung on the anniversary of this great delivery. The peace of St. Julien (July 21, 1603) marked the final defeat of the duke of Savoy in the long struggle waged (since 1290) by his house against the city of Geneva.

18th, 19th and 20th Centuries. — Geneva then entered on a period of tranquillity. Industry prospered, particularly the clockmaking industry, with the assistance of the refugees who fled to Geneva at the time of the St. Bartholomew massacre (*q.v.*) and the revocation of the Edict of Nantes (*q.v.*). There grew up a patrician class which constantly became more exclusive, and several attempts were made by the cultivated middle classes to gain some share in the aristocratic government of the town. Following the French revolution, Geneva, imitating the example of Paris, had its "Terror." An attempt was made to remedy the situation by the egalitarian constitution of 1794, but an end was not put to disorder until a short time before the French occupation of 1798.

On the fall of Napoleon (1814) the city recovered its independence, and finally, in 1815, mas received as the-junior member of the Swiss confederation. The constitution of 1814 set up a common form of government for the city and the canton, the city not obtaining its municipal independence until the constitution of 1842. A more advanced and liberal constitution was accepted by popular vote on May 21, 1847.

After World War I Geneva, with its tradition of independence and Swiss neutrality, was chosen as the seat of the League of Nations (*q.v.*). Although a nucleus of League officials remained after the outbreak of World War II, no meetings of the council or the assembly were held, and the League's activities largely ceased. The International Labour office was at first housed at Pregny, 1½ mi. outside Geneva, and in 1926 in a new building near Ariana park. The departure after 1939 of League officials and Labour office personnel dealt a blow to the prosperity of Geneva. By 1942 more than 11% of its houses were unoccupied.

The situation improved considerably after World War II; the population substantially increased and unemployment disappeared. In 1947 the city mas designated as the European centre of the United Nations. In the following year the International Labour office, the secretariat of the International Labour organization, returned to its headquarters in Geneva, and the World Health organization established its headquarters in the Palais des Nations, followed by other international organizations. It was in Geneva that the Asian conference (United States, France, United Kingdom, Soviet Union) took place in 1955 to settle the situation in Vietnam. During that same year the European Centre ior Nuclear Research began the construction of a research laboratory at Meyrin.

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GENEVA, LAKE OF, the largest lake in central Europe. It is *Lacus Lemannus* of classical writers: but from the 16th century onward Lac de *Genève,* though from the end of the 18th century the name Lac *Léman* was revived. Its area is 224½ sq.mi., of which about 134 sq.mi. are Swiss and 90½ sq.mi. French. The French part takes in nearly the whole of the south shore, save its west and east ends, which belong respectively to Geneva and to Valais.

The lake is formed by the Rhône, which enters it at its east end, between Villeneuve and St. Gingolph and quits it at its west end, flowing through the city of Geneva. The only important tributaries are the Drance (S.), the Venoge (N.) and the Veveyse (N.). The length from the east end to Geneva is 45 mi., the maximum depth is 1,017 ft., mean depth 500 it., greatest width (between Morges and Amphion) 8½ mi., normal width 5 mi. The lake forms two well-marked divisions separated by the strait of Promenthoux, and as a bar, divides the Grand Lac from the Petit Lac. The "Grand Lac" is to the east and the "Petit Lac" (W.) is the special Genevese portion. The unusual blueness of the waters has long been remarked, and transparency increases away from the Rhône entry as the river-borne mud sinks to the bottom. The lake level is highest in summer. There are remarkable temporary disturbances of level known as *seiches* both longitudinal and transverse, in which the whole mass of water in the lake rhythmically swings from shore to shore. The currents are irregular. The principal minds that blow over the lake are the *bise* (northeast), the *vaudaire* or *Föhn* (southeast), the *sudois* or *vent de pluie* (southwest) and the *joran* (northwest). The storm winds are *molan* (from the Arve valley) and the *bornan* (from the Drance valley). The lake is not as rich in fish as the other Swiss lakes. Prof. Forel knows of but 20 indigenous species (of which the *Féra,* or *Coregonus fera,* is the principal) and six that have been introduced by man in the 19th century. Lake dwellings, of varying dates, have been found on the shores.

Despite steamers first placed on the lake in 1823, and railways along each shore, the red lateen sails of minor craft still brighten the landscape. The railway along the northern shore runs from Geneva past Nyon, Rolle, Morges, Ouchy (the port of Lausanne), Vevey and Montreux to Villeneuve (56½ mi.). That on the south shore gains the edge of the lake at Thonon only (22¼ mi. from Geneva), and then runs past Evian and St. Gingolph to Le Bouveret (20 mi. from Thonon). In the harbour of Geneva two erratic granite boulders project above the water, and are named *Pierres du Niton* (supposed to be altars of Neptune). The lower of the two has been taken as the basis of the triangulation of Switzerland.

GENEVA CONVENTIONS, a series of four international agreements for the protection of war victims, signed on Aug. 12, 1949, by 58 governments and the Holy See. Convention I, "for the amelioration of the condition of the wounded and sick in armed forces in the field," had a history intimately linked with the founding of the International Committee of the Red Cross. In response to an appeal by Henri Dunant in his book *Un souvenir* de *Solférino* (1862), dramatically recalling the suffering of the wounded in the battle of Solférino, the International Red Cross committee was created in 1863. The original convention came out of a conference called by the Swiss Federal council in 1864. Twenty-six governments in attendance agreed to respect war wounded, neutrality of hospitals bearing the Red Cross sign and other humanitarian rules.

The development from the convention of 1864 to the comprehensive series of agreements of 1949 reflected the appalling growth of total warfare. The 1864 convention, revised in 1906, was adapted to naval warfare at The (Second) Hague Peace conference of 1907 and, the previous British objections withdrawn, adopted there as Convention X. In its 1949 version, it became known as Convention II (Armed Forces at Sea). Convention III of 1949 (Prisoners of War) was first agreed upon also in Geneva, in 1929. It reflected the problems of treatment and repatriation of war prisoners. which came to the fore in World War I. (See PRISONERS OF WAR.) Finally, the new technology of warfare, which carried its effects among the noncombatants in World War II, resulted in the addition in 1949 of Convention IV (Protection of Civilian Persons in Time of War).

As long as war, though legally outlawed, continued to exist de facto, the Geneva conventions were an indispensable part of the effort to keep warfare within some confines. During the Korean war (1950–53), all the parties involved declared themselves bound by the conventions, even if they had not signed or ratified them. The cause *célèbre* of Korea, the repatriation of prisoners of war, involved Convention III. Although tightened in 1949 to favor the prisoners' rights, this convention was susceptible of literalist interpretation, which would have worked a forcible repatriation.

This was the drawback of engagements of this type, responding only to past stimuli, rather than assaying a forward-looking regulation. The ideological dimension of contemporary warfare and the postulate of international protection of human rights, although extant as factors and likely to increase in prominence, were not positively incorporated into the Prisoners of War convention. Convention IV (Civilians) appeared also outdated in some particulars by developments in war technology. Yet it was also true that the fundamental value of the Geneva conventions was their humanitarian spirit, which was ageless and not letterbound.

See also WAR; LAWS OF WAR; HAGUE CONFERENCES.

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GENEVA SUMMIT CONFERENCE (1955), a conference held in Geneva, Switz., from July 18 to July 24, 1955. The 1955 Geneva conference was the first meeting of the heads of government of the four principal powers which had fought national socialist Germany in World War II since the conference held in Potsdam, Ger., in July 1945. The Geneva conference became generally known as the "summit conference." Its purpose was to lessen the serious tension which had developed after World War II between the U.S.S.R. on one side and the western democracies — the United States, Great Britain and France — on the other.

In May 1953 British prime minister Winston Churchill had proposed a conference of the principal heads of government with the aim of bridging the widening gulf between democracy and communism. The subsequent settlement of the conflicts in Korea and Indochina and the signing of the Austrian peace treaty in Vienna on May 15, 1955, helped to create a climate of opinion in which there seemed to be some hope for the success of a summit conference.

At the conference the four governments were represented by Pres. Dwight D. Eisenhower of the United States, Prime Minister Anthony Eden of Great Britain. Premier Edgar Faure of France and, on the Soviet side by Prime Minister Nikolai Bulganin and Party Chiei Nikita Khrushchev. Before leaving for Geneva, President Eisenho er stated in a broadcast that a change in spirit uould be "the greatest step towards peace, towards future prosperity, and tranquility that has been taken in all the history of mankind," adding "we shall be conciliatory . . . we shall be tolerant." Eisenhouer's conciliatory attitude during the conference made a deep impression on world public opinion and seemed to convince the Soviet leaders of the peaceful intentions of the west. Yet, the negotiations ended without any concrete achievement, although a joint statement on Germany was approved—"The heads of government . . . have agreed that the settlement of the German question and the reunification of Germany by means of free elections shall be carried out in conformity with the national interests of the German people and in the interests of European security." "For the purpose of establishing European security," the foreign ministers of the four powers were instructed to discuss, in addition to reunification, "a security pact for Europe or for a part of Europe, including provision for the assumption by member nations of an obligation not to resort to force and to deny assistance to an aggressor." President Eisenhower made proposals for exchanging military blueprints, publicizing military expenditures, and for establishing control posts and aerial inspection of military installations.

The "spirit of Geneva" evaporated quickly as soon as the discussions were brought down from generalities to concrete measures. The foreign ministers of the Big Four—John Foster Dulles Harold Macmillan, Antoine Pinay and Vyacheslav Molotov—met in Geneva from Oct. 27 to Nov. 16, 1955. No agreement could be reached on German reunification or on European security, the western demand for reunification of Germany being countered by the Soviet demand for a security pact which would have involved the abandonment of NATO. Molotov rejected free elections for Germany and regarded all concrete proposals for inspection of disarmament as interference with the internal affairs of the C.S S.R. By the end of 195j it became evident that the disagreement on all fundamental and all practical questions between the U.S.S.R. on the one hand, as leader of the communist bloc. and the uestern democracies on the other hand, was as complete as it had been in the last years of Stalin's regime. (H. Ko.)

GENEVIÈVE, SAINT (*c.* 422–*c.* 500), patron saint of Paris, was born, according to tradition, at Nanterre near Paris. At the age of seven she was induced by St. Germain, bishop of Auxerre, to dedicate herself to the religious life. and on the death of her parents she moved to Paris, where she distinguished herself by her benevolence, as well as by her austere life. She is said to have predicted the invasion of the Huns; and when Attila with his army was threatening the city, she persuaded the inhabitants to remain on the island and encouraged them by an assurance. justified by subsequent events. that the attack would come to nothing (451). She is also said to have had great influence over Chiideric. father of Clovis, and in 460 to have caused a church to be built over the tomb of St. Denis.

She was buried in the church of the Holy Apostles, popularly known as the church of Ste. Genevittve. In 1793, when the church that had been built in her honour (in 1764) became the Panthéon, her body was removed from it and burned on the Place de Grève; but the relics were enshrined in the church of St. Étienne-du-Mont, where they still attract pilgrims.

Her festival is celebrated on Jan. 3.

See C. H. Lesêtre, *Les Saints* (1900); *A.* **D.** Sertillanges, *Sainte Genevikve* (1917).

GENEVIÈVE (GENOVEVA or GENOVEFA) OF **BRABANT,** heroine of a legend first recorded by Jacobus de Voragine (d. 1298) in his *Legenda sanctorum* ("The Golden Legend"). On the return of her husband, Siegfried of Trèves, from an expedition against the Saracens. Genevittve was falsely accused of infidelity by his steward Golo who had tried to seduce her. Condemned to death but spared by her executioners, she lived with her child for six years in a cave in the Ardennes, nourished by a roe. Eventually Siegfried hunted the roe, which led him to his wife; her innocence was recognized and Golo was executed, but Geneviève died shortly after. Popularized by the Jesuit René de Ceriziers (1603–62) in *L'innocence reconnue dans la vie de Sainte Genevikve, princesse de Brabant* (1634), the legend, in various forms, inspired novels and plays in France, Germany and elsewhere and a light opera by Offenbach (1875).

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GENGA, GIROLAMO (*c.* 1476–1551), Italian painter and architect, a transitional figure between Renaissance and mannerism, was born in Urbino and studied under Signorelli (working with him on the frescoes in Orvieto cathedral), later under Perugino and at Florence. The "Martyrdom of St. Sebastian" (Uffizi, Florence) exemplifies his style thus formed. Toward 1509 he painted tno frescoes in Pandolfo Petrucci's palace at Siena (Siena gallery), and in 1510 the "Transfiguration" (Museo dell'Opera del duomo, Siena). His plastic mature style is seen in the altarpiece painted for the church of S. Agostino, Cesena (1513–18; Brera, Milan, predella panels at Bergamo and Washington), the "Marriage of St. Catherine" (Barberini palace, Rome) and in his masterpiece, the already Mannerist "Resurrection," in the church of Sta. Caterina da Siena, Rome (1519 or later). From the 1520s Girolamo Genga was in the service of the dukes of Urbino, and by 1530 was supervising the fresco decoration of the Villa Imperiale near Pesaro and constructing large additions to it. He was architect of S. Giovanni Battista. Pesaro (1543), the work being continued by his son. Bartoiomeo (1516–59), a military as well as civil architect. Preparatory drawings by Girolamo for the Cesena altar are in the British museum. London, the Uffizi, and the Louvre. He died in Urbino on Aug. 11, 1551. (P. M. R. P.)

GENISTA, a Eurasian and North African genus of about 100 species of unarmed or armed shrubs usually evergreen in appearance, belonging to the family Leguminosae. The leaves are simple or trifoliolate. The small, usually yellow flowers occur in terminal racemes or panicles. The genus is frequently confused with *Cytisus,* many species of both groups being designated commonly as brooms. In the United States it is cultivated from Maine to Virginia. Several species are geographically limited; *e.g.,* in Sicily, Syria and Palestine, etc. The petty whin or needlefurze, an armed plant. is common on the moors of England. The well-known ornamental of Eurasia, *G. tinctoria,* the woad-waxen or dyer's greenweed, yields a yellow dye. (J. D. DR.)

GENITIVE, in grammar, one of the cases or declensions of nouns to indicate their relationship with other words in a sentence. Latin contained the genitive—indicating origin or source—and five other declensions of nouns. In English the genitive (the only declension used regularly) usually indicates possession and is also called the possessive case, though it may indicate other relationships.

See GRAMMAR.

GENIUS, meaning literally in Latin "the begetter," is a word of several meanings derived from and having some relation to the original use of the word in Roman religion.

Roman Usage.—In its earliest meaning in private cult, the *genius* of the Roman housefather and perhaps the *iuno (see* JUNO) of the housemother were worshiped. These certainly were not the souls of the married pair, as is clear both from their names and from the fact that no early document mentions the *genius* or *iuno* of a dead person. As no cult was paid to the *genius* of any other member of the family, it seems reasonable to suppose that they were the male and female forms of the family's, or clan's, power of continuing itself by reproduction, which were in the keeping of the heads of the family or clan for the time being and passed at death to their successors. In this as in all forms of his cult, the *genius* was often conceived as appearing in the form of a snake, although he is also shoun in art as a young man, generally engaged in sacrificing. At every wedding a bed, the *lectus genialis,* was made for the *genius* and *iuno* of the husband and wife, and its presence in the house was a sign of matrimony.

Individual Genius.—Because of the rise of individualism and also of the prevalence of Greek ideas concerning a guardian spirit or daimon, the genius lost its original meaning, and came to be a sort of personification of the individual's natural desires and appetites; hence the phrases *indulgere* genio, *genium* dejrudare, signifying respectively to lead a pleasurable and a stingy life. However. the development did not stop there. The genius came to be thought of as a sort of guardian angel, a higher self; and, as the Greek *daimon* was sometimes rationalized into the individual's character or temper, so also Horace half-seriously in one of his Epistles says that only the *genius* knows what makes one person so different from another, adding that he is a god who is born and dies with each one of us. This individual *genius* was worshiped by each individual, especially on his birthday. A few inscriptions even mention the genius of a dead person, as Christian epitaphs sometimes speak of the dead person's angel.

Genius of the Emperor.--To show reverence for the genius of another, or to swear by it, was a mark of deep respect; hence it is not unnatural that the genius of Augustus and of his successors formed objects of popular cult. Thus to worship the *genius Augusti* avoided the feeling against worshiping any living emperor, which remained fairly strong in Italy; for of course all genii were divine and might properly be worshiped.

Further Developments.—As Greek *daimones* were by no means always the guardian spirits of individuals, so also there were a vast variety of genii, *i.e.,* guardian spirits, of places, *genius* loci, including buildings (*genius balneorum,* etc.) and corporations of all sorts, from the state (genizrs *populi Romani*) to small bodies of troops, guilds of tradesmen and so forth. A very curious development is that the *genius* of a god, even of Jupiter, or of the iuno of a goddess, is sometimes referred to.

Modern English Usage.—The word genius is used in two closely related but somewhat different senses. In the first sense, as popularized by Lewis M. Terman, genius refers to high intellectual ability as measured by performance on a standardized intelligence test. The exact- intelligence quotient designating genius varies. Terman set the intelligence quotient for "potential genius" at 140 or over, a level reached by about 1 in 250 of the general population. This seemed to some writers an insufficiently stringent criterion. Leta S Hollingworth set it at 180 or over, a level reached by perhaps no more than 6 in 1,000,000 of the general population, and this seemed to other writers too stringent. In any event, genius here means simply high intellectual ability and refers to potentiality rather than to attainment In this sense, the term may be used to characterize children who have not yet had an opportunity to gain eminence by achievement. A growing and probably more practicable usage is to refer to children of this sort as "gifted," and to make a distinction between first-order gifted children, those in the upper 0.1% of the general population, and second-order gifted children, those in the upper 10% of the remaining population.

In the second and more popular sense, as derived from Sir Francis Galton, "genius" is used to designate creative ability of an exceptionally high order as demonstrated by actual achievement In this sense, men of genius are identified by the eminence of their accomplishment. Although eminence alone may be an imperfect measure of genius, it is held to be the best available, always provided that such eminence is not merely transitory or the result of accident of birth, as in the case of hereditary rulers. To be a sign of genius, eminence must have been won through personal attainment of a superior order.

Genius is distinguished from talent both quantitatively and qualitatively. Talent refers to a native aptitude for some special kind of work. It implies the relatively quick and easy acquisition of a particular skill. Genius is more than this. It involves originality, creativeness and the ability to think and work in areas not previously explored and thus to give to the world something of pre-eminent value it would not otheraise possess. Although men of genius have usually left their unique mark in a particular field, and some writers accordingly include in the term genius persons with special aptitudes independent of more generalized intelligence. studies of the early development of these people appear to show that the general intelligence of the highly talented individual is also exceptionally high. It may very well be that the two senses in nhich the concept genius has been used represent two sides of the same coin.

There have been a variety of attempts to explain the nature and source of genius. One theory holds that the man of genius belongs to a separate psychobiological species, differing as much from ordinary man in his mental and emotional processes as man differs from the ape. Another theory looks upon genius as closely related to neurosis and psychosis. Cesare Lombroso is perhaps the most widely cited among those who held or hold this point of view. Although modern psychoanalytic theory would also hold that genius, like neurosis and psychosis, has its source in basic conflict between the self and environment, in the genius these conflicts are resolved in such way that the symptoms and products are socially useful and valued. Investigations indicate that the man of genius is actually somewhat less prone to mental disorders, physical weakness and bodily deformities than are people in general. Children who show exceptionally high general intelligence of the sort that may be classified as "gifted" or "potential genius" are on the average superior to other children in physique and health and in emotional and social adjustment.

Galton, aho inaugurated the systematic study of genius, formulated the theory that genius is a very extreme degree of three combined traits—intellect, zeal and power of working—that are shared by all men in various "grades." In his *Hereditary Genius,* ahich appeared in 1869, he presented the first clear statistical evidence that genius, as measured by outstanding accomplishment, tends to run in families. Since then the extent to which biological heredity. as distinct from education and opportunity, is responsible for the great differences in achievement of different individuals has been the subject of scientific controversy. The question of how much "nature" and how much "nurture" remains unsettled. However, the consensus is that genius is a function of both hereditary and environmental factors. The original potentiality for exceptional achievement comes from heredity, but whether or not this potentiality mill be brought to fruition depends, at least to some extent, upon opportunity and training.

Studies of famous men and women show that there is no country and no period of time that has not produced some persons of genius calibre. Perhaps the greatest proportion of men of genius to total population that has ever occurred was found in Athens during the period extending roughly from the 5th to the 2nd century B C . when the city-state aith a population averaging not more than 25,000 gave to the world such men as Pericles. Plato, Aristotle, Themistocles and others of equal or near-equal rank.

In all countries and all periods there have been families, social classes and communities that have produced more than their quota of genius. The chance that men who have themselves achieved prominence will have children who rank in the genius group, either by reason of their exceptional endowment as children or on the basis of exceptional accomplishment as adults, is unquestionably greater than that for the population in general. It is, however, impossible to say with any certainty whether this is due to superior heredity or to superior environment. What must always be borne in mind is that in all places and at all times men of genius have arisen from all ranks of society. John Bunyan's father was a poor tinker; the father of Pierre Simon Laplace was a farmer of limited means. A place in Who's *Who* is by no means reserved from father to son.

See also INTELLIGENCE; PRODIGY; PSYCHOLOGICAL MEASUREMENTS; ROMAN RELIGION.

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GENLIS, STÉPHANIE-FÉLICITÉ DU CREST DE SAINT-AUBIN, COMTESSE DE (1746–1830), French writer and educator, was born at Champcéry, Autun. France. At six years of age she was received as a canoness into the noble chapter of Alix, near Lyons, with the title of Madame la Comtesse de Lancy, taken from the town of Bourbon-Lancy. Her entire education, however, was conducted at home. In her 16th year she was married to Charles Brûlart de Genlis, a colonel of grenadiers, who afterward became marquis de Sillery. Some years later, through the influence of her aunt, Madame de Montesson, who had been clandestinely married to the duke of Orleans, she entered the Palais Royal as lady-in-waiting to the duchess of Chartres (1770). She acted with great energy and zeal as governess to the daughters of the family, and was in 1781 appointed by the duke of Chartres to the responsible office of gouverneur of his sons, a step which led to the resignation of all the tutors as well as to much social scandal. She wrote several works for the use of her pupils, the best known of which are the *Théâtre d'éducation* (4 vols., 1779–80), a collection of short comedies for young people, Les *Annales* de la vertu (2 vols., 1781) and *Adèle* et *Théodore* (3 vols., 1782). She anticipated many modern methods of teaching. History was taught with the help of magic lantern slides and her pupils learned botany from a practical botanist during their walks. Madame de Genlis welcomed the Revolution, but the fall of the Girondins in 1793 compelled her to take refuge in Switzerland along with her pupil Mademoiselle d'Orléans. In this year her husband, from whom she had been separated since 1782, was guillotined. In 1794 Madame de Genlis fixed her residence at Berlin, but was expelled by order of King Frederick William, and afterward settled in Hamburg, where she supported herself for several years by writing and painting. After the 18th Brumaire (1799) she returned to France, and was well received by Napoleon, who gave her apartments at the arsenal and assigned her a pension of 6,000 fr. Her government pension was discontinued by Louis XVIII. Her Diners du Baron *d'Holbach* (1822) set forth with a good deal of sarcastic cleverness the intolerance and fanaticism of 18th century "philosophes." She died on Dec. 31, 1830.

GENLISEA: see PITCHER PLANTS.

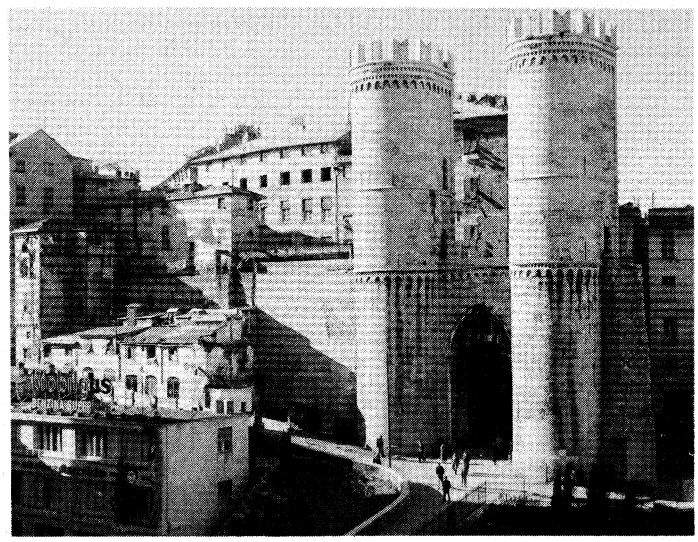
GENNADIUS II or GEORGIOS SCHOLARIOS (d. *c.* 1468). patriarch of Constantinople, 1454–56, philosopher and theologian. was one of the last representatives of Byzantine learning. He appears to have been born at Constantinople and to have served the emperor John VII Paleologus as counsellor. He was present at the great council held in 1438 at Ferrara and Florence with the object of uniting the Greek and Latin Churches, and there met the Platonist, Gemistus, Pletho. In church matters, as in philosophy, the two were opposed—Pletho maintaining strongly the principles of the Greek Church, Georgios being more willing to compromise. On his return to Greece, however, Georgios opposed the union. In 1448 he became a monk at Pantokrator. and in 1453 was elected patriarch of Constantinople by Mohammed II. A few years later he found his position under a Turkish sultan so irksome that he retired to the monastery of John the Baptist near Serrae in Macedonia, where he died about 1468.

GENOA (anc. GENUA, Ital. GENOVA, Fr. GÊNES), capital of the province of Genoa, It. Pop. (1951) of greater Genoa (from Nervi to Voltri), 688,447; of the city, 648,078 (1937 est.) 736.135 (commune). Situated on the Gulf of Genoa, it is the chief port of Italy, the seat of an archbishop and a university and a strong fortress. The city, as seen from the sea, is "built nobly." The original nucleus is that portion which lies to the east of the port in the neighbourhood of the old pier (Molo Vecchio). In the middle of the 12th century, it was found necessary to extend the line of circumvallation, but it was not till 1320–30 that a third line took in the greater part of the modern site of the city proper. This presented about 3 mi of rampart toward the land side which can still be traced. though large portions. especially toward the east, have been dismantled. The present line of circumvallation dates from 1626–32, the period when the independence of Genoa was threatened by the dukes of Savoy. From the mouth of the Bisagno in the east and from the lighthouse point in the west, it stretches inland over hill and dale to the great fort of Sperone (the Spur) on the summits of Monte Peraldo at a height of 1,604 ft. The circuit is little less than 12 mi.

HISTORY

The discovery of a Greek cemetery of the 4th century B.C. is the only proof that Genoa was ever occupied by the Greeks. The city was destroyed by the Carthaginians in 209 B.C. but restored by the Romans, who made it and Placentia their headquarters against the Ligurians. An inscription of 117 B.C. (now preserved in the Palazzo Municipale at Genoa and called the "Bronze tablet") refers to the decision of the judges sent from Rome to settle the boundaries between the Genuates and the Veturii, the inhabitants of a neighbouring hill town. It is known only from inscriptions of other places that Genoa had municipal rights. The city was a *municipium* and the headquarters of the Roman fleet which, among its admirals, had the famous Agrippa whose house is thought to have been in the Piazza Cavour. Strabo (iv, 6, 2, p. 202) states that Genoa exported wood, skins and honey and imported olive oil and wine, though Pliny speaks of the wine of the district as the best of Liguria (*Hist. Nat.*, xiv, 67).

The history of Genoa during the dark ages, throughout the Lombard and Carolingian periods, is but the repetition of the general history of the Italian communes. The patriotic spirit and naval prowess of the Genoese, developed in their defensive wars



SILBERSTEIN FROM MONKMEYER

THE PORTA SOPRANA OR PORTA DI S. ANDREA. GATE OF THE OLD CITY WALL IN THE CENTRE OF GENOA. THE GATE WAS BUILT IN 1155

against the Saracens, led to the foundation of a popular constitution and to the rapid growth of a powerful fleet, and earned Genoa its title of La Superba, "the proud." From the necessity of leaguing together against the common Saracen foe, Genoa united with Pisa early in the 11th century in expelling the Moslems from the island of Sardinia; but the Sardinian territory thus acquired soon furnished occasions of jealousy to the conquering allies, and there commenced between the two republics the long naval wars which terminated fatally for Pisa in the battle of Meloria (1284). Genoa secured great advantages from the trade stimulated by the crusades. The seaports wrested at the same period from the Saracens along the Spanish and Barbary coasts became important Genoese colonies, while in the Levant, on the shores of the Black sea and along the banks of the Euphrates were erected Genoese fortresses of great strength.

The commercial and naval successes of the Genoese during the middle ages were the more remarkable because, unlike their rivals, the Venetians, they were the unceasing prey to internal discord—the Genoese commons and nobles fighting against each other, rival factions among the nobles themselves striving to grasp the supreme power in the state, nobles and commons alike invoking the arbitration and rule of some foreign captain as the sole means of obtaining a temporary truce. From these contests of rival nobles, in which the names of Spinola and Doria stand forth with greatest prominence, Genoa was soon drawn into the great vortex of the Guelph and Ghibelline factions; but its recognition of foreign authority—successively German, Neapolitan and Milanese—gave way to greater independence in 1339, when the government assumed a more permanent form with the appointment of the first doge, an office held at Genoa for life, in the person of Simone Boccanera. Alternate victories and defeats of the Venetians and Genoese—the most terrible being the defeat sustained by the Venetians at Curzola (1298) where the famous Venetian traveller. Marco Polo, dictated his book of voyages, *Il Milione,* during his four years of captivity—ended by establishing the inferiority of the Genoese rulers, who fell under the power now of France, now of the Visconti of Milan. The Banca di S. Giorgio, uith its large possessions, mainly in Corsica, formed during this period the most stable element in the state, until in 1528 the national spirit appeared to regain its ancient vigour when Andrea Doria succeeded in throwing off the French domination and restoring the old form of government. The government as restored by him, with certain modifications tending to impart to it a more conservative character, remained unchanged until the outbreak of the French Revolution and the creation of the Ligurian republic.

Between Aug. 26 and Oct. 30, 1451, the great navigator Christopher Columbus was born in Genoa, in the Piazza de Ferrari. The original house was demolished in 1684 and the House of Columbus built on the site. Nearby a cloister has been constructed in the Roman style of the former monastery of S. Andrea, which had links with Columbus.

The Ligurian republic was soon swallowed up in the French empire, but not before Genoa had experienced terrible privations in the siege when André Masséna held the city against the Austrians (1800). In 1814 Genoa rose against the French, on the assurance given by Lord William Bentinck that the allies would restore to the republic its independence. It had, however. been determined by a secret clause in the treaty of Paris that Genoa would be incorporated with the dominions of the king of Sardinia. The discontent so created kept alive in Genoa a republican spirit which, through the influence of a young Genoese citizen, Giuseppe Mazzini, was a permanent menace not only to the Sardinian monarchy but to all the established governments of the peninsula. A republican outbreak occurred in 1848, but after a short and sharp struggle the city, momentarily seized by the republican party, was recovered by Gen. Alfonso la Marmora.

In World War II Genoa was heavily bombed by the Allies; its port and industrial areas were virtually demolished by the repeated aerial attacks.

THE CITY

Architectural Features.—The main architectural features of Genoa are its mediaeval churches, with striped faqades of black and white marble, and its magnificent 16th-century palaces.

The earlier churches show a mixture of French Romanesque and the Pisan style—they are mostly basilicas with transepts and as a rule a small dome; the pillars are sometimes ancient columns and sometimes formed of alternate layers of black and white marble. The faqades are simple, without galleries, having only pilasters projecting from the wall, and are also alternately black and white. This style continued in Gothic times also. The oldest church is Sta. Maria di Castello (11th century), the columns and capitals of which are almost all antique. S. Cosma and S. Donato (with remains of the 10th-century building) belong to the 12th century, and S. Giovanni di Pre, S. Agostino (with a fine campanile) and S. Stefano to the 13th. S. Matteo, the church of the Doria family, was founded in 1126 by Martino Doria. The faqade dates from 1278, and the interior from 1543; in the crypt is the tomb of Andrea Doria by Giovanni Montorsoli, and above the high altar hangs the dagger presented to the doge by Pope Paul III. To the left of the church is an exquisite cloister of 1308 with double columns. in which a number of sepulchral inscriptions of the family and the statue of Andrea Doria by Montorsoli are preserved. The little square in front of the church is surrounded by Gothic palaces of the Doria family. The cathedral of S. Lorenzo was reconstructed about the end of the 11th century and consecrated in 1118. The faqade has three elaborate doorways (13th century), the interior was rebuilt in 1307, the campanile, which rises above the right-hand doorway, was completed in 1522, and the cupola was erected after the designs of the architect Galeazzo Alessi in 1567. The fine Early Renaissance (1448) sculptural decorations of the chapel of St. John the Baptist were due to Domenico Gaggini of Bissone on the Lake of Lugano. In the treasury of the cathedral is an octagonal bowl, the Sacro Catino, brought from Caesarea in 1101, which corresponds to the descriptions given of the Holy Grail and was long regarded as an emerald of matchless value, but is in reality a remarkable piece of ancient glass. The church of St. Ambrose, rebuilt by the Jesuits (1587), has a richly decorated interior (16th century). The Annunziata del Guastato (1587), one of the largest churches in the city, is a cruciform structure with a dome; its interior is covered with gilding and frescoes of the 17th century. S. Siro was rebuilt by the Benedictines in the 11th century and restored and enlarged by the Theatines in 1576, the faqade being added in 1830. Sta. Maria di Carignano belongs mainly to the 16th century and was designed by Alessi in imitation of St. Peter's at Rome; the highest gallery of the dome is 368 ft. above sea level and 194 ft. above the ground.

The palaces of the Genoese patricians, famous for their sumptuous architecture, their general effectiveness and their artistic collections, were many of them built in the latter part of the 16th century by Alessi, a pupil of Michelangelo, whose style is imposing and displays marvellous ingenuity in using a limited or unfavourable site to the greatest advantage. Several of the villas in the vicinity of the city are also his work. The Via Garibaldi is flanked by a succession of magnificent palaces, chief among which is the Palazzo Rosso. It was presented by the duchess of Galliera to the city in 1874, along with its valuable contents, its library and picture gallery, which includes fine examples of Van Dyck and Paris Bordone. The Palazzo Municipale, built by Rocco Lurago at the end of the 16th century, once the property of the dukes of Turin, has a beautiful entrance court and a hanging terraced garden fronting a noble staircase of marble which leads to the spacious council chamber. In an adjoining room are preserved two autograph letters of Christopher Columbus, and the violin of Nicolo Paganini (*q.v.*), both natives of Genoa. Opposite the Palazzo Rosso is the Palazzo Bianco, bequeathed to the city by the duchess of Galliera in 1889 and subsequently converted into a museum. In the Via Balbi is the Durazzo Pallavicini palace, with a noble faqade and staircase and a rich picture gallery, also the Palazzo Balbi-Senarega, which has Doric colonnades and an orangery. The Palazzo dell' Universita has an extremely fine court and staircase of the early 17th century. The Palazzo Doria in the Piazza Principe, presented to Andrea Doria by the Genoese in 1522, was remodelled in 1529 by Montorsoli and decorated with frescoes by Perino del Vaga. Its garden was destroyed by the building of the railway. The old palace of the doges, originally a building of the 13th century, to which the tower alone belongs, stands near the cathedral. Another very fine building is the Gothic Palazzo di S. Giorgio, near the harbour, dating from about 1260, occupied from 1408 to 1797 by the Banca di S. Giorgio, now completely restored and occupied by the offices of the port authority. The Cimitero di Staglieno, about 1½ mi. from the city on the right bank of the Bisagno, contains a collection of remarkable modern sepulchral monuments.

The centre of the university is the old palace of Via Balbi, but the great number of students (10,200 in 1955) necessitates the distribution of many faculties in various parts of the city. Other institutions include the academy of arts, the archives of the fathers of the commune, the Mazzinian institute for the study of the Renaissance and the headquarters of the hydraulic institute of the Italian navy, founded in 1872. Genoa's hospitals and the asylum for the poor are among the finest in Italy.

Forced by the narrowness of the level shore to climb the lower hills of the Ligurian Alps, and having been surrounded for many centuries by walls of fortification, Genoa is now a picturesque confusion of narrow streets, lanes and alleys, with stairways climbing the steeper slopes and bridges spanning the deeper valleys. Much of the city is inaccessible to cars and many of the important streets have very little room for traffic. To unite certain quarters three tunnels had to be dug through the hills and other tunnels serve the harbour. The Piazza de Ferrari is the centre of the stock exchange and general business of the city and from there the Via XX Settembre, famous for its elegance and beauty, slopes down to end between the Piazza della Vittoria, with its fine memorial to World War I, and the Piazza Verdi, where one of the two big railway stations stands. The Theatre Carlo Felice, destroyed in World War II, is to be rebuilt. The Corso Buenos Ajres connects the city with the new residential quarter that extends practically to Nervi. The Via Roma runs from near the Piazza de Ferrari to the Piazza Corvetto, with its equestrian statue of Victor Emmanuel II. which lies between the two main parks, Acquasola and Villetta Di Negro. In front of the principal station is the Piazza Acquaverde, with a statue of Columbus, at whose feet kneels the figure of America. The T'ia di Circonvallazione a Monte leads up to the hills at the back of the town, where new suburbs have been constructed. Three funicular railways from different points of the city give access to the highest parts of the hills behind the town. In the east the covering in of the Bisagno from the Piazza Verdi to the sea, and in the west the cutting of a road through the lighthouse promontory (S. Benigno) have enabled the city to be more intimately connected to the nearby communes. In 1926 the communes were fused to form greater Genoa.

Commerce and Industry.— Though its existence as a maritime power was originally due to its port, it was only after 1870 that Genoa provided the conveniences necessary for the modern development of its trade, the duke of Galliera's gift of £800,000 to the city in 187j being devoted to this purpose. A further enlargement of the harbour became necessary after the opening of the St. Gotthard tunnel in 1882, which extended the commercial range of the port of Genoa through Switzerland into Germany.

The old harbour is semicircular in shape, 232 ac. in area, with numerous quays, and protected by moles from southern and southwesterly winds. An outer harbour, 247 ac. in area, has been constructed by extending the Molo Nuovo by the Molo Duca di Galliera. and another basin, the San Pier d'Arena basin, for coaling vessels. with an area of 96 ac.. has been formed to the west of this, between it and the lofty lighthouse which rises on the promontory at the southwestern extremity of the harbour. A further extension in front of San Pier d'Arena as far as the mouth of the Polcevera river was in progress in the mid-1950s.

The largest ships can enter the harbour, which may be divided into three parts: the eastern zone for yachts, fitting out and repairs to naval ships, with four graving docks; the central zone which is the old harbour, with a graving dock; and the western zone which comprises the industrial ports of San Pier d'Arena, Cornigliano and Sestri Ponente. In the harbour between 8,000,000 and 9,000,000 tons of goods are handled yearly. Imports are mainly raw materials such as oil, coal, iron ore, hides, wool and cotton. Heavy industries, including steelworks, have developed near the harbour in the valley and at the mouth of the Polcevera.

Genoa is an important rail centre for Milan, Turin, Ventimiglia (France) and La Spezia (Rome). The road connecting Rome with the Azure coast (Via Aurelia) passes through the city and other major roads are the Scoffera pass to Piacenza, the Dei Giovi pass to Serravalle and the Turchino pass to Ovada. The connection of the harbour with the hinterland is, however, made very difficult by the presence of the Apennines. There is a marshalling station, connected directly with the harbour by tunnels, at Campasso north of San Pier d'Arena. Genoa is the most important harbour in the western Mediterranean with the exception of Marseilles, with which port it carries on a keen competition.

Bibliography.—Among Genoese chroniclers and historians the most important are Caffarus, J. Bracellus, J. Bonfadio, A. Giustiniani, F. M. Casoni, F. M. Accinelli, C. Varese *(Storia della Repubblica di Genova, dalla sua origine sino al 1814*, 7 vol.; 1835–37) and C. Manfroni. For the social, religious, economic and political history *see* the publications of the *Società Ligure di Storia Patria* (1857–), the Commune, the Chamber of Commerce and the Consorzio Autonomo del Porto. *See* also F. Podestà, *Il Porto di Genova* (1913); G. Monleone and G. Pessagno, *Cristoforo Colombo* (1931, Eng. version, 1932); P. Revelli, *Il Genovese* (1951); O. Grosso, *Genoa* (1950) and other guide books; A Issel, *Liguria geologica e preistorica (1892).* (Ao. B.)

GENOA, CONFERENCE OF (April 10–May 19. 1922). a meeting of representatives of the British dominions and of 29 European states, including not only the Allies and former neutrals, but all the former enemy powers except Turkey (which was excluded on the ground that it was an Asiatic country). Above all, the conference mas attended by representatives of Soviet Russia. and the dominant issue was the renewal of relations between Russia and Europe. Before the conference met. Aristide Briand had been succeeded as premier by Raymond PoincarC. Since the project of the Genoa conference had already been accepted by the supreme council. Poincaré could not reject it altogether, but he sought to interpret the agreed program in the narrowest sense and to hedge the participation of Russia with the fullest possible restrictions. He gave detailed and stringent instructions in this sense to his representative, Louis Barthou.

The general conference was preceded by a meeting between PoincarC and D. Lloyd George at Boulogne, on Feb. 2j, a meeting of Allied economic experts in London from March 20 to 28, which drew up detailed agenda for Genoa, and two other preliminary meetings of a regional character, one between the members of the little entente at Belgrade, and another at Warsaw between Poland, Latvia, Estonia and Finland. The parties represented at Warsaw subsequently conferred at Riga with representatives of Soviet Russia. The invitation to Genoa was accepted by the Soviet government with alacrity. but was declined by the United States.

The conference set up four commissions, the first to examine methods of putting into practice the principles of the Cannes resolution of Jan. 6, 1922 (see Cannes, Conference of), while the other three were to deal respectively with financial subjects. economic and commercial subjects and transport. These three latter commissions all reported before the conference came to an end; but their reports were bound to remain academic unless the first commission achieved positive results. The task of the first commission was more difficult, because it was general and political in character, and its work was soon suspended in favour of informal discussions between the three principal Allied powers and Belgium on the one side and the Russians on the other. Meanwhile the Germans signed. on April 16, a separate treaty with the Russians at Rapallo (*q.v.*), in which the objects of the Genoa conference were achieved as between these two parties by a mutual renunciation of reparation claims and a resumption of normal consular and diplomatic relations.

This separate Soviet-German treaty damaged the general prospects of the conference by the fear it instilled into the Allies. In these circumstances there was little prospect of success for a general pact of nonaggression, which Lloyd George suggested on April 25. But the conference actually broke down through the intransigence of Belgium, which insisted upon the integral restitution of foreign-owned private property in Russia. France supported the Belgian contention. Eventually a formula on the British lines was carried, even Belgium finally giving way; but it was so evident that, with Great Britain and France divided, no positive result could be achieved, that the Genoa conference was quietly wound up by remitting its agenda to a mixed commission of experts, who duly met at The Hague from June 26 to July 20, 1922, but also foundered on the rock of foreign-owned private property in Russia.

The Genoa conference was interesting because economic and financial problems were approached from the point of view of reconstruction, and not of reparation. It was also the first attempt at a settlement between the European governments and Soviet Russia.

See Sir C. Gordon and E. Montpetit, *The Genoa Conference,* Joint Report of the Canadian Delegates *(1922)*; J. S. Mills, *The Genoa Conference (1922).*

GENOVESI, ANTONIO (1712–1769), Italian philosopher and economist who proposed reforms in the kingdom of Naples in a spirit that sought to combine the ideas of the Enlightenment with an extremely radical Christianity, was born at Castiglione, near Salerno. on Nov. 1. 1712. Ordained priest in 1737, he went to Naples in 1738 and was in 1741 appointed to teach metaphysics in the university there. His *Disciplinarum metaphysicarum elementa* (1743–52) incurred some suspicion of heresy, and in 1748 he decided not to publish the companion work on theology (his treatises on logic and on physics had both appeared in 1745). In

1753, however, he dedicated his *Discorso sopra* alcuni trattati *d'agricoltura* . . . in cui si tratta del vero fine delle lettere to the influential Bartolomeo Intieri, with the result that in 1754, when Intieri founded at Naples the first European chair of "commerce and mechanics" (*i.e.,* political economy), he stipulated that Genovesi should be its first occupant. Thenceforward Genovesi wrote and lectured mainly in Italian instead of Latin. His subsequent publications included Meditazioni *filosofiche* sulla religione e sulla morale (1758), Lettere accademiche (1764) and, most important of all, Delle *lezioni* di *commercio* (1765; new ed., 1768), the first Italian work on his subject. Genovesi died in Naples on Sept. 23, 1769.

For his metaphysics Genovesi took much from Leibnizian monadism. His theory of knowledge was largely empiricist. His mercantilist system of economics is distinguished by his remarkable analysis of demand, by his high valuation of labour and by his efforts to reconcile protectionism with free competition. In the political field his contention that ecclesiastical authority should be strictly limited to spiritual matters and that the state should dispossess the clergy and religious orders of their lands was most welcome to Bernardo Tanucci's "enlightened" administration in Naples.

See E. Gambini, Antonio Genovesi (1910); G. Monti, Due grandi riformatori del settecento (1926); A. Tisi, *Il* Pensiero religioso *d'Antonio* Genovesi (1932).

GENRE PAINTING has primarily to do with a type of subject, but the proper application of the term is limited also by the painter's attitude toward the subject. (See also STILL-LIFE PAINTING.) In genre painting, intimate scenes and subjects from ordinary daily life are dealt with. The elimination of imaginative content focuses attention upon the shrewd observation of types. costumes and settings and upon the beauty and appropriateness of colour, form and texture. In true genre painting such subjective qualities as the dramatic, historical, ceremonial, satirical, didactic, romantic, sentimental and religious should be reduced to a minimum. Characteristic works by Jan Steen, Honoré Daumier, Thomas Rowlandson and William Hogarth would thus be too satirical or didactic to be called genre, while those of Francis Wheatley, George Morland and J. H. Fragonard would be too sentimental and those of J. F. Millet too romantic.

In Europe, genre painting does not begin clearly to emerge until the late middle ages, when illuminated calendars showing the occupations appropriate to the months or seasons are found in manuscript books (see ILLUMINATED MANUSCRIPTS). These little genre pictures give intimate glimpses of the life of the time. Soon the taste for genre became so keen that Petrus Christus, Pieter Aertsen and Pieter Brueghel painted scenes in shops and kitchens occasionally thinly disguised as religious subjects. The greatest home of genre painting was indeed 17th-century Holland, when Adriaen van Ostade, Gerard Dou, Gabriel Metsu, Jan Vermeer, Pieter de Hooch and Gerard Terborch flourished. Among later exponents are J. B. S. Chardin in France and Pietro Longhi in Italy. Although in modern times colour photography has practically usurped the place of genre painting, the term might include interiors by Jean Édouard Vuillard and Pierre Bonnard, leaders of the French *Intimiste* school, and similar works by Henri Matisse.

(D. L. FR.)

GENTIAN, botanically Gentiana, a large genus of herbaceous plants belonging to the family Gentianaceae (*q.v.*). The genus comprises about 400 species, most of them perennial plants with tufted growth, growing in hilly or mountainous districts, chiefly in the northern hemisphere, but also in New Zealand and South America. The leaves are opposite, entire, smooth and often strongly ribbed. The flowers have a persistent four- to five-lobed calyx and a four- to five-lobed tubular corolla; the stamens are equal in number to the lobes of the corolla. The ovary is onecelled, with two stigmas, either separate and rolled back or contiguous and funnel shaped. The fruit when ripe separates into two valves and contains numerous small seeds. The majority of species are remarkable for the deep or brilliant blue colour of their blossoms, comparatively few having yellow, white or, more rarely, red flowers; the last are almost exclusively found in the Andes.

About 60 species occur in North America, widely distributed throughout the continent, but most numerous in the Rocky mountain region. Of about 18 species found from the Great Plains eastward, among the best known are the fringed gentian (G. *crinita*), one of the most beautiful American wild flowers; the closed or bottle gentian (G. andrewsii), the commonest species; the downy gentian (G. *puberula*), of the prairie region; and the stiff gentian or agueweed (G. *quinquefolia*), which extends southward to Florida. Of the many Rocky mountain species, those with fringed flowers, as G. elegans and G. barbellata, are among the most conspicuous. Representative of the 12 or more species found in California and northward in the coastal mountains are the single-flowered gentian (G. simplex), with slightly fringed flowers, and the explorer's gentian (*G.* calycosa), which throughout the summer forms sheets of intense blue in alpine meadows from California to British Columbia and eastward to Montana.

There are ten species of gentian native to Great Britain. Three of them are perennials belonging to the genus Gentiana, while seven, all of which are annuals or biennials, are credited to the genus Gentianella, a name preferred by British botanists for annual and biennial gentians but not widely accepted in the United States.

Of the perennial species the marsh gentian (Gentiana *pneumonanthe*), also called the Calathian violet, is six to nine inches high, has blue flowers and is rather rare from Cumberland to Dorsetshire. The spring gentian (G. verna) and the small gentian (G. *nivalis*) are much lower plants, have bright blue flowers and are more widely distributed throughout the British Isles.

The annual or biennial gentians of the genus Gentianella comprise the felwort (G. amarella), often called autumn gentian, which has dull purple flowers and is widely distributed; G. *campestris,* two to nine inches high, with blue or white flowers and found throughout Great Britain; G. anglica, confined to southern England, has purple flowers and is only three to five inches high; *G. uliginosa,* a low annual, rare in Pembroke and Glanmorgan; and G. germanica, a biennial, with blue flowers, rather common on calcareous grasslands throughout Great Britain.

Some of these, but more especially the much finer species from North America, the Himalayas, Burma, Tibet, China and Japan, are much cultivated for ornament in England, where over 150 species are known. Less than 50 of these are much grown in the United States, where the climate is far less suited to gentians than that of England. None of them is particularly easy to grow, and many of them need the specialized conditions of scree or moraine in the rock gardens. All require coolness and moisture, especially the perennials.

Several preparations obtained from the root of Gentiana lutea are used in medicine to stimulate the alimentary tract, thus improving digestion. The chief of these is compound gentian tincture, comprising 100 g. of powdered gentian root, 40 g. of bitter orange peel and 10 g. of cardamom seed, mixed with glycerin, alcohol and water. In Germany and France other species of gentian, notably G. *purpurea,* G. punctata and *G. pannonica,* are sometimes permitted substitutes of G. lutea.

G. lutea is a large handsome plant three or four feet high, growing in open grassy places on the Alps, Apennines and Pyrenees, as well as on some of the mountainous ranges of France and Germany, extending as far east as Bosnia and Asia Minor. It has large, oval, strongly ribbed leaves and dense whorls of conspicuous yellow flowers. Its use in medicine is of very ancient date. Pliny and Dioscorides mention that the plant was noticed by Gentius, a king of the Illyrians, living 180–167 B.C., from whom the name Gentiana is supposed to be derived. During the middle ages it was much employed in the cure of disease, and as an ingredient in counterpoisons. In 1552 Hieronymus Bock (Tragus), a German priest, physician and botanist, mentions the use of the root as a means of dilating wounds.

The root is tough and flexible, scarcely branched and of a brownish colour and spongy texture. It has a pure bitter taste and faint distinctive odour. The bitter principle, known as gentianin, is a glucoside, soluble in water and alcohol. It can be decomposed into glucose and gentiopicrin by the action of dilute mineral acids. It is not precipitated by tannin or subacetate of lead. A solution of caustic potash or soda forms with gentianin a yellow solution, and the tincture of the root to which either of these alkalis has been added loses its bitterness in a few days. Gentian root also contains gentianic acid, which is inert and tasteless. It forms pale yellow, silky crystals, very slightly soluble in water or ether but soluble in hot strong alcohol and in aqueous alkaline solutions. This substance is also called gentianin, gentisin and gentisic acid.

The root also contains 12% to 15% of an uncrystallizable sugar called gentianose, of which fact advantage has long been taken in Switzerland and Bavaria for the production of a bitter cordial spirit called Enzianbranntwein. The use of this spirit, especially in Switzerland, has sometimes been followed by poisonous symptoms, which have been doubtfully attributed to inherent narcotic properties possessed by some species of gentian, the roots of which may have been indiscriminately collected with it, but it is quite possible that it may be due to the contamination of the root by that of hellebore (Veratrum album), a poisonous plant growing at the same altitude and having leaves extremely similar in appearance and size to those of G. lutea. See VERATRUM; HELLEBORE. (N. TR.)

GENTIANACEAE (GENTIAN FAMILY), of subclass Sympetalae of dicotyledons, includes some of the most beautiful flowering plants of woodlands, meadows and moors. The fringed gentian (Gentiana crinita) is a popular favourite but the Andean genus Lagenanthus, with showy scarlet tubular flowers four to five and a half inches long, is virtually unknown. The family contains about 1,000 species in 80 genera; mostly temperate or montane in all continents except Africa, with epicentres in the Alps, Himalayas, western North America and the Andes; mostly annual or perennial herbs of erect tufted habit by the repeatedly dichotomous branching. Less frequent growth forms include vines (Cuban genus Goeppertia and Asiatic Crawfurdia), rhizomatous perennials (Menyanthes, etc.), water lilylike aquatics (Nymphoides, etc.), weedy short-lived annuals (Centaurium, Hoppea, etc.), ericoid subshrubs (Enicostema) and shrubs attaining a height of 12 ft. or more (Macrocarpaea, Symbolanthus). Rock gardeners value low, clump-forming alpines (Gentiana acaulis, bavarica, etc.) displaying large campanulate flowers of intense shades of blue. Cytologically the family is prevailingly polyploid, with recorded diploid base numbers of 5, 7, 9 and 13.

1. HORACE MCFARLAND CO.
FRINGED GENTIAN (GENTIANA CRINITA)

The leaves are generally in two-ranked opposite pairs, smooth and shining, the margins without teeth, rarely in whorls (Curtia and Frasera) or trifoliate (Menyanthes). Reduced scalelike leaves occur in anomalous genera of slender nongreen saprophytes (Voyria, etc.); these are often confused with Burmanniaceae. The inflorescence is generally cymose, but the flowers may be densely spicate (Coutoubea spicata) or even solitary (some true gentians). The flowers are perfect and regular with parts in fives (less often in fours), the pistil bicarpellate (uniloculate in Menyanthes and allies). The sepals generally form a tubular calyx, but in the primitive neotropical genus *Chorisepalum* they are separate. The corolla varies widely but is plaited or smooth, and most often bell shaped, funnelform or salverform, or sometimes rotate (British genus Chlora). Yellow is the primitive flower colour, retained in Gentiana lutea, but more numerous are species that have evolved with hues from pale blue to ultramarine. The throat is frequently provided with fringed scales, nectaries, appendages or colour streaks (nectar guides). Stamens, which equal in number but alternate with the corolla segments, are inserted at various levels on the tube, the slender filaments bearing delicate versatile anthers which dehisce by longitudinal slits. In Centaurium the stamens coil tightly after anthesis. Exceptional variation in pollen grains occurs among genera but this character is evidently not closely correlated with any other floral character although it has been used unsatisfactorily in support of phylogenies. Gelatinous pollen is produced in Gentiana *parryi* and others, where the orientation of the anthers may vary between the closed gentian type and those species with open corollas. The style, which may be short to long, undivided or bilobed, usually terminates in a distinct stigma. Placentation is parietal. The superior ovary contains numerous anatropous (or half-anatropous) ovules; these mature into minute seeds, each provided with copious endosperm in which the small embryo is embedded.

Insect pollination is general in the family. Both oligotropic species (*i.e.,* obligate to specific insects), for example, Gentiana subgenus Cyclostigma where such long-tongued Lepidoptera as the diurnal hawk moths are vecters, and facultative species (*i.e.,* non-obligate), for example, Gentiana lutea where the nectar is accessible to all visitors, are recognized. Although Centaurium and Chlora are nectarless, they are visited by Lepidoptera; perhaps here the twisting of the stamens which are easily intercepted by the insect aids in pollination. Dimorphism obtains in Menyanthes, Nymphoides and some true gentians. It has been observed in the dimorphic Menyanthes that when only long-styled flowers occur in a marsh, ripe fruits fail to be produced.

Bitter principles are widespread in the vegetative parts, especially in the rhizomes and roots, and have fostered their use in medicine; *e.g.,* in Gentiana lutea and others. See GENTIAN. (J. A. EN.)

GENTILE, GIOVANNI (1875–1944), Italian philosopher and politician, was born at Castelvetrano (Trapani) on May 30, 1875. He studied literature and philosophy at the University of Pisa and, after a series of university appointments, became in 1917 professor of the history of philosophy in the University of Rome. From 1903 to 1922 he collaborated with Benedetto Croce in editing the periodical La *Critica.* Though he soon developed a philosophy of his own, he remained a friend of Croce until 1924, when they disagreed over Fascism. As minister of education in the Fascist government from Oct. 1922 to July 1924, Gentile carried out an organic reform of Italian education; and as president of two commissions for the reform of the constitution he contributed to laying the foundations of the Fascist corporative state (1925). Later, though he was made president of the supreme council of education (1926–28), a member of the Fascist grand council (1925–29) and president of various cultural institutions, his political influence steadily declined. From 1925 to 1943 he planned and edited the Enciclopedia *Italiana.* After Sept. 8, 1943, he adhered to the Fascist government established at Salò and was made the president of the Accademia d'Italia. He was killed in Florence by anti-Fascist partisans on April 15, 1944.

Gentile's philosophy is an extreme form of monistic idealism. He denies the existence of individual minds and of any distinction between theory and practice, subject and object, past and present. blind is the absolute, and education is the process of revelation of the absolute. In this sense education is always self-education and is ultimately identical with philosophy. Gentile's interest in education and his warm and forceful style of writing explain his great popularity among teachers and educational reformers before 1935. Later his pupils went their own ways; their views continued to be expressed in the Giornale critico della filosofia italiana, founded by Gentile in 1920.

Among Gentile's numerous works, which include editions of Giordano Bruno, Tommaso Campanella, G. B. Vico, Vincenzo Cuoco. Antonio Rosmini, Vincenzo Gioberti and Spinoza (with a commentary) and a translation of Kant's Krifik der *reinen Vernunft,* are: La filosofia di Marx (1899); Dal Genovesi *al Galluppi* (1903), a volume of the Storia della filosofia italiana; *Il* modernismo (1909); Bernardino Telesio (1911); I problemi della scolastica e *il pensiero italiano* (1913); La riforma della dialettica hegeliano (1913); Sommario di pedagogia come scienza *filosofica,* 2 vol. (1913–14); *Teoria generale dello spirito come atto puro* (1916; Eng. trans., *Theory of Mind as Pure Act,* 1922); *I fondamenti della filosofia del diritto* (1916); *Sistema di logica come teoria del conoscere* (1917–23); *Le origini della filosofia contemporanea in Italia,* 4 vol. (1917–23); *Il problemo scolastico del dopoguerra* (1920); *La riforma dell' educazione* (1920; Eng. trans., *The Reform of Education,* 1923); *Studi sul Rinascimento* (1923); *Bertrando Spaventa* (1924); *Il fascismo al governo della scuola* (1924); *Che cosa è il fascismo* (1925); *Manzoni e Leopardi* (1928); *La filosofia dell' arte* (1931); *Memorie italiane* (1936); and *La mia religione* (1943). (A. D. Mo.)

GENTILE, in the English Bible, the term generally applied to those who were not of the Jewish race. It is an adaptation of the Lat. *gentilis,* of or belonging to the same *gens,* "the clan" or "family." In post-Augustan Latin *gentilis* meant "national," belonging to the same race. Later it meant "foreign," *i.e.,* other than Roman, and was used in the Vulgate with *gentes,* to translate the Hebrew *goyyim,* "nations," the non-Israelitish peoples. It is also used by Mormons of all who are not Mormons. (A. L. W.)

GENTILE DA FABRIANO (*c.* 1370–1427), Italian painter, was the first great Umbrian master. He was born at Fabriano and about 1411 went to Venice, where by order of the doge and senate he was engaged to adorn the great hall of the palace with frescoes from the life of Barbarossa. He executed this work so entirely to the satisfaction of his employers that they granted him a pension for life and accorded him the privilege of wearing the habit of a Venetian noble. These paintings, which influenced the development of Venetian art, are unfortunately no longer extant. About 1320 Gentile went to Florence, where in 1423 he painted an "Adoration of the Magi" for the church of Sta. Trinita, which is preserved in the Gffizi at Florence and is considered his best work now extant. Another fine example of his work is a "Madonna and Child" (1425), the central panel of an altarpiece, in Buckingham palace, London. The wings of this altarpiece are in the Uffizi. Gentile attained a wide reputation, and was engaged to paint pictures for various churches, more particularly Brescia, Siena. Perugia and Orvieto. In 1427 he was called to Rome by Pope Martin V to adorn the church of St. John Lateran with frescoes. Michelangelo said of him that his works resembled his name, meaning noble or refined. They are full of a quiet joyousness, and show a naïve delight in splendour and in gold ornaments.

ALINARI

"ADORATION OF THE MAGI" BY GENTILE DA FABRIANO. IN THE UFFIZI GALLERY, FLORENCE

GENTILESCHI (Lomi), **ARTEMISIA** and **ORAZIO,** Italian painters.

Orazio Gentileschi (*c.* 1562–*c.* 1647) is commonly named Orazio Lomi de' Gentileschi. He was born in Pisa and studied under his half brother Aurelio Lomi. He afterward went to Rome and painted frescoes in Sta. Maria Maggiore, in the Lateran and in S. Niccolo in Carcere; he was associated with the landscape painter Agostino Tassi, executing the figures for the landscapes of this artist. Among his best works are: "The Circumcision" in the church of Gesu at Ancona; "The Madonna and St. Clara" in the Casa Rosei at Fabriano; "The Annunciation" in S. Siro, Genoa; "The Finding of Moses" in the Prado, Madrid; "SS. Cecilia and Valerian" in the Brera. Milan; a "Flight Into Egypt" in the Louvre, Paris, and another in the Belvedere, Vienna; and "Joseph and Potiphar's Wife" at Hampton court. At an advanced age Gentileschi went to England at the invitation of Charles I, being employed in the palace at Greenwich. Van Dyck included him in his portraits of a hundred illustrious men. His works generally are strong in shadow and positive in colour. He died in England about 1647.

Artemisia Gentileschi (1597–after 1651), Orazio's daughter, studied first under Guido Reni, acquired much renown for portrait painting and considerably excelled her father's fame. She was a beautiful and elegant woman; her likeness, painted by her own hand, is to be seen in Hampton court. Her most celebrated composition is "Judith and Holofernes," Wadsworth Atheneum. Hartford, Conn., certainly a work of singular energy. She went to England about 1638 and painted many portraits there. Artemisia refused an offer of marriage from Agostino Tassi and married Pier Antonio Schiattesi, continuing, however, to use her own surname. She settled in Naples, to which she returned from England, and was commissioned to paint three pictures for the cathedral of Pozzuoli. Her style was violent. characterized by brilliant colour.

GENTILI, ALBERICO (1552–1608), Italian jurist who has great claims to be considered the founder of the science of international law, was born on Jan. 14, 1552. at San Ginesio, Macerata, Italy. After taking the degree of doctor of civil law at the University of Perugia, and holding a judicial office at Ascoli, he returned to San Ginesio and was entrusted with the task of recasting its statutes. In 1579, however, as a result of his Protestant opinions, he was obliged to flee, first to Carniola in Austria and then to England. By the autumn of 1580 he had reached Oxford, and shortly afterward was qualified to teach by being admitted to the same degree which he had taken at Perugia. His lectures on Roman law soon became famous. The dialogues, disputations and commentaries which he published henceforth in rapid succession established his position as a civil lawyer and secured his appointment in 1587 to the regius professorship of civil law. It was, however, by his application of the old learning to the new questions suggested by modern international relations that Gentili produced his most lasting results. In 1584 he was consulted by the government as to the proper course to be pursued with Bernardino de Mendoza, the Spanish ambassador, who had been detected in plotting against Elizabeth I. Shortly afterward he developed his opinion on this question into a book, the *De legationibus libri tres* (1585). In 1588 Alberico published in London the *De jure belli commentatio prima.* A second and a third *Commentatio* followed, and the whole of this material, with many additions and improvements, appeared at Hanau, Prussia, in 1598 as the *De jure belli libri tres.* It nas doubtless in consequence of the reputation gained by these uorks that Gentili became henceforth more and more engaged in forensic practice, resided chiefly in London and left his Oxford work to be partly discharged by a deputy. In 1600 he was admitted to Gray's Inn, and in 1605 was appointed standing counsel to the king of Spain. He died on June 19. 1608, and was buried in the churchyard of St. Helen's, Bishopsgate. His notes of the cases in which he was engaged for the Spaniards were posthumously published in 1613 at Hanau as *Hispanicae advocationis libri duo.* This was ın accordance with his last wishes; but his direction that the remainder of his manuscripts should be burned was not complied nith Fifteen volumes of them found their way, in 1805, from Amsterdam to the Bodleian library at Oxford.

In contrast with earlier writers who had dealt with various international questions singly and with submission to the decisions of the church, Gentili examined as a whole the relations of states to one another and attempted the solution of the problems involved by principles entirely independent of the authority of Rome. He used the reasonings both of the civil and of the canon law, combined them with the *Jus Naturae* and identified this with the consent of the majority of nations, by which historical precedents were to be criticized and, when this appeared to be necessary, set aside.

His writings have many faults. His style is prolix, obscure and to the modern reader pedantic; but a comparison of the De jure belli with the treatises of Pierino Belli. Dominico Soto or even Balthasar Ayala shows that he greatly improved upon his predecessors, not only by the fullness with which he worked out points of detail, but also by clearly separating the law of war from martial law, and by placing the subject upon a foundation independent of theological differences. A comparison of the same work with the De *jure* belli ac *pacis* (1625) of Hugo Grotius, moreover, reveals the latter's indebtedness to Gentili not only for much of his illustrative erudition but also for what is commendable in his method and arrangement.

The principal works on international law by Gentili have been republished and translated in the "Classics of International Law Series" on behalf of the Division of International Law of the Carnegie Endowment for International Peace: De legationibus libri tres, two volumes, English translation by G. J. Laing, introduction by E Nys (1924); De *jure* belli libri tres, two volumes, English translation by J. C. Rolfe, introduction by C. Phillipson (1933); and Hispanicae advocationis libri duo, two volumes. English translation and introduction by F. F. Abbott (1921). (T. E. HD.; X.)

GENTILI, LUIGI (ALOYSIUS BONAVENTURA FRANCESCO CAMILLUS GENTILI) (1801–1848), Italian Roman Catholic missionary to England, was born in Rome on July 14. 1801, the son of a Roman lawyer. As a young advocate, Gentili showed strong social ambitions, especially among the aristocratic English colony in Rome, and taught languages privately with notable success. But he suddenly abandoned society to join Antonio Rosmini-Serbati (*q.v.*) in 1830 in his new Institute of Charity. which trained priests dedicated to special duties. In 1835 Gentili went to England, at the request of Bishop P. A. Baines, to assist in organizing the new Roman Catholic college at Prior Park. near Bath. Later (1840) he went to Leicestershire, to undertake missionary work in the district surrounding Grace Dieu. which Ambrose Phillipps had made the focus of a Roman Catholic revival. Through Phillipps, Gentili became acquainted with the leaders of the Tractarian movement at Oxford. Gentili's great gifts as a preacher led to demands for his services all over England, particularly in the new industrial cities, which contained large numbers of Irish immigrants. In 1846 he was appointed an itinerant missionary, to work in England and Ireland. On a mission in the Dublin slums in 1848 he contracted cholera and died on Sept 28 of that year. In addition to bringing the Rosminians to England and Wales, Gentili was responsible for introducing in England such popular devotions as the Stations of the Cross and the Forty Hours exposition of the Blessed Sacrament.

See D. R. Gwynn, Father Luigi Gentili and His Mission (*1801–1848*) (1951). (D. *G.)*

GENTLEMAN, in its original and strict signification, a term denoting a man of good family (from Lat. gentilis, "belonging to a race or gens," and "man"; the Lat. *generosus* [its invariable translation in English-Latin documents]). In this sense it is the equivalent of the Fr. gentilhomme, "nobleman," which latter term has in Great Britain been long confined to the peerage (*q.v.*): and the term "gentry" ("gentrice" from O.Fr. *genterise* for gentelise) has much of the significance of the Fr. noblesse or the Ger. *Adel.* Selden (Titles of Honor, 1672), discussing the title "gentleman," speaks of "our English use of it" as "convertible with nobilis," and describes in connection with it the forms of ennobling in various European countries. William Harrison, writing a century earlier. says "gentlemen be those whom their race and blood, or at the least their virtues, do make noble and known." But for the complete gentleman the possession of a coat of arms was in his time considered necessary.

In this way Shakespeare himself was turned, by the grant of a coat of arms, from a "vagabond" into a gentleman.

The fundamental idea of "gentry," symbolized in this grant of coat-armour, had come to be that of the essential superiority of the fighting man; and, as Selden points out (p. 707), the fiction was usually maintained in the granting of arms "to an ennobled person though of the long Robe wherein he hath little use of them as they mean a shield." At the last the wearing of a sword on all occasions was the outward and visible sign of a "gentleman"; and the custom survives in the sword worn with "court dress." This idea that a gentleman must have a coat of arms, and that no one is a "gentleman" without one is, however, of comparatively late growth, the outcome of the natural desire of the heralds to magnify their office and collect fees for registering coats; and the same is true of the conception of "gentlemen" as a separate class. That a distinct order of "gentry" existed in England very early has, indeed, been often assumed, and is supported by weighty authorities. Thus, the late Professor Freeman (Ency. Brit. xvii. p. 540 b, 9th ed.) said: "Early in the 11th century the order of 'gentlemen' as a separate class seems to be forming as something new. By the time of the conquest of England the distinction seems to have been fully established." Stubbs (*Const. Hist.,* ed. 1878, iii. 544, 548) takes the same view. Sir George Sitwell, however, has conclusively proved that this opinion is based on a wrong conception of the conditions of mediaeval society, and that it is wholly opposed to the documentary evidence. Even so late as 1400 the word "gentleman" still only had the sense of generosus, and could not be used as a personal description denoting rank or quality, or as the title of a class. Yet after 1413 we find it increasingly so used; and the list of landowners in 1431, printed in Feudal Aids, contains, besides knights, esquires, yeomen and husbandmen, a fair number who are classed as "gentilman."

Sir George Sitwell gives a lucid explanation of this development. The immediate cause was the statute 1 Henry V. cap. v. of 1413, which laid down that in all original writs of action, personal appeals and indictments, in which process of outlawry lies, the "estate, degree or mystery" of the defendant must be stated, as well as his present or former domicile. Now the Black Death (1349) had put the traditional social organization out of gear. Before that the younger sons of the *nobiles* had received their share of the farm stock, bought or hired land, and settled down as agriculturists in their native villages. Under the new conditions this became increasingly impossible, and they were forced to seek their fortunes abroad in the French wars, or at home as hangers-on of the great nobles. These men, under the old system, had no definite status; but they were generosi, men of birth, and, being now forced to describe themselves, they disdained to be classed with franklins (now sinking in the social scale), still more with yeomen or husbandmen; they chose, therefore, to be described as "gentlemen." On the character of these earliest "gentlemen" the records throw a lurid light. According to Sir George Sitwell (p. 76), "the premier gentleman of England, as the matter now stands, is 'Robert Erdeswyke of Stafford, gentilman,'" who had served among the men-at-arms of Lord Talbot at Agincourt (ib. note). He is typical of his class. "Fortunately — for the gentle reader will no doubt be anxious to follow in his footsteps — some particulars of his life may be gleaned from the public records. He was charged at the Staffordshire Assizes with housebreaking, wounding with intent to kill, and procuring the murder of one Thomas Page, who was cut to pieces while on his knees begging for his life." If any earlier claimant to the title of "gentleman" be discovered, Sir George Sitwell predicts that it will be within the same year (1414) and in connection with some similar disreputable proceedings.

From these unpromising beginnings the separate order of "gentlemen" was very slowly evolved. The first "gentleman" commemorated on an existing monument was John Daundelyon of Margate (d. c. 1445); the first gentleman to enter the House of Commons, hitherto composed mainly of "valets," was "William Weston, gentylman"; but even in the latter half of the 15th century the order was not clearly established. As to the connection of "gentilesse" with the official grant or recognition of coat-armour, that is a profitable fiction invented and upheld by the heralds; for coat-armour was but the badge assumed by gentlemen to distinguish them in battle, and many gentlemen of long descent never had occasion to assume it, and never did. This fiction, however, had its effect; and by the 16th century, as has been already pointed out, the official view had become clearly established that "gentlemen" constituted a distinct order, and that the badge of this distinction was the heralds' recognition of the right to bear arms. It is unfortunate that this view, which is quite unhistorical, has of late years been given a wide currency in popular manuals of heraldry.

In this narrow sense, however, the word "gentleman" has long since become obsolete. The idea of "gentry" in the continental sense of *noblesse* is extinct in England, and is likely to remain so, in spite of the efforts of certain enthusiasts to revive it *(see* A. C. Fox-Davies, *Armorial Families,* Edinburgh, 1895). That it once existed has been sufficiently shown; but the whole spirit and tendency of English constitutional and social development tended to its early destruction. The comparative good order of England was not favourable to the continuance of a class, developed during the foreign and civil wars of the 14th and 15th centuries, for whom fighting was the sole honourable occupation. The younger sons of noble families became apprentices in the cities, and there grew up a new aristocracy of trade. Merchants are still "citizens" to William Harrison; but he adds "they often change estate with gentlemen, as gentlemen do with them, by mutual conversion of the one into the other." A frontier line between classes so indefinite could not be maintained, especially as in England there was never a "nobiliary prefix" to stamp a person as a gentleman by his surname, as in France or Germany. The process was hastened, moreover, by the corruption of the Heralds' College and by the ease with which coats of arms could be assumed without a shadow of claim; which tended to bring the "science of armory" into contempt. The word "gentleman" as an index of rank had already become of doubtful value before the great political and social changes of the 19th century gave to it a wider and essentially higher significance. The change is well illustrated in the definitions given in the successive editions of the *Encyclopedia Britannica.* In the 5th edition (1815) "a gentleman is one, who without any title, bears a coat of arms, or whose ancestors have been freemen." In the 7th edition (1845) it still implies a definite social status: "All above the rank of yeomen." In the 8th edition (1856) this is still its "most extended sense"; "in a more limited sense" it is defined in the same words as those quoted above from the 5th edition; but the writer adds, "By courtesy this title is generally accorded to all persons above the rank of common tradesmen when their manners are indicative of a certain amount of refinement and intelligence."' The Reform Bill of 1832 has done its work; the "middle classes" have come into their own; and the word "gentleman" has come in common use to signify not a distinction of blood but a distinction of position, education and manners. The test is no longer good birth, or the right to bear arms, but the capacity to mingle on equal terms in good society. In its best use, moreover, "gentleman" involves a certain superior standard of conduct, due, to quote the 8th edition once more, to "that self-respect and intellectual refinement which manifest themselves in unrestrained yet delicate manners." The word "gentle," originally implying a certain social status, had very early come to be associated with the standard of manners expected from that status. Thus by a sort of punning process the "gentleman" becomes a "gentle-man." This use develops through the centuries, until in 1714 we have Steele, in the *Tatler* (No. 207), laying down that "the appellation of Gentleman is never to be affixed to a man's circumstances, but to his Behaviour in them," a limitation over-narrow even for the present day. In this connection, too, may be quoted the old story, told by some—very improbably—of James II., of the monarch who replied to a lady petitioning him to make her son a gentleman, "I could make him a nobleman, but God Almighty could not make him a gentleman." Selden in referring to similar stories "that no Charter can make a Gentleman, which is cited as out of the mouth of some great Princes that have said it," adds that "they without question understood Gentlemen for *Gcnerosus* in the ancient sense, or as if it came from *Gentilis* in that sense, as *Gentilis* denotes one of a noble Family, or indeed for a Gentleman by birth." For "no creation could make a man of another blood than he is." The word "gentleman," used in the wide sense with which birth and circumstances have nothing to do, is necessarily incapable of strict definition. For "to behave like a gectleman" may mean little or much, according to the person by whom the phrase is used; "to spend money like a gentleman" may even be no great praise; but "to conduct a business like a gentleman" implies a standard at least as high as that involved in the phrase *"noblesse oblige."* In this sense of a person of culture, character and good manners the word "gentleman" has supplied a gap in more than one foreign language.

The evolution of this meaning of "gentleman" reflects very accurately that of English society; and there are not wanting signs that the process of evolution, in the one as in the other, is not complete. The indefinableness of the word mirrors the indefinite character of "society" in England; and the use by "the masses" of "gentleman" as a mere synonym for "man" has spread *pari passu* with the growth of democracy. It is a protest against implied inferiority, and is cherished as the modern French *bourgeois* cherishes his right of duelling with swords, under the *ancien régime* a prerogative of the *noblesse.* Nor is there much justification for the denunciation by purists of the "vulgarization" and "abuse" of the "grand old name of gentleman." Its strict meaning has now fallen completely obsolete. Its current meaning varies with every class of society that uses it. But it always implies some sort of excellency of manners or morals. **(W. A. P.; X.)**

GENTZ, FRIEDRICH VON (1764–1832), German publicist and statesman, was born at Breslau on May 2, 1764. His father was an official, his mother an Ancillon, distantly related to the Prussian minister of that name. On his father's transference to Berlin, as director of the mint, the boy was sent to the Joachimsthal gymnasium there; his brilliant talents, however, did not develop until, at the university of Konigsberg, he fell under the influence of Kant. But though his intellect was sharpened and his zeal for learning quickened by the greater thinker's influence, Kant's "categorical imperative" did not prevent him from yielding to the taste for wine, women and high play which pursued him through life.

His interest in public affairs was first aroused by the outbreak of the French Revolution, which he greeted at first with enthusiasm; but its subsequent developments cooled his ardour and he was converted to more conservative counsels by Burke's *Essay on the French Revolution,* a translation of which into German (1794) was his first literary venture. This was followed (1795) by translations of works on the Revolution by Mallet du Pan and Mounier. He also founded and edited a monthly journal, the *Neue deutsche Monatssckrift,* in which for five years he wrote, mainly on historical and political questions, maintaining the principles of British constitutionalism against those of revolutionary France. The knowledge he displayed of the principles and practice of finance was especially remarkable. His literary output at this time, all inspired by a moderate Liberalism, included an essay on the results of the discovery of America, and another, written in French, on the English financial system *(Essai sur l'état de l'administration des finances de la Grande-Bretagne,* London, 1800). Especially noteworthy, however, was the *Denkschrift* or *Missive* addressed by him to Frederick William III on his accession (1797), in which, *inter alia,* he urged upon the king the necessity for granting freedom to the press and to commerce. Opposition to France was the inspiring principle of the *Historisches Journal* founded by him in 1799–1800, which once more held up English institutions as the model, and became in Germany the mouthpiece of British policy toward the revolutionary aggressions of the French republic. In 1801 he ceased the publication of the *Journal,* and issued instead, under the title *Beiträge zur Geschichte,* etc., a series of essays on contemporary politics. The first was *Uber den Ursprung und Charakter des Krieges gegen die franzosische Revolution* (1801), by many regarded as Gentz's masterpiece.

This activity brought him reputation and gifts of money from the British and Austrian governments; but it made his position as an official in Berlin impossible, for the Prussian government had no mind to abandon its attitude of cautious neutrality. A separation from his wife also made it desirable for Gentz to leave the Prussian service. In May 1802, accordingly, he took leave of his wife and left with his friend Adam Miiller for Vienna. In Berlin he had been intimate with the Austrian ambassador, Count Stadion, whose good offices procured him an introduction to the emperor Francis. The immediate result was the title of imperial councillor, with a yearly salary of 4,000 gulden (Dec. 6, 1802); but he was not actively employed until 1809 Before returning to Berlin to make arrangements for transferring finally to Vienna, Gentz paid a visit to London, where he made the acquaintance of Pitt and Granville, who guaranteed him an annual pension by the British government in recognition of the value of his writings against Bonaparte. From this time forward he was engaged in a ceaseless polemic against every fresh advance of the Napoleonic power and pretensions; he denounced the recognition of Napoleon's imperial title, and drew up a manifesto of Louis XVIII against it. The formation of the coalition and the outbreak of war for a while raised his hopes, in spite of his lively distrust of the competence of Austrian ministers; but the hopes were speedily dashed by Austerlitz and its results. Gentz used his enforced leisure to write a brilliant essay on "The relations between England and Spain before the outbreak of war between the two powers" (Leipzig, 1806); and shortly afterward appeared Fragmente aus der neuesten Geschichte des *politischen Gleichgewichts* in *Europa* (trans. Fragments on the Balance of Power in Europe, London, 1806). This latter, the last of Gentz's works as an independent publicist, was a masterly expose of the actual political situation, and at the same time prophetic in its suggestions as to how this should be retrieved: "Through Germany Europe has perished, through Germany it must rise again."

He realized that the dominance of France could only be broken by the union of Austria and Prussia, acting in concert with Great Britain. He watched with interest the Prussian military preparations and, at the invitation of Count Haugwitz, went at the outset of the campaign to the Prussian headquarters at Erfurt, where he drafted the King's proclamation and his letter to Napoleon. The writer was known, and it was in this connection that Napoleon referred to him as "a wretched scribe named Gentz, one of those men without honour who sell themselves for money." In this mission Gentz had no official mandate from the Austrian government, and whatever hopes he cherished of privately influencing the situation in the direction of an alliance between the two German powers were dashed by the Jena campaign.

The downfall of Prussia left Austria the sole hope of Germany and of Europe. Gentz, who from the winter of 1806 onward divided his time between Prague and the Bohemian watering-places, occupied himself with a series of essays on the future of Austria and the best means of liberating Germany and redressing the balance of Europe.

In 1809, on the outbreak of war between Austria and France, Gentz was for the first time actively employed by the Austrian government under Stadion; he drafted the proclamation announcing the declaration of war (April 15), and during the continuance of hostilities his pen was ceaselessly employed. But the peace of 1810 and the fall of Stadion once more dashed his hopes, and he again retired to Prague. It was not till 1812 that there sprang up between him and Metternich the close relations that were to ripen into life-long friendship. But when Gentz returned to Vienna as Metternich's adviser. he was no longer the fiery patriot who had sympathized and corresponded with Stein in the darkest days of German depression and called upon all Europe to free itself from foreign rule. Disillusioned and cynical. though clear-sighted as ever, he was henceforth before all things an Austrian, more Austrian on occasion even than Metternich; as when, during the final stages of the campaign of 1814, he expressed the hope that Metternich would substitute "Austria" for "Europe" in his diplomacy and secure an Austro-French alliance by maintaining the husband of Marie Louise on the throne of France.

From 1812, for ten years Gentz was in closest touch with all the great affairs of European history, the assistant, confidant and adviser of Metternich. He accompanied the chancellor on all his journeys; was present at all the conferences that preceded and followed the war; no political secrets were hidden from him; and he drafted all important diplomatic documents. He was secretary to the congress of Vienna (1814–1815) and to all the congresses and conferences that followed, up to that of Verona (1822). and his vast knowledge of men and affairs made him a power. He was under no illusion as to their achievements; his memoir on the work of the congress of Vienna is at once an incisive piece of criticism and a monument of his own disillusionment. But the liberalism of his early years was gone and he had become reconciled to Metternich's view that, in an age of decay, the sole function of a statesman was to "prop up mouldering institutions." It was the hand of the author of that offensive Missive to Frederick William III, on the liberty of the press, that drafted the Carlsbad decrees; he inspired the policy of repressing the freedom of the universities; and noted in his diary as "a day more important than that of Leipzig" the session of the Vienna conference of 1819, in which it was decided to make the convocation of representative assemblies in the German states impossible, by enforcing the letter of article XIII of the Act of Confederation. He died June 9, 1832.

Gentz has been described as a mercenary of the pen, but he was more than the "wretched scribe" sneered at by Napoleon. That he was in the habit of receiving gifts from all who hoped for his backing is beyond dispute. Yet he never made any secret of these gifts; Metternich was aware of them, and he never suspected Gentz of writing or acting in consequence against his convictions. No man was more free or outspoken in his criticism of the policy of his employers than this apparently venal writer.

Indeed, the very impartiality and objectivity of his attitude make the writings of Gentz such illuminating documents for the period. Allowance must of course be made for his point of view, but less so perhaps than in the case of any other writer so intimately concerned with the policies which he criticizes.

A selection ot Gentz's works (*Ausgewählte Schriften*) was published by Weick in 5 vol. (1836–38); his lesser works (Mannheim, 1838–40) in 5 vol. and *Mémoires* et lettres *inédites* (Stuttgart, 1841) were edited by G. Schlesier. Subsequently there have appeared Briefe an *Chr. Garve* (Breslau, 1857), correspondence (*Briefwechsel*) with Adam Muller (Stuttgart, 1857); Briefe an Pilat, 2 vol. (Leipzig, 1868), Aus dem *Nachlass Friedrichs* von Gentz, 2 vol., ed. Count Anton Prokesch-Osten (Vienna, 1867); *Aus* der alten Registratur der *Staats-Kanzlei*; Briefe *politischen Inhalts* von und an Frzedrzch von *Gentz,* edited by C. von Klinckowström (Vienna, 1870); *Dépêches inédites du* chev. de Gentz *aux* Hospodars de *Valachie 1813–1828* (a correspondence on current affairs commissioned by the Austriar government), ed. Count Anton von Prokesch-Osten the younger, 3 vol. (Paris, 1876), incomplete, but partly supplemented in *Oesterreichs Teilnahme an* den *Befreiungskriegen* (Vienna, 1887), a collection of documents of the greatest value; *Zur* Geschtchte *der orientalischen* Frage: *Briefe aus* dem *Nachlass* Friedrtchs von Gentz (Vienna, 1877), ed. Count Prokesch-Osten the younger; Briefe von und an *Friedrich* von Gentz, ed F. C. Wittichen, 4 vol. (1909–13). Finally Gentz's diaries, from 1800 to 1828, an invaluable mine of authentic material, were edited by Varnhagen von Ense and published after his death under the title Tagebucher, etc. (Leipzig, 1861), new ed, 4 vol. (Leipzig, 1873).

GENUS, a category of classification ranking between the family and the species. used in biology to include a group of structurally or phylogenetically related species, or sometimes consisting of an isolated species showing unusual differentiation (monotypic genus, as *Rhoeo* discolor). Thus the species of roses collectively form the genus *Rosa*, of horses and zebras, the genus *Equus*. The genus name is the first word of a binomial scientific name and is always capitalized. *See* SPECIES. (J. M. BL.)

GEOCHEMISTRY. Geochemistry is the study of the chemistry of the earth. Chemists, geologists and geochemists have presented various definitions of the scope of geochemistry, some of which are greatly divergent, but Victor M. Goldschmidt gave the most precise definition. He formulated the three tasks of geochemistry as follows: (1) to establish the terrestrial abundance relationships of elements; (2) to account for the terrestrial distribution of elements in the geochemical spheres, for instance, in minerals and rocks of the lithosphere and in natural products of various kinds; and (3) to detect the laws governing the abundance relationships and the distribution of elements. Still another task of geochemistry is the study of the chemical evolution of the earth.

C. F. Schönbein, in 1838, was the first to use the name geochemistry. He also mapped out a program for research. K. G. Bischof and J. Roth discussed extensively the field and problems of geochemistry in books published in 1847–54 and 1879–93, respectively. F. W. Clarke and H. S. Washington, V. L. Vemadsky and A. E. Fersman, G. von Hevesy, Ida and W. Noddack and P. Niggli were among the scientists who contributed toward the making of modern geochemistry. From the 1930s, there developed a worldwide interest in the various branches of the science which is closely allied to physics, chemistry, astrophysics, geology and the biological sciences.

Further discussion of theories and concepts involved in the study of geochemistry will be found in the articles CRYSTALLOGRAPHY and MINERALOGY. Crystallization processes which are basic to understanding the geochemistry of the earth's crust are also discussed in PETROLOGY and in articles on various rocks and minerals, as FELDSPAR; PEGMATITE; OLIVINE; QUARTZ. Additional references to related articles will be found in the various sections of this article which are as follows:

I. CHEMISTRY OF THE EARTH

A. METEORITES AND GEOCHEMISTRY

Meteoritics, or the science of cosmic matter captured by the earth, supplies information about the properties and composition of nonterrestrial matter. Because the meteorites are believed by many to be fragments from the interior of a broken planet comparable with the earth in size and in general physical chemical properties, they are used to give evidence of the internal structure of the earth and of the general geochemical character and abundance of the elements. The meteorites are chiefly composed of three phases—metal, silicate and sulfide.

According to the predominance of the metal or the silicate phase, the meteorites are divided into three principal groups: irons (siderites), stony-irons (siderolites) and stones (aerolites). The tektites, commonly believed to be glass meteorites, make a fourth group. The constituents of the meteorites are called meteorite minerals, and many of them are identical with the minerals found in terrestrial rocks of a corresponding chemical composition. Several meteorite minerals have no terrestrial counterparts.

The most important meteorite minerals are kamacite and taenite (both nickel-iron); olivine, clinoenstatite-clinohypersthene, diopside-hedenbergite, augite, enstatite-hypersthene, and plagioclase (silicates); and, as accessory constituents, troilite and oldhamite (sulfides), schreibersite (phosphide), cohenite (carbide), graphite and quartz.

TABLE *I.—Average Chemical Composition of Meteorites*
(In weight percentage)

Constituent	Irons	Phase of stones	
		Metal	Silicate
Fe	90.78	88.58	13.25*
Ni	8.59	10.69	0.50 (NiO)
Co	0.63	0.71	0.03 (CoO)
SiO_2			46.26
Al_2O_3			3.45
Cr_2O_3			0.51
MnO			0.38
MgO			27.56
CaO			2.90
Na_2O			1.10
K_2O			0.25
P			0.17
TiO_2			0.15
H_2O			0.59
Total	100.00	99.98	97.10

*From FeO and Fe_2O_3.

The chemistry of the meteorites is of geochemical importance. The average chemical composition of irons, the metal phase of stones and the silicate phase of stones is presented in Table I according to H. Brown and C. Patterson.

The average chemical composition of all meteorites serves as a basis of computation of the relative terrestrial and cosmic abundance of the elements. An uncertainty affecting all such calculations is the difficulty of estimating the relative amounts of meteorite phases.

TABLE II.—*Average Chemical Composition of All Meteorites**

Element	Per cent by weight	Element	Per cent by weight
O	32.30	Mn	0.21
Fe	28.80	K	0.15
Si	16.30	Cl	0.10–0.15?
Mg	12.30	Ti	0.13
S	2.12	Co	0.12
Ni	1.57	P	0.11
Al	1.38	C	0.03
Ca	1.33	Cu	0.02
Na	0.60	Zn	0.01
Cr	0.34		

*Based on a ratio silicate phase: sulfide phase: metal phase of 10:1:2.

For Goldschmidt's calculation, based on the ratio of stones to irons equal to 5:1, see Table II. The tektites resemble chemically the aluminum-rich clay sediments. They may represent the uppermost part of the silicate shell of the hypothetical broken planet from which the meteorites proper may have been derived. *See* also METEORITES; TEKTITE.

B. ABUNDANCE AND ORIGIN OF ELEMENTS

1. Abundance of Elements. — The surface layer of the silicate shell of the earth (the lithosphere) is composed of three groups of rocks of different origin—igneous, sediments and sedimentary, and

TABLE *111.—Chemical Composition of the Uppermost Lithosphere*
(In weight percentage)

Constituent	Igneous rocks*	Cordilleran and Appalachian rocks†	re-Cambrian rocks of Finland‡	Canadian Shield§
SiO_2	59.14	61.64	67.45	63.08
Al_2O_3	15.34	15.71	14.63	16.75
Fe_2O_3	3.08	2.91	1.27	2.38
FeO	3.80	3.25	3.13	2.91
MgO	3.49	2.97	1.69	1.78
CaO	5.08	5.06	3.39	4.07
Na_2O	3.84	3.40	3.06	3.64
K_2O	3.13	2.65	3.55	3.07
Subtotal	96.90	97.59	98.17	97.68
H_2O	1.15	1.23	0.79	0.80
TiO_2	1.05	0.76	0.41	0.80
P_2O_5	0.30	0.26	0.11	0.22
MnO	0.12	0.16	0.04	0.02
Total	99.52	100.00	99.52	99.52

*From F. W. Clarke and H. S. Washington. †From A. Knopf. ‡From J. J. Sederholm. §From F. Grout.

metamorphic. The last two groups are composed of material ultimately derived from igneous rocks. Consequently, the average chemical composition of the uppermost lithosphere is very nearly equal to the average chemical composition of igneous rocks. Beginning in the 1880s, calculations have been made of the mean chemical composition of igneous rocks. Among the representative ones. the averages of Clarke and Washington, based on 5,159 analyses of igneous rocks from all parts of the world, along with some other computations, are presented in Table III. The averages of J. J. Sederholm and F. F. Grout include also sedimentary and metamorphic rocks. It appears that the areal averages in which the quantitative distribution of the various rock types is considered are all more silicic than the world-wide average. Sederholm's and Grout's averages indicate a granodioritic composition, that is, granitic with more plagioclase feldspar than orthoclase, for the rocks of the Pre-Cambrian areas investigated.

The calculations in Table III show that eight elements constitute the bulk of the uppermost lithosphere. These main elements are oxygen, silicon, aluminum, iron, calcium, sodium, potassium and magnesium. When calculated as elements, the values of Clarke and Washington yield the composition for igneous rocks indicated in Table IV. All other elements, collectively called accessory or minor or trace, make 1.72% of the total mass of the igneous rocks. Table IV also shows the composition of the igneous rocks in percentage by volume, as recalculated by T. F. W. Barth on a water-free basis. The high oxygen content indicates that oxygen fills out most of the space in the lithosphere; the lithosphere is actually an oxysphere.

TABLE IV.—The Eight Main Constituents of Igneous Rocks

Element	Per cent by weight	Per cent by volume	Element	Per cent by weight	Per cent by volume
O	46.42	91.83	Ca	3.61	1.50
Si	27.59	0.83	Na	2.83	1.64
Al	8.08	0.79	K	2.58	[illegible]
			Mg	2.09	[illegible]
Fe	5.08	0.58	Total	98.28	99.94

The trace-element content of igneous rocks is usually determined by means of physical methods used in analytical chemistry. such as spectrochemical and colourimetric analysis and radioactivity methods. The abundance of all elements in them is listed in Table V. The abundance values for several elements are rather unreliable, and some have been determined only in composite mixtures of argillaceous, or clayey, rocks. The investigation of the abundance relationships of the elements reveals a picture that differs from the conventional opinion of abundance.

TABLE V.—Abundance of Elements in Igneous Rocks
(In parts per million)

Z	Element	Abundance	Z	Element	Abundance	Z	Element	Abundance
0	*n*	...	34	Se	0.09	68	Er	2.47
1	H	*	35	Br	1.62	69	Tm	0.20
2	He	0.003	36	Kr	*	70	Yb	2.66
3	Li	22	37	Rb	350	71	Lu	0.75
4	Be	2	38	Sr	220	72	Hf	4.5
5	B	3	39	Y	28.1	73	Ta	2.1
6	C	320	40	Zr	185	74	W	1.5; 69
7	N	46.3	41	Nb	24	75	Re	0.05
8	O	466,000	42	Mo	1	76	Os	*
9	F	700	43	Tc	†	77	Ir	0.001
10	Ne	0.00007	44	Ru	*	78	Pt	0.005
11	Na	28,300	45	Rh	0.001	79	Au	0.005
12	Mg	20,900	46	Pd	0.01	80	Hg	0.077; 0.5
13	Al	81,300	47	Ag	0.10	81	Tl	1.3
14	Si	277,200	48	Cd	0.15	82	Pb	15
15	P	1,180	49	In	0.11	83	Bi	0.2
16	S	520	50	Sn	40	84	Po	0.0000000003
17	Cl	314	51	Sb	1 (?)	85	At	*
18	A	0.04	52	Te	0.0018 (?)	86	Rn	*
19	K	25,900	53	I	0.3	87	Fr	*
20	Ca	36,300	54	Xe	*	88	Ra	0.0000013
21	Sc	20	55	Cs	6	89	Ac	0.0000000003
22	Ti	4,400	56	Ba	1,000	90	Th	11.5
23	V	150	57	La	18.3	91	Pa	0.0000008
24	Cr	200	58	Ce	46.1	92	U	4
25	Mn	1,000	59	Pr	5.53	93	Np	*
26	Fe	50,000	60	Nd	23.9	94	Pu	*
27	Co	23	61	Pm	†	95	Am	‡
28	Ni	80	62	Sm	6.47	96	Cm	‡
29	Cu	55	63	Eu	1.06	97	Bk	‡
30	Zn	111	64	Gd	6.36	98	Cf	‡
31	Ga	16	65	Tb	0.91	99	E	†
32	Ge	7	66	Dy	4.47	100	Fm	†
33	As	5	67	Ho	1.15	101	Mv	†

*Present. †Presence unsettled. ‡Presence probable.

In everyday life, the commonness or rarity of an element is usually mistaken for the commonness of its use in technical products and the like, that is, for its apparent abundance. For instance, gold and silver are less abundant in igneous rocks than are the relatively little used rare-earth metals (lanthanoids, or lanthanides) and hafnium.

There are considerable differences in the abundance of elements in terrestrial igneous rocks (Table V) and in meteorites (Table II). The meteoritic and cosmic abundance values indicate that the chemical composition of the uppermost lithosphere does not agree with the average chemical composition of matter in the universe. The reason for this difference is the manner of formation of the lithosphere by a process of chemical differentiation.

Table V shows that elements with an even proton number (atomic number, Z) are nearly always more abundant than their odd-numbered neighbours. This regularity, known as the rule of Oddo and Harkins, is based on observations made by G. Oddo and W. D. Harkins. The rule is still more evident when the cosmic abundance of elements is considered; this is well illustrated by Goldschmidt's graph in fig. 1. Geochemically coherent elements (*i.e.,* elements accompanying one another in nature) give examples of the rule. The abundance of the lanthanoids is particularly illustrative. (See fig. 2, which is based on analyses of E. Minami.)

The abundance values of Table V refer to the elements as natural mixtures of nuclides. Tabulations showing the relative cosmic abundance of the nuclides are based on the cosmic abundance of the elements and on their isotopic constitution. The abundance graph showing the abundance as a function of the mass number of the nuclides describes the general trend in cosmic abundance adequately. It shows a rapid, approximately exponential, decrease in abundance with increasing mass number up to a mass of approximately 100 and its essential constancy thereafter. The rule of Oddo and Harkins is valid also with reference to mass number.

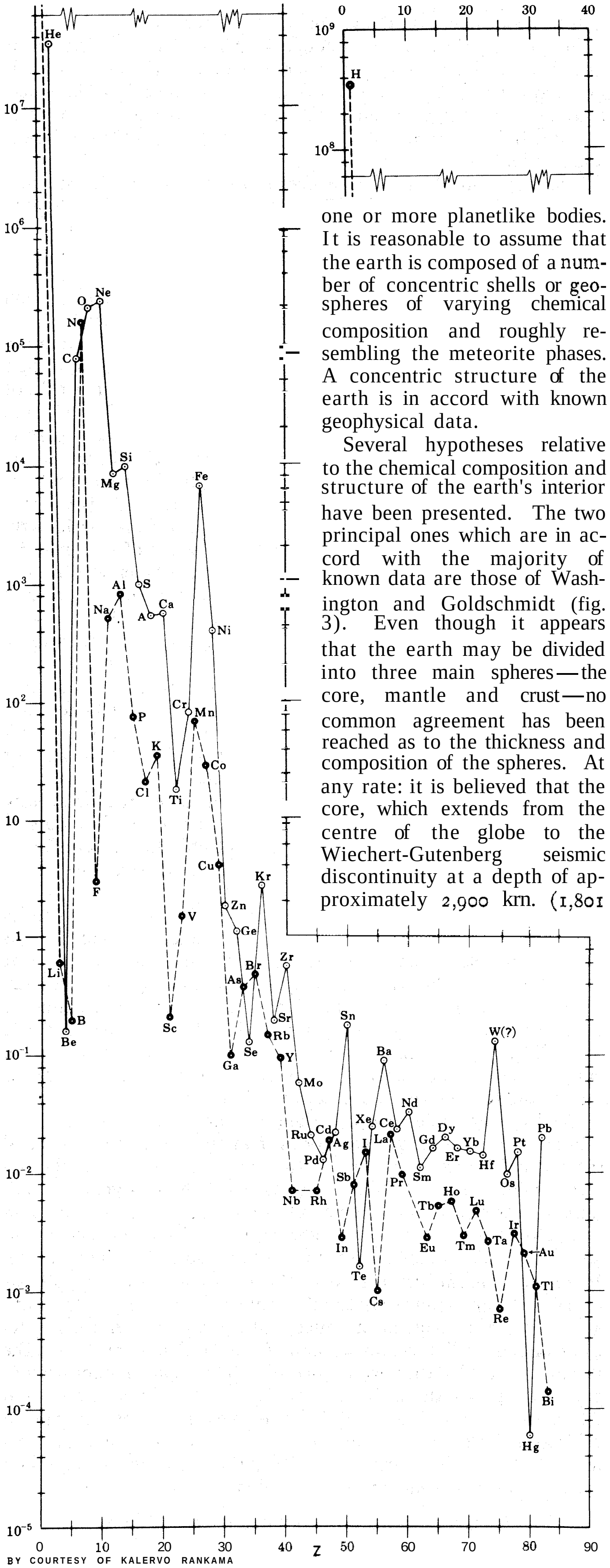
Numerous rules exist correlating the abundance with the proton, neutron and mass numbers of the nuclides; however, they possess a number of exceptions marked by abrupt changes in abundance. Such exceptions are connected with changes in the structure of the atomic nucleus.

2. Origin of Elements.— The existence of radioactive nuclides indicates that elements have not always existed in their present form. The relationships between cosmic abundance and nuclear properties make the basis of many speculations dealing with the origin of elements and the abundance of nuclides at the time of their formation. It is generally agreed that the relative abundance of nuclides was determined by physical conditions existing in an early stage of the expansion of the universe, when the density of matter and temperature were exceedingly high.

The hypotheses dealing with the origin and abundance distribution are of two principal categories, namely, the equilibrium and the nonequilibrium hypotheses. According to the former, the observed abundance distribution represents a thermodynamic equilibrium between nuclei. The equilibrium hypothesis explains in a satisfactory way only the abundance of the light and heavy nuclides and fails to explain reasonably the whole abundance range. In the nonequilibrium category, the neutron-capture hypothesis explains the abundance distribution chiefly as a result of the radiative capture of neutrons by nuclei, of a number of nuclear reactions among the lightest nuclei, and of radioactive decay among the unstable nuclides that were formed. The neutron-capture hypothesis explains the deficiency of lithium, beryllium, boron and fluorine (fig. 1) and many abundance rules, including the rule of Oddo and Harkins. None of the hypotheses is capable of answering completely the question of the making of the nuclides and the origin of their abundance distribution.

C. Geochemical Structure of the Earth

A. Boisse in 1850 was the first to suggest that the bulk chemical composition of the earth is comparable with the average chemical composition of the meteorites. This qualitative analogy has been used in the construction of various earth models, because it is most likely that the meteorites are derived from the different depths of



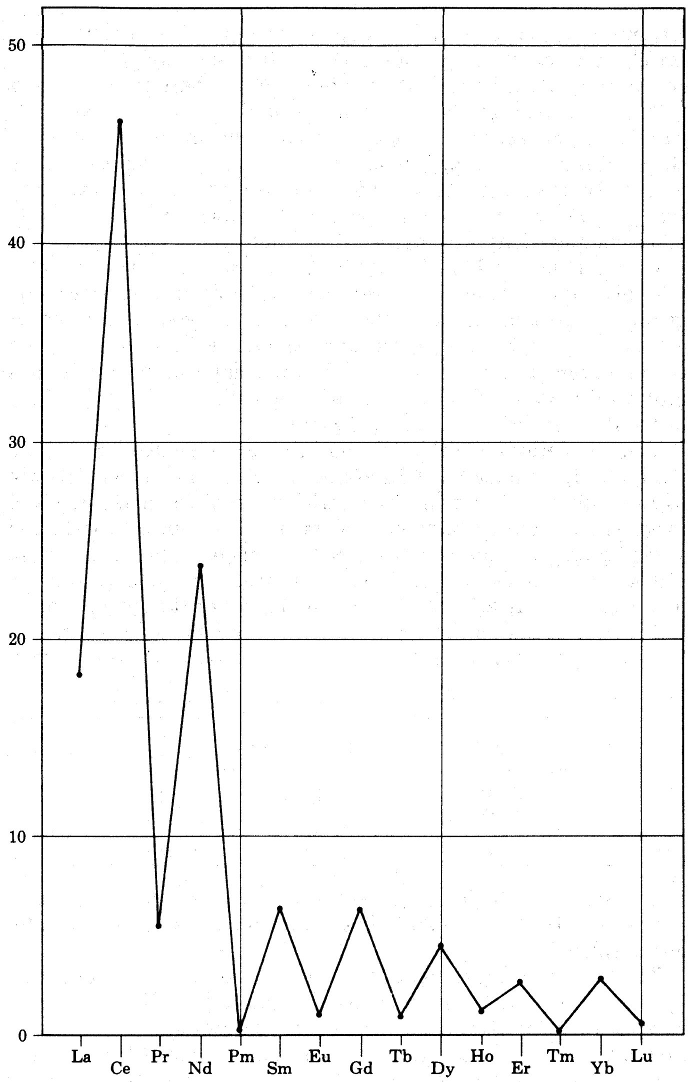
BY COURTESY OF KALERVO RANKAMA

FIG. 1.— SEMILOGARITHMIC PLOT OF COSMIC ABUNDANCE OF NATURAL ELEMENTS PER 10.000 ATOMS Si (SILICON) AS A FUNCTION OF PROTON NUMBER Z

Open circles represent an even proton number, filled circles an odd number. The two sections of the graph join as indicated by broken line

one or more planetlike bodies. It is reasonable to assume that the earth is composed of a number of concentric shells or geospheres of varying chemical composition and roughly resembling the meteorite phases. A concentric structure of the earth is in accord with known geophysical data.

Several hypotheses relative to the chemical composition and structure of the earth's interior have been presented. The two principal ones which are in accord with the majority of known data are those of Washington and Goldschmidt (fig. 3). Even though it appears that the earth may be divided into three main spheres—the core, mantle and crust—no common agreement has been reached as to the thickness and composition of the spheres. At any rate: it is believed that the core, which extends from the centre of the globe to the Wiechert-Gutenberg seismic discontinuity at a depth of approximately 2,900 km. (1,801 mi.), consists of metallic nickel-iron and corresponds to the pure iron meteorites. Most geophysicists and geologists agree in principle on a mantle composed of silicates and interstitial nickel-iron that increases in amount with depth. The mantle occupies the depth zone between approximately 2,900 km. (1,801 mi.) and approximately 30 km. (18.6 mi.) or 50 km. (31.1 mi.), the Mohorovicic discontinuity, or the upper boundary of the earth's mantle (see EARTHQUAKES: Earthquake Waves). In the crust, the continental areas consist of three continental layers, namely: a deep-seated intermediate layer, probably intermediate between basalt and granite in composition; a granitic layer above the intermediate layer; and a sedimentary layer composed of sediments, sedimentary and metamorphic rocks. In the Pacific basin, the continental layers are totally absent, and the uppermost gabbroic (basaltic) layer of the mantle is in almost direct contact with the ocean.



BY COURTESY OF KALERVO RANKAMA

FIG. 2.— ABUNDANCERELATIONS OF LANTHANOIDS IN SHALES

In addition to the shells or geospheres mentioned, three outermost geochemical spheres are distinguished. They are the hydrosphere, which consists of the salt and fresh waters and the continental ice; the atmosphere, or the gaseous outer envelope of the earth; and the biosphere, which comprises the living matter and is the part of the earth capable of sustaining biological activity. The biosphere occupies the lower part of the atmosphere and probably the whole hydrosphere, and makes a thin layer on the lithosphere.

D. DISTRIBUTION OF ELEMENTS

If shells of different composition exist in the earth, the elements will be distributed among them in fixed proportions. Their distribution is studied by means of meteorites and the separation of metal, sulfide and silicate phases in ore-smelting furnaces. Three elements—iron, oxygen and sulfur—their mutual affinity relationships, and the affinity of other elements for them are largely responsible for the distribution of the elements in the core, the mantle and the crust.

In Goldschmidt's geochemical classification the elements are divided into three main affinity groups. The siderophile elements are preferentially enriched in the nickel-iron core (siderosphere), the chalcophile elements in the sulfide-oxide shell (chalcosphere), and the lithophile elements in the silicate crust (lithosphere). The most typical elements of the atmosphere are called atmophile elements and those typical of the biosphere, biophile elements.

Thermochemical considerations indicate that lithophile elements have higher free energy of formation of oxide than does bivalent iron, while the elements with lower energy of formation of oxide are siderophile or chalcophile. Several exceptions to this rule indicate that the distribution is controlled also by isomorphic substitution. In the observed distribution of the elements between metal and sulfide phases there is little or no agreement with free-energy data of sulfides. In general, the geochemical character of an element depends largely on the electron configuration of its atom.

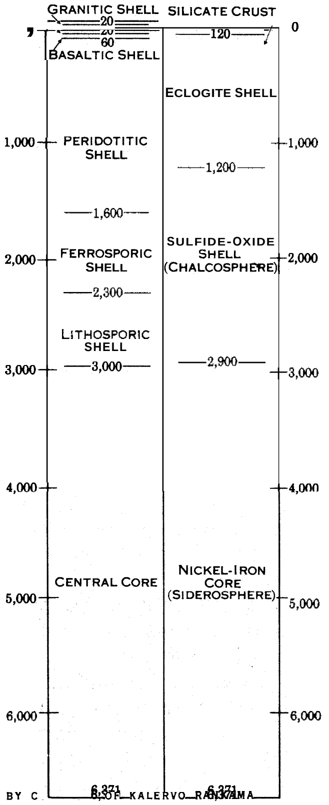


FIG. 3.—INTERNAL CONSTITUTION OF THE EARTH
(A) Hypothesis of H. S. Washington; (B) of V. M. Goldschmidt. Numbers refer to depths in kilometres

Used in a purely chemical sense without reference to any supposed distribution among the geochemical spheres the terms siderophile, chalcophile and lithophile are illustrative and prove useful for many geochemical purposes. The geochemical classification of the elements is shown in Table VI. It appears that the geochemical character is not sharply established for all elements, not even in strictly specified surroundings.

II. GEOCHEMISTRY OF THE LITHOSPHERE

The elements present in the lithosphere are appropriately divided into two groups on the basis of their most important manner of occurrence. The first group comprises the elements that occur largely or exclusively combined with oxygen in oxides, silicates, phosphates, carbonates, nitrates, borates, sulfates, etc. They are called oxyphile elements. Oxygen may be replaced by fluorine and chlorine to some extent. Elements of the second group, the sulfophile elements, form preferentially minerals free of oxygen (fluorine, chlorine), that is, sulfides, selenides, tellurides, arsenides, antimonides, intermetallic compounds, native elements, etc. All intermediate steps between the two groups are represented among the minerals, because the chemical affinity of the elements for oxygen (fluorine, chlorine) and sulfur (selenium, arsenic, etc.) is determined by the free energies of formation of the corresponding natural silicates and sulfides. Isomorphic substitution, that is, replacement of an element by another related element, may in some instances cause an element to become distributed between the silicate and sulfide phases in a manner that deviates from that expected from its affinity properties. Consequently several siderophile and chalcophile elements possess a more or less oxyphile character in the lithosphere. (See Table VII.)

TABLE VII.—*Typical Oxyphile Elements*

H Li				N		F
Na						
K	Ca	Sc	Ti	V	Cr	Mn
Cs	Ba	La-Lu	Hf	Ta	W	
	Ra	Ac-Mn				

A. CRYSTAL CHEMISTRY

The quantity of an element in a mineral does not adequately explain its role in the mineral structure. The structural positions occupied by the atoms and ions of an element in minerals essentially affect the manner of occurrence of the element. The properties of atoms and ions and the crystal structures of minerals largely regulate the incorporation of elements in minerals and, consequently, strongly affect their geochemical behaviour. The effective size of an atom or an ion in a structure (its atomic or ionic radius) depends on the nature of the binding forces between neighbouring particles, the electronic configuration of the particle, its polarization properties and co-ordination, *i.e.*, the number and arrangement of the neighbouring particles. (See Table VIII.)

The ionic bond predominates in the structures of important rock-making minerals, and the structures of the feldspars, pyroxenes, amphiboles and many other minerals may be considered essentially ionic. But in some other minerals, for instance, in sulfides, the structure differs very considerably from an ionic structure, and the ionic radii cannot be applied to such structures.

The length of the ionic radius depends on the position of the element in the periodic system. First, the radius decreases in each period when passing from left to right, for instance, in the series Na^+, Mg^{2+}, Al^{3+}, Si^{4+}, P^{5+}, S^{6+}. Second, in the groups and subgroups the ionic radius increases toward the higher atomic numbers, as in the series Li^+, Na^+, K^+, Rb^+, Cs^+. The lanthanoids, or the elements from lanthanum to lutecium, inclusive, make an exception to this rule, as the radii of their trivalent cations decrease with increasing atomic number. This phenomenon is called lanthanoid contraction and is a result of changes in the atomic structure of the lanthanoids. It is of high geochemical importance because it affects the geochemistry of the lanthanoids and of the elements to follow them in the periodic system. The ionic radii of the last mentioned elements are smaller than they would be in the absence of lanthanoid contraction, *e.g.*, the radius of the Hf^{4+} ion resembles closely the radius of the Zr^{4+} ion, and the similarity in space requirements along with the close chemical similarity makes hafnium and zirconium a geochemically high coherent pair of elements. alnays accompanying each other in nature.

In the actinoid (actinide) series a similar contraction (actinoid contraction) exists. Its geochemical importance is limited to the actinoids. It explains the relationship between uranium and thorium in some minerals.

The radius of the Li^+ ion is abnormally great and explains the substitution of magnesium by lithium in many silicate minerals.

TABLE VI.—*Geochemical Classification of the Elements*

Siderophile (Core)	Chalcophile (Mantle)	Lithophile (Crust)	Atmophile (Atmosphere)	Biophile (Living Organisms)
Au Ge Sn (Pb) C P (As) Mo (W) Re Fe Co Ni Ru Rh Pd Os Ir Pt	Cu Ag Zn Cd Hg Ga In Tl (Ge) (Sn) Pb As Sb Bi (Mo) S Se Te Fe (Co) (Ni) (Ru) (Pd) (Pt)	Li Na K Rb Cs Fr Be Mg Ca Sr Ba Ra (Zn) (Cd) B Al Sc Y La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu Ac Th Pa U Np Pu Am Cm Bk Cf Ga (In) (Tl) C Si Ti Zr Hf (Ge) (Sn) (Pb) V Nb Ta P (As) O Cr W Mn (Fe) (Co) (Ni) H F Cl Br I	H C N O I Hg He Ne A Kr Xe Rn	H C N O P (Na) (Mg) (S) (Cl) (K) (Ca) (Fe) (B) (F) (Si) (Mn) (Cu) (I)

TABLE VIII.—*Radii* in kX Units of Ions of Geochemical Importance*

Ion	Radius	Ion	Radius	Ion	Radius	Ion	Radius
Ag^+	1.26	Eu^{3+}	0.98	Na^+	0.97	Se^{2-}	1.98
Al^{3+}	0.51	F^-	1.33	Nb^{4+}	0.74	Se^{6+}	0.42
As^{3+}	0.58	Fe^{2+}	0.74	Nb^{5+}	0.69	Si^{4-}	2.71
As^{5+}	0.46	Fe^{3+}	0.64	Nd^{3+}	1.04	Si^{4+}	0.42
Au^+	1.37	Ga^{3+}	0.62	$[NH_4]^+$	1.48	Sm^{3+}	1.00
B^{3+}	0.23	Gd^{3+}	0.97	Ni^{2+}	0.69	Sn^{4-}	2.94
Ba^{2+}	1.34	Ge^{4+}	0.53	O^{2-}	1.40	Sn^{4+}	0.71
Be^{2+}	0.35	H^-	2.08	$[OH]^-$	1.41	Sr^{2+}	1.12
Bi^{3+}	0.96	Hf^{4+}	0.78	Os^{4+}	0.69	Ta^{5+}	0.68
Bi^{5+}	0.74	Hg^{2+}	1.10	P^{5+}	0.35	Tb^{3+}	0.93
Br^-	1.95	Ho^{3+}	0.91	Pa^{3+}	1.13	Te^{2-}	2.21
Br^{7+}	0.39	I^-	2.16	Pa^{4+}	0.98	Te^{4+}	0.70
C^{4+}	0.16	I^{5+}	0.62	Pb^{2+}	1.20	Te^{6+}	0.56
Ca^{2+}	0.99	I^{7+}	0.50	Pb^{4+}	0.84	Th^{4+}	1.02
Cd^{2+}	0.97	In^{3+}	0.81	Pd^{4+}	0.65	Ti^{3+}	0.76
Ce^{3+}	1.07	Ir^{4+}	0.68	Pr^{3+}	1.06	Ti^{4+}	0.68
Ce^{4+}	0.94	K^+	1.33	Pr^{4+}	0.92	Tl^+	1.47
Cl^-	1.81	La^{3+}	1.14	Pt^{4+}	0.65	Tl^{3+}	0.95
Cl^{7+}	0.27	Li^+	0.68	Ra^{2+}	1.43	Tm^{3+}	0.87
Co^{2+}	0.72	Lu^{3+}	0.85	Rb^+	1.47	U^{4+}	0.97
Co^{3+}	0.63	Mg^{2+}	0.66	Re^{4+}	0.72	V^{3+}	0.74
Cr^{3+}	0.63	Mn^{2+}	0.80	Rh^{3+}	0.68	V^{4+}	0.63
Cr^{6+}	0.52	Mn^{3+}	0.66	Ru^{4+}	0.67	V^{5+}	0.59
Cs^+	1.67	Mn^{4+}	0.60	S^{2-}	1.84	W^{4+}	0.70
Cu^+	0.96	Mn^{7+}	0.46	S^{6+}	0.30	Y^{3+}	0.92
Cu^{2+}	0.72	Mo^{4+}	0.70	Sb^{3+}	0.76	Yb^{3+}	0.86
Dy^{3+}	0.92	Mo^{6+}	0.62	Sb^{5+}	0.62	Zn^{2+}	0.74
Er^{3+}	0.89	N^{5+}	0.13	Sc^{3+}	0.81	Zr^{4+}	0.79

*The radii are given for 6-fold co-ordination. Cation radii are those of L. H. Ahrens, anion radii those of L. Pauling. (Exceptions: radii of $[NH_4]^+$ and $[OH]^-$)

1. Co-ordination of Particles. — The most fundamental feature of a crystal structure is the co-ordination of the particles present, *i.e.*, the number and arrangement of particles of one kind surrounding a given particle of another kind as its nearest neighbours. The co-ordination is different for different particles and structures, each particle attempting to occupy the co-ordination into which it fits best. A proper and fitting co-ordination results in strong bonds between the particles and in a stable structure. An ill-fitting and unsuitable co-ordination causes an unstable structure, *e.g.*, the co-ordination of the Zr^{4+} ion in the zircon $Zr[SiO_4]$ structure is not well suited to the space requirements of the ion and causes an unstable structure that is readily disintegrated by the action of alpha radiation (metamict alteration).

In an essentially ionic structure, the co-ordination of the cation, that is, the number and arrangement of the surrounding anions, depends largely on the cation/anion radius ratio. In the important rock-making minerals, oxygen is the principal anion, and such minerals are in fact aggregates of big oxygen ions whose interstices are filled up with the cations.

For instance, in quartz, SiO_2, oxygen makes up 98.7% by volume and silicon, only 1.3%. Consequently consideration of the co-ordination number of the cations with respect to oxygen in minerals is of importance. The co-ordination is variable, as illustrated in fig. 4, in which the cations, arranged according to their size, are plotted against the co-ordination number. The black areas indicate the approximate abundance of the co-ordinations of the ions in the upper lithosphere. The differences in the size of the area illustrate the fact that for big cations the co-ordination number is less definite because of the great size of the cation.

Because the crystal structures of almost all important minerals are known, they form a convenient basis for the classification of minerals. A structural classification of the complicated silicate minerals is particularly useful, and for the silicates the type of linkage of the silicon-oxygen tetrahedra present in their structures is a natural basis of classification. In nesosilicates the separate tetrahedral $[SiO_4]$ groupings do not share any oxygen atoms with neighbouring silicon-oxygen tetrahedra. In sorosilicates the separate groups of tetrahedra share one or more corners with neighbouring tetrahedra of the same group. The sorosilicates may consist of $[Si_2O_7]$ double tetrahedra, five tetrahedra in an open group, rings of three or six tetrahedra. The inosilicates are composed of infinite chains or double chains of silicon-oxygen tetrahedra. In the phyllosilicates there are infinite sheets of the tetrahedra, and in the tectosilicates there are continuous frameworks of linked tetrahedra sharing all four oxygen atoms with neighbouring tetrahedra.

2. Replacement of Elements. — Because minerals are rarely pure compounds, the chemical formulas usually given for them are idealized. Deviations from the ideal composition are partly a result of structural defects, but their main reason is the presence of impurities, either as mechanically admixed substances or in solid solution (in fixed positions or filling empty spaces in the structure) in the mineral. The solute may not belong to the structure of the solvent, as in the case of the occurrence of helium in beryl, or it forms a complete isomorphic (from the Greek *isos*, "equal," and *morphe*, "form") series with the solvent, as does ferrous orthosilicate $Fe_2[SiO_4]$ (fayalite), with magnesium orthosilicate $Mg_2[SiO_4]$ (forsterite), the Fe^{2+} ions occupying the structural positions of the Mg^{2+} ions. Between these t o extremes all intermediate types of solid solutions occur in minerals. Isomorphism and related phenomena are of high importance in geochemistry. If atoms and ions instead of compounds are considered. such atoms or ions occurring in a given structure are called diadochic (from the Greek diadochos, "successor") if they are capable of replacing each other, each occupying the position of the other. Consequently, forsterite and fayalite are isomorphic, but the Mg^{2+} and Fe^{2+} ions in their structures are diadochic. Diadochy may be complete or partial.

As a general rule, an ion may replace another ion diadochically if the difference in the size of their radii does not exceed approximately 15% of the radius of the ion to be replaced. Temperature affects the degree of diadochy; high temperature generally favours diadochic substitution. Complete diadochy usually requires a close similarity in ionization potential. The degree of diadochy depends on crystal structure. Finally, ionic charge affects the substitution. The charges may be similar, as in the important $Fe^{2+}-Mg^{2+}$ substitution, or the substitution ion may have lower (*e.g.*, $O^{2-}-OH^{-}-F^{-}$; $Ca^{2+}-Na^{+}$) or higher (*e.g.*, $K^{+}-Ba^{2+}-Sr^{2+}-Pb^{2+}$) charge than the ion to be replaced. If the charges are different, the electrostatic neutrality of the structure will be disturbed. Consequently, it must be re-established, for instance, by the simultaneous substitution of another ion in the structure, as in the substitution of $Ca^{2+}Al^{3+}$ by $Na^{+}Si^{4+}$ in the plagioclase feldspars (see FELDSPAR), or by the introduction of balancing ions outside the regular framework of the structure, or by leaving a structural position vacant.

Diadochic substitution in common rock-making minerals regulates the manner of occurrence of almost all elements in the upper lithosphere and is of particular importance for the geochemistry of the trace elements. Some trace elements may form independent minerals that are among the accessory constituents of rocks, among others, sulfur in sulfide minerals, phosphorus in apatite and monazite and fluorine in fluorite. Other trace elements, for instance, manganese, barium and vanadium, seldom, if ever, form independent minerals except in rocks in which they happen to be very strongly enriched. Theirs is a dispersed manner of occurrence. Some elements, such as lead and boron, are intermediate. Three types of diadochy regulate the dispersed manner of occurrence of the trace elements, namely camouflage, when a trace element diadochically replaces a common element of similar valence; capturing, when a trace element replaces a common element with a lower valence and is captured in the structure; and admission, when a trace element replaces a common element of higher valence. Examples are, among others, the substitution of silicon by germanium in silicate minerals (camouflage), of potassium by

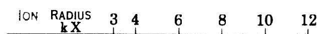


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FIG. 4—CO-ORDINATION NUMBER WITH RESPECT TO OXYGEN OF SOME GEOCHEMICALLY IMPORTANT CATIONS IN UPPER LITHOSPHERE

lead in potassium minerals (capturing) and of oxygen by fluorine in sphene and other minerals (admission).

B. Crystallization of Magma

1. Rock-Making Minerals.—Rocks are called igneous or magmatic if their material has been molten before attaining its present structure and composition. Their material may be primary magmatic or juvenile in the case of true igneous rocks, or secondary, derived by remelting of older rocks in the case of quasi-igneous or pseudoigneous rocks. Phenomena connected with the crystallization of rock melts are geochemically important.

The average chemical composition of igneous rocks approaches the composition of diorites or granodiorites. It indicates only the abundance of the elements and tells nothing about their manner of occurrence as characterized by the minerals in which they are incorporated. The mineralogy of the igneous rocks is illustrated by their average mineralogical composition presented, according to Clarke, in Table IX. The feldspars. pyroxenes, amphiboles and quartz are geochemically the most important minerals of the igneous rocks, while all other minerals are, both quantitatively and geochemically, of minor importance. The feldspars, the feldspathoids and quartz are the chief salic, or silica rich, rock-making minerals and contain Na^{+}, K^{+}, Ca^{2+} and Al^{3+} as their most typical cations. The femic, that is, comparatively low in silica, minerals contain Mg^{2+}, Fe^{2+}, Fe^{3+} and, in part, Ca^{2+} and Al^{3+}. The most important accessory minerals of igneous rocks are: zircon, sphene $CaTi\ [(O,Oh,F)|SiO_4]$, apatite $Ca_5[(F,Cl,OH)|(PO_4)_3]$; and opaque sulfides, such as pyrite FeS_2, pyrrhotite $FeS–Fe_5S_6$, chalcopyrite $CuFeS_2$, pentlandite $(Fe,Ni,Co)_9S_8$, bornite Cu_5FeS_4; also oxides (ilmenite, $FeTiO_3$; magnetite, Fe_3O_4; chromite, $FeCr_2O_4$).

Table IX.—*Average Mineralogical Composition of Igneous Rocks*
(In weight percentage)

Mineral	Content	Mineral	Content
Feldspars	59.5	Titanium minerals	1.5
Hornblende and pyroxene	16.8	Apatite	0.6
Quartz	12.0	Other rock-making minerals	5.8
Biotite	1.8	Total	100.0

Among the feldspars the most important are the various potash feldspars $K[AlSi_3O_8]$ and the plagioclase feldspars, mixtures of albite $Na[AlSi_3O_8]$ and anorthite $Ca[Al_2Si_2O_8]$. Structurally they are tectosilicates; chemically, typical aluminosilicates. The cations accommodated in feldspar structure include Na^{+}. K^{+}, Rb^{+}, Cs^{+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+} and Tl^{+}, also Fe^{3+} replacing Al^{3+}. In alkalic rocks, the feldspathoids are of equal importance as are the feldspars in calc-alkalic rocks, but their general geochemical importance is not too great. Nepheline $Na[AlSiO_4]$, and leucite β-$K[AlSi_2O_6]$, are the most important members of this petrographic group. Like the feldspars, the feldspathoids are aluminosilicates with a tectosilicate framework.

The pyroxenes and amphiboles are structurally closely related inosilicates. They consist of numerous minerals with the general formulas $R_2[Si_2O_6]$ for pyroxenes and $R_{14}[(OH)_4|Si_{16}O_{44}]$ for amphiboles. In these formulas R is Mg^{2+}, Fe^{2+}. Ca^{2+} and, in many minerals, Al^{3+}, Fe^{3+}, Ti^{3+}, Mn^{3+}, Mn^{2+}, Na^{+}, K^{+}, Li^{+}, etc. In amphiboles, the OH– group is partly replaced by O^{2-} or by F^{-}. Pyroxene species include, among others, enstatite $Mg_2[Si_2O_6]$ and augite, which contains Na^{+}, Ca^{2+}, Mg^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+} and Ti^{3+} as cations, Three pyroxene series occur in igneous rocks and pyroxene minerals are always mixtures. The augites are among the most important mafic constituents of igneous rocks. The amphiboles are chemically more complicated than the pyroxenes, and no simple structural formulas can be given for them because of the great number of possible diadochic substitutions. The hornblendes, in which R is Na^{+}, K^{+}, Ca^{2+}, Mg^{2+}, Fe^{2+}, Fe^{3+}, Al^{3+} and Ti^{3+}, are geochemically the most important amphiboles. In augites and amphiboles, particularly in hornblende~as much as one-fourth of the Si^{4+} ions may become replaced by Al^{3+}.

Some igneous rocks contain olivines as their principal constituents. The most important olivines are members of the forsterite-fayalite series. Olivines are nesosilicates. Quartz is a tectosilicate. The existence of free silica in igneous rocks is the result of the high abundance of silicon in the upper lithosphere.

Among the micas, which are aluminosilicates with a phyllosilicate structure, biotite $K(Mg,Fe,Mn)_3[(OH,F)_2|AlSi_3O_{10}]$ and muscovite $KAl_2[(OH,F)_2|AlSi_3O_{10}]$ are the most important species. Biotite is the most common mica in igneous rocks. There also exist KMg, NaAl and CaAl micas, and some varieties are known that are characterized by a high content of trace elements, such as lithium, barium, chromium, vanadium, manganese and titanium. The possibilities of diadochic substitution in the micas are numerous, just as in the pyroxenes and the amphiboles.

2. Chemical Differentiation of Rock Melts.—The igneous rocks are chemically widely variable, and rocks with a chemical composition similar to the average composition of igneous rocks are rare. Because it is believed that the original silicate crust of the earth was chemically rather homogeneous, the assumption follows that the igneous rocks are products of an extensive chemical differentiation in the crust. It is believed that the plateau basalts represent the parental magma that differentiated to produce all primary magmatic rocks present in the upper lithosphere. The changes in chemical composition caused by magmatic differentiation are geochemically important.

The general course of crystallization of a calc-alkalic basaltic magma comprises three stages: the early, the main and the late magmatic. Silicates (dunite, anorthosite), sulfides (pyrrhotite-pentlandite assemblage) and oxides (ilmenite, chromite, magnetite) will separate during this stage. The igneous rock series from gabbros through diorites to granites is the product of fractional crystallization during the main stage. The bulk of the volatile constituents of the magma will become enriched in the residual melts and solutions and separate in pegmatites and in pneumatolytic and hydrothermal deposits during the late magmatic stage. Escape of volcanic emanations completes the course of crystallization. The boundaries between the different stages are not very rigid becduse the processes are continuous.

The early magmatic stage incorporates the separation of much iron and sulfur, and the bulk of copper, nickel, titanium and chromium from the rock melt. Many ore bodies containing these elements are formed during this stage.

3. The Reaction Series.—The course of crystallization of calc-alkalic silicate rocks during the early and the main stage of differentiation may be described by the reaction series that contains both the mafic (dark) and the felsic (light) minerals. The reaction series, introduced by N. Bowen in 1922. is one of the cornerstones of petrology; fig. 5 shows it as a somewhat modified statement of the normal sequence of crystallization of calc-alkalic rocks.

In the right-hand branch containing the light constituents the framework of the Si-0-A1 tetrahedra in the mineral structures remains unchanged. whereas in the left-hand branch of the dark constituents the framework changes with proceeding crystallization from independent tetrahedra through chains and double chains to sheets. The stabilitv of the structures decreases in the same order.

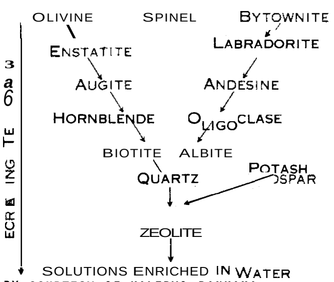

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Fig. 5.—Reaction Series
(see text for further information)

The general course of crystallization proceeds from ultramafic rocks 'through subsilicic and intermediate types to the silicic rocks largely as a result of fractional crystallization. The principal types of calc-alkalic rocks produced are dunite and anorthosite. gabbro, diorite and granite. Among other chemical changes the Fe/Mg ratio increases toward the later stages of crystallization. Magnesium and calcium are concentrated during the early stages of crystallization, while silicon, sodium and potassium become enriched in the silicic rocks. With respect to crystal chemistry, the course of crystallization is governed by forces that tend to capture the structural constituents of minerals from the melt with a low degree of order and to arrange them into structures with a high degree of order. The formation of the various minerals may be explained, as F. E. Wickman has done, by means of kinetic reasoning with temperature as an essential function. A given amount of energy is required to move an ion from a position with a given co-ordination to another position with a different co-ordination. The energy required is called the migration energy (the activation energy of the migration of the ion) and depends on the co-ordination, size and charge of the ion, the degree of order in the structure, temperature and pressure. The fact that the migration energy depends on ionic size explains the general separation of Mg^{2+} during an early, and of Fe^{2+} during a late stage of crystallization. Both ions are 6-co-ordinated in the olivine structure, but the size of the Mg^{2+} ion is closer to the optimum size required by 6-co-ordination, and consequently the migration energy of Mg^{2+} in the olivine structure is greater than the migration energy of Fe^{2+} therein. If two cations are of equal size but of different charge, the cation with the higher charge has the greater migration energy. The difference in migration energy between Na^+ and Ca^{2+} explains the order of crystallization of the plagioclase feldspars. The Na^+ ion with the smaller migration energy is the more mobile of the two ions, and consequently calcic plagioclases separate at higher temperatures than do the sodic plagioclases.

The properties of the Si–O framework determine the order of crystallization of forsterite and enstatite. Enstatite will crystallize before augite because of the absence of Ca^{2+} in its structure and the ensuing higher stability thereof. The separation of the amphiboles after the pyroxenes may be explained by differences in the Si–O framework, chiefly by the linkage differences of the Mg^{2+} ions. Micas crystallize after hornblende because the mica structure is still weaker and more unstable than the amphibole structure. Also, the K^+ ion is rather loosely bound in the structure. In alkalic rocks, the sequence of separation may be entirely different, particularly when certain nepheline syenites are formed. The light constituents may then be the first minerals to separate.

4. Residual Melts and Solutions. — After the close of the main stage of crystallization residual solutions will often remain that are rich in hyperfusible constituents, especially water. Pegmatites are produced during the differentiation of these liquors. Pegmatites of granites and nepheline syenites, or of the last rocks to form during the main stage of crystallization, are rather common. Elements too scarce to make independent minerals and those of ionic size unsuitable for their being incorporated in the rock-making minerals become gradually concentrated in the magmatic residues and separate in the pegmatites. Such elements are, among others, lithium, beryllium, boron, fluorine, rubidium, cesium, niobium, tantalum, uranium and the lanthanoids. Uranium, niobium, tantalum and a part of the lanthanoids are predominantly concentrated in granite pegmatites, whereas other lanthanoids, zirconium and often thorium are enriched in the nepheline syenite pegmatites. The pegmatites may be divided chemically according to the abundance relationships of sodium and potassium **versus** aluminum. In agpaitic pegmatites $Na+K>Al$, while in plumasitic pegmatites $Na+K<Al$ (the names are from locations of occurrences of type specimens in Iceland and California respectively). The different pegmatites have different typical minerals.

Strictly speaking, the formation of pegmatites marks the end of magmatic crystallization. No sharp boundary can be established between the pegmatitic stage and the ensuing pneumatolytic and hydrothermal stages. When a superheated aqueous solution containing dissolved silicates and other substances crystallizes at a temperature higher than the critical temperature of water vapour (374.5° C.), the deposits formed are called pneumatolytic. If crystallization temperature is lower than the critical temperature, the minerals and rocks formed are said to be hydrothermal.

Alkali feldspars, micas, quartz and characteristic minerals containing rare elements are the chief minerals formed during the pegmatitic stage; mineral veins are the most important among pneumatolytic and hydrothermal deposits. Many heavy metals separate in the veins and may form ore bodies. The veins contain many sulfophile elements either in the native state or as oxides, sulfides, selenides, tellurides, arsenides, antimonides and various sulfosalts. After deposition of most of their metallic constituents the dilute hydrothermal solutions may deposit quartz and zeolites and minerals containing volatile constituents such as boron compounds and carbon dioxide, if these are present in the solutions.

5. Volcanic Emanations. — In volcanoes the volatile constituents of the magmas escape as volcanic emanations into the atmosphere, dissolve in water, and form volcanic sublimates around the craters and vents.

Water vapour, carbon dioxide, nitrogen and native and combined sulfur are the quantitatively most important constituents of the emanations, but notable local and areal changes in their constitution are observed. Some of the constituents derive from the magma (juvenile constituents), while others come from the earth's surface (superficial constituents) or from the atmosphere (meteoric constituents). The temperature of the emanations and the time elapsed since the start of the volcanic activity also affect the composition of the emanations.

Geochemically, the volcanic emanations are of high importance because of their character as products of the degassing of the earth. They affect essentially the manner of occurrence and the geochemical cycle of many elements. Such elements as chlorine, sulfur and boron (all abundant in volcanic emanations) are directly supplied to the atmosphere and hydrosphere by volcanic emanations and will participate in geochemical processes on the earth's surface.

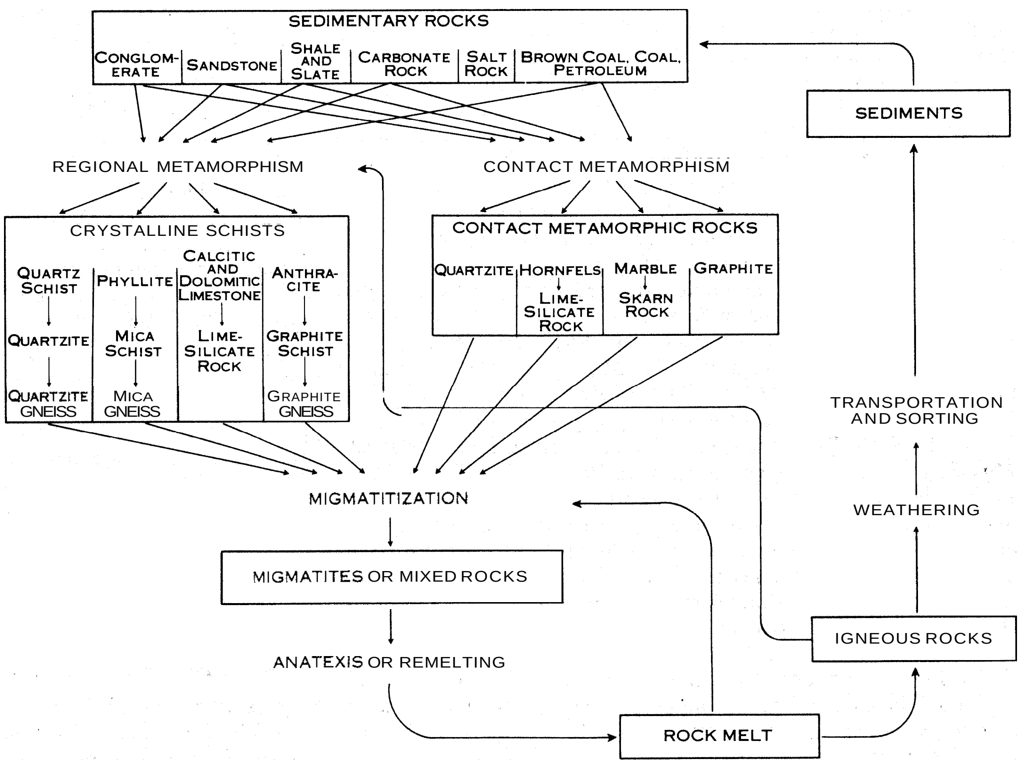

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FIG. 6. — THE MAJOR CYCLE OF MATTER

c. The Exogenic (Minor) Cycle

The upper lithosphere is the seat of numerous geochemical processes that affect its chemical composition both locally and areally. All matter on the surface of the earth and in the uppermost parts of the lithosphere participates in a slow complicated migration, or cycle, that causes more or less pronounced changes in the structure and chemical composition of rocks. New rocks with new properties are produced in this cycle. The migration of matter consists of the exogenic (the product of outside forces), or minor cycle taking place under the direct influence of atmospheric and hydrospheric agents and the major cycle, a material part of which is confined to the uppermost levels of the lithosphere.

In the exogenic cycle the elements behave differently, depending on their individual properties and in accordance with laws that differ basically from the rules valid for the crystallization of rock melts. The migration, consequently, yields products whose formation cannot be explained by the laws of magmatic crystallization. The exogenic cycle starts with solid crystalline rocks and ends in sedimentary rocks. It forms only a part of the major cycle. Unlike the major cycle, which is closed, the exogenic cycle, taking place only in one direction, is largely open and is closed only for sedimentary rocks. For all other rocks this cycle is irreversible.

The course of the exogenic cycle as a part of the major cycle is schematized in fig. 6. It consists of the weathering of rocks, transportation of products formed during weathering, and redeposition of material, usually in new surroundings. These processes are in many respects similar to a gigantic semiquantitative chemical rock analysis involving separations on a large scale. Because of its role as a separating and concentrating agent for many elements, the exogenic cycle is of importance for the manner of their occurrence in the uppermost lithosphere and on the surface of the earth.

1. Weathering of Rocks.—Rock weathering consists of a number of physical and chemical processes that gradually break down the fresh solid rocks into an aggregate of loose material, a part of which is dissolved or changed chemically, uhile another part remains unchanged. The principal agents of physical (mechanical) weathering are changes in temperature and the action of frost and of crystallizing salts. Chemical weathering is caused by the action of rain, surface and ground water and of the solids and gases dissolved therein. Oxygen, carbon dioxide, nitric acid, sulfuric acid, humic complexes, ammonia and chlorides are the most important chemically active agents in natural waters. The chemical processes taking place during weathering are rather complicated. Oxidation, reduction and action of carbon dioxide are geochemically important weathering processes.

The rock making minerals are of different stability against weathering, the mafic minerals decomposing more rapidly than the felsic minerals. The stability series of the rock-making minerals proposed by S. S. Goldich is exceedingly similar to the reaction series (fig. 5), the stability increasing from olivine and calcic plagioclase to quartz.

The solid products of completed weathering include substances that are stable under conditions existing on the earth's surface. Clay minerals, the hydroxides of ferric iron and aluminum, and their derivatives are the most abundant weathering products. The loose weathering residues and products are transported and sorted by the action of wind, flowing water, ice and organisms, and a number of chemically and physically different continental and marine sediments are thereby formed. Sorting is according to particle size but includes also chemical separation. In the course of time, deposited loose sediments may change by consolidation, recrystallization and chemical processes in diagenesis (*q.v.*); thus a sedimentary rock is formed. Several sediments and their derivatives also form from the remains of organisms, such as calcareous mud, peat and guano; and limestone, coal and phosphorite formed from them through diagenesis or decay and incoalation. They are known as biogenic sediments.

2. Geochemical Classification of **Sediments.**—According to their manner of deposition the sediments may be divided into physical (mechanical) and chemical sediments. For geochemical purposes another classification is used—that based on geochemical principles first proposed by Goldschmidt (see fig. 7).

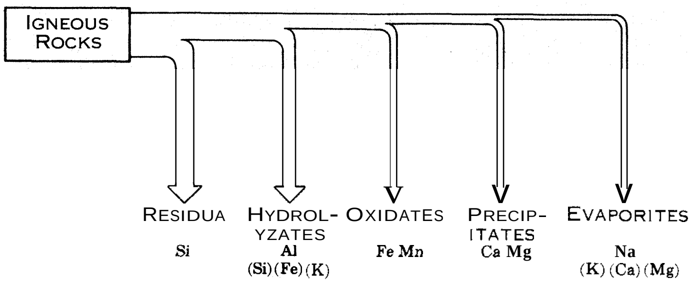

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FIG. 7.—GEOCHEMICAL CLASSIFICATION AND CHEMICAL CHARACTERISTICS OF SEDIMENTS FORMED DURING WEATHERING. TRANSPORTATION AND SEDIMENTATION

The residua consist of chemically undecomposed weathering residues, such as sands and gravels. The hydrolyzates consist partly of undecomposed. partly of hydrolytically decomposed matter. Clays are the foremost representatives of hydrolyzates. The crystalline clay minerals are the dominant constituents of clays. They are characterized by their capacity of exchanging their cations (anions) for other cations (anions) from aqueous solutions. The oxidates form by oxidation of Fe^{2+} into Fe^{3+} and of Mn^{2+} into Mn^{3+} and consist chiefly of hydroxides of the two metals. Iron and manganese ores of sedimentary origin belong to this group. The reducites, the opposites of oxidates, are formed in strongly reducing surroundings. Coal and petroleum, and muds and clays containing sulfides and carbonaceous matter are reducites. The precipitates form by inorganic precipitation from aqueous solutions. Deposits of inorganically precipitated calcium carbonate and magnesium carbonate are examples of precipitates. The evaporites are deposited from aqueous solutions as a result of evaporation of the solvent. They include extensive salt beds crystallized from sea water. The bioliths, or biogenic sediments often occur together with other sediments, *e.g.*, biogenic calcium carbonate may occur along with inorganically precipitated calcium carbonate. Because the sedimentation processes are continuous, sediments and their derivatives usually are mixtures belonging to two or three groups, and, consequently, the geochemical division of sediments is not categorical.

3. Chemistry of the **Exogenic** Cycle.—The total quantity of rocks decomposed and of sediments formed during the geological history of the earth is of great geochemical importance. The length of the time during which the exogenic agents have operated on the earth's surface is approximately 3.5×10^9 years (3,500,-000,000 yr.). Goldschmidt estimated, on the basis of the sodium content of sea water, that 160 kg. igneous rock per each square centimetre of the earth's surface have yielded a total of 169.6 $kg.cm.^{-2}$ (minimum value) of sediments. The argillaceous (clayey) and arenaceous (sandy) sediments are, quantitatively, the most important sediments produced. Another estimate based on the radioactivity of potassium gave 6,462 $kg.cm.^{-2}$ (maximum value) for the total quantity of weathered igneous rock.

The igneous rocks are formed by endogenic (produced by internal forces) differentiation deep under the earth's surface. Another kind of differentiation, called the exogenic differentiation, takes place on the surface and is intimately connected with the exogenic cycle of matter. Some elements become strongly enriched in certain types of sediments, even though a high degree of separation is not always reached. For many elements the exogenic differentiation is the most powerful concentrating and enriching agent. For instance, silicon and zirconium are concentrated in sandstones; aluminum, potassium and boron in shales; calcium, magnesium and carbon in limestones; iron, manganese and barium in oxidates; and sodium, chlorine, magnesium and sulfur in evaporites.

There are several factors of prime importance for the exogenic differentiation. Because most phenomena of the exogenic cycle are characterized by the presence of water, the physical and chemical properties of water are significant, such as the hydrogen ion concentration (pH). In most natural waters the pH is between 6 and 8. The changes in pH play an important role in the precipitation and mobilization of many elements in aqueous solutions, such as in the separation of iron and aluminum.

Because many elements occur in two or more oxidation states, oxidation and reduction are geochemically important processes. The presence of molecular oxygen and of reducing biogenic matter in the exogenic cycle indicates that here both oxidation and reduction occur in their geochemically most important surroundings. Along with the pH, the differences in the degree of oxidation or reduction cause many enrichment processes and the separation even of chemically closely related elements, such as sulfur and selenium. Iron, manganese and cobalt are often precipitated as a result of exogenic oxidation reactions. Many elements, such as sulfur. selenium and chromium, may become oxidized to complex anions that are readily transported in solution. Other elements become enriched under highly reducing conditions. For instance, descending weathering solutions from ore bodies deposit copper, silver and other metals as sulfides in reducing areas below the water table. Many rare elements are concentrated in bioliths in the original reducing environments. Biochemical processes may participate or dominate in the creation of oxidizing or reducing environments. Molecular oxygen liberated by green plants in photosynthesis is responsible for the highly oxidizing conditions on the earth's surface. On the other hand, decaying biogenic matter creates reducing conditions.

In the exogenic cycle the two extremes of the oxidizing and reducing conditions are represented by the highly oxidized residua and the strongly reducing bituminous sediments and their derivatives. During weak metamorphism, the degree of oxidation often remains unchanged, and a high degree of oxidation in rocks may afford proof of their superficial origin. With the higher grades of metamorphism, reduction will gradually take place and leads back to the reducing conditions of the rock melts.

During weathering a part of the chemically decomposed material going into solution is present as colloidal particles. A group of phenomena called geochemical sorption largely governs the properties of such particles in sediments and the distribution of elements among various sediments. The sorption of ions by colloidal particles is of high geochemical importance, for example, in the concentration of many elements (such as potassium) in clays.

Goldschmidt did show that a number of phenomena connected with the distribution of elements between sea water and sediments may be explained by considering the ionic potential of elements, that is. the charge of an ion divided by its radius. For instance, preferential adsorption of potassium in argillaceous sediments and preferential migration of sodium to the sea are in accordance with the loner ionic potential of potassium. The fixation of potassium in hydrolyzates may, however, be explained, according to C. S. Ross, by the incorporation of the K^+ ion in the structure of montmorillonite. a clay mineral. Goldschmidt divided the elements on the basis of their ionic potential into three groups, which become separated from one another during sedimentation in the sea. Wickman revised the division and gave a physical explanation to the phenomenon by means of the rules governing hydrogen and hydroxyl bonds in hydroxides. The cations with low ionic potential and ionic bonds in their hydroxides (*e.g.,* the alkali metals) generally remain in ionic solution. The cations with intermediate ionic potential and hydroxyl bonds in their hydroxides, such as aluminum, uranium and tantalum, are readily hydrolyzed and precipitate as hydroxides which are deposited in hydrolyzates. The cations nith the highest ionization potential form complex anions with oxygen, and these remain usually in solution. Nitrogen, carbon, sulfur and phosphorus, among others, belong to this group. Their complex anions have hydrogen bonds.

D. The Major Cycle

Along with the differentiation by crystallization of rock melts and the cycle of weathering, transportation and sedimentation, processes of still another kind take place in the uppermost lithosphere which cannot be included in either endogenic or exogenic differentiation. These processes, occurring at deeper levels in the crust. tend in part to distribute the elements among various rocks, but their essential role is in the opposite direction, inasmuch as they tend to level off the chemical differences already produced. They form the endogenic cycle of matter. The endogenic and exogenic cycles together form the major cycle.

The processes of the endogenic cycle start from sedimentary or igneous rocks and produce gradually a rock melt. These processes are largely, perhaps almost entirely, based on reactions taking place in the solid state. It is possible that the major cycle actually is the most important process in the chemical modeling of the upper lithosphere.

The course of the major cycle is presented in fig. 6. Unlike the exogenic. the major cycle is closed for all participating rocks. The hydrosphere, particularly the oceans, however, make a considerable leak in the cycle because of the (at least) semipermanent accumulation of many elements in sea water and in ocean-bottom sediments. The major cycle begins with molten rock and ultimately winds up with a regenerated rock melt. The melt, on cooling, will crystallize in the form of plutonic or volcanic rocks, according to the level of the seat of crystallization in the lithosphere. The true igneous rocks of juvenile origin must be distinguished from the quasi-igneous rocks that are partly or totally composed of remelted material. On the earth's surface, the rocks participate in the exogenic cycle whereby sediments are ultimately produced. The sediments and the sedimentary rocks formed from them by diagenesis may reparticipate in the exogenic cycle but may also be removed from immediate contact with the hydrosphere and the atmosphere by continuing deposition of sediments or by tectonic movements. If that is the case, they will depart from the exogenic cycle and, in the course of time, will take part in metamorphic processes.

1. Metamorphism **of** Rocks.—Metamorphism is the physical and chemical adjustment of rocks to conditions existing at the deeper levels of the upper lithosphere. Metamorphic changes are essential for the endogenic processes and may consist of purely mechanical (kinetic) metamorphism, or purely thermal metamorphism. or metasomatism, which is the introduction or removal of material by magmatic gases (pneumatolytic metamorphism), solutions (hydrothermal metamorphism), or molten rock (migmatitization in part). All these processes cause changes in both the mineralogy and chemistry of the rocks affected. Some metamorphic changes are termed autometamorphism, when they constitute reactions between a rock and the residual solutions from its crystallization. Complex controlling conditions cause regional metamorphism over wide areas under the combined influence of elevated temperature. variable pressure and high shearing stress, and plutonic metamorphism, which is the deep-seated regional metamorphism at high temperatures and pressures, often accompanied by strong deformation and augmented by injection or infiltration of molten rock or by incipient remelting. At a still greater depth, plutonic metamorphism merges into truly plutonic phenomena. Near the surface, regional metamorphism becomes gradually replaced by kinetic metamorphism. Deformation promotes and accelerates the chemical reactions incorporated in metamorphism.

Because of the complexity of the reacting system, chemical changes involved in metamorphism are usually complicated. When environmental conditions change, the minerals participating in a metamorphic reaction may become unstable and their structures mill be gradually torn down, ion by ion. Disorder is thereby created, but finally new structures different from the old ones will form. With reference to stability and composition, the new structures are adapted to new conditions. All these reactions may take place in a liquid phase, called the intergranular film, but structures may also react with one another in the solid state, whereby the ions are simply rearranged to make new structures. But some ions are alaays present that are not strictly and rigidly bound to any structure but form a separate phase, called the dispersed phase. The presence of a dispersed phase is the condition of all chemical reactions that take place in rocks. It may be a gas, or a liquid or ions temporarily detached from their original structural positions. Even in solid-state reactions the ions make up the new structure through a dispersed phase.

A process called migmatitization may set in with progressing regional metamorphism to produce migmatites. or mixed rocks, through the migration of the readily mobile elements, such as the alkali metals. and the intrusion of molten rock material into pre-existing rocks. The migmatites predominate in the deepest parts of mountain chains. The boundary of the zone of migmatitization is called the migmatite front. Many granites and associated rocks are believed to have formed by migmatitization (granitization). Metamorphism may, however, still increase in strength causing the partial remelting (anatexis) of rocks, followed by complete remelting. Thereby a rock melt is produced. and its crystallization, the starting phase of the major cycle, will set in. The most far-reaching and thorough metamorphic changes consequently mean the rebirth, or palingenesis, of rocks.

Regional metamorphism is the most common and petrologically the most important form of metamorphism. It may consist solely of changes that do not affect the bulk chemical composition of the metamorphosed rock. This is isochemical or internal metamorphism. It may also consist of substantial addition or removal of material. This is allochemical or metasomatic metamorphism, and in it the bulk chemical composition mill change.

Wholesale diffusion probably is important for the transfer of matter in metamorphism, but diffusion in the solid state. according to laboratory experiments, is insufficient to explain long-distance transport of matter. Migration through liquid and gaseous phases is also possible. and it appears that surface phenomena in the intergranular film are of great importance in controlling metasomatic metamorphism.

Metasomatic changes often pronouncedly affect the chemical composition of rocks. The substances introduced may consist of the alkali metals, calcium. iron with magnesium and silicon, boron, lithium, fluorine, chlorine, sulfur. silicon, tin and carbon dioxide, and the metasomatic changes are accordingly called alkali metasomatism, etc. These processes are little investigated quantitatively, but sometimes amounts of elements calculated in millions of tons are known to have been introduced or removed.

2. Migration in the Lithosphere. — The endogenic migration of matter in the lithosphere is characterized by its selectivity; this means that under given conditions certain elements are able to migrate more readily than others. The elements nith high atomic numbers are, in fact, relatively readily mobilized and become enriched in granites and in low-temperature assemblages in general, that is. in rocks and minerals that may be assumed to have formed through a rather notable circulation and migration of matter.

Migration is of importance in molding the chemical composition of the uppermost lithosphere. There is evidence of a global migration affecting many elements. During this migration, the elements become divided into two groups. The granitophile elements are known to be especially enriched in both igneous and quasi-igneous granites. They endeavour to concentrate in the outermost parts of the crust. The granitophobe elements. on the other hand, are pushed down toward the basaltic substratum.

Granitization (or the formation of granite by migration. anatexis and palingenesis) is one of the key processes in the geochemistry of metamorphism. P. Eskola proposed that granitization is caused by a fluid, called the granitic ichor and consisting of truly juvenile residual melts and of the melts first to become squeezed out during the partial remelting of already solidified rocks. The chief constituents of the ichor are silicon. aluminum, sodium and potassium; oxygen and hydroxyl ions also migrate therein. The ichor rises slowly into the superposed rocks giving them a granitic or granitelike composition. But it is probable that both pore solutions and ionic diffusion participate in granitization. The mobility of ions during regional metamorphism and granitization is a function of ionic radius. The Fe^{2+} and Mg^{2+} ions are very mobile and become concentrated in the so-called basic front which is the precursor of the fronts of migmatitization and granitization.

All gradations probably exist from juvenile granites to metasomatic and palingenetic granites. The formation of silicic and other rocks by metasomatic processes implies some loss of significance for the classic theory of differentiation by crystallization. This theory, however, is important as the basis of estimation of the mobility of elements in metasomatic metamorphism. See also METAMORPHISM; METASOMATISM.

III. GEOCHEMISTRY OF THE HYDROSPHERE

The lithosphere is partly covered by a water blanket called the hydrosphere: as much as 70.8% of the earth's surface is covered by water. The salt water bodies, the oceans, with a total volume of $1,370\,323 \times 10^6$ km^3 and a mass of $14,060 \times 10^{20}$ g., make by far the greatest and most important part of the hydrosphere. Salt water also occurs in some isolated areas on all continents, gathering in depressions to make alkaline or salt lakes.

Fresh water is present in the soil as ground water and in the pores of rocks as hygroscopic water. It flows to the surface of the earth as spring water, fills the ponds and lake basins. and flows in rivers and streams as surface water. The permanent fields of snon. the glaciers, inland ice and permanent ice at high altitudes all consist of frozen water. Ground water, mixed with juvenile water, that is, water that has never been to the surface, enters the volcanic emanations and hot springs. The cavities of rocks and minerals contain salt solutions that may be of primary magmatic origin, while other solutions consist of meteoric water trapped in the rocks.

According to Goldschmidt's estimate there are for every square centimetre of the earth's surface 278.11 kg of sea water. 0.1 kg. of fresh mater, 4.j kg. of continental ice and 0.003 kg. of water vapour. The absolute amount and relative proportions of the different kinds of water change continuously. Because the bulk of all water present in the hydrosphere consists of sea nater, it is appropriate to state that the composition of the hydrosphere equals the composition of ocean water. Natural waters in their various states are actually rocks formed by the mineral, water. H_2O, but they are never pure because they contain a number of dissolved gases and solids and particulate matter.

1. Ground Water. — Ground water is, essentially, of atmospheric (meteoric) origin. When the meteoric waters that contain oxygen. carbon dioxide and small amounts of dissolved substances derived from the atmosphere enter soil and rock, they incorporate the soluble inorganic and organic gases, liquids and solids available. The ground water charged with carbon dioxide and oxygen is a powerful weathering agent. Bicarbonates, sulfates and chlorides of the alkaline-earth and alkali metals are the chief constituents of ground water. Its chemical composition is constantly changed by the action of several physical and chemical agents and ranges from that of nearly pure rain water to that found in mineral wells and springs. Another kind of ground water, called connate water, contains substances that were present in solution at the time of deposition of the sediment beds soaked with such a uater.

Sulfates and carbonates are the most important constituents of spring water, whereas chloride is usually less important. Some spring waters may be rich in silica. Calcium is the most abundant cation. and consequently spring and well waters are hard. Their chemical composition and salinity depends on local conditions.

2. Surface Water. — Admixture of rain water, surface water and ground nater from elsenhere rapidly changes the chemical composition of the spring nater flowing to lakes and rivers. Precipitation, solution and pollution by sewage and industrial waste naters will affect the composition of river water, in small rivers in particular. Weathering products and the remaining original constituents of rain water are carried by rivers in their water. The amount of the ueathering products varies according to the climate and the chemical composition and physical properties of rocks and soils in the catchment area. Carbonates dominate in river water and are much in excess over sulfates and chlorides, and calcium is the principal cation. Sulfates and chlorides tend to prevail in naters from arid and semiarid regions. In tropical regions the salinity of river water is remarkably low and the dissolved solids are rich in silicon, the element essentially removed in lateritic weathering (see BAUXITE; LATERITE). With dissolved and colloidal inorganic substances surface waters contain dissolved gases, chiefly nitrogen, carbon dioxide and oxygen, and a number of organic substances.

River waters may be divided into two major groups—carbonate and sulfate. The former are the more common of the two. (See Table X.) While calcium preponderates among the cations in fresh waters, its content in the salts of sea water is rather low, and sodium predominates. Furthermore, carbonate and sulfate predominate among the anions in fresh-water salts, while chloride preponderates in sea-water salts. These differences result from the precipitation of calcium as carbonate and sulfate in lakes and seas and from incorporation of calcium carbonate in shells and skeletons by marine organisms. Removal of the compounds accounts for the relative enrichment of sodium and chlorine in sea water.

TABLE *X.—Average Chemical Composition of Dissolved Solids in Lake, River and Sea Waters*

(In weight percentage)

Constituent	Lake and River Water	Sea Water
CO_3	35.15	0.41*
SO_4	12.14	7.68
Cl	j.68	55.04
NO_3	0.00	
Ca	20.39	1.15
Mg	3.41	3.69
Na	5.79	30.62
K	2.12	1.10
Fe_2O_3, Al_2O_3	2.75	..
SiO_2	11.67	..
Sr, H_3BO_3, Br	..	0.31
Total	100.00	100.00

*As HCO_3^-

3. Mineral Springs and Hot Springs.—Waters in mineral springs and hot springs differ from ordinary well and spring waters in either concentration or composition, or both. chiefly as a result of local conditions. These waters may be classified into chloride, sulfate, carbonate and acid waters as the main types. Furthermore, there are silicate, borate, nitrate, sulfide, phosphate and mixed waters. Many mineral waters contain dissolved gases, such as carbon dioxide, hydrogen sulfide, nitrogen and inert gases. Natural brines of high salinity may contain salts dissolved from salt beds by percolating waters, salt solutions associated with petroleum deposits, or connate waters. Some trace elements are present in mineral waters, partly derived from volcanic emanations and partly leached out from surrounding rocks; the therapeutic value of mineral waters is largely caused by their presence. Juvenile waters or those of deep-seated magmatic origin are usually characterized by a notable content of heavy elements, but in waters of superficial or vadose, that is, above the water table or upper level of ground water, origin such elements commonly are totally or almost totally absent. Other differences also exist in the chemical composition of juvenile and vadose waters. Hot springs represent the closing stage of thermal activity in volcanic regions; theirs is largely surface water.

4. Closed Basins.—In semiarid and arid regions, the soluble weathering products remain in the soil or are transported to depressions. If the rate of evaporation is too rapid to allow the accumulation of any considerable body of water, great quantities of dissolved matter are deposited in the depressions and finally form alkaline or salt lakes, or even dry salt beds usually consisting of sodium, magnesium and calcium as sulfates, and of some bicarbonate. The basins devoid of an outlet receive water by rivers and streams. In the continental areas of such internal drainage, permanent reservoirs are formed that contain water concentrated by evaporation of incoming water and with a composition entirely different from the composition of sea water. Many salt lakes are in a semisolid state, and the composition of their brines varies according to local conditions. The salt and alkaline lakes are divided, according to the dominant ion, into lakes with chloride waters, characterized mainly by sodium chloride; bittern lakes rich in magnesium salts; sulfate lakes; and carbonate and bicarbonate lakes. In general, alkaline lakes are connected with volcanic areas, and saline lakes, with sedimentary rocks.

5. The Ocean.—Sea water contains dissolved salts that have escaped adsorption during the cycle of dissolved substances, and precipitation and crystallization during the history of the ocean. More than 50 elements have been detected in sea water or in marine organisms, and it is probable that all elements are found in solution in the sea. The constituents given in Table XI make up more than 99.9% of the known dissolved solids in sea water. The salt content of ocean water is usually between 3.3% and 3.8%.

TABLE *XI.—Major Constituents of Sea Water*

Ion	Content (parts per 1,000)	Ion	Content (parts per 1,000)
Cl^-	18.9799	Na^+	10.5561
SO_4^{2-}	2.6486	Mg^{2+}	1.2720
HCO_3^-	0.1397	Ca^{2+}	0.4001
Br^-	0.0646	K^+	0.3800
F^-	0.0013	Sr^{2+}	0.0133
H_3BO_3	0.0260	Total dissolved solids	34.4816

The total amount of dissolved elements in sea water is colossal, and the oceans contain vast potential supplies even of many trace elements. The relative abundance of elements in sea water differs pronouncedly from their abundance in igneous rocks. The content of silicon, aluminum and iron in sea water is rather low. Almost all elements have been available in greater quantities than are now present in sea water, and, consequently, have been removed by physical chemical processes and biological activity. Many elements participate in a constant biological cycle in the sea, and their regeneration is relatively complete, even though the marine organisms cause their redistribution in sea water. Many elements, such as iodine, calcium, carbon, phosphorus, silicon and vanadium, are concentrated by marine plants or animals. A small amount of dissolved organic matter is present in sea water, and varying amounts of atmospheric gases are dissolved therein. The bulk of the dissolved gases is made of oxygen, nitrogen and carbon dioxide (chiefly as carbonate and bicarbonate ions).

Sea water is normally alkaline with a pH between 7.5 and 8.4, but variations also occur in pH caused, for instance, by biological activity. Regional changes are observed in the composition of sea water and are mainly connected with biological activity; for instance, the Antarctic ocean is rich in nitrate and the Pacific ocean in silicate. Furthermore, there exists a close connection between the content of phosphate and nitrate and the extent of biological activity in the sea.

The total quantity of carbon dioxide in sea water per square centimetre of the earth's surface is 50 times as high as the quantity of carbon dioxide in the atmosphere. The four forms of carbon dioxide in the sea, namely, free carbon dioxide, carbonate and bicarbonate ions and the undissociated H_2CO_3 molecules, form a buffer system. All these forms are in equilibrium with one another and with the hydrogen ions present in solution, as follows:

$$\begin{array}{ll} \text{Atmosphere} & CO_2 \\ & \Updownarrow \\ \text{Sea water} & H_2CO_3 \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons H^+ + CO_3^{2-} \end{array}$$

The free (unbound and undissociated) carbon dioxide consists of CO_2 and H_2CO_3 molecules in solution and in equilibrium with each other. The carbon dioxide equilibrium depends on all physical, chemical and biological factors active in the sea. A change in the total concentration of carbon dioxide caused, for instance, by assimilation and respiration, results in a corresponding adjustment of all concentration constants until a new equilibrium is attained. The adjustments are also observable outside the phase boundary in the atmosphere and in solid carbonate phases. The atmosphere, however, regulates the tension of carbon dioxide in the sea. An exchange of other dissolved gases (certain nitrogen compounds) also takes place between the atmosphere and the sea.

Goldschmidt divided the elements into thalassophile (from the Gr. *thalassa,* "sea," and *philos,* "loved" or "having affinity for") and thalassoxene (from the Gr. *xenos,* "quest" or "stranger") groups according to their distribution between seas and continents. Chlorine, bromine. boron, sulfur (in sulfates), sodium and, partly, iodine are thalassophile, while all such elements are thalassoxene that precipitate in the hydrosphere because of the hydrolytic decomposition of their salts, *e.g.,* aluminum and iron. Some thalassophile elements, such as sodium, have increased in amount in the ocean during its history, while the amount of others (boron probably) has decreased. For still other elements, such as calcium, an equilibrium seems to be attained between the amount carried to the sea and the amount removed from the sea. Calculation of the geochemical balance of some elements in sea water (*i.e.*, the ratio between the total amount supplied and the amount now present) indicates that among the alkali metals only sodium is noticeably transferred to sea water, while the others are retained in clays. Other elements largely removed from sea water are calcium, aluminum, silicon, iron and manganese. The present content of chlorine, bromine, sulfur and boron in sea water is higher than the content calculated from the amounts actually transported into the sea. The four elements are added to the sea by volcanic emanations and juvenile waters.

Elements forming relatively readily soluble compounds, such as sodium. potassium, magnesium. carbon and nitrogen, remain in sea water in considerable quantities and finally crystallize out in the evaporites. Poisonous elements (mercury, arsenic and lead) are largely removed by incorporation in the hydrolyzates and the oxidates, in a process called depoisoning of sea water.

Particulate matter is carried by rivers into the sea, along with dissolved and colloidal substances. Physical chemical processes may take place between the particles and sea water. See also OCEAN AND OCEANOGRAPHY.

IV. GEOCHEMISTRY OF THE ATMOSPHERE

The atmosphere, or gaseous envelope surrounding the earth, is the outermost geochemical sphere. It consists of a mechanical mixture of gases and vapours extending up to approximately 1,600 km. (994 mi.) above the earth's surface and is in contact with the lithosphere and the hydrosphere. Air is present in the spaces between soil particles, in pores of rocks and is dissolved in water.

The lower limit of the atmosphere is determined by the depth of caves. mines and bore holes. In volcanoes the atmospheric gases are mixed with volcanic emanations. The gases in the cavities in rocks and minerals. occluded gases, petroligenic natural gas and the gases dissolved in the water of mineral springs and thermal springs all add to the atmosphere. Biochemical processes produce great quantities of gases, such as oxygen, nitrogen, carbon dioxide and methane.

1. Composition. — The atmosphere consists of four concentric layers without sharp boundaries. The lowermost layer, the troposphere, extends from sea level to approximately 11 km. (6.8 mi.) at middle latitudes. It is the convection region, and the atmospheric phenomena take place there. The next overlying layer is called the stratosphere, and the boundary between the troposphere and the stratosphere is called the tropopause. The stratosphere extends to an average altitude of 50 km. (31 mi.). In its upper reaches exists a high-temperature region, sometimes called the ozonosphere, caused by a concentration of ozone, which absorbs ultraviolet radiation of the sun. Above the stratosphere is the ionosphere that extends to about 600–700 km. (373–435 mi.) above sea level. The ionosphere is characterized by free electrical charges. Some of the gas particles in the ionosphere dissociate into ions and free electrons by the action of ultraviolet radiation. Furthermore, oxygen and nitrogen molecules dissociate into atoms. The temperature in the ionosphere is very high (2,200° C. at the height of 650 km. or 404 mi.). The outermost layer of the atmosphere is called the exosphere and is occupied by relatively freely moving gas particles.

It is believed that the earth's atmosphere is almost entirely of secondary origin and has been produced, like the hydrosphere, by volcanic emanations escaping from the lithosphere during the geological evolution of the earth. The first supply of free atmospheric oxygen formed in the photochemical decomposition of water vapour in the upper atmosphere, while the bulk was derived from water in photosynthesis by chlorophyll-bearing plants.

The total mass of the atmosphere is 51.3×10^{20} g. The average composition of dry air from the troposphere is presented in Table XII. Ozone content increases with height while radon (a gaseous radioelement) content decreases with height, and the content of water vapour varies from 0.02% to 4% by weight. The composition of the stratosphere is similar to the composition of

TABLE XII.—Average Composition of Dry Air from the Troposphere

Compound	Per cent by weight	Per cent by volume
Nitrogen (N_2)	75.51	78.09
Oxygen (O_2)	23.15	20.95
Argon (A)	1.28	0.93 } 100
Water vapour (H_2O)	Variable	Variable
Carbon dioxide (CO_2)	0.046	0.03
Seon (Ne)	0.00125	1.8×10^{-3}
Krypton (Kr)	0.00029	1×10^{-4}
Helium (He)	0.000072	5.24×10^{-4}
Xenon (Xe)	0.000036	8×10^{-6}
Hydrogen (H_2)	0.000003	5×10^{-5}
Ozone (O_3) (variable)	0.000002	1×10^{-6}
Radon (Rn) (variable)	4.52×10^{-17}	6×10^{-18}

the troposphere. Other constituents of the atmosphere are carbon monoxide, considerable amounts of which may be present in city air; formaldehyde; nitrogen oxides N_2O, NO_2 and N_2O_5; hydrogen peroxide; heavy waters HDO and D_2O; tritium, sulfur oxides SO_2 and SO_3; hydrogen sulfide; ammonia; iodine; methane; and radionuclides released by nuclear fission. These constituents originate in photochemical, electrochemical, biochemical and nuclear reactions. or are liberated in volcanic emanations or by the industrial activity of man. The composition of the atmosphere changes continuously because of the addition and removal of various substances. For example, helium actually slowly escapes from the atmosphere, as indicated by the fact that the amount of the isotope He^4 present in the atmosphere is much less than the amount generated by the alpha-decay of natural radionuclides during the geological history of the earth.

The elements notably enriched in the atmosphere are called atmophile (having an affinity for, or at home in the atmosphere) elements (see Table VI). Among the elements tabulated. only the inert gases and nitrogen are typically atmophile. Even though oxygen is enriched in the atmosphere, its amount is small compared with the huge amounts bound in the lithosphere and the hydrosphere. Consequently, the atmophile character of oxygen is not too pronounced

A certain amount of matter other than gaseous constituents is always present in the atmosphere. This matter consists of inorganic substances (*e.g.*, dust of various origin). organic constituents and organisms.

2. Rain Water. — The most important geochemical property of the atmosphere is the chemical disintegration of rocks and minerals caused by atmospheric oxygen and water vapour. Dry oxygen is rather inert. but in the presence of water vapour its reactivity increases. There is a continuous cycle of nater from the hydrosphere to the atmosphere and back to the former either directly in the form of rain water or indirectly by drainage. This cycle also includes the transport from sea water of salts, called cyclic salts, consisting chiefly of sodium chloride.

Rain water has a direct solvent action on minerals, and because it contains dissolved substances, it also acts indirectly as an effective carrier of denudation-promoting substances. Both inorganic and organic matter is dissolved in rain water, and particulate matter is often present. especially near cities. The most important among the dissolved inorganic constituents are chlorides, sulfates, nitrates and nitrites of sodium. potassium. calcium and magnesium. Nitrogen occurs also as free and albuminoid ammonia; humus and formaldehyde are frequently present. The gases dissolved in rain nater consist of approximately 63% nitrogen by volume, 34% oxygen and 3% carbon dioxide and other gases. The definite enrichment of oxygen and carbon dioxide in rain water over their content in air is the reason for the chemical activity of rain water. The chemical composition of rain water varies greatly and depends on the proximity of sea, character of the landscape, density of population and industrial activity. The purest water is obtained from rain falling after tropical thunderstorms. The average composition of rain nater is said to be as follows: chlorides, 3 o parts per 1,000,000; sulfates, 5 o; nitrates, 0.2; and free ammonia o 4 The nitrogen compounds in rain water are of importance as natural soil fertilizers. The composition of the other forms of atmospheric precipitation is similar to the composition of rain nater.

See also ATMOSPHERE.

V. GEOCHEMISTRY OF THE BIOSPHERE

The biosphere denotes organic nature as a whole and consists of plants, animals and microorganisms. It occupies the lower part of the troposphere, up to a height of approximately 5 km. (3.1 mi), probably the whole of the hydrosphere, and a thin layer on the lithosphere, with a lower limit at a depth of approximately 2 km. (1.2 mi.).

The biosphere is the region where reactions caused by solar radiation take place and is the part of the earth capable of sustaining life. It is the youngest among the geochemical spheres.

The branch of geochemistry dealing with the biosphere is called biogeochemistry. Unlike the hydrosphere, the biosphere is rather uniformly distributed over the whole surface of the earth. It is commonly divided into three habitats, or biocycles, which are the terrestrial, the fresh-water and the marine biocycle. The marine biocycle is, quantitatively, the most important of the three. Marine organisms play an important role in the cycle of inorganic and biogenic matter in the sea. The fresh-water biocycle is a small fraction of the terrestrial biocycle. Because of its lack of permanent life, the atmosphere does not form a biocycle.

If the weight of the biosphere is taken as unity, the relative weight of the atmosphere is 300, of the hydrosphere. 69,100, and of the uppermost part of the lithosphere, of the order of 10^6. Notwithstanding the negligible mass of the biosphere, its chemical activity is remarkable, and its geochemical role is important. For instance. most if not all of the free oxygen in the atmosphere is produced in the biosphere by photosynthesis. Chalk cliffs and coral reefs show profuse biological activity. All carbon deposited in the bioliths is collected from the atmosphere containing 0.03% carbon dioxide by volume, and there are mineral deposits of economic importance that are products of migration and concentration of elements in the biosphere.

The green chlorophyll-bearing plants synthesize organic compounds from carbon dioxide and water united in photosynthesis. The compounds synthesized are oxidized in living systems by respiration which is the main source of energy in animals.

1. Composition of Plants and Animals.— The biophile elements listed in Table VI are those occurring typically in the biosphere. Apart from the biophile elements proper, all those present in organisms are called biological elements. They vary considerably in importance, amount and distribution in the organisms. Some are basic elements present in all living matter, while others occur only in certain organisms. Among the basic elements. oxygen is essential for animals, nitrogen and carbon for plants and hydrogen and oxygen (as water) for all life. Approximately 60 elements are known to occur in the biosphere. Combined, they form all biological matter which is composed chiefly of water, carbohydrates, proteins and lipids, or fats and fatlike substances. The biological elements have a number of important functions in the organisms. Some (carbon and nitrogen) are found in the framework of plant and animal tissue. Others occur in shells and skeletons (calcium, magnesium, silicon, fluorine and phosphorus), as energy-exchange elements (hydrogen, oxygen), as electrolytes and osmotic regulators in cell liquors (sodium, potassium and chlorine as chloride), as catalysts in oxidation-reduction reactions (iron and copper, among others) and as enzyme activators (calcium, magnesium and cobalt). Some elements may be replaced by others in their functions, such as calcium by strontium or barium. The function of some elements is still unknown.

The presence or absence of an element in organisms depends primarily on its physiologic functions. Some elements are temporary constituents, while others are essential for the normal evolution and functions of the organism. The requirements as to essential elements even of closely related species may be different. Some just accumulate in organisms beyond all physiologic requirements, if any. Some nonessential elements may become concentrated in plants because of the defective selection power of the plants, which often cannot distinguish between essential elements and their nonessential fellow travelers.

The classificdtion of the biological elements according to their content in organisms is presented in Table XIII. The primary invariable elements make up the bulk of all living matter. They are essential constituents of carbohydrates, lipids and proteins. In lipids and proteins, some other invariable elements are always present. Among the variable elements, some are found in relatively high concentrations in certain species but are absent in other, even related, species. Plants and animals also differ notably in their composition. In general, the average chemical composition

TABLE XIII.—*Distribution of Elements in Organisms*
(In per cent of body weight)

Invariable			Variable		
Primary 60–1	Secondary 1–0.05	Micro-constituents <0.05	Secondary	Micro-constituents	Contaminants, among others
H	Na	B	Ti	Li	He
C	Mg	F	V	Be	A
N	S	Si	Zn	Al	Se
O	Cl	Mn	Br	Cr	Au
P	K	Cu		Co	Hg
	Ca	I		Ni	Bi
	Fe			Ge	Tl
				As	
				Rb	
				Sr	
				Nb	
				Mo	
				Ag	
				Cd	
				Sn	
				Cs	
				Ba	
				Pb	
				Ra	

of an organism is reminiscent of the composition of its environment. It is probable that the quantitative chemical composition of an organism is a specific feature.

The principal constituents of organisms are organic material, inorganic skeletal structures and inorganic compounds dissolved in body fluids. Organic material is largely composed of carbohydrates, lipids and proteins. Skeletal material consists mainly of calcium carbonate. calcium phosphate, or silica. Magnesium carbonate may occur as an important constituent of calcareous shells. The average total composition of living matter is presented in Table XIV for man and the alfalfa plant; apparently 11 elements

TABLE XIV.—*Average Total Composition of Living Matter*
(In per cent of dry weight)

Element	Adult Man (*Homo sapiens*)	Alfalfa (*Medicago sativa*)	Element	Adult Man (*Homo sapiens*)	Alfalfa (*Medicago sativa*)
C . . .	48.43	45.37	P . . .	1.58	0.28
O . . .	23.70	41.04	Na . .	0.65	0.16
N . .	12.85	3.30	K . .	0.55	0.91
H . .	6.60	5.54	Cl . .	0.45	0.28
Ca . .	3.45	2.31	Mg . .	0.10	0.33
S . . .	1.60	0.44	Total .	99.96	99.96

make up this matter. Among the trace elements in man, iron, zinc, copper and manganese are the most abundant. Sodium and calcium are usually microconstituents in plants, but in many animals (vertebrates) calcium is a primary constituent. Compared with animals, plants are usually richer in manganese, nickel, aluminum, titanium and boron but are impoverished in iron, zinc and copper. In general, elements of low atomic number predominate in all organisms. Tables V and XIV indicate that many of the constituents of organisms (*e.g.*, silicon, aluminum and iron) are definitely impoverished with reference to their content in igneous rocks, while many trace elements (such as carbon, hydrogen and sulfur) are concentrated in living matter. The oxygen and calcium contents in igneous rocks and organisms are of a similar degree of magnitude. It appears that organisms select the necessary biological elements irrespective of their concentration in the environment. Tables XI and XIV validate this result for sea water also.

According to classic plant physiology, the following ten elements are essential for the healthy growth of plants: carbon, hydrogen, oxygen, nitrogen, sulfur, phosphorus, potassium, calcium, magnesium and iron. The seven last-mentioned elements are called the major nutrients or the mineral nutrients. They are taken up by plants as simple cations, complex cations and anions and as free molecules. Moreover, there is the group of the micronutrient elements known to be essential for plants or to promote their growth when administered in small amounts. Boron, manganese, copper, zinc, molybdenum and, perhaps, gallium are micronutrients. Finally, some elements promote in small quantities the growth of certain plants, among others, lithium, vanadium. fluorine. bromine and nickel. In greater concentrations nearly all of these are poisonous. Some elements. such as aluminum, silicon and chlorine accumulate at least in some species or genera and may be essential in such instances. The toxicity of elements. in general. increases with increasing atomic number in the groups and subgroup? of the periodic system, but the toxic effects depend also on the individual properties of the plants. Also in animals, the major nutrients of plants are indispensable. along with sodium and chlorine. In addition the following trace elements are essential: iodine. manganese, copper zinc and cobalt

2. Accumulation of Elements in Organisms.—Certain organisms are accumulators of definite elements. Some plants tolerate great quantities of elements that, even in small doses. are poisonous to other plants. Many elements, such as aluminum silicon. sodium and chlorine, even though not essential to the species in question, accumulate in, and are concentrated by, many plants. Their concentration is independent of their value as plant nutrients; they are called ballast elements. Numerous trace elements are present in exceptionally high contents in many coal and browncoal ashes as compared with their content in igneous rocks. The highest degree of enrichment is observed for boron, germanium, arsenic. molybdenum and bismuth, and the enrichment is independent of the chemical and geochemical character of the element A similar concentration of elements is observed in the ashes of many plants as in those from old forests Sometimes, as in the case of boron and manganese, the accumulation is biological and takes place in the living plant. but the concentration during decay of biogenic matter is geochemically more important. In this instance the rare elements present in the subsoil are taken up by soil solutions, enter the plants through the roots and are deposited at the sites of strongest evaporation, especially in the leaves. In leaves turning yellow and withering the content of most of the trace elements decreases. The readily soluble compounds of the major nutrients are leached away by rain water. while the sparingly soluble or insoluble compounds of the rare elements, such as hydroxides and protein and humic complexes are retained, partly by adsorption, in the humus layer. By such simple physical processes as recurrent evaporation and filtration the plants will finally cause the concentration of many elements in the topmost layers of forest soils.

The physical nature of the process is the reason why enrichment is independent of the chemical and geochemical properties of elements. Among others, silver, gold. zinc, thallium germanium tin, lead. cobalt and nickel become enriched in humus soils. The concentration principle, called the Goldschmidt enrichment principle, explains the concentration of elements in coal ashes in a similar uay The degree of enrichment depends on the plant species.

Prospecting.—Many plants are able to become accommodated according to the chemical composition of their substratum, that is. by concentrating certain elements (gold zinc copper and others) from soil above or near ore bodies. The ability of plants to indicate the chemical composition of soil is applied to prospecting for metal ores (geobotanical prospecting). The enrichment phenomena are also used for this purpose (biogeochemical prospecting). Compared with plants animals appear to be able to concentrate only a limited number of trace elements—copper vanadium. manganese, bromine and iodine. The absence of certain essential elements (cobalt, iron and copper) in the soil may cause regional deficiency diseases in plants. in grazing animals. and even in man. The accumulation of toxic elements. such as arsenic and selenium, by plants may also result in pathological conditions.

3. Photosynthesis.— >lost of the energy needed in the functions of organisms is produced by respiration nhich is the slow oxidation of organic matter. The ultimate principal products of oxidation are carbon dioxide, water and nitrogen. The rate of decomposition is high enough to destroy all biogenic matter in approximately 20 years. except for the fact that a corresponding quantity of matter is concurrently synthesized. This decomposition and regeneration forms a part of the geochemical cycles of the elements present in biogenic matter. The biochemical process by which organic compounds are formed from carbon dioxide and water is called photosynthesis (*q.v.*). It takes place under the action of sunlight and is the fundamental biochemical process. From the first photosynthetic products a number of fats. proteins. nucleoproteins, pigments, enzymes, vitamins, cellulose and other substances are produced. They are oxidized and decomposed before or after the death of the plant. Photosynthesis is an important part in the cycle of oxygen. All oxygen present in the hydrosphere and atmosphere has repeatedly circulated in the cycle from the atmosphere through the biosphere into the hydrosphere and back during the time of existence of chlorophyll-bearing plants on the earth.

4. Geochemical Activity of Bacteria.—Among biogeochemically active agents, bacteria are of great importance in the biosphere and the adjoining geospheres. Their high rate of multiplication and great physiological activity cause their participation in chemical reactions involving considerable amounts of matter. They affect principally the geochemical cycles' of carbon, nitrogen, phosphorus and sulfur. They are responsible for many changes in the pH of sediments and in the creation of reducing surroundings Such surroundings favour the reduction or hydrogenation of organic matter and the formation and preservation of reduced substances, such as the petroleum hydrocarbons. The acids produced by bacteria may dissolve calcium carbonate and other inorganic constituents of sediments, and consequently bacteria affect the cycles of calcium and other elements. Other bacteria favour the precipitation of calcium carbonate and thereby preserve calcareous sediments. Some are able to attack several inorganic substances and almost any kind of organic matter; for instance, sulfate- and nitrate-reducing bacteria are usually abundant in marine sediments. Some are capable of fixing free atmospheric nitrogen, others liberate nitrogen from nitrites and nitrates, and still others oxidize ammonia to nitrites and nitrates. Some species produce carbon monoxide. others methane or higher hydrocarbons, nhile others utilize methane in their metabolic processes. Bacteria may create environments harmful to other forms of life. but they also serve as sources of food and producers of plant nutrients. They are active in rock weathering and may be operative in the formation of sedimentary iron and manganese deposits.

5. Marine **Biocycle.**—The biosphere and the hydrosphere are closely connected biochemically because water is essential for all life. The marine biocycle is the most important part of the biosphere. Sea water is an especially suitable nutrient for algae, but the content of dissolved phosphate and nitrite regulates marine plant life and consequently affects animal life in the sea as well. The distribution of animals in the sea is also governed by the salinity of sea water

Plants are the most important consumers of marine inorganic matter and form the supply of food for animal life in the sea. There is a constant life cycle between plants and animals and between the formation and decay of biogenic matter. Changes in chemical composition are produced by the gron th and decay of marine organisms. The degree of enrichment of the elements by marine organisms is variable. Nitrogen and phosphorus have the highest degree of enrichment, but the content of carbon, silicon, fluorine, iron and copper is also considerably affected by biological activity.

***6.* Anthroposphere.**—The part of the biosphere inhabited and governed by man is called the anthroposphere. It is increasingly active chemically. Man causes changes in the geochemical cycles of the elements and disturbs the natural balance in the uppermost geospheres. Artificial inorganic and organic compounds, minerals and rocks are produced in the anthroposphere as are metals. such as aluminum and magnesium, that never existed in the native state in the earth. The atmosphere and the hydrosphere are used as sources of raw materials.

Many chemical processes in the biosphere are steered and controlled by man. Noble metals tend to accumulate in the anthroposphere, and new heavy radioactive elements are made artificially by man. The geochemical cycle of carbon, of all elements, is the one that is most strongly affected by the industrial activities of man.

7. Bioliths.—The sediments formed by the geochemical activity of the biosphere are called bioliths. They are divided into caustobioliths (Gr. kaustikos, "capable of burning") that are combustible and acaustobioliths that are incombustible. Carbonate, phosphate and siliceous sediments, among others, are acaustobioliths. The caustobioliths consist of humites, liptobioliths and sapropelites, which all are carbonaceous sediments containing native carbon or its oxidizable compounds. Some sulfur deposits of bacterial origin are also included. This group contains all solid, liquid and gaseous sediments used as fuel and is of great technical importance. The humites and liptobioliths are predominantly products of land and marsh vegetation. but the sapropelites contain decay products of many water organisms. The nature of the bioliths formed depends on the presence or absence of oxygen. If an adequate supply of oxygen is present, the decay of biogenic matter will produce carbon dioxide, water, sulfates and nitrogen, nitrates or ammonia. No solid carbon residue (coal) is produced, and only the resins and waxes of low reactivity may remain as liptobioliths. If the supply of oxygen is inadequate, the decomposition is incomplete, and small amounts of carbon-bearing substances will form. If oxygen is deficient at the start and completely absent later during the decomposition, peat will form. Peat is a typical humite sediment of vegetal origin, and humus is the final product of peat formation. If no oxygen is present at all, putrefaction mill take place, and sapropel or foul mud and sapropelites are formed as its final products. They are typically lacustrine or marine sediments formed in stagnant water. Putrefaction is a kind of slow distillation in which proteins, fats, oils and waxes are converted into methane and other hydrocarbons, hydrogen sulfide, ammonia, hydrogen, carbon dioxide and many organic compounds. The formation of sapropel affects the cycle of many sulfophile elements by precipitating them as sulfides. If the chemical decomposition of organic matter under reducing conditions is carried still further, petroleum will form as the final product.

Humus.—During the decomposition of biogenic matter some residues are resistant to the action of microorganisms and accumulate. causing the formation of substances called humus. The formation of humus involves the removal, from their cycles, of a part of carbon, nitrogen, phosphorus, sulfur, potassium and other elements nhich are made available for plants; consequently the formation of humus regulates plant life. It is a highly complex mixture of amorphous organic substances which contains some inorganic compounds of phosphorus, sulfur, iron, calcium and magnesium. It is also in a state of constant decomposition and forms a colloidal system. The colloidal humus-bearing solutions are of importance in weathering because of their dissolving action on detrital minerals; iron and manganese, for instance, are brought into solution as humic complexes. Humus is an important mother substance of coal. Various types called water humus form under water and may be converted into peat.

Soil.—Humus also plays an essential part in the formation of soil. Soils. composed of a mixture of inorganic and organic substances, support the continental plant life. Their general character depends on the nature of the weathering of their substratum, climate. relief, biological activity and time. Physical, chemical and biological processes are active in their formation. Quartz, clay minerals, limonite, haematite and some carbonate and sulfate minerals are the most important mineralogical constituents of soils. Organic matter greatly affects the physical properties and fertility of soil. The humic complexes are by far their most important organic constituents. Ammonia. carbon dioxide, phosphates and sulfates form during decomposition of soil humus. Ammonia is gradually converted into nitrates. These compounds greatly influence the fertility of soil and form a supply of elements essential for the synthesis of organic substances by plants.

See also SOIL.

Coal, *Petroleum* and *Other* Products.--Sapropel and peat (*qq.v.*) are accumulations from which coal is formed. Peat. brown coal or lignite and the different varieties of coal are the most important humite sediments. There is no sharp distinction between peat and coal. During coalification which finally produces anthracite, the carbon content increases. but the content of hydrogen, nitrogen and, especially, oxygen, decreases by the formation and escape of carbon dioxide, water, methane and nitrogen. The coals are divided into humic coals and sapropelic coals according to their origin. Various transitions exist between the sapropelic coals and from them to oil shales and humic coals. The coals are essentially colloidal substances consisting of highly complex compounds of carbon, hydrogen and oxygen. Other more important constituents include nitrogen, sulfur and phosphorus. Sulfides of iron, lead, copper, zinc, nickel and other metals are incidental constituents of coal. Silicon, aluminum and iron are the principal constituents of coal ashes, in which many trace elements are concentrated. The chemical composition of the plant material changes continuously after its deposition, and peat, brown coal, coal and anthracite represent different stages of incoalation or coal formation. The process is materially accelerated by elevated temperatures.

Waxes, resins, fats and oils are able to resist chemical decomposition and may become concentrated to make liptobioliths. They are also responsible for the characteristic properties of sapropel and sapropelic coals, and of some peats. Liptobioliths include resin, wax and spore coals and fossil amber or succinite.

Petroleum is a complex mixture of liquid hydrocarbons in which a number of gaseous and solid hydrocarbons are dissolved. The crude oils also contain small amounts of numerous organic compounds of nitrogen, oxygen, phosphorus. sulfur and some hydrogen sulfide, carbon dioxide and nitrogen. Many metals. notably nickel, vanadium, lead and iron. are present in petroleum, perhaps as metalorganic porphyrin complexes. Many trace elements are constituents of petroleum ashes. Few, if any, of the petroleum hydrocarbons are unsaturated, and all are optically active. The chemical composition of the crude oils varies according to the substances from which they were formed. The mother substance of petroleum consists of plant and animal remains in near-shore marine sapropelic sediments. The remains are partly of marine origin, partly carried to the sea by rivers and deposited under essentially anaerobic conditions. During the formation of petroleum, bacterial action occurred along with the work of physical, chemical and geological factors. The highly reducing environment favoured the hydrogenation of organic matter and the preservation of the petroleum hydrocarbons. Later changes in the composition of petroleum probably were caused by radioactivity. Brines related to petroleum both geologically and genetically occur in connection with most petroleum deposits.

Ozocerite and asphalt are often found together with petroleum and are regarded as solid oxidation and polymerization products of the crudes. Ozocerite is a mixture of solid hydrocarbons. Some asphalts are remarkably rich in nickel and vanadium.

Natural gases are either inorganic gases connected with igneous activity, gases produced by carbonization in the biosphere (marsh gas and gases from coal mines) and gases connected with petroleum deposits. or the natural gases proper. Petroligenic natural gas contains the most volatile constituents of petroleum deposits and is concentrated in the uppermost parts of the oil-bearing beds. Most of its constituents are of biogenic origin The chief constituents of petroligenic natural gas are highly volatile hydrocarbons. Nitrogen, oxygen, carbon monoxide and dioxide, hydrogen sulfide, helium and hydrogen in varying amounts are its normal constituents; radon and argon are sometimes present. Petroligenic natural gases are divided into hydrocarbon, nitrogen, carbon dioxide and heliurn types. Many of the rich nitrogen gases are rich in helium also.

See also BIOCHEMISTRY.

VI. GEOCHEMICAL EVOLUTION OF THE EARTH

The study of the chemical evolution of the earth is one of the main tasks of geochemistry. For performing this task, the results of cosmochemistry, or chemistry of the universe, are particularly helpful, partly because of the role of geochemistry as a chapter in universal planetary chemistry, and partly because of the close relationships that link nuclear physics, physical chemistry and astrophysics together.

Traditional dogmatic geochemical speculation has dealt with the formation of a once totally molten earth largely according to the processes taking place in ore-smelting furnaces. This dogma, however, was slowly giving ground by the 1950s, and there is considerable evidence to indicate that the earth and other planets were formed by condensation and accumulation from a dust cloud at low temperatures. H. C. Urey developed the new approach in detail, largely on the basis of thermodynamic considerations.

The early stages of the primordial evolution of the earth are usually referred to as the astronomical time in the earth's history. The geological time started when a stable crust had formed and the exogenic processes first started thereon.

According to Urey, the final accumulation of the earth took place, at a temperature of approximately 0° C.. from small planetesimals containing metallic iron, carbon, iron carbide, titanium nitride and some ferrous sulfide. A gas phase had mainly been lost during the previous, high-temperature stage, and only small amounts of hydrogen, nitrogen, inert gases, water vapour, methane and hydrogen sulfide were left. The iron core of the earth accumulated slowly during the geological history of the earth from an almost uniform mixture of metallic iron and silicates. Consequently, the earth was not molten at the time of the accumulation of its materials.

See also COSMOGONY.

1. Evolution of the Lithosphere. — The lithosphere was formed by the separation of the iron and silicate phases and by fractional crystallization in the silicate shell. This differentiation is still going on. Crystallization caused the arrangement of the silicate shell according to the specific gravity of the crystallizing phases. The silicic magmas of low specific gravity and the aqueous residual solutions tend to rise upward. Heavy atoms actually should become concentrated in the lower levels of the lithosphere, but pneumatolytic and hydrothermal mineralization and metamorphism counteract the differentiation phenomena and concentrate these atoms in the uppermost parts of the lithosphere. The vertical movement of the phases of different specific gravity also explains the present distribution of the elements in the upper lithosphere. The modification of the surface layer by endogenic and exogenic processes started with the formation of a stable solid crust. During the earliest phase of geological history volcanic and plutonic activity probably took place on a larger scale than they ever did later. The exogenic cycle has grown in activity with the formation of the hydrosphere and the evolution of an atmosphere containing oxygen. Metamorphic and metasomatic processes are active in the present modification of the composition of the upper lithosphere, just as they were before. Metasomatic processes which involve the introduction of new substances into rock (see METASOMATISM) tend to equalize the composition, while exogenic processes cause a chemical differentiation. At present, differentiation predominates over equalization in the earth as a whole. Crystallization and differentiation by crystallization still cause chemical dissimilarity in the upper lithosphere, and light granitic magmas still wander upward through the crust.

The primary distribution of the elements in the various layers of the upper lithosphere may originally have been uniform in all parts of the globe, but at present there are many instances of an inhomogeneity in the upper lithosphere, in particular, among the granites which appear to be the more deficient in certain trace elements the higher their age. A secular migration of the elements on a global scale may take place in the crust causing the chemical inhomogeneity. The explanation of the global migration and differentiation is the continuous self-repeating granitization that is believed to take place in connection with the mountain-building processes. The granitization also enhances the silicic character of the uppermost layers of the lithosphere.

2. Evolution of the Atmosphere. — There is much evidence to indicate that the present atmosphere and hydrosphere of the earth are of secondary origin. It is unlikely that the primordial atmosphere contained free oxygen. According to Urey the primitive reducing atmosphere contained water vapour, hydrogen, ammonia, methane and some hydrogen sulfide. Hydrogen escaped from the gravitational field of the earth, and water was phntochemically decomposed into hydrogen and oxygen in the upper levels of the atmosphere. The oxygen formed was consumed in the gradual oxidation of ammonia to nitrogen and water, and of methane to carbon dioxide and water. Finally an excess of free atmospheric oxygen was formed, and an oxidizing atmosphere appeared, perhaps about 700,000,000 or 800,000,000 years ago. The formation of free oxygen is, geochemically, the most important step in the evolution of the atmosphere. Most or all free oxygen present in the atmosphere has been gradually produced from water by photosynthesis taking place in chlorophyll-bearing plants. The small initial supply of oxygen required by plants to make respiration possible was probably a product of the photochemical dissociation of water vapour. Carbon dioxide, like the bulk of water, was gradually added to the atmosphere by volcanic emanations, but its content has not remained stable. At the present time much carbon dioxide is added to the atmosphere as a result of various activities in the anthroposphere. The content of carbon dioxide is bound to increase until the regulating mechanism (*i.e.,* equilibrium between the hydrosphere and the atmosphere) becomes active. All carbon dioxide is finally bound in carbonates during weathering, and chances are small that it will ever be completely released by endogenic processes. Similarly, nitrogen also may be largely juvenile, and its supply has increased by nitrogen released from rocks during weathering. The inert gases are released into the atmosphere by volcanic emanations and weathering of rocks. Helium and argon are constantly produced by radioactive decay. Hydrogen and helium still escape from the uppermost levels of the atmosphere.

3. Evolution of the Hydrosphere. — The present hydrosphere is of secondary origin as is the atmosphere. The primeval hydrosphere must have been much smaller than the present hydrosphere. It is possible that the amount of water in the hydrosphere is still increasing. Even though much water is removed by weathering and sedimentation, it is, at least partly, returned during the slow vertical migration of matter in the upper lithosphere. Much water vapour is given off by the volcanoes, but this water is probably largely of meteoric origin. Changes have occurred in the chemical composition of the oceans during the geological evolution. Many substances, partly produced by rock weathering, accumulate constantly in the ocean. Vast amounts of volatile substances released by volcanic activity are finally transported into the sea. It is possible that all material deposited in the abyssal regions is permanently lost to the cycle.

4. Evolution of the Biosphere. — It is likely that life started soon after the earth had cooled to a proper temperature and that it covered the earth in a geologically short time. The oldest trace of biological activity is finely disseminated biogenic carbon in slates in Manitoba with an approximate age of 2.55×10^9 years. It appears that vast amounts of complex prebiological organic compounds were synthesized during the reducing stage in the atmospheric evolution in thermochemical, photochemical and electrochemical reactions. Life probably started during the change of the reducing atmosphere into an oxidizing atmosphere. Plant life probably could not start until there was some free oxygen in the atmosphere. A landmark in the development of animals is the appearance of the first calcareous skeletons in the Cambrian. about 500,000,000 years ago. The formation of animals is one of the most important processes in the evolution of the biosphere. The anthroposphere as a powerful geochemical agent has been operative but a few hundred years.

The geochemical evolution of the earth did not stop with the formation of a solid crust, the hydrosphere and the atmosphere. Actually, the evolution has continued throughout the geological history of the earth, and new stages have been added, such as the formation of the biosphere. The earth is changeable chemically, and its geochemical evolution still continues.

See also EARTH.

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GEOCHRONOLOGY, a term first used by the geologist H. S. Williams in 1893 to designate studies in which the geological time scale in absolute time is applied to the evolution of the earth and its inhabitants. The term came to include the various methods of absolute dating in terms of years of those periods of time which precede historical records, thus comprising human prehistory as well as the whole geological. past *(see* GEOLOGY: *Historical Geology: Absolute Dates).*

Geochronological methods in use in the second half of the 20th century included the following:

Tree ring analysis or dendrochronology, a method which uses the cycle of the year as expressed in the formation of growth rings of wood. This method is applicable only in climates with pronounced seasonal fluctuations and areas covering historic and prehistoric phases, especially in North America. Its range is about 3,000 years.

Varve (a Swedish word meaning "layer") analysis, that is, analysis of annual layers of deposition by melting glaciers, is a method which relies mainly on the annual cycle and. to a lesser extent, on the sunspot cycle and precession of the equinoxes. Cycles of duration shorter than one year are also involved. Geological deposits of a rhythmic character, such as the layers formed by melt waters of the Pleistocene ice sheets, depend in thickness on the weather conditions of any particular year; hence cross identification of sequences of varves is possible. The method applies mainly to the last 15,000 years; *i.e.,* to the postglacial period, but it has been used also in earlier geological periods right back to Pre-Cambrian times.

The radiocarbon method relies on the radioactive disintegration of carbon 14 (C^{14}), an isotope of carbon created in the atmosphere under the influence of cosmic rays. A constant concentration which is present in living organic matter disintegrates at a constant rate with a half-life period (time required for one-half the initial number of atoms to decay) of about 5,600 years. The content of C^{14} found in dead organic matter thus gives an indication of its approximate age, the method being applied to about the last 30,000 years.

The per cent of equilibrium method is confined to the study of deep-sea cores and covers about 300,000 years. It relies on the rate of disintegration of radium precipitated in deep-sea sediments.

The solar radiation method approximately covers the Pleistocene period and with it the Old Stone Age of man. It is based on the comparison of geological evidence for climatic fluctuations within the Pleistocene period with the fluctuations of solar radiation received at various degrees of latitude in the summer half and the winter half of the year. It extends over a period of about 1,000,000 years.

Geological methods — this term comprises methods based on estimated time rates of sedimentation. denudation, erosion, weathering and chemical changes in minerals. Geological methods can be applied to all geological epochs but are, on the whole, not very reliable.

Uranium and other radioactivity methods take advantage of the disintegration of certain radioactive minerals with long half lives. The commonest methods rely on the accumulation of lead or helium, or both, formed by the disintegration of uranium. They have been applied to all geological periods before the Pleistocene and, in a modified form, to estimate the age of the earth's crust as a whole, the result being approximately [illegible] years. Other methods use the change of rubidium into strontium, and of potassium into argon. For a discussion of the archaeological applications of these methods of dating, as well as pollen dating, *see* ARCHAEOLOGY: *The Materials of Archaeology.*

See also COSMIC RAYS; ISOTOPE: *Naturally Occurring Radioactive Isotopes.*

See F. E. Zeuner, *Dating the Past,* 4th ed. (1958). (F. E. Z.)

GEODE, a hollow nodule of stone formed in sedimentary rock and having walls lined with crystals, among which calcite and quartz are the commonest. Other not uncommon minerals are dolomite, chalcedony. barite and celestite. Exterior surfaces of geodes are usually irregular. The wall minerals may have been deposited by circulating waters as the enclosing sediments became lithified or subsequent thereto.

A common method of origin of the cavities of geodes is by deposition of materials from solution along structural and fracture surfaces of shells, thus producing enlargement of original shell cavities and at the same time or subsequently lining the cavities with crystalline materials. Geode cavities of this origin are known to have formed from shells of brachiopods, crinoids and others.

If wall materials of geodes are more resistant to weathering than the enclosing rocks, the geodes are released and remain after the enclosing rocks have disappeared. If the opposite is the case: the minerals lining the cavities disappear and only cavities remain. Geodes range in size from very small to ten inches or more in diameter.

See R. S. Bassler, "The Formation of Geodes," *Proc. U. S. Nat. Mus.,* vol. 35, pp. 133–154. (W. H. TL.)

GEODESY. Geodesy, one of the oldest sciences of the world, has both scientific and practical purposes. Its scientific mission is to determine the size and shape of the earth and, in co-operation with other sciences, to study the internal structure of the earth. The practical task of geodesy is to carry out the measurements and computations needed for making accurate and reliable maps of the earth's surface.

This articleis divided into the following sections:

The most important practical objective of geodesy is the determination of the exact co-ordinates of control points on the earth's surface. When two co-ordinates of a control point are known. for instance, its geographic latitude and longitude and, in addition, its elevation above sea level, the exact position of this point on the earth's surface is known. In mapping large areas, such as a whole state or country, not only the curvature of the earth but also its flattening must be considered. The English usage of the word geodesy includes all the measurements, computations and objectives mentioned above.

A reliable control point system is a prerequisite for accurate maps. It may be compared with a skeleton which has to be covered with flesh and blood, *i.e.,* by a filling-in of details. The filling-in process also belongs to the domain of geodesy, though an essential part of this work can be done on the basis of aerial pictures, by the methods of photogrammetry (*q.v.*). The elevations of the control points and of other measured points are obtained by precise trigonometric or barometric leveling, methods which are discussed in the article SURVEYING.

I. OBJECTIVES

Although it may seem easy to determine control points on the earth's surface merely by making astronomical observations of the latitude and longitude at these points. this method is not satisfactory because astronomical observations are not sufficiently accurate. the highest accuracy obtained by the astronomic method being of the order 0″.2 to 0″.3 (arc seconds), or 6 to g metres along the earth's surface. Furthermore, serious errors will be caused by the irregularities of the earth's figure, to which the astronomical observations refer.

The earth's figure is that of a surface called the geoid, which over the sea is the average sea level and under the continents the imaginary continuation of sea level. The visible and invisible mass anomalies of the earth cause essential irregularities to the geoid and bring about essential errors, sometimes exceeding a mile, when distances between control points are determined astronomically.

Because of these facts we must use as a reference surface a regular mathematical surface that fits the geoid as closely as possible. This surface is an ellipsoid of revolution called a reference ellipsoid. Its surface is in some areas below. in other regions above, the geoid. The angle of tilt between the ellipsoid surface and geoid surface, or between the normal of ellipsoid and the normal of geoid, or plumb line, is called the deflection of the vertical, or deflection of plumb line.

Mathematically speaking the geoid is an equipotential or level surface, characterized by the fact that over its entire extent the so-called potential function is constant. This potential function is a result of the effect of the gravitational attraction of the earth mass, combined with the effect caused by the rotation of the earth about its axis. Since, if air masses are disregarded, there are at the oceans no masses above the sea level, mean sea level is a part of the geoid surface. In the continental areas the geoid is an imaginary sea level surface defined by spirit level. If small sea level canals were dug into the interior of the continents or if open-ended pipes, like inverted siphons, were run from the land out into the ocean, the surface sought would be defined physically at various points by the level of the water in these canals or pipes.

To get a system of geodetic control points it is necessary to have the geodetic datum for these points. The geodetic datum is completely determined when we know five quantities: the geographic latitude ϕ and longitude λ of the initial point of the geodetic datum, a direction (azimuth A of the direction between the initial point and some other control point) and finally the equator radius, a, and the flattening, f, of the reference ellipsoid. In other words, we need a point from which to compute, a direction in which to compute and a surface along which to compute. The co-ordinates of any control point computed in this geodetic system are comparable with one another. Their accuracy depends on the accuracy of the astronomical and geodetic measurements.

If only one of these five quantities changes, the whole geodetic system will also change. Until recent decades most countries had their own initial point of geodetic datum; therefore their geodetic systems were. of course, different even if they used the same reference ellipsoid.

One problem in geodesy is to obtain sufficiently accurate dimensions for the reference ellipsoid. Another .difficulty appears in converting the existing geodetic systems to one world system. A third difficulty is caused by the fact that all geodetic observations have to be referred to the geoid, but the computation of the co-ordinates must be carried out along the reference ellipsoid. To get rid of this "dualism" we have to know the distance, N, called warping or undulation of the geoid or the geoid distance, and the tilt between these two surfaces at the initial points of all these geodetic systems. It is also difficult to get the geodetic datum by precise leveling since the sea level is not constant but is affected by geological changes which raise or lower the continents and the ocean beds.

II. HISTORICAL

It is surprising that ancient civilized peoples, such as the Babylonians and Egyptians, who were interested in astronomy did not realize that the earth is a sphere, since its spherical shape should have been easy to deduce from several phenomena. The earth's shadow during the moon's eclipse has the shape of a circular arc, a shape that only a spherical earth can cause. The stars, while south in meridian, appear much higher in the sky when viewed from Alexandria than from Athens. When a ship approaches port, one first sees the'masts and only later the hull. But the significance of these phenomena dawned on mankind only slowly.

The co-ordinates of latitude and longitude were used at the suggestion of Hipparchus (*fl.* 146–127 B.C.). Because the world known to the ancients was long in the east-west direction from Spain to Persia and relatively short in the north-south direction from the Alps to North Africa, longitude was counted in the east-west direction, latitude in the north-south direction.

Still, Homer, in approximately 900–800 B.C., thought that the earth was a convex disk surrounded by the Oceanus stream. According to the other Greeks of that time the earth plate was supported by four elephants standing on a big turtle. But what supported the turtle they could not say. The philosopher Pythagoras (*fl* 532 B.C), was perhaps the first who thought the earth to be a sphere. Hipparchus and Aristotle (384–322 B.C.) came to the same conclusion. Eratosthenes (*c.* 276–194 B C.), however, is considered the founder of geodesy because he was the man who first measured the size of the earth, assuming that it was a sphere.

To determine the earth ellipsoid it is necessary to solve two problems, one geodetic and the other astronomical. The length, l, of an arc along the earth's surface must be measured in some direction. In the astronomical problem the central angle, v, corresponding to the measured arc. must be measured. By the aid of l and v the earth radius R can be obtained from the elementary formula $l:2\pi R = v^\circ:360^\circ$, or from $R = l/v$, if v is given in radians. The longer the measured arc and the more accurate the astronomical observations, the more accurately R can be obtained. Earlier the arcs l were measured at, or at least close to. the meridian directions, because v was relatively easy to determine in the north-south direction.

With the advent of accurate time signals and perfected clocks it became possible to determine the geographic longitude as accurately as the latitude, and arcs in any direction could be measured with equal accuracy.

This astrogeodetic method was used by Eratosthenes. He knew that in Upper Egypt in Syene, now called Aswan, on the Nile, the sun shone at noon in mid-summer vertically down into a well. His measurements showed that in Alexandria the direction of the sunbeams at the same time of the year at noon made with the vertical direction an angle 360°/50 or 7.2° (see fig. 1). Supposing that Syene and Alexandria were at the same meridian, he concluded that the centre angle v_1 between Syene and Alexandria was 7.2°.

As to the measurement-of the arc l he was told that a camel caravan needed 50 days to travel from Alexandria to Syene. Assuming that the rather constant speed of camels was 100 stadia a day, the distance between Alexandria and Syene would be 5,000 stadia and the length of the whole meridian circle 50 times larger. So he obtained for a meridian circle the length 250,000 stadia. If the Attic stadium, 185 metres, were used. the length of the whole meridian was, according to Eratosthenes, 46,250,000 m. This value is 16% too large, because the real length of the meridian by the definition of metre is, or at least used to be, 40,000,000 m. Fig. 1 also indicdtes how, by using the same principle, the U.S. army map service (F. W. Hough) determined the value for the equatorial radius of the earth as 6,378,260 m., using also the 100° long arc (central angle v_2), Tornio, Fin.-Cape Town, and the best available measuring instruments.

Considering that Alexandria and Syene are not at the same meridian, that the sun 2.200 years ago at noon in mid-summer could not shine in a vertical direction into the well of Syene. and that the measurement of the arc using the camel as a measuring instrument was certainly not accurate, it is surprising that Eratosthenes's result was not more in error. He deserves full credit, however, because his method was right in principle. Modern geodesists follow the same principle but make the astronomical observations with fine obiervation instruments and measure the length of the arc by triangulation. This important method was conceived by the Dutch scientist, Willebrord Snell (Snellius), in 1615.

The second known determination of the earth's radius was done by Poseidonius (*c.* 135–50 B.C), uho measured the distance between Rhodus and Alexandria on the basis of the time a boat needed to sail from Alexandria to Rhodus The corresponding central angle was measured astronomically. He realized that the star Canopus was on the horizon when seen from Rhodus island at the same time that the sunbeams in Alexandria made an angle of 7.j° with the horizon. Consequently, the central angle was, according to his observations, 7.5°. The radius value obtained by him was 11% too large

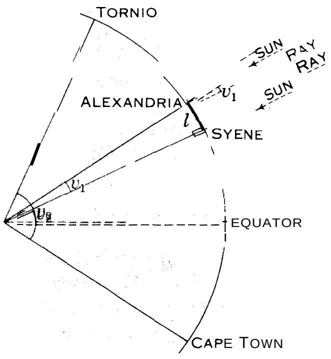

FIG. 1.—THE ARC MEASURING METHOD

Nine hundred years passed before the next measurement of the earth's dimensions was carried out at the suggestion of the caliph Abdullah al Mamun (A.D. 786–833) at the Zinjar plateau close to Baghdad. The Arabs made an actual measurement of the length of the arc by using wooden rods. They also made relatively accurate astronomical observations. According to the Arabs the following relation between the different length units exist:

$$1^\circ = \frac{170}{3}\text{ mi.}$$

1 mi. = 4,000 ell
1 ell = 24 in.
1 in. = 6 barley seeds
1 barley seed = 3.526 mm. (according to Snell)

Using these units, the Arabs obtained the meridian quadrant of 10,359 km., only 3.6% too long.

III. ELLIPSOIDAL ERA OF GEODESY

A new epoch began in geodesy with the use of triangulation. The idea of triangulation was apparently conceived by the Danish astronomer Tycho Brahe before the end of the 16th century and was used by him to establish a geodetic connection between Ven island and the main islands of Denmark. Triangulation was developed as a science, however, by Snell, who also first used it for measuring the dimensions of the earth. The triangle chain of Snell had 33 triangles and rendered for the meridian quadrant a value which was as much too small (3.4%) as that of the Arabs was too large.

The triangulation of Jean Picard (1620–82), which extended from Paris to north 1°.2 and consisted of 13 triangles, is methodically important because in it the telescope was first used for astronomical observations and logarithm tables were used in computing the results. Picard also measured by wooden rods a base line in the modern sense of this term. This measurement was significant also in that Sir Isaac Newton, when deriving his law of gravitation in 1665–66, used the equator radius value obtained by Picard.

The idea of triangulation is to measure only the angles of consecutive triangles. If in addition, as in fig. 2A, the length of one side, B_1B_2, of one triangle has been measured, all sides of the other triangles can be computed from the sine theorem. The triangulation points are chosen on hilltops and mountains so that the neighbouring points *A*, C, D, E can be seen from point B and thus the angles between them can be measured. When the length of the sides is known, the distance between any point (*e.g.*, between *A* and F) can be computed along the reference ellipsoid, and thus all points of the triangulation can be referred to the same geodetic system. Triangulation can have the shape of a triangle chain as shown in fig. 2A; or that of an "envelope chain" (fig. 2B), much used in the United States; also a triangle net as shown in fig. 2C.

One side of a triangle is obtained directly by measuring the field base line as accurately as possible. In principle, one base line for every triangulation system would be sufficient. Because of the impossibility of avoiding errors in observation, several base lines, each at an interval of 200 to 300 mi. are measured. Then an adjustment computation is made to take care of the observation errors. For instance, the sum of the angles of every triangle must be $180^\circ + \epsilon$; ϵ is a small quantity called the spherical excess of the triangle in question and is caused by the sphericity of the earth. In a similar way, for every measured base line, computation of its length along the triangles beginning from another base line must give exactly the same length as the measurement itself gives. When computing a closed loop of triangles it is necessary to get for the beginning point its original co-ordinates. So in triangulation there are numerous conditions that the observations must satisfy: the angle control, side control, base line control and co-ordinate control. All these will be handled in the geodetic adjustment computation based on the "least square" method, which means that the observations have to be corrected so that the sum of the squares of the corrections is a minimum. The main purpose of the adjustment computation is to eliminate the discrepancy in the triangulation net so that exactly the same co-ordinates will be arrived at for any of the triangulation points, regardless of which way they have been computed from the initial point. This does not mean, however, that the errors themselves have been eliminated. The observation errors exist but their effect has been made as harmless as possible.

The best results can be obtained, however, only when the observation errors are as small as possible. Therefore, in triangulation much attention is given to the accuracy of the measurements. For instance. the angles of every triangle are measured not once or twice but as many as 24 times. Similarly the base lines are measured several times and by different measuring wires to reduce the observation error.

Methods of triangulation have been so perfected that the accuracy of the base lines is from 1:2,000,000 to 1:4,000,000 of the length of the base line.

The period from Eratosthenes to Picard may be called the spherical era of geodesy. because the earth was thought to be a sphere. The geodetic problem was then relatively simple. It was necessary only to determine the radius of the sphere. The new era. the ellipsoidal era, began with the theoretical studies of Newton and his contemporary Christiaan Huygens. The physical

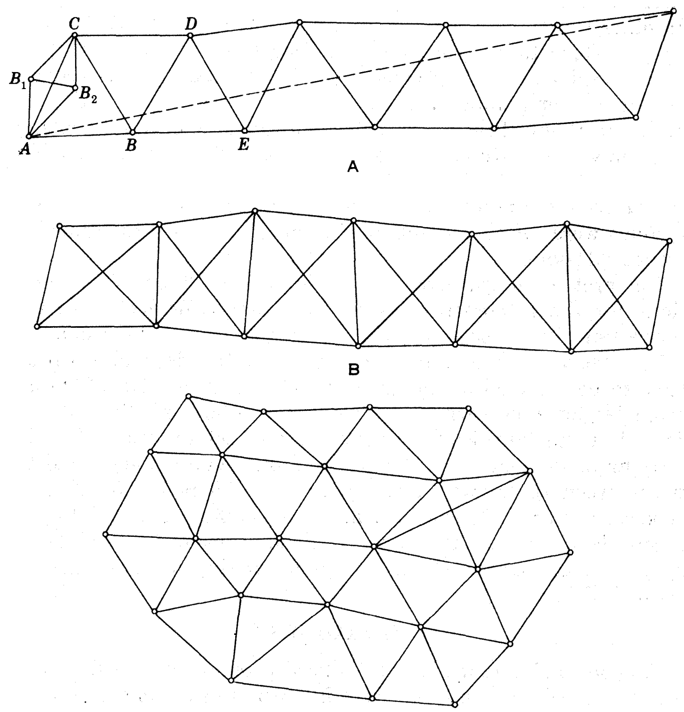

FIG. 2.— THE PRINCIPLE OF TRIANGULATION

(A) single triangulation chain, (B) "envelope" chain, (C) triangulation net proofs of the sphericity of the earth had so far been proofs of its general rotundity. In the Ptolemaic astronomy it had seemed natural to assume—for reasons usually of a metaphysical sort—that the earth was an exact sphere; but with the growing conviction that the Copernican system was true and that the earth rotates about its axis. and with the advance in mechanical knowledge due chiefly to Newton and Huygens, it seemed natural to think of the earth as an oblate spheroid flattened at the poles. There was also the experimental evidence of the astronomer Jean Richer (1630–1696), who found that his clock, regulated to keep time at Paris, lost $2\frac{1}{2}$ min. a day at Cayenne in South America, where he had been sent to make observations.

But the arguments from theory and the evidence of Richer's clock. confirmed by the experience of other observers, seemed to be contradicted by the work of Jean Dominique Cassini and his son Jacques, in France. If the earth is an oblate spheroid. the length of a degree of latitude must increase from the equator to the pole. but the Cassinis, continuing the arc of Picard north to Dunkirk and south to the boundary of Spain, came to the opposite conclusion. They divided the measured arc into two parts, one northn-ard, the other southward of Paris. The length of a meridian degree north of Paris was 111.017 m., or 265 m. shorter than one south of Paris (111.282 m.). This result could only happen either by a prolate (egg-shaped) earth or by errors in observation. In any case, their observations were strongly against the flattened earth.

It may seem strange that the length of the meridian degree is longer at the pole than it is at lower latitudes and at the equator. One might think that the reverse would be true, because the pole radius is shorter than the equator radius. Fig. 3 shows, however, why the length of a meridian degree increases with the latitude. The central angles v at the equator and pole are equal. but the radius EC_1 (radius of curvature) of the meridian AE at the equator E is shorter than the radius of curvature PC, at the pole P. Consequently, the meridian degree PB at the pole is longer than the meridian degree *Ed* at the equator. The pole radius PD and the equator radius ED are quite different from the radii of curvature EC, and PC,.

Because of the Cassinis' results a heated controversy began between the French and British scientists. The British scientists (the "earth flatteners") claimed that the rotating earth must be flattened as Newton and Huygens had theoretically shown. The Frenchmen, particularly the Cassinis, defended their own measurement and continued to believe the earth to be egg-shaped.

To settle this controversy, the French Academy of Sciences in 1735 sent an expedition led by Pierre Bouguer and Charles Marie de la Condamine. to a section of the Spanish province of Peru (which later became Ecuador) to measure the length of a meridian degree close to the equator. Another expedition in 1736, under P. L. M. de Maupertuis, was sent to Lapland to make a similar measurement near the Arctic circle. According to the resulting measurements the length of a meridian degree in Peru is 56.734 toise (French fathom); in Paris 57,060 toise; and in Lapland, 57,422 toise. The meridian degree was found to be longer the farther away from the equator the observations were carried out. These results showed irrefutably that the Cassinis were wrong and that the earth is flattened. The measurements in Peru and Lapland gave for the flattening the value 1:213, quite far from the value 1:297.0, used since 1924.

The general opinion of the geodesists was that the meridian arc measured by the Maupertuis expedition was not as long as the measurement indicated. The control measurements of the Swedish Geodetic Institute (Svanberg) in 1804, in fact, showed that the error was relatively large, according to him, 226 toise or 441 m. In 1928, the Finnish geodesist, Y. Leinberg, discovered that Maupertuis' measurement accumulated a number of errors that totaled 393 m. Unfortunately, all Maupertuis' errors were effected in the same direction, but it was fortunate that they gave him too long a meridian arc. Had his measurement been 441 m. too short, the problem concerning the shape of the earth would not yet have been solved definitely.

Eighteenth Century.—During the 18th century there were numerous measurements of arcs. The trigonometric survey of England was begun in 1783. primarily to establish geodetic connection between Greenwich and Paris. More important. honever, was the French arc measurement. In 1791 the French national assembly accepted a nen length unit replacing the toise. This unit was called a metre, by definition 1:10.000.000 part of the meridian quadrant from equator to pole along the Paris meridian. To get the length of this unit, additional accurate observations were needed. Therefore, a new arc measurement between Dunkirk and Barcelona. Sp , nas carried out by Pierre François Méchain and Jean Baptiste Delambre in 1792–98 Their publication in three volumes. *Base du système métrique decimal* (1806–10), in which the measurements carried out in France and Peru mere applied, gave for the length of a metre the following value: 1 metre = 443.296 Paris lines; 1 toise = 6 feet = 72 inches = 864 Paris lines. The ratio between toise and metre is therefore 864: 443.296, or 1 toise = 1.9490363 metres. Later arc measurements, however, showed that the metre does not correspond to its definition. In fact, the meridian quadrant of the international ellipsoid is 10,002,288.3 m. The metre is consequently 0.02% "too short." The following table may be used for reference:

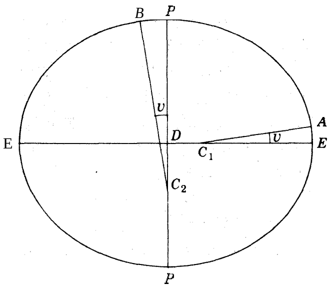

FIG. 3.—THE RELATIONSHIP BETWEEN MERIDIAN DEGREE AND LATITUDE

Fundamental Elements of the International Ellipsoid of Reference

a = semimajor axis (equatorial radius) = 6,378,388 metres

f = ellipticity (flattening) = $\frac{a-b}{}$ = 1/297 = 0.003,367,003,367

Derived Quantities

b = semiminor axis (Polar radius) = 6.356,911.946 m.

e^2 = square of eccentricity = $\frac{a^2-b^2}{a^2}$ = 0.006,722,670,022

Length of quadrant of the equator= 10,019,148 4 m.
Length of quadrant of the meridian= 10,002,288.3 m.
Area of the ellipsoid = 510,100,934 sq km
Volume of the ellipsoid = 1,083,319,780,000 cu.km.
Radius of sphere having same area as ellipsoid = 6,371,227.7 m.
Radius of sphere having same volume as ellipsoid = 6,371,221.3 m.
Mass of the ellipsoid = 5 988 $\times 10^{21}$ metric tons.

Nineteenth Century.—Of great significance were the arc measurements carried out in the 19th century by the survey of India under the leadership of the English surveyors general such as Sir George Everest, Sir Andrew Waugh and Sir Sidney Burrard; other scientists included G. H. Pratt, Sir George Airy and, later, F. deGraaff Hunter. In fact, this geodetic work made India the birthplace of isostasy (see below) and yielded detailed shape of the geoid over an area covering nearly all of India.

During the ellipsoidal era. which lasted to the 20th century, several geodesists computed reasonable values for the dimensions of the reference ellipsoid. In addition, the turn of the 19th century brought to geodesy, through the genius of 18-year-old K. F. Gauss (1795) and of A. M. Legendre (1806) development of the important adjustment computation as well as the definition of the metre and a preliminary value for it. The 19th century introduced the methodically basic triangulation work of Gauss and F. W. Bessel; the mathematical basis (Stokes' formula) of physical geodesy; as well as the international co-operation required for the development of geodesy.

IV. GEOIDAL ERA OF GEODESY

The period after 1900 can be called the geoidal era. because after this time it was possible to start the determination of the detailed shape of the geoid and its accurate dimensions to replace the approximations provided by the reference ellipsoid. During this geoidal era new instruments for geodetic, astronomical and gravimetric measurements were devised; the international ellipsoid and international gravity formula to be used in geodetic and gravimetric studies were adopted; extensive isostatic studies of basic significance to physical geodesy were carried out; several long-range triangulations were made; and electronic, celestial and gravimetric methods were applied to geodesy.

In the 19th century when every country was satisfied with a control point system of its own, the problems of geodesy were not too complicated. If a country was not too large, any reasonable reference ellipsoid could be used, since the effect of possible errors on its dimensions was quite small and not significant in practical mapping work. The reliability of the co-ordinates of the control points depended mainly on the accuracy of the astronomical, triangulation and traverse measurements. Relatively simple adjustment computation eliminated any inner discrepancy of the geodetic system in question. It did not matter how much the geodetic systems of different countries disagreed with one another. As late as 1947, for instance, the differences of the co-ordinates of the same control point amounted to 95 rn. between the Danish and Swedish systems, 250 m. between the Danish and German systems; 171 m. between the Danish and Norwegian systems; and 191 m. between the English and French systems. The exact extent of differences between the geodetic systems of the various continents and ocean islands is not known. They may be as great as 5 mi. or more.

World Geodetic System.—By mid-20th century it was clear that such confusion could not be allowed to continue. The demands of hydrographic surveying and aviation made it of basic importance that the co-ordinates of the different countries and continents be under the same system, that the existing geodetic systems, even across the oceans, be converted as accurately as possible to a single world geodetic system. It did not matter where the initial point of the world geodetic datum was located.

To standardize a world geodetic system the follo ing would be necessary: (1) a common scale or yardstick throughout the world; (2) new arc measurements along the continents and across the oceans; (3) exact localizing of these arcs on the reference ellipsoid; (4) more accurate dimensions of the reference ellipsoid; (j) extremely accurate values of the geoid distances N and the deflections of the vertical components ξ and η at the initial points of the different geodetic systems. As shown in fig. 4. N is the distance between the reference ellipsoid and the geoid at a given point. The tilt of the geoid is given by the angles ξ, the deviation between the plumb line and the perpendicular to the ellipsoid (dotted line) measured in a north-south plane, and η, the deviation measured in an east-west plane (perpendicular to the diagram, fig. 4, and so not shown).

The significance of a common scale is easy to understand. If the length unit obtained by the base line measurements is different in the various countries and on different continents, the computed geodesic lines to be used in the world-wide computations will not be comparable with one another and will cause systematic errors. Because of this fact it is necessary to measure in the different countries, or at least on every continent, one accurate standard base line on which to calibrate the wires or tapes to be used in the measurement of the field base lines. The light-interference method, invented by the Finnish astronomer Y. Väisälä, and put into practice by the Finnish Geodetic institute, supplies the needed standard base lines.

The United Nations' Regional Cartographic Conference for Asia and the Far East in Mussoorie, India, in Feb. 195j, recommended to the governments of the Asian countries "that a few standard base lines in this region should be established by the Vaisala method for assuring the uniform scale in all networks and for calibrating invar tapes and other equipment." The relative accuracy of the standard base lines of Nummela, Fin., and Buenos Aires, Arg., measured by T. J. Kukkamaki (1948) and T. B. Honkasalo (1953) are 1:17,000,000 and 1:9,000,000, or approximately 0.1 in. per 2j mi.

The Geodimeter.—Designed by E. Bergstrand and developed in Sweden, the United States and Germany, this instrument is based on Armand Fizeau's method for measuring the velocity of light. Instead of using a toothed wheel as the modulator and the human eye as the detector, the geodimeter applies a Kerr cell as the modulating unit and a photomultiplier tube as the detecting unit.

To measure distances the transmitter of the geodimeter sends light impulses at a modulating frequency of 10 mc. The impulses are reflected back from a target and are then detected in the photomultiplier tube of the receiver. If the distance between transmitting and target points is an integral amount of quarters of modulated light waves (about 7.5 m.) a special null detector indicates zero, which can be obtained by alternating the modulating frequency to apply a new unit of measurement. If only one frequency is used the distance must be accurate to $\pm$7.5 m. In practice, however, another frequency deviating 1% from the main frequency is used when the distance must be known only to $\pm$750 m. The instrumental accuracy is mainly dependent on the frequency, which is accurate to 1 or 2 parts in 10,000,000. The practical accuracy is a function of the velocity of light waves in *vacuo* and of the propagation anomalies caused by changing atmospheric conditions. These can be determined with an accuracy of about 1:1,000,000.

To measure the exact dimensions of the reference ellipsoid more and longer geodetic yardsticks (*i.e.,* accurately measured arcs in different parts of the world) are imperative. By the latter 19jos. for the most part, only the classic triangulation method had been used for this purpose. On the basis of astronomical observations of latitude and longitude at or near the end points of these yardsticks. we can locate the arcs approximately at the right places on the earth's surface. This astrogeodetic method can be used on the continents. In fact, the mathematicians of the U.S. army map service in 1956 computed new dimensions for the reference ellipsoid on the basis of the long arcs: Tornio, Fin.–Cape Town; Alaska–Chile; one meridian arc and one longitudinal arc in mainland U.S.; and one Eurasian arc, Atlantic coast–Siberia.

V. MODERN ARC MEASURING METHODS

Since the old triangulation method fails completely over the oceans, new methods were needed to connect the continents with one another geodetically. Two modern methods of measuring have been applied: the electronic and the celestial.

Electronic Method.—In the electronic method (Shoran, Hiran, Loran) it is necessary to know only the velocity of light and relatively short triangulation chains for calibrating the equipment which measures the long distances. Lines up to 880 km. have been measured so far with the highest relative accuracy: 1:120.000.

Shoran measurements need two ground stations, A and B, and one or more air-borne stations which carry the transmitting equipment for broadcasting the electromagnetic impulses. The aeroplane flies in loops over approximately the middle of line AB. The Shoran readings give the time which elapses when the impulses travel from the aeroplane to the ground station and back. From this time the distance from station A to aeroplane, as well as the distance from station B to aeroplane, can be computed. The, sum of these distances is different depending on how far the aeroplane is from the vertical plane through the line AB. Every reading gives a single value for the combined distance A-aeroplane-B. These values, reduced to the minimum distance, supply the distance between the ground stations A and B.

Celestial Method.—Four celestial methods have been developed: the rocket–star, solar eclipse, occulation and moon camera.

Rocket–Star.—This is a triangulation method invented and developed by Y. Vaisala in 1946. In this method a rocket is launched in an accurately vertical direction to a certain elevation (*e.g.,* 200 km.) and the neighbouring stars are photographed simultaneously from several observatories or other observation points. By measuring the small angular distances between the images of the stars and the rocket, the direction of the rocket from the observation points can be accurately computed. If the rocket were launched to an elevation of several hundred kilometres it would be possible to find distances across the oceans, and for triangulation on the continents.

The advantage of the rocket–star method lies in the large triangles which can be used.

Solar Eclipse.—This once popular method was developed in 1943 by I. Bonsdorff, director of the Finnish Geodetic institute. It is based on the scheme of the Polish astronomer T. Banachiewic and is used for measuring distances across the oceans. The method is simple although technical difficulties appear. With sound-film techniques photographs are made at two stations, A and B (each on different continents), around the moments when the totality of the eclipse begins and ends. The exact time, *t*, elapsing between the beginning (and end) of the totality at A and B is measured from the film, which also contains the tracks of the time signals and chronometer ticks. The time, t, renders with relatively high accuracy the distance between the stations, if the distance of the moon at the observation time is known accurately. For that purpose at least two solar eclipse stations, B and C, must be located on the same continent and their distance must have been measured by triangulation. The known distance BC gives the distance of the moon, on the basis of which the unknown distance AB across the ocean can be computed. For intercontinental geodetic ties this method was applied during the total solar eclipses in 1945, 1947, 1948, 1954 and 195j. Unfortunately conditions were so capricious —a cloudy sky too often hindered the observations — that only once was it possible to compute the distance across the Atlantic by this method. The accuracy of this tie, according to Kukkamäki's publication, is of the order of 80 m. An essential part of this error was brought about by the irregularity of the moon's topography.

Enthusiasm for this method has waned since total solar eclipses occur rather seldom, and because of the often inconvenient locations of the observation stations, which are determined by the path of the moon's shadow. Also the irregularity of the moon's limb (outline) decreases the accuracy of the observations. and too frequently "heavenly sabotage" destroys the work of the expedition.

Occulation.—In this method the moments during which a star disappears behind the moon's limb and emerges from behind it are observed. As in the solar eclipse method: the distance between the observation points can be computed assuming that the distance of the moon is known. This method also can be applied only relatively seldom, though more frequently than the solar eclipse method.

Moon Camera. — The moon camera method, invented by William Markowitz at the U.S. naval observatory, photographs the moon together with the neighbouring stars from observatories on different continents. The moon camera is so constructed that the moon's limb and the neighbouring stars are held stationary during the exposure of the film. The small angular distances of the distinct points of the moon's limb from the neighbouring stars, measured from the film, give the direction to the moon from the observation points. In theory two complete observations of the moon suffice. Analytically considered, two complete observations give four quantities, and only three unknowns have to be found. Considered geometrically, each observation gives a line of sight along which the station lies. Two lines of sight, well separated in direction, will intersect in a point which locates the station. In practice, the use of the moon in the solution of astronomical and geodetic problems is rather difficult from the standpoints of both computation and observation. What is measured is the displacement of the moon from a calculated position. The moon, however, may be displaced for reasons other than that due to the displacement of the station from the centre of the earth. In order to separate all the unknowns involved numerous observations must be made. Moreover, the moon must be observed over a large portion of its orbit, and at each station it must be observed in different parts of the sky. Before mid-20th century this had not been feasible because of the restrictions involved in determining the position of the moon accurately.

The geocentric co-ordinates of these points can, according to Markowitz, be computed, the geocentric radius R with the accuracy of about 40 m. The variation of R with the latitude and longitude of the observation points gives the general shape of the earth with the mentioned accuracy if a sufficient number of observation points exist. Twenty astronomical observatories of different continents agreed to co-operate during the International Geophysical Year 1957–1958 to apply this method on a world-wide scale.

The three moon methods are similar in that the moon is used as one triangulation point of this celestial triangulation. They help in determining the size and general shape of the earth.

All types of arc measuring methods render the length l of an arc of a great circle of the earth, which is necessary in determining the equatorial radius a.

The flattening f of the reference ellipsoid can be determined also by other astronomical methods utilizing the observed mechanical effects produced by the earth's equatorial protuberance, *i.e.,* by the polar flattening of the earth. This equatorial bulge produces periodic perturbations in the moon's perigee and of the node of its orbit on the ecliptic. The moon in turn acts on the equatorial bulge of the earth and produces the greater part of the slow displacement of the equinoxes known as precession; the sun contributes a fairly large part of the observed precession and the planets the small remainder. From any one of the effects mentioned the flattening of the earth may be deduced. Although there are theoretical difficulties in all of the methods the flattening deduced from the precession is as satisfactory as any; it agrees substantially with the flattening, 1:297, of the international ellipsoid. The flattening deduced by the other lunar methods tends to come out a trifle greater than this. The application of these different methods can reduce the errors in calculating the earth's dimensions.

All these celestial methods require land stations and fail over the open oceans. In addition, they are bound to the existing triangulation chains and to the relatively few astronomical observation points. ,Since the shape of the geoid must be determined point by point, it remained necessary to find a universal method which could be used everywhere in the world. This method will be rendered by physical geodesy.

VI. PHYSICAL GEODESY

There is a difference between geometrical geodesy and physical geodesy. Triangulation, either in the classic or the modern sense, with astronomical observations (*i.e.,* the arc measuring method), is spoken of as geometrical geodesy because it does not consider the structure of the earth's interior. Solely astronomical observations on. and triangulation along. the earth's surface give the size and general shape of the earth even if its structure is unknown. In this respect geometrical geodesy has had considerable success and has supplied reference ellipsoids that are not too diiferent from the actual geoid.

In the classic computations of the dimensions of the reference ellipsoid physical geodesy played an important role. It had been necessary to make the astronomically observed latitude, longitude and azimuth as representative as possible. In other words, in analyzing the astrogeodetic deflection of the vertical components, ξ and η, we must consider not only the effect of the visible topographic features but also the invisible compensating masses of the earth, and thus consider the internal structure of the earth's crust and of the layers under it. J. F. Hayford's ellipsoid, although based entirely on arc measurements made nithin the United States, wàs sufficiently accurate to be adopted in 1924 as the international ellipsoid because he used the topographic-isostatic reduction. *i.e.,* the method of physical geodesy. A similar case was W. A. Heiskanen's derivation of the equator value 978.049 cm. per sec. per sec. of the international gravity formula.

Gravity Anomalies. — The main tool of physical geodesy is, honever, the gravimetric method. The advantage of this method lies in its use of only one quantity, the gravity anomalies. To get the gravity anomalies it is necessary to reduce in some way the observed gravity from the observation point to sea level. Depending on the reduction method used, different values are obtained for sea level gravity g,. Since the earth rotates around its axis and, in addition, is flattened, the g_0 values are smallest at the equator arid increase with latitude. The gravity anomalies seem to have a relation not only to latitude but to longitude as well. Therefore, several scientists have derived gravity formulas assuming that the earth is a triaxial ellipsoid instead of an ellipsoid of revolution; in other words, the equator and the parallel circles are ellipses instead of circles. According to them the long axis of the equator would be close to longitudes 0° and 180°; the short axis close to longitudes +go° and —go°. The difference between the large and small semiaxes of the equator is about 120 m.

The triaxiality of the earth is quite difficult to explain geophysically and even the increasing use of gravimetric methods had not completely proved its existence. It appeared that this problem would best be solved—and in exact form—when the detailed shape of the geoid had been determined gravimetrically. From the geoid map of the world it would be easy to see whether the real geoid is closer to the triaxial ellipsoid or to the ellipsoid of revolution.

The physical basis of physical geodesy lies in the fact that the disturbing masses ***Am*** result in the geoid distances N, the deflection of the vertical components ξ and η, and the gravity anomalies $\Delta g = g_o - y$, where g_o is the observed gravity reduced to sea level and y is obtained from the international gravity formula,

$y = 978.049\ [1 + 0.0052884 \sin^2 + - 0.0000059 \sin^2 2\phi]$ cm./sec^2.

Of these quantities, Δg can be measured, and from it the quantities N, ξ and η can be computed. Figs. 4 and 5 show why the geoid is irregular. Fig. 4 indicates that the mass surplus of the

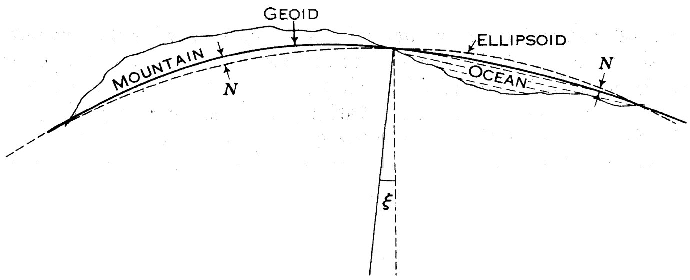

FIG. 4.—THE INFLUENCES OF SURFACE IRREGULARITIES UPON THE SHAPE OF THE GEOID

mountain pulls the plumb line; the mass deficiency of the ocean pushes it toward the mountain. Consequently, the plumb line (solid line) and the normal of the ellipsoid (dotted line) are not the same but make an angle with one another, the deflection of the vertical, ξ. Because the geoid (as an equipotential surface) is always perpendicular to the plumb line, the geoid under the mountains must be above the ellipsoid, and at the oceans it must be below the ellipsoid, if we assume that the mass surplus of the mountains and mass deficiency of the oceans are real and not isostatically compensated. Fig. 5 also shows that the invisible mass anomalies Δm, surplus (++++) or deficiency (− − − −), bring about the gravity anomalies hg, geoid distances N and the deflection com-

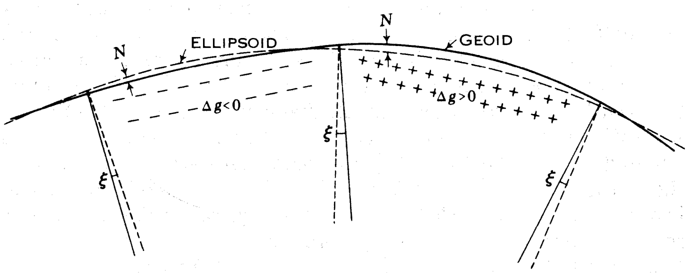

FIG. 5.—THE RELATIONSHIP OF MASS ANOMALIES AND GRAVITY ANOMALIES

ponents ξ and η. In these figures the quantities N and ξ as compared with the size of the earth have been exaggerated greatly to make the picture more clear. In fact, the largest N-values are less than 1:64,000 part of the radius (6,400,000 m.) of the earth, in other words, less than one inch on a sphere of one mile radius.

VII. METHODS AND ACHIEVEMENTS OF PHYSICAL GEODESY

The mathematical basis of physical geodesy is the Stokes' function, as set forth by Sir George Stokes in 1849, and its derivatives, developed by F. A. Vening Meinesz in 1928. The Stokes' function holds that the shape of the geoid can be determined if the gravity anomalies in the neighbourhood of the computation point are known rather well and those around the world are known in broader terms. The Vening Meinesz formulas indicate that in this case the deflection of the vertical components also can be computed.

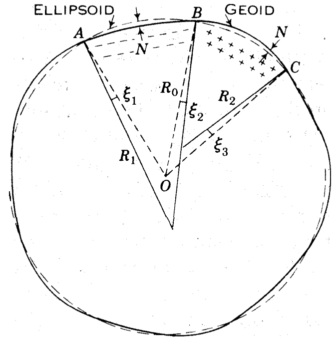

FIG. 6.—THE RELATIONSHIP OF VERTICAL DEFLECTIONS AND DIMENSION OF THE REFERENCE ELLIPSOID

Computations.—Fig. 6 shows how the irregular form of the geoid will interfere in the computation of the radius of curvature of the earth. Because of the warping N of the geoid (solid line) and the deflections of the vertical ξ_1, ξ_2 and ξ_3, it is easy to get wrong dimensions for the earth ellipsoid (dotted line). The arc AB, where the geoid is under the reference ellipsoid, gives too large a radius R_1; arc BC, where the geoid is above the ellipsoid, gives too small a radius R_2; the correct value is R,. Through the isostatic reduction of the astrogeodetic deflections of the vertical the irregularities of the geoid can be "smoothed" and the disturbing effect of the deflections of the vertical on the 'radius R_0 can be reduced and a better result achieved. The whole effect of the quantities ξ_1, ξ_2 and ξ_3, however, can be eliminated only if they are known and considered. Then both arcs dB and BC give the real radius R_0 of the ellipsoid. To put it more mathematically, the curvature of the geoid along the measured arc is obtained instead of the curvature of the mathematical reference ellipsoid as is the case when the deflections of the vertical ξ are not known. The gravimetric method supplies these quantities ξ.

Figs. 7 and 8 explain the limitations of the arc measuring method. Fig. 7 shows that the fictitious geoid distances N_1, N_2 are obtained if the exact dimensions of the reference ellipsoid are not known. Similarly fig. 8 indicates that wrong N-values also result in the case that at the initial point A of the geodetic datum an unsuitable deflection of the vertical ξ_0 has been used. Therefore, we cannot convert the various geodetic systems to a single world system unless we know the real deflections and the geoid distances at the initial points of these systems, or can connect the initial points with one another directly either by triangulation or by some other method.

When the arcs used in the determination of the dimensions of the earth are relatively short as compared with the radius of the earth, the error brought about by the deflections of the vertical at the end points of the arcs used can amount to hundreds of metres. If, for instance, the unknown relative deflection of the vertical at the end points of an arc $\frac{1}{3}$ the radius of the earth is only $4''$, the error in the obtained radius of the earth will be not less than 372 m. If longer measured arcs are available, the error caused by the neglected deflections of the vertical is smaller. If, for instance, in South Africa close to the southern end of the meridian arc Cape Town–Tornio, the ξ-component is $-10''$ and at the northern end, about $+2''$, neglect of these deflections will produce an error in the radius of the earth, computed by aid of this 100° long arc, of about 220 m. if other astrogeodetic points are not used.

As the examples show, in using measured arcs for checking the dimensions of the earth it is necessary not only to know the length of the yardsticks, but also to be able to localize the arcs at the right places on the ellipsoid to be computed. The central angle of the ellipsoid corresponding to the measured arcs must be determined accurately, considering the absolute deflections of the vertical at the end points of the arcs, if the arc is to be converted from geoid to ellipsoid.

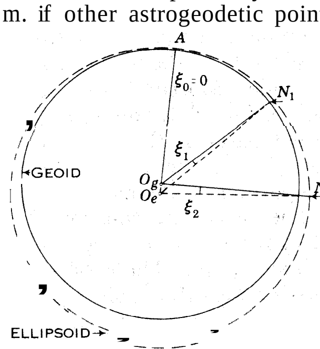

FIG. 7.—THE RELATIONSHIP BE- [illegible] RADIUS [illegible] REFERENCE ELLIPSOID AND THE GEOID DISTANCE N AND DEFLECTIONS ξ

In geodesy two methods have been used for checking the dimensions of the earth ellipsoid: the arc method, as explained earlier. and which comes into consideration if only triangulation chains are availabie; and the area method.

The Area **Method.**—When triangulations with astronomical points cover large areas as in the United States, Europe, the U.S.S.R., or India, use of the area method is preferable. One of the astrogeodetic points of the triangulation will be chosen as the initial point of the geodetic datum For instance, for the triangulation of the United States the initial point is Meades Ranch in Kansas, lat. 39° 13' 26".686; long. 98° 32' 30".506, azimuth to Waldo 75° 28' 14".52. Beginning at this initial point the latitude ϕ, longitude λ and azimuth A are computed geodetically along the chosen reference ellipsoid. The astronomical quantities ϕ', λ' and A' are referred to the geoid, the quantities ϕ, λ and A to the reference ellipsoid used. The differences of these quantities give, at all such triangulation points where astronomical observations are available, the deflections of the vertical components ξ and η, as the following classic formulas show:

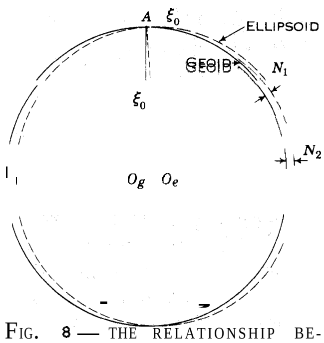

FIG. 8 — THE RELATIONSHIP BETWEEN THE VERTICAL ξ DEFLECTION OF GEOID DISTANCES AT INITIAL POINT

$$\xi = \phi' - \phi$$
$$\eta = (\lambda' - \lambda) \cos \phi$$
$$\eta = (A' - A) \cot \phi.$$

The 7-component can be obtained from the longitude observations as well as from the azimuth observations. If both are available, the point will be called the Laplace point and from the two equations for η the famous Laplace equation is obtained: $(A'-A) = (\lambda'-\lambda) \sin \phi$. Because of the observation errors this equation is not satisfied, but becomes instead the equation: $(A'-A) - (\lambda'-\lambda) \sin \phi = w$. The quantity w of the Laplace equation has nothing to do with deflections of the vertical, but is only the measure of the observation errors. The larger the errors are, the greater is w; $w = 0$ means that the observation error is zero.

If the undulation N_0 at the initial point of the geodetic datum is known or can be guessed then the warping N of the geoid can be computed with the aid of the obtained(- and η-values, along the arc measuring chain, if it has sufficient astronomical points. If this is combined with the gravimetric method the N-values can be interpolated even when only a few astronomical points are available.

In checking the dimensions of the reference ellipsoid based on the arc measurements, the criterion $\Sigma\xi^2 = \min$, or $\Sigma\eta^2 = \min$, or $\Sigma\ (\xi^2+\eta^2) = \min$. has been used depending on whether the arc has been measured in the direction of the meridian, or perpendicular to it, or in some other direction. This method is accurate if the measured arcs are long, but not if they are short, or if the astrogeodetic points used cover an area where the real deflections of the vertical are systematically either negative or positive. For instance, in Europe the criterion $\Sigma\ (\xi^2+\eta^2) = \min$ cannot be used because the average value of ξ in that area is of the order $+5''$ and the average η of the order $+2''$ to $+3''$.

The Gravimetric Method. — The gravimetric method makes it possible to obtain essentially more accurate dimensions for the reference ellipsoid merely by making extremely accurate astronomical observations at or in the neighbourhood of the end points of the measured arc. In addition the deflections of the vertical components ξ_g and η_g at both end points of the arc or close to them can be computed gravimetrically. On the other hand some arbitrary values have been chosen for the astrogeodetic deflection of the vertical components ξ_a and η_a (*e.g.*, zero) at one end (initial) point of the arc and computed along the arc ξ_a and η_a at the other end point. The computed quantities ξ_a, η_a depend on the reference ellipsoid used, while (η_g are nearly independent of it. If the differences $(\xi_g - \eta_a)$ and $(\eta_g - \eta_a)$ at both end points of the arc are nearly equal, the reference ellipsoid used is correct. If there is a difference, say, of 10″, the dimensions of the reference ellipsoid must be corrected so that this difference disappears.

Needless to say, if at, or close to, the end point of every measured arc accurate astronomical observations and the best local gravity survey have been carried out, these can be used for checking the dimensions of the earth. By the least square method the different measured arcs of this kind will give. together, the best possible correction to the equator value of the reference ellipsoid used.

In the area method, of course, the same criterion is used. The astrogeodetic points to be used must be as far as possible from the initial point but not too close to the boundary of the gravimetrically surveyed areas. The detailed gravity field must be available, say, to 500 km. from the computation point to get reliable gravimetric deflections of the vertical.

The deflections of the vertical average less than 5″; the values over 10″ are exceptional. They have been found for the most part in mountainous regions, and in quite a few cases on islands also, and even in lowlands where abnormally light or abnormally heavy disturbing layers are close to the computation point and to the earth's surface. For instance, in flat land in the neighbourhood of Moscow deflections of even 8″ exist. Similarly in south Finland, in the Aland islands, between Finland and Sweden, the deflection is 9″, and close to Columbus, O., also in level land, deflections of 10″ have been found.

Among the largest measured deflections of the vertical are the ξ- and η-values found in the Puerto Rican area (43″, according to D. Rice) and in certain of the British islands in the Pacific (54″, according to William Kaula). The relative deflections of the vertical on the south and north coasts of these islands differ as much as about 50″. When the distance between such stations is only about 50 mi., this distance, if computed from the astronomical co-ordinates, can have an error of 1 mi. or 1:50 of the whole distance. Since it is impossible to determine beforehand where the deflections of the vertical exist, it is impossible to use the astronomical co-ordinates as control points of any maps.

If the gravimetric ξ_g and η_g are known the astronomical quantities ϕ', λ' and A' can be converted to the geodetic quantities ϕ, λ and η from the formulas:

$$\phi = \phi' - \xi_g$$
$$\lambda = \lambda' - \eta_g \sec \phi$$
$$A = A' - \eta_g \tan \phi.$$

The obtained values ϕ, λ and A give the distances and azimuths along the ellipsoid. This is the principle of the astrogravimetric method for determination of the co-ordinates of the control points.

Another example of this principle concerns the western part of the boundary between the United States and Canada, which is the 49th parallel of latitude. For reasons of convenience this parallel was defined astronomically, and the result showed that one bounding station is about 8″ north of where a geodetic determination would have placed it, and another station less than 100 mi. away is about 6" south. The greatest relative error between two adjacent stations is about 7" in a distance of 20 mi., which means an error in the direction from one station to the other, as inferred from the latitudes, of about 35 ft. per mile.

When the quantities N, ξ_g and η_g are known they can be used to: (1) compute the distances along the reference ellipsoid between the astronomic points where ξ_g and η_g have been computed; (2) convert the existing geodetic systems to a single world geodetic system; (3) obtain with greater accuracy the dimensions of the earth; (4) check the accuracy of superlong triangulation, which greatly needs checking, especially where the triangulation chains were measured under difficult conditions, *e.g.*, the chain from Alaska to Chile; (5) reduce the geodetic base lines from the geoid to the ellipsoid; (6) compute the error caused by the deflections of the vertical at the triangulation points which in high mountains can be more than 2"; and (7) draft world maps for the geoid distances N, another set of world maps for the deflection of the vertical component ξ_g and a third set for η_g.

These maps have an exceptionally practical geodetic significance; they are also important for geophysics since there is always a close relation between the N, ξ_g and η_g-values and the internal structure of the earth.

By the 1950s. several areas, including large parts of the United States, Europe, India. Russia, Argentina, Canada and South Africa, had been so well covered by gravity station nets that reliable values, particularly for ξ_g and η_g could be obtained. The enormous progress in this respect was possible because of the folloning: (1) the invention of very fast, accurate gravimeters which can in three minutes measure a gravity value with 20 to 50 times more accuracy than had been possible to get in two days uith pendulum observations; (2) the invention of the Vening Meinesz pendulum apparatus for gravity observations at sea; (3) the invention of the underwater gravimeter for measuring gravity in the shallow shelf areas which cover about 7% of the ocean areas; (4) the interest of the oil companies in carrying out detailed gravity surveys for exploration purposes and universities conducting surveys for scientific purposes.

VIII. MEASURING INSTRUMENTS USED IN GEODESY

For longitude observations in the astronomical part of geodesy the transit instrument has been in general use for a long time. Those used at mid-20th century ordinarily were provided with a self-recording micrometer and were used in conjunction with a chronograph. For latitude determination the same transit, with broken axis, and the zenith telescope (*q.v.*) are used almost universally. For determination of azimuth and triangulation angles, the modern theodolite is used; this instrument is more accurate than the ordinary surveyor's theodolite but does not differ essentially. In addition, accurate chronometers. crystal clocks and radio receivers are needed for measuring the observation time and taking time signals. The accuracy of the astronomical observations. if observations are made on two or three nights at the same point, are of the order 0".1j in latitude and 0".20 in longitude. The standard error of the measurement of one angle in triangulation varies between 0".3 to 2".5 in different countries.

Bars and rods were used earlier for the base line measurements but they were inconvenient. The measurement went slowly and the accuracy was not high regardless of how carefully the observations were made. By mid-20th century bases were measured with tapes or wires made from invar alloy. The coefficient of the temperature expansion of invar is so small (of the order 10^{-7}/°C.) that the temperature need not be determined with high accuracy. The wires and tapes must be calibrated before and after the field work. That can best be done at the standard base lines described earlier.

In principle, the instruments for precise leveling are the same as the usual engineering leveling instruments but are, of course, much more accurate. The development of geodesy as a science closely followed the development of geodetic instruments since as the instruments became handier, more accurate and more rapid, the geodetic observations themselves became more accurate and more convenient.

In modern physical geodesy gravity observations are of basic significance, therefore gravimetric measuring instruments and methods are most important. Gravimetric observations are either absolute or relative. In absolute measurement it is necessary to measure the actual gravity that exists at the observation point. In the relative observation it is necessary to measure only the difference or ratio between the gravity g_0 at the base station and the gravity g at the field stations. When the base station gravity g_0 is known. the difference $(g-g_0)$ or ratio g/g_0 will give the gravity g at the field stations.

Pendulum Apparatus. — Until about 193j the pendulum apparatus was used almost exclusively in gravity observations. Its principle is simple. If the length l and period T of the pendulum can be measured the gravity g can be obtained from the formula

$$T=2\pi\sqrt{l/g}.$$

T is relatively easy to determine, but the measurement of the length of the pendulum l, involves difficulties. In addition the length l varies with temperature and other atmospheric conditions. Therefore, absolute gravity observations at one point take many months and in spite of the utmost care the accuracy is relatively low, rarely more than 3 to 4 mgal. (in geophysics unit g has been named the "gal" [after Galileo]: 1 milligal [mgal.] = 0.001 gal= 0.001 cm./sec./sec.). In relative gravity observations it is necessary to measure only the period T of the pendulum at the base station and the field stations, assuming that l has not changed between the observations. The formula, $g:g_0=T_0^2:T^2$, gives the gravity g if T_0 and T have been measured at the base and field stations and g_0 is known.

Pendulum apparatus needs stable support in order to give the best observational results. In the Netherlands, where the land is not stable. Vening Meinesz, after running into difficulties in his gravity measurements, developed in 1923 a pendulum apparatus that could be used not only there but on the oceans as well. Two pendulums of equal length are allowed to swing in the same vertical plane but in different phase angles. By the use of a certain hypothetical pendulum. the phase of which at any instant is the difference between the phases of the two pendulums at that instant, the disturbing effect of the horizontal acceleration of the support can be eliminated. When the apparatus was supported in gimbals in a submarine 30 to 50 m. below sea level, it was possible to eliminate the effect of the horizontal acceleration of the submarine and so to measure gravity on the open sea. The accuracy of these observations is of the order 2 to 3 mgal. or sufficient for thorough studies of the oceans. particularly since the east-west velocity of the vessel which is not known accurately because of the ocean currents can cause an error (Eotvos effect) of 3 to 4 mgal.

Vening Meinesz measured about 900 stations along different oceans. Later, British. French. Russian. Italian and Spanish scientists continued these observations. However, the greater part of the sea observations between 1945 and 1955 were carried out by Columbia university, New York, under the leadership of W. Maurice Ewing and John Lamar Worzel. More than 4,000 ocean points were observed. Gravity surveys at sea are of basic significance from the geodetic point of view. since without them no application of the Stokes or the Vening Meinesz formulas to geodetic purposes would be possible.

Gravimeters. — Pendulum observations take much time and the results are not very accurate; therefore, various types of gravimeters were devised in the different countries, particularly in the U.S. They are ingenious instruments, working essentially on the principle of the spring balance. and are so accurate that in a few minutes the gravity difference can be read with an accuracy of 0.02 mgal., which is 50 times higher than that obtained earlier by pendulum observations of two days.

As the Vening Meinesz pendulum opened the oceans to gravimetric survey. gravimeters began a new era in the gravity survey of the continents. Oil companies, universities and geodetic institutes around the world were competing to carry out regional and local gravity surveys that by the latter 1950s covered an essential part of the continental surfaces. Gravimeters, however, must be calibrated preferably at the base stations by measuring them several times by an accurate pendulum. Gravimeters considered best for geodetic purposes (Worden, Norgaard gravimeters) have large range (as great as 5,000 mgal.), high accuracy and small weight.

Gravity observations throughout the world can be used for computing geoid distances and deflections of the vertical only if they all refer to the same world gravimetric system, regardless of which system it is. Cntil the latter 1950s all gravity anomalies were computed by the Potsdam system. The absolute gravity observations of this system were done at Pendulum hall. Potsdam, Ger., in 1900–03. The observed gravity value was g = 981,274 gal which, however, according to later observations appeared to be about 15 mgal. too high. Fortunately. the error did no harm since the value is used to obtain gravity differences in the formula, $\Delta g=g-\gamma$. If g is 1j mgal. too large, then γ is also 1j mgal. too large and Δg remains the same.

Gravity values can be best changed to the same system if scientists use the same type of gravimeters and air transportation and carry out gravity observations at national gravity base stations. Such a conversion was made over a ten-year period (1947–57), particularly by the University of Wisconsin group under G. P. Woollard. This group occupied more than 3,000 base stations all over the world and integrated the essential part of the gravity data with the world gravimetric system, in most cases with an accuracy higher than 1 mgal.

IX. ISOSTASY

The mountains, valleys and oceans make it apparent that the earth is not in hydrostatic equilibrium. But the earth is, in broad terms, in isostatic equilibrium in that, beginning from a certain depth in the earth's interior. the surface units are under the same pressure whether they are beneath mountain, lowland or ocean. The depth of the uppermost surfaces is known as the depth of compensation and this type of equilibrium is called isostasy, at the suggestion of the U.S. geologist. C. E. Dutton, in 1889. This isostatic equilibrium is only possible if the mountains are not absolute mass surplus areas nor the oceans absolute mass deficiency areas. In other words, the mean density of the earth's crust must be smaller under the mountains, and larger under the oceans than under the lowlands.

The man who first glimpsed the idea of isostatic equilibrium was Leonardo da Vinci, that many-sided genius of the Renaissance era. Pierre Bouguer and R. J. Boscovich came to the same conclusion much later (18th century). The principle of isostatic equilibrium was, however, developed in a scientific sense in India, where triangulation with astronomical observations was carried out close to the Himalayan mountains before 1850. The difference between latitudes computed geodetically and observed astronomically at the same point was smaller than the mass surplus of the mountains of Asia would indicate. The observed difference of the deflection of the vertical at the Kaliana and Kalianpur stations was only 5″.24 but the value computed from the topographic masses was 15″.88. Therefore, J. H. Pratt in 1854 surmised that the mean density of the crust under the mountains of Asia must be smaller than in the lowlands, to compensate the attraction of the mass of the mountains of Asia to the plumb line direction. The astronomer G. B. Airy came to a similar conclusion in 1855 although he explained the isostatic equilibrium in a different way.

Pratt's isostatic assumption was that mountains rose from the subcrustal area after the manner of fermenting dough. the density of which would be smaller as it rose higher. Airy, on the contrary, reasoned that the high mountains of Asia had sunk in the substratum and would float as timber or icebergs float. The smaller density of the earth's crust under the mountains would, according to Pratt, compensate the effect of the topographic masses and cause the equilibrium. According to Airy the light root formations of the mountains have the same effect.

Pratt contended that if the earth were completely fluid, no mountains or valleys or ocean basins would be possible. But as the earth's crust began to form and gradually grow thicker, contractions and expansions might have taken place in some of its parts which would depress and elevate corresponding areas of the surface. Airy thought that there could be no other support than that afforded by the downward projection of a portion of the earth's light crust into the denser lava; and that this downward projection was of an extent to balance the projection above the lava; in much the same manner, nhen logs float upon the water and the upper surface of one is observed to be higher than that of the others, one assumes that its loner surface lies lower in the water than does that of the other logs.

The isostatic assumptions of Pratt and Airy were completely contradictory; although both were able to explain the discrepancy between the observed and the computed deflections of the vertical and gravity anomalies on the basis of the topography. Both theories have found defenders. The ideas of Pratt were developed in detail by the U.S. scientists. J. F. Hayford and William Bowie. According to them the compensation is complete and local, *i.e.*, every mountain, hill. valley and island is isostatically compensated, however large or small it may be. This assumption was used for practical reasons—to make the mathematical computations as simple as possible. Havford and Boaie computed needed formulas and tables for the topographic isostatic correction of the deflections of the vertical and gravity anomalies corresponding to different values of the depth of compensation, D. Every different value of D renders different gravity anomalies (and deflections of the vertical) at the observation points. When computing different sets of gravity anomalies. corresponding to different values D, it is possible to discuss which D-value is closest to the real structure of the earth's interior. Computations along these lines carried out by different scientists showed that D is close to 100 km. In geodetic computations the value 113.7 km. obtained by Hayford has been used.

From the geophysical point of view, the Pratt-Hayford assumption did not seem suitable; therefore, W. A. Heiskanen made a series of computations (1924, 1931 and 1938) based on Airy's assumption. Heiskanen's method rendered for the normal thickness of the earth's crust an average value close to 30 km.

Of course, according to the Airy-Heiskanen system, the actual thickness. T, of the earth's crust is the function of the topography. The higher the topography. the deeper is the root formation; the deeper the ocean, the thicker is the antiroot of heavy material under the ocean (see fig. 9). The light root formation (density

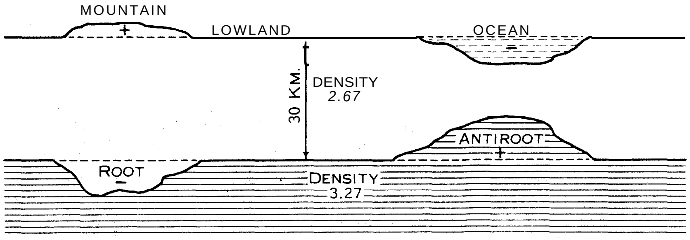

FIG. 9.—THE PRINCIPLE OF ISOSTATIC COMPENSATION

2.67) compensates the mass surplus of the mountains and the heavy antiroot (density 3.27) compensates the mass deficiency of the ocean. Using the density difference 0.6, the real thickness of the earth's crust is j.j km. greater for every kilometre of mountain elevation and 3.7 km. less under the oceans for every kilometre of ocean depth. In this way, the underboundary of the earth's crust. also called the Mohorovicic discontinuity. is in a way an exaggerated mirror picture of the real topography.

For practical reasons it has been assumed in both theories that compensation is complete and local, but in fact, this is not so. Small hills or tiny valleys or islands cannot be in complete isostatic equilibrium. Therefore, Vening Meinesz developed the theory of regional isostatic compensation. This modification of Airy's flotation theory claims that every topographical feature has an isostatic effect not only in the vertical direction under it but in the horizontal direction as well, to as much as 100 or 200 km. horizontal distance R. He computed (1931 and 1940) the needed tables for this regional theory according to different T- (normal thickness of the earth's crust) and R-values. Therefore by the 1950s three different systems—the Pratt-Hayford, the Airy-Heiskanen and the Vening Meinesz—existed for the isostatic study of the earth's structure.

Isostatic studies on the basis of gravity material of different countries, continents and oceans have shown that 85% to 90% of the mass deficiency of the oceans and mass surplus of the high mountains is isostatically compensated. Isostatic equilibrium is the rule. Areas such as small ocean islands, the belts of negative gravity anomalies and the postglacial land uplift regions where the isostatic equilibrium is not complete are exceptions. Since isostatic equilibrium prevails the geoid distances N are rather small. Under the Ieadership of Heiskanen and under the contract of the Cambridge Research center of the U.S. Air Force, the geoid computed in 1951–57 at Ohio State university on the basis of large gravity material of 35 countries revealed that the *N*-values seldom exceed ±50 m. Without the isostatic compensation N would in some cases even exceed 1,000 m., making the geoid studies more difficult. (W. A. Hn.)

X. VARIATION OF LATITUDE

The astronomical latitude of every observation point is variable, caused by a displacement of the axis of rotation in the body of the earth. There is in every body, however irregular in shape, an axis of figure. the axis about which the moment of inertia is a maximum. If for any reason the axis of figure and the axis of rotation do not coincide, the pole of the axis of rotation will describe in the body a closed curve about the pole of the axis figure. For a nearly spherical body like the earth, the axis of rotation will retain in space a nearly invariable direction.

The first general rule of variations for a rigid rotating body was stated (1744) by Leonhard Euler. With Euler's theorems in mind astronomers sought to detect by observation a possible variation in latitude, but succeeded only in reaching the conclusion that if any such existed, it must be small. Finally about 1881. S. C. Chandler undertook a careful study apart from any preconceived theory, basing it both on observations of his own and a study of old records. notably those of Greenwich observatory. At about the same time. the reality of a change in latitude due to a motion of the pole mas proved by simultaneous latitude observations in Berlin, Ger., and Honolulu, Hawaii, places differing in longitude by almost 180°. It was found that an increase in latitude in one occurred simultaneously with an approximately equal decrease at the other. This could not have resulted from local conditions or from incorrect star locations, but must have been due to a motion of the pole of rotation which in approaching one place receded from the other.

Chandler found that the motion of the pole of rotation about the pole of figure required about 14 months. whereas Euler's theory had led astronomers to expect a 10-month period. Simon Newcomb's euplanation. published in 1895, showed that Euler's theory was based on an ideal body absolutely unyielding and unchangeable in shape, a thing unknown in nature. The elastic yielding of the earth and the mobility of the ocean water lengthen the period from 10 months to 14. There is also a motion of the pole of rotation in the body of the earth because the pole of figure itself undergoes a displacement due to seasonal variations in barometric pressure. snow load, etc. The period of these seasonal changes is obviously one year.

The amplitudes of both the annual and the 14-month variations are of the order of magnitude of 0″.1. The quantities sought are small and difficult to measure, but it appears that both components of the polar motion are subject to unpredictable changes. Since the maximum deviation of the pole from its mean position is about 0″.3, which is small in comparison with the usual deflections of the vertical, the reduction of the observed astronomical latitudes to some more or less conventional mean value is not a vital matter in ordinary geodetic work. (It should be noted that the motion of the pole affects longitudes and azimuths also.) The interest of the subject is more on the astronomical and geophysical side.

The International Geodetic association in 1899 organized an International Latitude service with six special latitude observatories. all on parallel 39° 08'; three have remained in continuous operation. The advantage of having them in the same latitude is that all may use the same stars and uncertainties in the star places do not affect the conclusions. The observations may in fact be used to correct the star places.

XI. INTERNATIONAL GEODETIC ORGANIZATIONS

In 1862 the Central European Geodetic association (*Mitteleuropäische Gradmessung*) was organized on the initiative of Gen. Johann Baeyer of Prussia. Its first general conference was held in 1864 with representatives of 13 states or countries, many of them German states later united into the German empire. General conferences at intervals of three years were arranged, with a permanent committee directing the affairs of the organization between conferences. At the next conference (1867) in recognition of a widening scope, the name was changed to European Geodetic association (*Europäische Gradmessung*).

England and the United States were represented at the general conference in 1883 at which matters of world-wide interest, such as a common prime meridian and an international time system, nere discussed. In 1886 the name International Geodetic association *(Internationale Erdmessung)* was chosen to indicate a still wider scope, and a definite international convention was adopted providing for contributions from the member nations. F. R. Helmert, director of the Geodetic institute at Potsdam, Ger., exerted a powerful and beneficent influence on the work of the association. The headquarters, or bureau, of the association remained at Potsdam. The outbreak of World War I prevented the holding of the general conference planned for 1915, leaving that of 1912 in Hamburg the last held by the organization.

In 1919 the International Union of Geodesy and Geophysics was organized at Brussels, Belg., in connection with the newly created International Research council. The International Geodetic and Geophysical union consists of seven semi-independent associations, the largest of which, the International Association of Geodesy, took over the work of the former International Geodetic association. The work of the International Latitude service was taken over jointly by the section of geodesy and the newly formed International Astronomical union, since the subject was of interest to both organizations. The general assembly of the union meets every three years.

On the initiative of I. Bonsdorff the Baltic Geodetic commission was established in 1924 at Helsinki, Fin. It included representatives of eight nations bordering on the Baltic sea and dealt with geodetic problems of common interest to them. The triangulation carried out by this commission around the Baltic sea is extremely accurate, the closure error of this nearly 3,000 km.-long triangulation being only 2.j m. or 1:1,200,000, unparalleled in any earlier studies. (W. D. LA.)

See also INTERNATIONAL GEOPHYSICAL YEAR.

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GEOFFREY (1158–1186), duke of Brittany, fourth son of the English king Henry II and his wife Eleanor of Aquitaine, was born on Sept. 23, 1158. In 1167 Henry suggested a marriage between Geoffrey and Constance (d. 1201), daughter and heiress of Conan IV, duke of Brittany (d. 1171). Conan assented to this proposal. Having received the homage of the Breton nobles, Geoffrey joined his brothers, Henry and Richard, who, in alliance with Louis VII of France, were in revolt against their father; but he made his peace in 1174, afterward helping to restore order in Brittany and Normandy. In July 1181 his marriage with Constance was celebrated, and practically the whole of his subsequent life was spent in warfare with his brother Richard. In 1183 he made peace uith his iather, who had come to Richard's assistance; but a fresh struggle soon broke out for the possession of Anjou, and Geoffrey was in Paris treating for aid with Philip Augustus, when he died on Aug. 19, 1186.

GEOFFREY, surnamed MARTEL (1006–1060), count of Anjou, son of the count Fulk Nerra (*q.v.*) and of the countess Hildegarde or Audegarde, was born on Oct. 14, 1006. During his iather's lifetime he mas recognized as suzerain by Fulk l'Oison ("the Gosling"), count of Vendôme, the son of his half-sister Adela. Fulk having revolted, he confiscated the countship, which he did not restore till 1050. On Jan. 1, 1032, he married Agnes, widow of William the Great, duke of Aquitaine, and taking arms against William the Fat, eldest son and successor of William the Great, deieated him and took him prisoner at Mont-Couër (Sept. 20, 1033). He then tried to win recognition as dukes of Aquitaine ior the sons of his wife Agnes by William the Great, who were still minors, but Fulk Nerra promptly took up arms to defend his suzerain William the Fat, irom whom he held the Loudunois and Saintonge in fief against his son. In 1036 Geoffrey Martel had to liberate William the Fat, on payment oi a heavy ransom, but the latter having died in 1038, and the second son of William the Great, Odo, duke of Gascony, having fallen in his turn at the siege of Mauzé (March 10, 1039) Geoffrey made peace with his father, and had his wife's two sons recognized as dukes. He had interfered in the affairs of Maine, though without much result; for having sided against Gervais, bishop of Le Mans, who mas trying to make himself guardian of the young count of Maine, Hugh, he had been beaten and forced to make terms with Gervais in 1038. In 1040 he succeeded his father in Anjou and was able to conquer Touraine (1044) and assert his authority over Maine (*see* ANJOU). He died at Angers on Nov. 14, 1060.

See Louis Halphen, *Le Comté d'Anjou au XIe sidcle* (1906). A summary biography is given by Célestin Port, *Dictionnaive historique, géographique et biographique de Maine-et-Loire* (3 vols., Paris-Angers, 1874–78), vol. ii., pp. 252–253, and a sketch of the wars by Kate Norgate, *England under the Angevin Kings* (2 vols., 1887), vol. i. chs. iii. iv.

GEOFFREY, surnamed PLANTAGENET (PLANTEGENET) (1113–1151), count of Anjou, was the son of Count Fulk the Young and of Eremburge (Arembourg) of La Flèche; he was born on Aug. 24, 1113. He is also called "le bel" or "the handsome," and received the surname of Plantagenet from the habit which he is said to have had of wearing in his cap a sprig of broom (*genêt*). He married (June 2, 1129) Matilda, daughter of Henry I of England, and widow of the emperor Henry V. He died on Sept. 7. 1151. He had three sons: Henry Plantagenet (*see* HEKRY II), Geoffrey and William. *See* also ANJOU.

GEOFFREY OF MONMOUTH (d. 1154), bishop of St. Asaph and creator of the Arthurian legend, was born about the year 1100. In 1129 Geoffrey appears at Oxford among the witnesses of an Oseney charter. A first edition of his *Historia Britonum* was in circulation by the year 1139, although the test which we possess appears to date from 1147. This famous work professes to be a translation from a Celtic source; "a very old book in the British tongue" which Walter, archdeacon of Oxford, had brought from Brittany. There is nothing in the matter or the style of the *Historia* to preclude us irom supposing that Geoffrey drew partly upon confused traditions, partly on his own powers of invention, and to a very slight degree upon the accepted authorities for early British history. The romancer achieved an immediate success. He obtained, about 1140, the archdeaconry of Llandaff "on account of his learning"; and in 1151 was promoted to the see of St. Asaph.

Before his death the *Historia Britonum* had already become a model and a quarry ior poets and chroniclers. The list of imitators begins mith Geoffrey Gaimar, the author of the *Estorie des Engles* (*c.* 1147), and Wace, whose *Roman de Brut* (1155) is partly a translation and partly a free paraphrase of the *Historia*. In the next century the influence of Geoffrey appears in the *Brut* of Layamon, and in the rhyming English chronicle oi Robert of Gloucester. Among later historians who were deceived by the *Historia Britonum* were Higden, Hardyng, Fabyan (1512), Holinshed (1580) and John Milton. Still greater was the influence of Geoffrey upon Warner in *Albion's England* (1586), and Drayton in *Polyolbion* (1613). The *Historia Britonum* provided the material for the earliest English tragedy, *Gorboduc* (1j6j), the *Mirror for Magistrates* (1587), and Shakespeare's *Lear.*

But in the work of expanding and elaborating this theme the successors of Geoffrey went as far beyond him as he had gone beyond Nennius; but he retains the credit due to the founder of a great school. For the development of the tradition *see* ARTHURIAN LEGEND. Of the 12 books into which it is divided only three (Bks. IX, X, XI) are concerned with Arthur. Earlier in the work, however. we have the adventures of Brutus; of his follower Corineus, the vanquisher of the Cornish giant Goemagol (Gogmagog); oi Locrinus and his daughter Sabre (immortalized in Milton's *Comus*); of Bladud the builder of Bath; of Lear and his daughters; of the three pairs of brothers, Ferrex and Porrex, Brennius and Belinus, Elidure and Peridure. The story of Vortigern and Rowena takes its final form in the *Historia Britonum;* and Merlin makes his first appearance in the prelude to the Arthur legend. Besides the *Historia Britonum* Geoffrey is also credited with a *Life of Merlin* composed in Latin verse. The authorship of this work has, however, been disputed, on the ground that the style is superior to that of the *Historia*. A minor composition, the *Prophecies of Merlin,* was written before 1136, and later incorporated with the *Historia,* of which it forms the seventh book. (H. W. C. D.; X.)

GEOFFREY OF PARIS (d. *c.* 1320), French chronicler, was probably the author of the *Chronique métrique de Philippe le Bel,* or *Chronique rimée de Geoffroi de Paris.* This work, which deals with the history of France from 1300 to 1316, contains 7.918 verses. Various short historical poems have also been attributed to Geoffrey, but there is no certain information about either his life or his writings.

GEOFFRIN, MARIE THÉRÈSE, *née* **RODET** (1699–1777), a Frenchwoman who played an interesting part in French literary and artistic life, was born in Paris on June 2, 1699. She married, on July 19, 1713, Pierre François Geoffrin, a rich manufacturer and lieutenant colonel of the national guard, who died in 1750. It was not till 1748, when Mme. Geoffrin was nearly 50, that she became a power in Parisian society and started her two dinners a week, one on Monday for artists, and one on Wednesday for her friends the encyclopaedists and other men oi letters. She received many foreigners of distinction, Hume and Horace Walpole among others. Walpole spent much time in her society before he was finally attached to Mme. de Deffand, and speaks of her in his letters as a model of common sense. She adopted the pose of an old woman earlier than necessary, and her coquetry, if such it can be called, took the form of being mother and mentor to her guests, many of whom were indebted to her generosity ior substantial help. Although her aim appears to have been to have the *Encyclopédie* in conversation and action around her, her advanced views did not prevent her from observing the forms of religion, and she was extremely displeased with any of her iriends who were so rash as to incur open disgrace. A devoted Parisian, Mme. Geoffrin rarely left the city, so that her journey to Poland in 1766 to visit the king, Stanislas Poniatowski, whom she had known in his early days in Paris, was a great event in her life. Mme. Geoffrin died in Paris on Oct. 6, 1777.

GEOFFROY, ÉTIENNE FRANÇOIS (1672–1731), French chemist. whose name is best known in connection with his tables of affinities (*tables des rapports*), which he presented to the French Academy in 1718 and 1720. Born in Paris on Feb. 13, 1672, he was first an apothecary and afterward practised medicine. After studying at Montpellier he accompanied Marshal Tallard on his embassy to London in 1698 and thence traveled to Holland and Italy. Returning to Paris he became professor of chemistry at the Jardin du Roi and of pharmacy and medicine at the Collkge de France, and dean of the faculty of medicine. He died in Paris on Jan. 6. 1731.

The tables of affinities were lists, prepared by collating observations on the actions of substances one upon another, showing the varying degrees of affinity exhibited by analogous bodies for different reagents. and they retained their vogue for the rest of the century, until displaced by the profounder conceptions introduced by C. L. Berthollet. Another of his papers dealt with the delusions of the philosopher's stone. but nevertheless he believed that iron could be artificially formed in the combustion of vegetable matter.

Geoffroy's *Tractatus de materia medica,* published posthumously in 1741, was long celebrated.

His brother CLAUDE JOSEPH, known as Geoffroy the younger (1685–1752), was also an apothecary and chemist who, having a considerable knowledge of botany, devoted himself especially to the study of the essential oils in plants.

GEOFFROY SAINT-HILAIRE. ETIENNE (1772–1844), French naturalist whose law of compensation, or balancing of gron th. had much influence on contemporary thought. was born at Étampes, Seine-et-Oise, on April 15, 1772. He nas originally intended for the church and studied natural philosophy under M. J. Brisson at the Collkge de Navarre in Paris. In 1788 he obtained a canonry of the chapter of Ste. Croix at Étampes, and also a benefice. His preference. however. was for science, so he took up residence at the College du Cardinal Lemoine in Paris, where he studied law and became the pupil and friend of the mineralogist *abbe'* R. J. Haüy. Taking his law degree in 1790, Geoffroy began medical studies under A. F. de Fourcroy at the Jardn du Roi and L. J. RI Daubenton at the College de France. His studies were interrupted in Aug. 1792 when Hauy and all the professors of the Collège du Cardinal Lemoine and of the College de Navarre were arrested by the revolutionists as priests. Geoffroy had some harrowing experiences when he attempted to save the lives of his professors.

At the beginning of the winter of 1792 he returned to his studies in Paris, and in March of the following year Daubenton, through the interest of Bernardin de Saint Pierre, procured him the office of subkeeper and assistant demonstrator of the Cabinet d'Histoire Naturelle du Roi, vacant by the resignation of B. G. E. Lacépède. By a law passed in June 1793, Geoffroy was appointed one of the 12 professors of the newly constituted Muséum National d'Histoire Naturelle. being assigned the chair of zoology. In the same year he began a menagerie there.

In 1794 through the introduction of A. H. Tessier he entered into correspondence with Georges Cuvier. After Cuvier's appointment as assistant at the Muséum d'Histoire Naturelle, he and Geoffroy wrote five memoirs on natural history, one of which, on the classification of mammals, puts forward the idea of the subordination of characters upon which Cuvier based his zoological system.

It mas in a paper entitled "Histoire des Makis, ou singes de Madagascar." written in 1795, that Geoffroy first gave expression to his views on "the unity of organic composition." the influence of which is perceptible in all his subsequent writings; nature, he observes, has only one plan of construction, the same in principle, but varied in its accessory parts.

In 1798 Geoffroy was chosen a member of the great scientific expedition to Egypt, and on the capitulation of Alexandria in Aug. 1801, he took part in resisting the claim made by the British general to the collections of the expedition. Early in Jan. 1802 Geoffroy returned to his usual work in Paris. He was elected a member of the Académie des Sciences in Sept. 1807 In March of the following year the emperor selected him to obtain collections from the museums of Portugal, and in the face of considerable opposition from the British he eventually was successful in retaining the collections permanently for France. In 1809, the year after his return to France, he was made professor of zoology at the Faculty of Sciences at Paris, and from that period devoted himself more exclusively than before to anatomical study. In 1818 he published the first part of his celebrated Philosophie *anatomique,* the second volume of which, published in 1822, and subsequent memoirs account for the formation of monstrosities on the principle of arrest of development, and of the attraction of similar parts.

When, in 1830, Geoffroy proceeded to apply to the invertebrates his views as to the unity of animal composition, he found a vigorous opponent in Georges Cuvier, and the discussion between them. continued up to the time of the death of the latter. soon attracted the attention of scientists throughout Europe. Geoffroy, a synthesist, contended, in accordance with his theory of unity of plan in organic composition, that all animals are formed of the same elements, in the same number, and with the same connections; homologous parts. however they differ in form and size, must remain associated in the same invariable order. He held that if one organ takes on an excess of development, it is at the expense of some other part; and he maintained that. since nature takes no sudden leaps, even organs that are superfluous in any given species, if they have played an important part in other species of the same family, are retained as rudiments testifying to the permanence of the general plan of creation. It was his conviction that, owing to the conditions of life, the same forms had not been perpetuated since the origin of all things, although it was not his belief that existing species are becoming modified. Cuvier. who was an analytical observer of facts, admitted only the prevalence of "laws of coexistence" or "harmony" in animal organs, and maintained the absolute invariability of species. which he declared had been created with a regard to the circumstances in which they were placed, each organ contrived with a view to the function it had to fulfill, thus putting, in Geoffroy's consideration, the effect for the cause.

In July 1840 Geoffroy became blind. He resigned his chair at the museum in 1841, and died at Paris on June 19, 1844.

Geoffroy wrote: *Catalogue drs mammifères du Muséum National d'Histoire Naturelle* (1813), not quite completed; *Philosophie anatomique,* vol. i, *Des organes respiratoires* (1818), and vol. ii, *Des monstruosités humaines* (1822) ; *Sur le principe de l'unité de composition organique* (1828) ; *Principes de philosophie zoologique* (1830) ; *Notions synthétiques, historiques et physiologiques de philosophie naturrlle* (1838), and other works; also part of the *Description dr l'Égypte par la commission des sciences* (1821–30) ; and, with *Frédéric Cuvier* (1773–1838), a younger brother of G. Cuvier. *Histoire naturelle des mammifères,* 4 vol. (1820–42).

See *Vie, travaux, et doctrine scientifique d'Étienne Geoffroy Saint-Hilaire, par son fils M. Isidore Geoffroy Saint-Hilaire* (1847), to which is appended a list of Geoffroy's works.

GEOFFROY SAINT-HILAIRE, ISIDORE (1805–1861). French zoologist. distinguished for his work on anatomical abnormalities in man and animals: was a son of the preceding, born on Dec. 16. 1805. at the Jardin des Plantes, Paris, where he spent most of his life.

In 1824 he joined his father at the Muséum d'Histoire Naturelle as assistant naturalist and after taking his M.D. in 1829 taught zoology at the Athénée from 1830 to 1833, The end of his first year's course was interrupted by the outbreak of the July revolution, with fighting close to the Jardin des Plantes in the street that bears his family name. He was elected a member of the Académie des Sciences, Paris, in 1833. and in 1837 acted as deputy for his father at the Faculté des Sciences, Paris; the following year he was sent to Bordeaux to organize a similar faculty there. Subsequently he became successively inspector of the Academy of Paris (1840); professor at the museum (1841) ; a member of ihe royal council for public instruction (1845); and in 1850 professor of zoology in the Faculty of Sciences. Paris.

He took an active interest in general natural history, teratology and applied zoology, and wrote numerous memoirs in various scientific publications.

Geoffroy Saint-Hilaire died in Paris on Nov. 10, 1861.

His more important works include *Histoire générale et particulière des anomalies dr l'organisation chez l'homme et les animaux,* 3 vol. (1832); *Essais de zoologie générale* (1840); *Vie . . . d'Étienne Geoffroy Saint-Hilairr* (1847); and *Histoire naturelle générale des règnes organiques,* 3 vol. (1854–60).

See also *R.* Knox, *Great Artists and Great Anatomists* (1852).

(EN. HE.)

GEOGRAPHY (ARTICLES ON). The nature of geography as a discipline is discussed in GEOGRAPHY. which surveys the history of geographical exploration; the geographical theories of the ancients; the work of such pioneers of scientific geography as Humboldt and Ritter; the fields of professional specialization that have won general recognition, and the deviant theories. As GEOGRAPHY explains. the scope of the subject is so broad that it touches on many topics that constitute the core of other disciplines. Many articles written by specialists in these separate areas of study thus have implications of a geographic nature.

In the articles on continents and their subdivisions. the degree of detail increases as the size of the area diminishes. For example. EUROPE in its section on physical geography lists the Paris basin as one of the natural areas; a section of FRANCE is devoted to the geography of the Paris basin; PARIS gives additional detail; and there are two brief articles on SEINE, one referring to the political subdivision of northern France to which Paris belongs, the other referring to the Seine river, which forms a natural highway in Paris.

The geographical areas of a general nature to which articles are devoted include ARCTIC, THE; ANTARCTICA; PACIFIC ISLANDS; MELANESIA; POLYNESIA; etc. Articles on various oceans. mountains, rivers, lakes, marshes, grasslands, etc., offer additional perspectives.

The article NATURAL RESOURCES gives a world survey, in terms of natural regions, of vegetation, soil, animal products: water supply and minerals. This broad picture is supplemented by separate articles on major raw materials and industries. For example, the fishing industry, discussed in a subdivision of NATURAL RESOURCES, is represented also by the article FISHERIES. Regional distribution of basic materials is analyzed in the articles on the continents as well as in such articles as PETROLEUM; IRON AND STEEL; WHEAT; COTTON; FORESTS AND FORESTRY, etc. COMMERCE. HISTORY OF, analyzes, largely in historical terms, the relationship between factors of geography and commerce. TRADE, INTERNATIONAL emphasizes contemporary problems and data.

ZOOGEOGRAPHY divides the world into zoological regions and traces, in text and maps, the spread of animals throughout the world in the course of the evolutionary process.

Population geography is discussed in the articles on nations, states, cities, etc.. and in POPULATION. In the fields of urban and settlement geography, articles of special interest are URBAN SOCIOLOGY; CITY PLANNING; REGIONAL PLANNING.

Among the articles that may be of interest to the student of military geography. in addition to the articles on wars. battles and campaigns, are MOUNTAIN WARFARE; INTELLIGENCE, MILITARY AND GOVERNMENTAL; STRATEGY.

MAP surveys the history and techniques of map making, from the flat world of the ancients to the various types of cartographical projection now in use. The reader interested in modern maps of distribution will find examples in such articles as: TRADE. INTERNATIONAL; FOOD SUPPLY OF THE WORLD; CLIMATE AND CLIMATOLOGY: OCEAN AND OCEANOGRAPHY; TIDES; TROPICAL STORM.

Among the articles on various aspects of political geography are SPHERES OF INFLUENCE; MONROE DOCTRINE. THE; LAND REFORMS.

GEOPOLITICS describes an application of political geography that is generally regarded by geographers as pseudoscientific. but has had a powerful impact on the contemporary world.

The science of ecology, which investigates the relationship of plants. animals and human beings to their environment. has made significant contributions to geography. These are discussed in ECOLOGY, ANIMAL; POPULATION ECOLOGY; a section of PLANTS AND PLANT SCIENCE; and sections on human ecology in SOCIOLOGY and ANTHROPOLOGY.

The relationship between geography and ethnology in various areas of the world is discussed in RACES OF MANKIND. A historical perspective on this subject is presented in MIGRATION, which traces the origin of the connection between various racial groups and the lands with which they are now identified.

GEOGRAPHY is that field of learning in which the characteristics of particular places on the earth's surface are examined. It is concerned with the arrangement oi things and with the associations of things that distinguish one area from another. It is concerned with the connections and movements between areas. The face of the earth is made up of many different kinds of features. each the momentary result of an ongoing process. A process is a sequence of changes. systematically related as in a chain of cause and efiect. There are physical and chemical processes developing the forms of the land surface, the shapes of the ocean basins. the differing characteristics of water and climate. There are biotic processes by which plants and animals spread over the earth in complex areal relation to the physical features and to each other. And there are economic, social and political processes by which mankind occupies the world's lands.

As a result of all these processes the face of the earth is marked off into distinctive areas: geography seeks to interpret the significance of likenesses and differences among places in terms of causes and consequences.

In ancient and mediaeval times geographers could do no more than identify and describe the features that gave distinctive character to different countries. Writers of geography. to be sure, speculated regarding cause and effect processes. sometimes with amazing insight. They made the first attempts to measure things and to place them on maps. During the great age of exploration which began about 1500. the methods of mapping were greatly developed: the, continental outlines were plotted with ever-increasing accuracy; the rivers appeared in more and more detail; the positions of mountain ranges were established by survey rather than guesswork. Furnished with all these new data. geographers about the middle of the 18th century started to define broadly homogeneous regions in terms of physical make-up. or in what were conceived to he the major characteristic associations of plants and animals, or in terms of the economic life, or in terms of the political organization of national territories.

As man's understanding of the world increased, more and more attention was given to systematic studies; that is, to those features that were systematically related to each other because they were the result of a single process. Geography has sometimes been called the mother of sciences, since many fields of learning that started with observations of the actual face of the earth turned to the study of specific processes wherever they might be located. These new disciplines were defined by the subjects they investigated. Some of the processes at work on the surface of the earth, notably the physical and chemical ones, were reproduced under laboratory conditions where they could be examined in isolation from the environments of particular places. From these studies there resulted a great increase in the understanding of cause and effect relations. and numerous fundamental principles were formulated to describe the ideal or theoretical sequences of change. In a similar way the biotic processes were examined under controlled conditions. and such important concepts were developed as those of evolution and natural selection. The social sciences, too, have sought to understand the theoretical sequences of economic. social and political change as these sequences were presumed to go on when isolated from the disturbing circumstances of actual places. Since the so-called cultural processes could not be isolated in laboratories, they were isolated symbolically by such phrases as "other things being equal."

Modern geography starts with the understandings provided by the systematic sciences. Unlike these other fields, geography cannot be defined by its subject matter. for anything that is unevenly distributed over the surface of the earth can be examined profitably by geographical methods. Rather geography is a point of view. a system of procedures. It makes three kinds of contribution to understanding: (1) it extends the findings of the systematic sciences by observing the differences between the theoretical operation of a process and the actual operation as modified by the conditions of the total environment of a particular place; (2) it provides a method of testing the validity of concepts developed by the systematic sciences; and (3) it provides a realistic analysis of the conditions of particular places and so aids in the clarification of the issues involved in all kinds of policy decisions.

Obviously a large amount of geographic work is done by persons not identified professionally as geographers. Scholars in the various systematic fields do not fail to concern themselves with the applications of their theoretical understandings to the study of conditions in particular situations, and such applications usually involve geographic work. When an economist examines the economic conditions of a country and prescribes remedial measures designed to provide for more production. he is involved in part with the geographic point of view. When a businessman studies the advantages or disadvantages of a specific location for his factory or his retail store, or when he plans for the more efficient operation of a system of transportation or of a marketing organization. he is working in part with geographic data.

Professional geographers can offer certain concepts and methods derived from experience in the analysis of the significance of areal differences on the earth. They play a role similar to that of the proiessional historian. Many persons who are not historians write accounts of the sequences of events that are called history: but such persons would be severely criticized if they failed to make expert use of historical method. Professional geographers encourage nongeographers to apply geographic concepts and to make use of acceptable geographic method. but they condemn the inexpert use of concepts or method. Uniortunately much work of a geographic nature is done by scholars in other fields. by businessmen and engineers, in a way that reveals an ignorance of the concepts of modern geography and that makes crude and imprecise use of geographic method. (PE. J.)

PROGRESS OF GEOGRAPHIC EXPLORATION

Exploration, in one form or another. has always been a major concern of geography. Geographic exploration was started long before the beginning of recorded history. As early as it n-as possible to communicate ideas or experiences. some of these ideas must have been concerned with the nature of the face of the earth, the human habitat. Even if the purpose was to describe the characteristics and arrangement of hunting grounds, or the strange things observed in distant lands, the result was geography of a sort. At first the chief effort was to gather and present facts about places: later the effort was organized around systems of facts, groups of facts related to single processes. Geography was concerned also with the perfecting of methods for selecting and measuring facts. The first phases of this work have been completed: no part of the earth today can be said to be completely unknonn; in no part of a map can the cartographer safely draw pictures of Martian monsters or spouting whales. But knowledge of places is a relati e matter. There are vast areas of the earth that are not mapped precisely, and the characteristics of many areas are not sufficiently well known to provide a basis for making practical application of geography. The new exploration is no longer concerned nith continental outlines; rather it is concerned with filling in those outlines with precise detail relevant to the economic, social, political or military problems nith which mankind is faced.

MEDITERRANEAN REGION

Geographic exploration, in so far as its record has been handed down as a part of the stream of occidental culture, had its beginnings in the Mediterranean. Even the names Europe, Asia and Africa were first applied to the three shores of the eastern Mediterranean. later to be extended as the geographic horizons were widened.

Egyptians and Phoenicians. — The Egyptians had explored and conquered large tracts of land before the 14th century B.C., both southward up the Nile and northeastward to the borders of Assyria; but the first seagoing explorers seem to have been the Phoenicians. who made Sidon a commercial port as early as 1400 B.C. and later raised Tyre to equal fame. The merchant adventurers of Tyre and Sidon explored the whole coast of the hlediterranean. founding the colony of Carthage before 800 B.C. They and other colonizers on the shores of the Iberian peninsula sailed northward along the Atlantic coast, probably trading with Cornwall for tin, and to the south. going far along the west coast of Airica. They certainly reached the Azores, because Carthaginian coins of the 4th century B.C. have been found on the island of Corvo. With the support of Egypt they traded also on the Red sea. reaching lands yielding gold and ivory: probably on the coast of Africa or Arabia. It is probable that they also reached India from the Red sea. Herodotus heard in Egypt that in the days of Ring Kicho (600 B.C.) a Phoenician fleet. sent from the Red sea southward along the African coast, had returned to Egypt by the Pillars of Hercules. Herodotus was the earliest of the Greek travellers to give a full and trustworthy narrative of his peregrinations in Asia as far as Persia, in Egypt and North Africa, on the Black sea coasts as far as the Caucasus, and in Italy (c. 464–447 B.C.).

Greeks. — The maritime trade of the Greek city-states and their colonies became more important than that of the Phoenicians soon after the jth century B.C. Greek ships sailed beyond the Mediterranean, opening up the Black sea on the east and the borders of the Atlantic on the west. Massilia (on the site of the modern Marseilles) was a colony of Greeks from Phocaea, and thence a voyage of great importance was made by Pytheas about 330 B.C. His own narrative is lost and the facts have to be gathered from references by Strabo 300 years later to criticisms of the voyage in lost books of the Greek geographers. Pytheas was probably the first navigator to fix the position of the lands he reached by crude astronomical observations, and he seems to have been a keen observer of places and people. He coasted the Bay of Biscay and the east of Britain as far as Orkney, where he heard a report of Thule, a more northern land, and a confused hint of the arctic region. On a later voyage he coasted along the east side of the North sea and probably entered the Baltic. During the same years the conquests of Alexander the Great opened to the Greek world a knowledge of the continent of Asia as far as the northern plain of India, and his general Kearchus conducted a fleet from the mouth of the Indus to the Persian gulf. This was the first voyage in the Indian ocean to be described in a manner comparable with the record of the land journey of Xenophon a century earlier, when. after the death of Cyrus, he led the 10,000 from Mesopotamia across the plateau of Armenia to the Black sea. In the following centuries the Ptolemies, Greek kings of Egypt, encouraged exploration, and about 115 B.C. Eudoxus of Cyzicus under their auspices explored the Arabian sea; he planned to circumnavigate Africa but could not get support for so daring a project.

Romans. — The rise and extension of the Roman empire involved scouting expeditions before and surveys after the conquest of each province of the lands bordering on the Mzditerranean in Europe, Asia and Africa. Conquering generals described the tribes they subdued and the regions they occupied, and Julius Caesar won renown as a writer no less than as a fighter. Each province of the empire was bound to Rome by the causeways mhich still form the skeleton of the road map of Europe. Pliny and Seneca say that Nero (about A.D. 60) sent two centurions to follow up the Nile from Egypt, and they were stopped by great marshes, probably those of the Sudan. about 19° N. The practical advantages of discovery appealed to the Roman mentality more powerfully than did the abstract theories mhich fascinated the Greeks; for example. Hippalus. who, about A.D. 79, learned from the Arabs of the regular seasonal changes of the monsoons. made these winds serve him as the means of establishing a trade route between the Red sea and India across the open ocean, whereas earlier navigators had had to hug the coast. Trade along this route continued to develop, and a century later Pausanias makes it appear that direct communication had even been opened up with China. In the time of Justinian (483–565) two Nestorian monks made the journey from Constantinople overland to China and on their return introduced the first silkworms into the Mediterranean lands.

After the fall of the Roman empire and the incursion of barbarians from the north, a wave of Arab domination surged over the Asiatic and African provinces and swept far into the southern peninsulas of Europe. The geographical learning of the Greeks and Romans enshrined in the writings of Ptolemy of Alexandria (*fl.* A.D. 150) passed to the Arabs and was forgotten in Christian Europe! where the conception of the globe degenerated to that of a flat disk with Jerusalem at the centre. The Arabs trading with India. China and the east coast of Africa acquired a sound knowledge of the Indian ocean and a fair idea of the interior of Africa before the year 1000. Among the well-known geographical writers of this period were Abu Zaid, Masudi, Istakhri and Idrisi.

NORSEMEN

Meanwhile the Norsemen from the fiords of Scandinavia were harrying the coasts of northern Europe and even making their way into the Mediterranean. Othar of Helgeland discovered the North cape and, rounding it, proceeded as far as the White sea in the middle of the 9th century. Later he visited the court of Alfred the Great, and it was the English king who first reduced to writing the discoveries of the earliest polar explorer and introduced to literature the midnight sun of the arctic summer. Late in the 9th century Iceland was colonized from Norway, and in 982 Eric the Red. sailing westward, discovered Greenland; soon afterward his son Leif Ericsson, sailing thence to the southwest, came on a new land; which he named Vinland, and was thus the first European to reach America.

ASIAN AND AFRICAN LAND JOURNEYS

The domination of central Asia from the Caspian to the Pacific by the Mongol emperors made very long overland journeys practicable at the close of the middle ages. and Venetian merchants had thus established contact with China before Marco Polo set out in 1271 for Cambaluc (approximate site of modern Peking), the capital of Kublai Khan. The story of his 17 years' sojourn in the far east and of his journeyings by land and sea in central Asia, China, the Malay archipelago and India was the greatest work on travel of the middle ages, and for the first time it made the venerable civilization and the rich products of the orient familiar to the people of Europe. Many of his statements were derided by contemporaries. but his substantial veracity and remarkable powers of observation have been vindicated by modern travellers and students. Missionaries, whose activity increased as that of the crusaders diminished, pushed far afield in Asia, and their records contain some grains of geographical value among a vast quantity of superstitious and ignorant chaff. One only need be mentioned here, Friar Odoric of Pordenone. who. early in the 14th century, visited India, the Malay archipelago. China and Tibet, where he was the first European to enter Lhasa, not yet a forbidden city. A Moslem contemporary. Ibn Batuta. was the greatest of the Arabian travellers who left accounts of their journeys. Between 1325 and 1355 he explored Arabia and Persia and spent eight years in the service of the Mogul ruler of Delhi. going on to China and the Malay archipelago. He also visited the East African coast as far south as Mombasa and Kilwa and crossed the desert from the Red sea to Syene on the Nile; finally he explored West Africa by land, reaching Timbuktu and the Niger.

Many travellers in the early part of the 15th century made notable journeys throughout the mainland of Asia and the eastern archipelago, impelled by the growing demand for the silks, spices and other valuable products of the tropics. From Spain Ruy Gonzalez de Clavijo journeyed to the court of Timur at Samarkand: from Italy Nicolo de' Conti later in the century spent 25 years in the far east, reaching China, Java and Sumatra.

OPENING OF THE OCEANS

Long voyages out of sight of land began in the 15th century after the use of the magnetic compass had become general. As early as the 13th century portolano charts had been prepared to guide navigators from port to port. and they were quite accurate with regard to the Mediterranean coasts. But whereas latitude could be measured with fair accuracy by the use of the astrolabe. the measurement of longitude remained a matter of guesswork. The first voyages into the open oceans originated in Portugal and Spain.

Portuguese.— A large amount of geographical data was collected in Portugal by Prince Henry the Navigator, and under his auspices the earliest great voyages were undertaken. The first objective of the Portuguese was the exploration of the African coast, with the hope that eventually a nay would be found to reach India by sea. The Azores. 800 mi. out in the open Atlantic. were rediscovered and settled in 1432, while successive expeditions stimulated by the prnce crept by degrees along the Sahara coast to the fertile lands beyond; in 1462, after his death, they reached Sierra Leone and a few years later explored the whole Guinea coast. Then discovery became rapid. In 1481 the equator was crossed, in 1482 Diogo Cam passed the mouth of the Congo. and in 1488 Bartholomeu Diaz de Novaes. by a splendid effort, fetched a wide sweep far out of sight of land and reached Mossel bay. In returning he saw the southern point of Africa and named the Cape of Storms. This was the greatest landmark in the history of exploration. The King of Portugal, seeing the wealth of the Indies within his grasp. changed the name to Cape of Good Hope, and Vasco da Gama (*q.v.*) realized the hope in 1498 by sailing round the cape to the Arab port of Mombasa, whence with the aid of local pilots he reached India and fulfilled the dream of ages. Luis de Camoens. uho himself made the voyage half a century later, celebrated the achievement in his epic poem, the *Lusiads*.

Spanish.—Paolo del Pozzo Toscanelli as early as 1474 had pointed out from Ptolemy's maps that the east coast of Asia might be reached more easily by sailing due west than by going south and then east and north. Christopher Columbus, a native of Genoa who had much experience of navigating the Atlantic and had sailed to Iceland, became possessed with the idea of making this voyage. He spent many years in the endeavour to find a patron, and in 1492 had almost persuaded the king of England and the king of Spain to embark on the enterprise; the king of England hesitated the longer, and Columbus with Spanish ships made an easy passage from the Azores to the islands which he named the West Indies. Following a suggestion of the pope. a meridian line running north and south through the middle of the Atlantic was fixed by treaty between Spain and Portugal, the former country agreeing to restrict exploration to the western hemisphere so marked out and the latter country to the eastern hemisphere. Columbus, after other voyages to the West Indies. died in 1 jo6 in the belief that he had reached the islands off the coast of Asia.

The merchants of Bristol had often sent their ships several weeks' sail to the westward into the Atlantic in search of legendary islands; in 1497 John Cabot. no doubt inspired by the success of Columbus. persevered until he found the coast of Labrador and Newfoundland, thus repeating the old Norse discovery of North America and. though the quest was not then pursued. pegging out a claim to England's oldest colony. The companions of Columbus continued to cruise among the West Indies and quickly traced out the shores of the Spanish Main to the south. and the limits of the Caribbean sea to west and north. In 1513 Vasco Nuñez de Balboa caught the first glimpse of an inaccessible ocean to the west from "a peak in Darien" and recognized that Asia was still far off. In 1500 Vicente Pinzón. sent from Spain to explore the coast southward from the Orinoco. first sighted land near Pernambuco and, following it northward round Cape São Roque, discovered the mouth of the Amazon. His shipmate Amerigo Vespucci. a clever man who took part in several voyages of discovery, described this voyage, and by a curious chance his Christian name in its latinized form was attached forever to the continents of America. By making a westward sweep in a voyage to the Cape of Good Hope, Pedro Alvares Cabral lit on the coast of Brazil in the sarne year. The Spaniards. realizing that America was a solid obstacle between Europe and Asia. pushed forward to discover a passage to the south. In 1515 Juan Diaz de Solís reached the Rio de la Plata, which seemed to offer a way through. Five years later Ferdinand Magellan showed that it was only an estuary, and, proceeding southward. he found and passed through the tortuous strait which bears his name, so piercing the harrier of America. Persevering in face of every difficulty which could befall an explorer; he pushed on across the incredible breadth of the Pacific. Although he met his death in the Philippine Islands in 1521, his ship the "Vittoria" under Juan Sebastian del Cano with a handful of survivors returned to Spain in 1j22 by the Cape of Good Hope after the first circumnavigation. Among his rewards Del Cano received the world as his crest with the proud motto *Primus circumdedisti* me.

Voyages by Other Europeans.— The Spanish and Portuguese between them soon completed the rough outlines of Africa and the two Americas. But the 16th century saw their maritime power challenged by the enterprise of France. England and the Netherlands, whose sailors disregarded alike papal bulls and private agreements between Spain and Portugal. These other Europeans established their claim to a share in the new world and in the sea routes to the east. French fishermen following in the track of Cabot early began to frequent the Grand Banks of Newfoundland. and the king of France in 1524 sent out Giovanni da Verrazano, a Florentine. who explored the coast of North America between the lands discovered by Cabot in the north and by the Spaniards in the south. He found no way through, and ten years later a French expedition under Jacques Cartier set out to search the Gulf of St. Lawrence for a way to the far east. In a second voyage in 1535 Cartier ascended the St. Lawrence to the present site of Montreal and, although only the name of Lachine Rapids remains of this attempt to reach China that way, he spent two years in the effort to start the French colony of Canada.

Queen Elizabeth I saw a wave of enthusiasm for discovery sweep over England, rousing sailors. soldiers. merchants. parsons, philosophers. poets and politicians to vie with each other in promoting expeditions overseas for the glory of their country and their own fame and profit. The gallants of the court were ever ready to command the expeditions for which the shrewd City merchants found the means. while quiet scholars like Richard Hakluyt promoted the work by recording the great deeds of earlier as well as contemporary adventurers. Hakluyt's *Principal Navigations,* first published in 1589, is to this day delightful reading. and. supplemented by *Hakluytus Posthumus or Purchas His Pilgrimes,* published in 162;. forms the only record of many great expeditions. On the continent similar compilations such as those of the Italian Gian Battista Ramusio (1583–1613) and the splendidly illustrated Dutch volumes of Theodorus de Bry (1590–1634) played a similar stimulating part. In England as elsewhere at first the object was to find a westward route to the far east. Richard Chancellor tried for a northeast passage, and though he got no farther than the White sea he went on by land to Moscow and opened up direct trade with Russia, leading to the formation of the Muscovy company, the first of many chartered companies for exploration and trade. In 1576 Martin Frobisher made a spirited attempt to find a northwest passage to China and reached the coast of Labrador at its northern extremity. John Davis, one of the greatest arctic explorers of all time, took up the quest in 1585, and in successive years he navigated the broad strait which bears his name to 72° N., finding open sea to the northward and hope of an ultimate passage westward. Francis Drake, setting out to trace a route from the other side, made the second circumnavigation of the world in 1577–80. He passed the Strait of Magellan, after which he was blown southward to 56° S., and satisfied himself that the Atlantic and Pacific oceans met south of Tierra del Fuego. Drake proceeded northward and explored the Pacific coast of North America to 48° in vain search of a passage to the east. Eventually he returned by the Philippines and the Cape of Good Hope. Thomas Cavendish repeated this voyage in 1586–88, adding to the confidence with which long voyages were undertaken, and Richard Hawkins, though less fortunate, again showed the British flag in the Pacific before the end of the century.

Walter Raleigh, Humphrey Gilbert and many more took part in exploring the North American Atlantic coast, and in 1600 Queen Elizabeth I granted a charter to the East India company, which initiated direct trade with India and prepared the way for the British empire in the east. Spanish exploration from the Pacific ports of Spain's American possessions was renewed, partly no doubt in order to anticipate English discoveries. In 1567 Alvaro de Mendaña de Neyra, sailing from Callao, crossed the Pacific and discovered the Solomon Islands. Pedro Sarmiento de Gamboa in 1579 went south from Callao and surveyed the Strait of Magellan with a view to fortifying it and so holding for the Spaniards what they then supposed to be the only entry to the Pacific. The Dutch made many attempts to find a northern passage to China in the last decade of the 16th century. Willem Barents, after discovering Spitsbergen, was wrecked on the north coast of Novaya Zemlya, and after wintering there made a heroic journey by boat along the coast, on which he died; his crew returned safely in 1597.

In the 17th century the search for a northern passage to the far east still went on. The work of Davis was followed by that of Henry Hudson, who in 1607 reached a latitude of 81° N. in the Spitsbergen region; in 1610 he discovered the inland sea now known as Hudson bay. William Baffin came later, reaching about 77° 45′ N. in 1616 and naming Smith sound to the north of the great bay called after him at the end of Davis strait. A charter for the Hudson's Bay company was granted in 1670.

SEARCH FOR THE SOUTHLAND

A belief in a southern continent surrounding the pole and extending into middle and even low latitudes had found expression on maps since the time of the early Greek geographers. Magellan believed that Tierra del Fuego was a part of this great land mass. Many explorers were drawn by the magnet of this illusion into the unknown parts of the great oceans. Pedro Fernández de Quiños and Luis Vaes de Torres were sent out in 1605 by the viceroy of Peru to take possession of the supposed southern continent; on reaching the New Hebrides Quiños believed he had gained his goal and took possession with great ceremony of "Australia del Espiritu Santo," the first appearance of the name "Australia" on the map. In returning Torres passed through the strait which bears his name, discovering the northern end of Australia and exploring part of the coast of New Guinea.

The great period of Dutch voyages began with the formation of the Dutch East India company in 1602, though Dutch merchant adventurers, sailing by the Cape of Good Hope, were active on the coast of Japan by 1600 and soon after were successful rivals to the Portuguese already established in India and the Malay archipelago. The company in 1614 determined to find a way into the Pacific south of the Strait of Magellan and sent out Jacob Lemaire in the "Eendracht" and Willem Schouten in the "Hoorn." These ships passed south of Tierra del Fuego, proving that it was not part of a southern continent, named Staten Land (not recognizing it as an island) and saw and named Cape Horn on Jan. 29, 1616. Lemaire and Schouten crossed the Pacific, sailed along the north coast of New Guinea and reached the Moluccas. Other Dutch mariners working from the north discovered the west coast of Australia, still supposed to be a projection of a vast southern continent, Dirk Hartog reaching 26° S. on that coast in 1616. Anthony van Diemen, governor of the Netherlands Indies, resolved in 1642 to explore the coast of the southern continent and sent Abel Janszoon Tasman to carry out the task. Tasman's voyage was the greatest contribution to exploration since Magellan. He sailed westward across the Indian ocean to Mauritius, then in a great sweep southward and eastward he came on high land which he named after Van Diemen, though it is now known as Tasmania. Sailing farther east he came on the west coast of another lofty land which he named Staten Land, believing it to be part of the southern continent continuous with Schouten's Staten Land off South America. It was really New Zealand. He sailed on to the Fiji Islands and returned along the north coast of New Britain and New Guinea to Batavia. In 1644 he went out again with three ships, when he explored in some detail the south coast of New Guinea and the north and west coasts of Australia, which he called New Holland. In 1699 William Dampier, a noted buccaneer in his early days, made an important voyage on H.M.S. "Roebuck" along the west and north of Australia and the north of New Guinea, rediscovering and naming New Britain. His voyages were remarkable for his extraordinarily keen observations of natural phenomena; in some respects he was the pioneer of scientific exploration. The Dutchman Jacob Roggeveen in 1721 and the Frenchman J. B. C. Bouvet de Lozier in 1739 set out expressly to discover and annex the southland, and the latter took an ice-clad islet of the South Atlantic to be part of it.

EXPLORATION OF THE PACIFIC

By the middle of the 18th century the methods of navigation had greatly improved, and the introduction of the quadrant gave new precision to determinations of latitude. The great bugbear of long voyages was scurvy, supposed to be an inevitable result of life on board the small craft of those days and often fatal to the larger part of the crew. In the second half of the 18th century scientific geographers in Europe secured a more systematic system of exploration in which adventure, though still encountered, was subordinated to research. Already in the first year of the century the astronomer Edmund Halley had been sent in command of a British warship to the South Atlantic in order to study the variation of the compass. In 1764 John Byron was sent on a circumnavigation voyage for discovery. On his return a larger expedition was dispatched under Samuel Wallis and Philip Carteret; it was absent from 1766 to 1769, discovering Tahiti and many other islands in the Pacific. A French expedition under L. A. de Bougainville followed, and for half a century there was keen rivalry between France and Great Britain in the Pacific.

Voyages of Cook and Others.—A new era in exploration, which raised British maritime enterprise to a unique place in the eyes of the world, was introduced with the three great voyages of James Cook. The first of these voyages, from 1768 to 1771, was undertaken in part to observe the transit of Venus of 1769 from a suitable place in the Pacific. This mission was carried out, and much more was accomplished. Many island groups in the Pacific were discovered, New Zealand was identified as separate from the southland, and much of the east coast of Australia was surveyed with amazing accuracy. It was on Cook's second voyage of 1772 to 1775 that the chronometer was first used, which for the first time permitted the accurate determination of longitude. Cook sailed far to the south of the Antarctic circle and proved beyond doubt that habitable land did not exist to the south of the known continents. Perhaps the greatest result of this voyage, however, was the proof that scurvy was preventable by proper diet. The third voyage, started in 1776, had the objective of seeking a northern passage from the Pacific to the Atlantic. Cook surveyed the northern part of the Pacific coast of North America and, after passing through Bering strait, pushed northward to 70° N., where he was stopped by ice. In these three voyages Cook not only had sailed completely around the world, but had covered more than 140° of latitude. On retiring to Hawaii for the winter Cook mas killed by natives in 1779, but Edward Clarke, his second in command spent another season in the effort to penetrate the Arctic ocean from Bering strait; he returned to England in 1780.

Cook's voyage around the antarctic continent was supplemented by a great Russian expedition under Fabian von Bellingshausen in 1819–21, and by a group of hardy American and British sealers in the first third of the 19th century, chief among them James Weddell, who in 1823 reached 74° 15' S in the sea named after him. and John Biscoe, who in 1831–32 made a complete circumnavigation, discovering the most southerly land so far known.

Port Jackson, the present Sydney. was founded as the first settlement in Australia in 1788, and the coasts were explored by such daring boat travellers as Matthew Flinders and George Bass, the latter proving that Tasmania was an island in 1798. Cook was followed on the west coast of North America in 1792–94 by George Vancouver. who extended northward from Cape Mendocino the work of Spanish explorers and made exact surveys along the coast. The French expedition of J. F. de Galaup, comte de la Pérouse, in two ships spent the years 1785 to 1788 in crossing and recrossing the widest part of the Pacific; the expedition never returned, and many efforts were made to discover its fate. the most extensive being that made by J. A. Bruni d'Entrecasteaux in 1791–93.

COMPLETING THE CONTINENTAL OUTLINES

The 18th century saw the completion of the great task of outlining the continental shores. Even those of the Arctic sea had been traced out by Russian travellers such as Vitus Bering (by birth a Dane), Simon Dezhneff and T. Chelyuskin, whose name remains on the most northerly cape of the old world. The Spaniards had made known the broad lines of the geography of South America, Central America and the southern part of North America, the central and northern portions of which had been penetrated in all directions by French and British pioneers. The interior of Australia remained totally unknown, as were the arctic regions north of 80° N. and the antarctic south of the polar circle. In the old world Asia had been traversed in all directions, although large areas remained unvisited between the trade routes and the tracks of explorers. China was mapped by Jesuit missionaries in the early years of the century, and the accurate mapping of India was under way before its close. Africa was the least known of the continents. and the French geographer J. B. B. d'Anville, despairing of reconciling the conflicting accounts drawn from tradition and the stories of Arab traders, who had undoubtedly penetrated far into the interior. swept the map clear of all features which had not been seen by European travellers and left a blank of "unexplored territory" within the coast line from Morocco and Abyssinia on the north to Cape Colony and Natal on the south. James Bruce explored the Blue Nile from its source in Abyssinia to its junction with the White Nile, and before his death a strong effort was made in England by the founding of the African association, which enabled John Ledyard to make a great journey across the Sudan from east to west and Mungo Park to trace much of the course of the Niger. Scientific geography was powerfully advanced by the measurement of arcs of the meridian near Quito on the equator by a French commission under C. M. de la Condamine in 1735–43 and another in Lapland under P. L. M. de Maupertuis in 1736.

THE ARCTIC

Only a few outstanding expeditions to the arctic in the 19th and 20th centuries can be mentioned among the hundreds that carried out important work in that area. Sir John Ross in 1818 reached the mouth of Smith sound beyond Baffin bay, and. seeking a northwest passage, his nephew James Clark Ross reached the north magnetic pole on Boothia peninsula in 1831. Sir John Franklin set out in 1845. lured by the fatal fascination of the passage, and when he failed to return there began the rush of arctic exploration known as the Franklin search. Out of much that was weak, foolish and incompetent in direction there arose in execution heroes and geniuses such as Sir Francis Leopold M'Clintock, who developed the method of man-hauled sledging and stood out among those who explored the coasts and channels of the arctic archipelago. Americans vied with British in the search, and a high place must be given to Elisha Rent Kane. who in 1853 pushed through Smith sound. some of his parties reaching 80° N. In 1873 Karl Weyprecht and Julius Payer on an Austrian expedition discovered Franz Josef Land. In 1875 the last of the old-fashioned British naval polar expeditions in two ships with hundreds of men was sent out under Sir George Nares to reach the north pole. It failed to get through Smith sound but Albert H. Markham in a sledge journey pushed on to 83° 20′ N. In 1878 Baron N. A. E. Nordenskiold in the Swedish ship "Vega" made the long-sought northeast passage along the coast of Siberia and circumnavigated Europe and Asia. In 1882 a series of circumpolar stations for scientific observations was set up by international agreement; the honour of occupying the most northerly point fell to the United States expedition under A. W. Greely, and from his base J. B Lockwood got to 83° 24′ N. Fridtjof Nansen in 1888 crossed the interior of Greenland for the first time. and by travelling on skis and inventing new devices for camping and cooking revolutionized polar travel Five years later by a still more daring and original plan he drifted in the "Fram" across the Arctic sea and got to 86° 14′ N. In 1903–06 Roald Amundsen, another Norwegian in the "Gjoa" was the first to carry a ship through the half-forgotten northnest passage. Invaluable work was done by American. Italian, British and especially Danish explorers, including Mylius Erichsen, Knud Rasmussen and Lauge Knoch in northern Greenland. Robert E. Peary, who had been engaged in polar exploration since 1885, was the first to reach the north pole in 1909. During the 1920s the first air flights to the pole were made. In 1926 Richard E. Byrd flew to the pole from Spitsbergen and returned rhere. A few days later Roald Amundsen and Lincoln Ellsworth with the ltalian pilot Umberto Nobile flew in the dirigible "Norge" from Spitsbergen across the pole to Alaska. After World War II numerous weather stations were established permanently in the arctic regions. and flights to the vicinity of the pole occurred frequently. (See also ARCTIC REGIONS.)

ANTARCTIC EXPLORATION

The antarctic regions were explored for the last time by sailing ships by three expeditions In the period between 1838 and 1843. It seems probable that the first to sight the coast of the antarctic continent was an expedition under the command of the U.S. naval officer Charles Wilkes, in 1840. A French expedition under J. S. C. Dumont d'Urville also sighted land at about the same time in the sector south of Australia. A year later a British expedition under James Clark Ross discovered the south-running coast of Victoria Land. with its tno great volcanoes, Erebus and Terror, and the great ice barrier that bears his name. The antarctic seas remained largely unvisited, except for a souihward dash by the "Challenger" in 1874, until Scottish and Norwegian whalers went in search of new whaling grounds in 1892–95. Scientific expeditions equipped mainly by private enterprise, under the inspiration of the International Geographical congress of 1895, went out from Belgium under Adrien de Gerlache in 1897. spending the antarctic night for the first time drifting in the pack ice south of South America; and from London under C. E. Borchgrevink in the "Southern Cross," spending the winter upon the antarctic continent for the first time in 1898–99. These were succeeded by four simultaneous and purely scientific expeditions in 1901–04. The British national expedition in the "Discovery," under Robert F. Scott of the royal navy, initiated antarctic sledging, taking advantage of Nansen's methods, and penetrated far into the frozen continent. The German expedition under Erich von Drygalski in the "Gauss," the Swedish expedition under Otto Nordenskjold in the "Antarctic" and the private Scottish national expedition under W. S. Bruce in the "Scotia" were all commanded by men of science and did much valuable scientific work.

In 1907–09 Ernest H. Shackleton in a private expedition in the "Nimrod" succeeded, by the innovation of using ponies for transport. in getting to within 97 geographical miles of the south pole and turned only because his provisions were exhausted, while other parties climbed Mt. Erebus and reached the magnetic pole. On Jan. 18. 1912. Scott in the great "Terra Nova" expedition succeeded in reaching the pole by Shackleton's route only to find that he had been anticipated by a month (Dec. 14, 1911) by Roald Amundsen, who had made a dash on skis with dog sledges from a more easterly base. Meanwhile an Australian expedition under Douglas Mawson. with J. K. Davis in command of the "Aurora," explored a great stretch of coast from George V Coast to Queen Mary Coast and penetrated far into the icy interior.

After the addition of air flights and air photography to the techniques of exploration, the antarctic continent was revisited and its character became better known. Among the numerous expeditions sent out for scientific purposes after 1920, the three expeditions under the command of Richard E. Byrd were especially important. The basic purpose was to gather climatic data, to increase the knowledge of antarctic geology and to complete the mapping of the coast line. The first expedition of 1928–30 was followed by a second in 1933–35. A vast amount of meteorological data mas gathered, and the coast-line mapping mas considerably advanced. A third expedition in 1939–41 established two bases on opposite sides of the continent and carried out numerous exploratory flights back and forth between these bases. The British Graham Land expedition of 1934–37 also brought back important new maps and observations. *(See* also ANTARCTIC REGIONS.)

INNER ASIA

In Asia three great areas remained practically unexplored well into the 19th century. These were Arabia, the mountains and tablelands north and east of India and the deserts of central Asia beyond them. The northern half of Arabia was traversed in many directions by European travellers, prominent among them W. G. Palgrave in the middle of the century. followed by Charles Doughty, Wilfrid Scarven Blunt, C. Huber, Gertrude Bell and T. E. Lawrence. To the north of India the great effort was to penetrate the Himalayas and explore Tibet. Most of the work was done by officers of the survey of India, such as George Everest, Sir Richard and Henry Strachey and H. H. Godwin-Austen. Private explorers also had their part: foremost among them were the French missionaries Évariste Huc and Joseph Gabet, who reached Lhasa irom China in an expedition of 1844–46; the great botanist Joseph D Hooker, who explored Sikkim in 1848–49; mountaineers, including the three brothers Hermann, Adolf and Robert von Schlagintueit in 1854–57, W. M. (later Baron) Conway. Douglas Freshfield, the duke of the Abruzzi, F. de Filippi, William Hunter Workman and Fanny Bullock Workman. Finally the many attempts to climb the world's highest mountain, Mt. Everest, culminated in the successful British expedition under John Hunt in 1953.

In central Asia north of the great plateau Russian travellers visited the khanates of Bokhara and Samarkand, and many scientific expeditions ranged the vast spaces. Chief among them were those oi Nikolai Prjevalsky, who between 1870 and 1885 traversed nearly the whole breadth of the continent and defined the great system of internal drainage and its mountain rampart. His work was supplemented and extended by many of his countrymen and in a high degree by the Swedish scholar Sven Hedin from 1894 onward. Francis Younghusband and other British officers made great journeys in the deserts of Gobi and Takla Makan. and the remains of ancient cities attracted the archaeological survey of India, for which Xurel Stein made important journeys. Of great significance in the history of Cnited States geography was the expedition of 1903 to central Asia under the leadership of Raphael Pumpelly, in which such outstanding scholars as William Morris Davis and Ellsworth Huntington took part.

AFRICA

Africa had been left at the end of the 18th century with the map of its interior a blank, the lower course of the Nile, the middle of the Niger and the mouths of the Congo and Zambezi remaining as openings to the mysteries of the interior. The Niger was traced to its mouth at an early date. and between 1822 and 1827 Dixon Denham and Hugh Clapperton made difficult journeys in the Sahara and Sudan and discovered Lake Chad for the African association. In 1849 David Livingstone, the greatest of all African travellers, began his missionary journeys from Cape Colony and explored the Kalahari desert, discovering the salt Lake Ngami. Convinced that mission work was of little use until the continent was opened up, he spent the rest of his life in settling the puzzling hydrography of central Africa. He traced the course of the Zambezi by 1855. Later he pushed his way northward, discovering Lake Nyasa and exploring Lake Tanganyika, and at the time of his death in 1873 he was intently following the northward-flowing Lualaba in the hope that it would prove to be the ultimate source of the Nile. The Nile problem, under the encouragement of the Royal Geographical society, attracted many scientific and adventurous explorers. Richard Burton and J. H. Speke in 1858 discovered the vast Victoria Nyanza (Lake Victoria) on the high plateau under the equator, collecting the headwaters which issued from it as the White Nile; and pushing southward they reached Lake Tanganyika in the great rift which cleaves Africa from north to south. In 1864 Samuel Baker, exploring the Sudan, discovered the Albert Nyanza, another feeder of the Nile. Details of the geography of the Sudan were worked out by scientific men such as Gerhard Rohlfs, Georg Schweinfurth and Wilhelm Junker between 1860 and 1875. H. M. Stanley, a newspaper correspondent who had been sent out by the New York Herald to "find Livingstone" in 1871, found also that he himself was a born explorer, and in a magnificent journey lasting from 1874 to 1877 he crossed Africa from east to west, proving that Livingstone's Lualaba ran not to the Nile but to the Congo and following that huge equatorial river to the sea. The formation of the Congo Free State under the king of the Belgians led to the rapid exploration of the Congo basin, largely by Belgian officers, and the launching of a German colonial policy in 1884 brought many German explorers and men of science into eastern and western Africa. In the extension of spheres of influence most of the geographical problems of the once dark continent were solved before the end of the century, French officers (Gen. Louis Lyautey prominent among them) completing our knowledge of the western Sahara and Sudan.

AUSTRALIA

Australia was almost completely explored by white settlers under their own governments within the 19th century. Matthew Flinders was the first to sail round Australia, the coast of which he laid down in 1801–03. The eastern mountain chain shut off the first settlers in New South Wales from the west. but when the range was crossed rivers were found flowing inland and a vague theory of a great inland sea attracted explorers. John Oxley traced part of the Lachlan river in 1816, the fine pastures of the Darling Downs were discovered in 1827, and the Murray river was followed to the sea in 1829–30. The search for new pastures was the main motive for discovery until after 1850, when prospective new gold fields became a rival lure. The formation of the Saan River Settlement in 1834 and of Adelaide in 1836 gave new points of attack on the interior, and in 1840 E. J. Eyre travelled on foot round the shore of the Great Australian Bight which separated them. In 1844 Ludwig Leichhardt made a splendid journey of 3.000 mi. across tropical Australia from east to west, including the southern shore of the Gulf of Carpentaria, and in the following year Charles Sturt, leaving the east coast farther south, penetrated to the very centre of the continent. John McDouall Stuart succeeded in crossing the continent from south to north in 1862 after two abortive attempts. and his route was afterward followed by an overland telegraph line. In 1861 Robert O'Hara Burke and William John Wills crossed the continent with the aid of camels but perished on the return, a calamity which drew many expeditions into the wilderness to learn their fate. From 1874 for more than 30 years Western Australia was the scene of exploration in search of pasture arid of gold, beginning with the journeys of John Forrest, A. C. and F. J. Gregory, P. E. Warburton and

Ernest Giles and culminating in the great 5.000-mi. march of David Carnegie in 1895. Journeys of pure scientific research were also made, foremost among them those of Baldwin Spencer.

(H. R. Mı.; P. E. J.)

THE AMERICAS

The geographic exploration of the Americas. which resulted in the filling in of the continental outlines with information about the rivers, the mountains, the climate and vegetation and the native peoples. was for the most part carried out by missionaries, gold seekers, fur trappers and adventurers. In any case. they were mostly persons who did not write books. As a result the history of geographic exploration usually omits reference to the Americas. Yet the *bandeiras* of Brazil. those bands of explorers that visited the remotest parts of the interior of South America during the 16th and 17th centuries. and the Spanish expeditions that pushed out from the chief centres of colonial settlement into the unknown. seeking Indians to Christianize or gold to carry back home or good land to settle on—all these were also explorers who gradually reduced the areas on maps that had to be labelled "unknown." Francisco de Orellana, the Spaniard who was the first European to travel the length of the Amazon, deserves as much of a place among the world's explorers as is accorded to the discoverers of the Nile sources. In North America. the first Europeans to push across the great interior were Spanish missionaries in the southwest and French missionaries and fur trappers in the east and north. There were many pioneers from the English colonies along the eastern seaboard who pushed westward. Some of these, such as Daniel Boone, are well known, but there were many others whose names are not recorded.

After the United States had acquired a vast territory west of the Mississippi as a result of the Louisiana Purchase of 1803, a number of exploring parties and surveys were dispatched to report on conditions in the area between the settled part of the country and the Pacific coast. Some of these expeditions were sent out by the army. some by such civilian agencies of the government as the geographical and geological survey. One of the earliest of these was the expedition headed by Meriwether Lewis and William Clark, which reached the mouth of the Columbia river in 1805. Other exploring parties were headed by Zebulon Pike. John C. Frémont and Stephen H. Long. In 1878 John Wesley Powell. who in 1869 had been the first European to descend the Colorado river through the Grand canyon. published a report on the arid region of western United States, the result of many years of painstaking geographical work. He was perhaps the last of the explorers and also the first of the field men who undertook to prepare inventories of the quality and potential uses of the land.

DEVELOPMENT OF GEOGRAPHIC CONCEPTS

During all the centuries when geography mas chiefly concerned with the exploration of unknown areas and nith the plotting of continental outlines, geography as a field of scholarship was developing slowly. Attention was directed at first to the nature of the observable features that gave distinctive character to particular countries. From the Greeks on, however geographers hdve been seeking for more precise ways of measuring things and for plotting them on maps Over the centuries many concepts regarding the purposes and methods of geography have been formulated, tested. reformulated or abandoned.

Geographic Ideas of the Greeks.—The stream of geographic ideas that permeates the western norld had its origin in the writings of the early Greeks. The Homeric poems include a strange mixture of fact and fancy concerning the lands and peoples of the Aegean area However, it is Thales of, Miletus (640–546 B C.) who is commonly recognized as the first Greek geographer. During a visit to Egypt Thales became acquainted with the practices of abstract geometry as developed in that country for the measurement of land and he introduced the geometry of lines to Greek thought. His disciple Anaximander (611–*c.* 547 B C.) made a map of the world based on iriformation obtained from sailors in Miletus.

One of the fundamental problems with which the Greek geographers wrestled was the form and size of the earth. Before the time of Homer (goo B.C.) the earth had been conceived as a flat disk surrounded by the river Oceanus. Anaximander offered the concept of the earth as a cylindrical mass suspended in a spherical universe. It was Aristotle. however, nho first demonstrated the sphericity of the earth by noting: (1) that all matter tended to fall together toward a common centre; (2) that the earth threw a circular shadow on the moon during an eclipse: and (3) that as one travelled from north to south familiar stars disappeared and new ones came above the horizon.

Eratosthenes of Alexandria (c. 276–*c.* 194 B.C.) calculated the circumference of the earth. He learned of a deep well located at Syene (now Aswan) in Egypt nhich was completely illuminated by the sun at the summer solstice. Assuming this place to be on the tropic. and assuming Alexandria to be directly north of Syene, he measured the zenith distance of the sun at the latter place at the solstice. Reckoning the distance between the two places to be about 500 geographical miles, he arrived at a figure for the whole circumference of the earth which was remarkably close to the figure which is known to be correct.

The Greek geographers. like most of the Greek philosophers, were great believers in the concept of symmetry Herodotus (c. 484–425 B.C.), who was both a geographer and a historian. held to the view that the inhabitable lands were not circular, but were longer from east to west than they were broad from north to south. from which is derived the modern designation of longitude and latitude. He followed the principle of symmetry to fill in the arrangement of lands and the courses of rivers beyond the limits reached by explorers. He insisted that the Nile must flow from nest to east before turning north in order to balance the Danube. nhich flows from west to east before turning south. He also named the three continents that border the eastern Mediterranean: on the northern side. Europe; on the eastern side. Asia; and on the southern side, Africa. The geographical and historical ideas that Herodotus accumulated nere derived from the critical examination of a vast number of documents and also from extensive and arduous travels and field observations.

The first geographer to divide the surface of the earth into zones based on latitude (known as *klimata*) was Parmenides (c. 450 B.C). He conceived of a torrid zone nhich mas too hot to be inhabitable. two frigid zones that were too cold, and two intermediate temperate zones which constituted the inhabitable earth. Aristotle developed the idea of zones of climate and defined the temperate zone as extending from the tropics to the polar circle. Purely on the basis of theory he assumed the existence of a south-temperate zone corresponding to the known world of the Greeks. He, too, believed that the torrid zone was too hot to be inhabitable and that people who lived too close to the equator had been burned black by the sun.

The word "geography" was probably first used by Eratosthenes. The writing of geography, under whatever name. was greatly stimulated by the expansion of Greek culture, partly through the establishment of colonies of Greeks around the coasts of the Mediterranean and the Black sea. and partly through the conquests of Alexander the Great. who extended Greek horizons eastward to India.

Ideas of the Romans.—Unlike the Greeks, the Romans were primarily concerned with practical questions. The first of the encyclopaedic descriptive works dealing with the geography of countries came from the Roman geographers. The one whose works are best known is Strabo (c. 64 B.C.–A.D. 20). His 17 volumes describing the whole of the known world, and supported in considerable part by his own field observations. are like a handbook for the guidance of military commanders or public administrators. This work set a pattern for encyclopaedic geographic writing nhich has been followed ever since.

Claudius Ptolemaeus, known as Ptolemy. was a mathematician, astronomer and geographer who lived in Alexandria between A D. 127 and 141 or 151. In his great work on geography (c. 150–160) he brought together the results of Greek geographical learning. He attempted to provide the data on latitude and longitude by which maps might be constructed, but unfortunately he discarded the estimate of the earth's circumference made by Eratosthenes in favour of a much less accurate one offered by another Greek geographer. He adopted a suggestion of Hipparchus that the equator be divided into 360 parts (later known as degrees). Ptolemy recognized the difference between treatments of the world as a whole. of parts of the world or regions. and of localities; for these different kinds of writings he used the terms "geography." the treatment of the world as a whole; "chorography," the treatment of parts of the earth; and "topography," the treatment of small localities in detail.

Moslem Geographers. — The dark age of geography began before the fall of the Roman empire. It resulted in part from the completion of Roman conquests and in part from the rise of Christianity. A narrow interpretation of the scriptures led certain ecclesiastics to deny the sphericity of the earth and any of the geographical concepts based on it. Greek science gave way to widespread ignorance and bigotry.

Many of the Greek writings, and especially the works of Ptolemy, were translated into Arabic and tested by new observations over a wide area. Such travelling merchants as Ibn Haukal in the 10th century. and Ibn Batuta in the 14th century journeyed far beyond the limits reached by the Greeks. Ibn Batuta (1304–78) went far to the south along the east coast of Africa to a place nearly 10° S. of the equator. He found the temperatures on the equator more moderate than those farther to the north. The idea of uninhabitable torrid zones which appears in the book by Aristotle was thrown in doubt. Yet so simple and persuasive is the idea that the world's climates can be properly grouped in just three zones and that these zones have some effect on the way people live in them that even in the mid-20th century it was still being taught in the schools. This oversimplification has been the cause of much obscurity regarding the relation of man to climate.

The Moslem scholars did much not only to preserve and criticize Greek learning but also to add new kno ledge and new concepts of their own. The works in historical geography of Al-Biruni, Al-Baladhuri and especially of Ibn Khaldun (1332–1406) reach new standards in accuracy of observation and in interpretation of the relations of people to the land. It is apparent, too, that the Moslem geographers had started to formulate ideas concerning the uplift of mountains by folding and the erosion of slopes by running water, and also of the great amounts of time which these processes require. Such advanced ideas were developed by field men. by great travellers; for example. Ibn Batuta. during 30 years of travel. is estimated to have covered 75,000 mi., ranging as far east as India and the Malay archipelago. The Moslems, however, contributed nothing to the progress of cartography.

Revival of 16th–18th Centuries. — While the Moslem geographers were making their contributions to the development of geographic thought. the geographic horizons in Christian Europe remained narrow. Roger Bacon. writing in the 13th century and generally credited with originating the modern scientific method, described Ethiopia in terms which Ptolemy would have considered naïve and careless and which were based on information as much as 1.joo years old. Geographic horizons were reopened in Europe first as a result of the crusades and then of the discoveries of the Portuguese and Spanish expeditions.

The revival of geographic thought is recorded in the works of several scholars during the 16th. 17th and 18th centuries. The first of these was Petrus Apianus (Peter Bienewitz), whose book published in 1524 went back to Ptolemy for its inspiration. Gerardus Mercator (Gerhard Kremer) (1512–94) was a student of Apianus and later established a geographical institute at Louvain. where he worked on the development of his well-known projection. Sebastian Münster in 1544 published a descriptive book that followed the example of Strabo. But not until Philip Cluwer (1580–1623) and Bernhardus Varenius (Bernhard Varen) (1622–50) wrote their monumental geographical treatises was the revival of geographic learning well started. Varenius divided the field into general geography (dealing with the earth as a whole) and special geography (dealing with parts of the earth on a chorographic or topographic scale). His early death at the age of 28 prevented him from undertaking his proposed work on special geography, but a century later his general geography was still the accepted standard authority. In 1625 Nathanael Carpenter published the first geographical work in English. in which he showed a remarkable degree of scientific objectivity in his interpretations of observed phenomena. He foreshadowed the point of view of geographers of later centuries by focusing attention on the areal relationships of things on the surface of the earth. In 1686 Edmund Halley produced the first mind chart and presented his theory of the trade winds which related them to the distribution of heat on the earth. In the second half of the 18th century and the early 19th century there was a large amount of geographical writing. bringing together a vast number of new observations concerning physical geography. Some of this was summarized in the works of Philippe Buache (1756), the first geographer to make use of contour lines (1737), and in writings by Torbern Bergman (1766) and J. R. Foster (1783). At the same time Jedidiah Morse of Charlestown. Mass., published his compendium of geography (1789); in Britain John Pinkerton's *Modern Geography* appeared in 1802; and on the continent Conrad Malte-Brun started the publication of the first *Géographie universelle* in 1810. This was the period in which there was a wave of new scientific writing, including works by such masters as J. B. de Lamarck. P. S. de Laplace, A. G. Werner, James Hutton, Charles Lyell, Georges Cuvier. William Smith, J. F. Blumenbach and others. This was the intellectual environment in which Immanuel Kant lived.

Kant.—Kant. the great German master of logical thought. gave geography its place in the over-all framework of organized, objective knowledge (science). For a number of years after 1765 he lectured at the Cniversity of Königsberg on physical geography, and these lectures were subsequently published. It is possible, according to Kant, to classify all knowledge gained from observation in either of two ways: a classification of things perceived in accordance with some logical system. a logical classification; or a classification of things perceived in terms of the time and space where they occur, a physical classification. From the former method a systematic classification of nature is gained, as when plants or animals are placed in a system of species and genera regardless of where they occur. From the latter a geographic description of nature is gained, as when the plants and animals that occur together in the same area are identified. Description according to time is history; description according to place is geography. History is a report of phenomena that follow one another; geography is a report of phenomena that are beside one another. Geography and history together fill up the entire circumference of our perceptions. This is essentially the concept of the place of geography among the sciences that has guided the main stream of geographic thought since Kant.

Kant regarded physical geography as the summary of nature, the basis not only of history but also of "all other possible geographies." Of the latter he enumerates five: (1) mathematical geography. the measurement of the form, size and movements of the earth and its place in the solar system; (2) moral geography (in the sense of mores), an account of the different customs and characteristics of mankind; (3) political geography. the study of areas according to their governmental organization; (4) commercial geography, dealing with trade in surplus products of countries; and (j) theological geography, the study of the distribution of religions.

Humboldt and Ritter.—Until the latter part of the 18th century there mere essentially two main purposes of geographic study: there was the study of the shape and size of the earth, represented by Ptolemy and Apianus-Mercator; and there was the compilation of informative descriptions of countries and regions, represented by Strabo and Miinster. Kant provided a place in the broad framework of geography for both. Since Rant the mathematical tradition has been carried on by the cartographers, on the borderline between geography and geodesy; the tradition of descriptive writings about places has become the main stream of geographic work.

With Alexander von Humboldt (1769–1859) and Karl Ritter (1779–1859), however, the nature of the main stream itself was changed. When Strabo was writing, and even when Münster was reviving the descriptive tradition, geographers were seeking to identify the phenomena and the associations of phenomena that gave distinctive character to particular places. Understanding of process had not advanced far enough to permit a recognition of phenomena that were systematically related to each other in that they had been produced by the same process. The purpose of descriptive writing had been an essentially practical one: that of providing geographically organized information either for the use of military commanders or public administrators or as a basis for the understanding of history. No scientific principle (that is, no concept of systematically related phenomena) guided the selection of what information to include, what classifications of phenomena to adopt. Such writings have been described as encyclopaedic in that the information included was not necessarily tied together by its relevance to a problem.

By the beginning of the 19th century the systematic sciences, each discipline being devoted to the examination of a particular process (as defined in the introduction to this article), had so far advanced the understanding oi physical and chemical processes that no longer could such knowledge be disregarded in the study of particular places. Since the beginning of the 19th century the selection of phenomena to include in a study of the physical aspects of geography and the definition of categories of phenomena to be included in a system of classification have been guided by systematic knowledge of the processes involved. This advance in geographic theory was the result of the work of numerous geographers in the late 18th century who made the first applications of the new knowledge; yet it remained for two men to make the first effective use of these ideas and so to stand out as giants in the development of geographic thought.

It is remarkable that geography all over the world should owe so great a debt to two scholars — Humboldt and Ritter—who worked at the same time, both in Germany, and both for 30 years in the same city, Berlin. They were in many ways quite different in their backgrounds and in their approach to the common subject. Humboldt began his education with the purpose of becoming a diplomat, but stimulating contacts with teachers of science developed the passion and capacity for careful, direct field observations of natural phenomena. During his early 20s he travelled in England and in 1795 he made a geological and botanical tour of Switzerland and Italy. Then for five years (1799–1804) he travelled in South and Central America, amassing a vast amount of recorded and measured data regarding the countries he visited. Later, in 1829, at the age of 60, Humboldt travelled info central Asia. For most of the later years of his life, however, he was engaged in the writing of his great works: the account of his travels in America and his description of the physical geography of the earth in the *Kosmos*. He lived alternately in Paris and Berlin.

Humboldt's great contributions to geographic procedure were two. First, he applied his knowledge of physical and biological processes to the systematic classification and comparative description of the phenomena he and others had observed; second, he devised methods of measuring the phenomena he observed. For example, in his field studies of tropical mountains in America he measured the temperature at different elevations and for the first time showed temperature differences on a map by drawing lines to connect points of equal temperature (isotherms). He made use of census data where they were available, but in the absence of such data he carefully checked estimates of the population of various regions and countries of America. The step from qualitative, encyclopaedic description to quantitative, systematic description was a major one in the history of geography.

Karl Ritter was Humboldt's junior by ten years. He always regarded Humboldt as his master and in many ways based his geographical writings on the ideas of the elder scholar. Perhaps no man had a broader background of preparation for geographic study than did Ritter. He was taught by men who insisted that knowledge of the world could be gained only by the direct observation of nature. Like Humboldt, Ritter was a persistent and careful field observer; unlike Humboldt, he never made long journeys to distant places, but rather confined his field observations to Europe. He received a fine training in the natural sciences, and he was also a student of history and theology. In many of his writings he was more historian than geographer, and opposition to his ideas that developed after his death arose in part from the accusation that he had made geography a handmaiden of history. He wrote what has come to be known as geographical history (a geographical interpretation of history) rather than historical geography (the reconstruction of past geographies and the tracing of geographical changes through time). Ritter emphasized the importance of comparative studies of different parts of the world and the danger of drawing conclusions or formulating generalizations on the basis of knowledge of one area alone. In his studies he always attempted to show how things existed together in the same areas in mutual interrelationship. He thought of geography as a kind of physiology and comparative anatomy of the features of the earth's surface. Yet his deeply religious attitude led him to adopt a strongly teleological point of view. His monumental work, ***Die Erdkunde im Verhiiltnis zur Natur und zur Geschichte des Menschen*** (2 vol., Berlin, 1817–18; 2nd ed., 1822–59), covered only Asia and a part of Africa.

Ritter also made two contributions to geographic method. First, he insisted that one should proceed from observation to observation, not from opinion to hypothesis to observation. He was among the first, for example, to show that Buache's idea of continuous mountain systems separating the drainage basins of the great rivers was contrary to observed facts. In gathering together impressive arrays of data from the reports of others, Ritter's purpose was to let these data speak for themselves in bringing out the coherent relations among things. He was the first to provide a system of subdivisions of the continents based on surface features as a framework for his detailed regional descriptions. Second, Ritter's approach was regional rather than systematic; that is, he focused his attention on particular places and on the phenomena unsystematically associated there rather than on systematically related phenomena wherever they might occur. Yet Ritter himself acknowledged that without the systematic studies of Humboldt his own work could never have been carried out.

GEOGRAPHY AFTER HUMBOLDT AND RITTER

Humboldt and Ritter had gathered together the geographical ideas of the past, and from their writings there emerged a new and unified concept of the nature of geography. The main stream of geographic scholarship since Humboldt and Ritter has been devoted to an understanding of the significance of likenesses and differences from place to place on the earth and of the meaning of the associations and interconnections among phenomena in particular places. Armchair geography, based on the spinning of elaborate theories in advance of precise observation, is no longer acceptable; in contrast geography has become essentially an out-of-door subject, based in large measure on the direct observation of phenomena in the field. One technical problem has been the method of recording such direct observations. At first such data were recorded only in the form of notes (written or sketched) ; since 1915 the recording of field data on maps in the field has became standard practice, and since about 1930 the recording of observations on vertical air photographs has given a new precision to geographical study that it never could have possessed before.

The idea that Humboldt represented a systematic or topical approach to geographic study in contrast with Ritter's regional approach has been overemphasized by some geographers. Clearly both these scholars used both approaches, perhaps with varying emphasis. The modern concept does not recognize the topical and the regional approach as different aspects of geography, but rather recognizes the need for combining them.

In the period since the middle of the 19th century chorographic study (that is, study of areal differentiation and its meaning) has been moving steadily away from the encyclopaedic description of the Strabo-Münster tradition toward an organization of material relevant to a specified purpose or objective. Modern geographic writing starts with a problem and applies the geographic method to the search for answers or for clarification of the issues involved in the formulation of policy.

Meanwhile, however, a number of deviations from the main stream of geographic scholarship have appeared. One such deviation conceived of geography as a science of relationships, specifically those between man and his physical environment. Another conceived of geography as devoted solely to the interpretation of the visible features of the landscape. Still another and widely popular deviation identified geography with geopolitics. Others, such as the identification of geography with geophysics! need not be discussed in this article since they have few if any adherents in the modern period.

THE MAIN STREAM: GEOGRAPHY AS CHOROGRAPHIC SCIENCE

Chorographic science is that aspect of learning which treats of the areal arrangements and associations of things on the face of the earth and seeks to understand the causes and consequences of such areal differentiation. As already stated. geography cannot be defined by its subject matter, for anything that is unevenly distributed over the earth can be examined by the methods of geographic study. The continued development of the chorographic approach has led to greater and greater attention to procedures for selecting features to be studied and for rejecting other features as irrelevant. It hss also led to great increase in precision of field observation. Both these developments were adumbrated in the writings of Humboldt and Ritter.

Clearly the main stream of geographic scholarship was defined in Germany by two late 19th- and early 20th-century figures. These were Ferdinand von Richthofen and Alfred Hettner. In the modern period the geographers whose contributions have been of the utmost importance, and who have set forth their philosophical ideas regarding the content of geography, are too numerous to permit mention of more than a few. The ideas of Richthofen and Hettner and of many others were discussed and critically analyzed in English in the monumental work of Richard Hartshorne, ***The Nature of Geography*** (1939).

French Tradition of **Regional Studies.**—No country has contributed more to the development of geography than France. In proportion to the size of the country and the financial resources of its universities the quantity and quality of French geographic work has been outstanding. But France has achieved this status largely during the 20th century.

During most of the 19th century geography was widely taught and geographic writings were in demand. The first chair of geography was established at the Sorbonne in 1809, and in 1821 one of the oldest geographical societies in the world was established at Paris. Rut the geographical writings of that century were in the encyclopaedic tradition and the teaching was aimed chiefly at a geographic interpretation of history. Two comprehensive series were published under the title *Géographie universelle:* the 8-volume series (1810–29) by Conrad Malte-Brun, and the 19-volume series (1875–94) by Elisée Reclus. The series by Reclus represented in its day the most scholarly kind of descriptive geography; yet it represented no conceptual advance over the work of Ritter, since the genetic approach had not yet been applied to the study of population.

French geography was raised to a new level of accomplishment by the great master Paul Vidal de la Blache (1845–1918). In 1899 Vidal de la Blache set the new tone for French geographical studies in his inaugural address at the Sorbonne. He expressed himself as opposed to any strict determinism with regard to the relation of human activities to the physical environment; rather he recognized man as the active agent, operating in a setting that offered both possibilities and obstacles to man's wishes. But he was convinced that the way to go forward in geographical studies was to focus attention on relatively small areas in which to examine in detail the areal differentiation resulting from physical and human processes. Vidal's influence was great, and most of the French geographers after his time were either his pupils or pupils oi his pupils.

Perhaps Vidal's greatest disciple was Jean Brunhes (1869–1930), whose *Human Geography* is a widely read book in English as well as in the originai French.

The French geographers who developed under the influence of Vidal showed a remarkable unity of purpose and achieved a high standard oi performance. The French regional monographs, some dealing with parts of France, others dealing with other parts of the world, are a famous and distinctive part of geographic literature. Vidal was responsible for formulating the original plans for another great *Géographie universelle,* and after his death the direction of the project was carried on by his successor Lucien Gallois. The first of these volumes to appear were the ones on Great Britain and the Netherlands by Albert Demangeon (1927). The whole series was completed in 1946–48 with the publication of the three volumes on France by Emmanuel de Martonne and Demangeon. No finer books bringing together material on the geography of the whole world had ever been published.

Although all the volumes are of a high standard of accuracy and of literary quality, the outstanding volumes by De Martonne and Demangeon on *La France,* by De Martonne on *Europe Centrale,* by Henri Baulig on *Amérique Septentrionale* and by Pierre Denis on *Amérique du Sud* should be given special mention. In these the regional descriptions are given focus through the inspired identification of central themes around which the descriptive material is organized.

The French regional tradition was passed, also, to workers in other countries. In Germany Friedrich Ratzel initiated a series of regional monographs dealing with different parts of Germany under the general title of *Forschungen zur deutschen Landeskunde.* The Pan American Institute of Geography and History, a specialized agency of the Organization of American States, undertook to plan and co-ordinate the preparation of a series of volumes dealing with the countries of the western hemisphere. Brazilian geographers were especially active in the writing of regional monographs in the French tradition. They were stimulated, in part, by the presence of several outstanding French scholars, notably Pierre Deffontaines and Pierre Monbeig. The Brazilians were also influenced by the German-American geographer Leo Waibel and by several geographers irom the United States who introduced techniques of field mapping and resource inventory.

The French and German chorographic tradition was extended, also, to other parts of the world, where a number of outstanding scholars made contributions to geographic thought. Major geographic work has been done in Australia, New Zealand and South Africa, in Italy, Czechoslovakia, Poland and the Russian S.F.S.R. The Russians were especially important during the 19th century for introducing new concepts in the study of soil geography. Geographical work has also been important in China, Japan and India.

20th-Century Developments.— By the middle of the 20th century the chorographic tradition had been notably advanced by new concepts regarding the focus of geographic objectives and by new techniques of observation and analysis. These changes had their roots in the 19th century, but appeared strongly after World War I. France, Germany, Great Britain and the United States shared in the return to the main stream of geography.

In the first place the need for a central theme or problem around which to organize geographic material became more widely recognized. The encyclopaedic coverage of areas was recognized as important; but it became more and more clearly demonstrated that even an encyclopaedia must be written for a specific purpose or to fill a specific kind of need. This involves, then, a certain amount of selection in the kinds of data to be treated. If the encyclopaedia is to provide background information for the planning of a military campaign, this determines the kind of information required. If the encyclopaedia is to be used as a reference work in schools or colleges, a different selection is required. But there are also many kinds oi questions concerning origins and antecedents that may be asked regarding the geographic ieatures oi an area, and these questions are problems which in turn provide a means for distinguishing betw-een relevant and irrelevant items. Or there may be an economic, social or political situation which needs to be changed or remedied, and this also provides a problem around which to organize the materials and analyses of geography. By mid-20th century leaders in professional geography were critical of research undertakings not specifically directed toward stated ends.

This trend away irom the uncritically encyclopaedic kind of writing gave additional emphasis to direct field observation, again in the tradition of Humboldt. Direct field observation must of necessity be carried out in small areas, ior the range of human vision on the curved surface of the earth is small. When the features of the earth are mapped on small-scale maps they must be highly generalized, as when a pattern of specific fields and farms is generalized into a kind of agricultural region. But the agricultural region cannot be seen directly, for it is too big; the details that make it up are the specific features of human settlement, the specific slopes and soils, and these must be mapped on large-scale maps. Geographers still use the adjective "topographic" to define that scale of field mapping which permits the plotting of specific fields and farms or specific blocks and even buildings in a city; a topographic map is one with a scale large enough to permit such specific features to be mapped.

Topographic studies, using the word in this sense, were common in Great Britain even during the 19th century. As early as 1895 Hugh Robert Mill wrote an essay in which he described in detail the characteristics of a small part of Sussex. He urged similar treatment for the area of each of the sheets of the British topographic maps (inch to the mile scale). The numerous essays brought together under the editorship of Alan Grant Ogilvie in 1928 (*Great Britain: Essays in Regional Geography*) dealt with specific kinds of problems or features in relatively small areas. In few of these studies, however, were the physical, biotic and human features of an area treated with the same degree of detail. It was commoner to treat the physical characteristics of an area in detail and then to sketch in the human aspects superficially.

The development of geographic thought and method were greatly advanced when geographers in the United States first developed the procedures ior treating all the relevant features of a small agricultural area with the same degree of detail. One of the first geographers to insist on the need for such balance was Wellington D. Jones. With Carl O. Sauer he published an outline for the detailed field study of an agricultural area in 1915. In the summer of 1915 graduate students at The University of Chicago were ofiered the first field course in which such a balanced approach was taught. Shortly thereafter Sauer made field study a basic part of graduate training at the University of Michigan, Ann Arbor. Thereafter it became standard procedure to examine geographic problems in the field in small areas.

Surveys and Inventories.— In the period since 1920 the methods of detailed field study have been applied, with increasing success, to the practical problems of land planning. By mid-20th century it was widely appreciated that an inventory of land quality and existing land use was an essential basis for formulating land-use policy. The first survey with the purpose of providing such background information was the Michigan Land Economic survey undertaken during the 1920s and 1930s to tell the policy makers what actually existed in the cutover lands of the northern part of the state. During the 1930s similar field methods were used by geographers to survey the area of the Tennessee Valley authority. There, for the first time in connection with a large survey, mapping was done on air photographs.

At this same time, L. Dudley Stamp introduced the idea of the detailed field survey to Great Britain. In 1930 the British Land Utilisation survey was started with the objective of recording on maps of suitable scale the facts of land use and land quality for every acre of England, Scotland and Wales. The survey was carried out by unpaid volunteers from the universities, colleges and schools under the guidance of professional geographers, using maps of a scale of 1:10,560 (six inches to the mile). This survey proved of inestimable value during World War II, when Britain was forced to make use of every available acre of land for agricultural production. It is not too much to say that the survey was a most important factor in helping Britain to survive the war years. It also provided the material for Stamp's book *The Land of Britain: Its Use and Misuse.*

Two other surveys made use of geographic field methods for resource inventory and land-use mapping as a basis ior the formulation of public policy. One was the Puerto Rico Rural Land Classification program (1948–52), done for the government oi Puerto Rico, in which the island was mapped on a scale of 1:10,000. From these maps effective plans for the better use of the limited agricultural base were drawn up. Another survey was directed broadly at the resources of tropical Africa under the direction of George H. T. Kimble. It was widely recognized that at mid-20th century there were not enough adequately trained field men to carry on surveys fast enough, even in the world's critical areas. Geographers and others were seeking to perfect the methods of resource inventory through the interpretation of air photographs with a minimum of direct field contact. In this development professional geographers in the universities were handicapped by lack of financial support; meanwhile government apencies and private organizations were in some cases proceeding without the benefit of the experience gathered by the geographic profession over centuries of field study.

Spatial Interchange.— The study of the movements and communications that connect one area with another has long been an essential aspect of chorographic work. To treat areal differentiation as a purely static phenomenon is insufficient. During the 19th century, especially in Germany and France, there was much interest in transportation as a geographic phenomenon. The study of spatial interchange deals not only with the volumes of movement but also with the facilities, such as railroad equipment, or the capacities of ports and ships to move different kinds of goods. At mid-20th century a tendency had appeared to apply mathematical iormulas from the field of physics to the description of the volume and velocity of movements in relation to the factors of location and distance.

DEVIANTS FROM THE MAIN STREAM

During the 19th and 20th centuries there were a number of deviant developments in the field of geography. Some of these died out early; for example, the proposal that geography should concern itself wholly with geophysics, abandoning studies oi human geography as "unscientific." Other deviants were proposed by individual scholars but attracted iew followers; for example, that geography should be defined as human ecology, a field already claimed if not developed by sociology. Among the various deviant currents that have appeared, three may be given special attention: (1) geography as the science of relationships; (2) geography as the study of landscape; and (3) geography as geopolitics.

Science of Relationships.— The idea of defining geography as the study of relationships appeared during the second half of the 19th century. At that time the understanding of the physical and biotic processes at work on the earth had been much iarther advanced than the understanding of the economic, social and political processes. Few geographers have at any time thought of their field as covering only the physical and biotic aspects of the earth or of omitting study of the human or cultural aspects; yet the concepts of causal relationship as developed in 19th-century physical geography and biogeography were quite out of harmony with those oi human geography. The theory of evolution applied to the changes in plants and animals had a tremendous influence on the intellectual world. It was reflected in physical geography, especially, by attempts to define ideal sequences of change, such as the cycle of youth, maturity and old age of land forms. These attempts were notably successful. William Morris Davis, professor of geography at Harvard university, was an outstanding leader in this development.

But when the new concepts appeared in physical geography and biogeography, no similar principles were immediately forthcoming to organize the treatment of man and his works. It was in this situation that an attempt was made to relate the human aspects of geography to the better-understood physical aspects and to define geography as the study of the interrelationships between man and his physical environment.

In Germany, Friedrich Ratzel attempted to bring the treatment of man into line with the treatment of physical features. In the first volume of his *Anthropogeographie* (1882 and 1899), he organized his material in terms of the natural conditions of the earth, in relation to which he examined various cultural ieatures. In the second volume (1891 and 1912) he did the opposite, organizing his material in terms of human culture, in relation to which he examined the physical features of the earth. Ratzel, however, was thoroughly in sympathy with the tradition of Humboldt and Ritter; he never lost sight of the need for direct observation of all relevant elements of a situation. Thus in his classic volume on *Deutschland* he pointed out that two physically similar areas, the Black Forest and the Vosges mountains, had developed in quite different ways because of the differences in economy and historical tradition.

Some of Ratzel's disciples were not so careful to observe all the relevant interrelated phenomena. Especially those who were trained chiefly in physical geography insisted that a geographic analysis must show a relationship that crossed the border between physical and human phenomena, thus neglecting the relationships on the same side of the border. Few geographers ever subscribed to such extreme forms of environmental determinism as suggested by the historian H. T. Buckle and others; but many went forth deliberately to seek examples of environmental influence on human activities, and many remained blind to contrary evidence. As a result geography was divided into physical geography (a well-developed field of science) and human geography (a relatively superficial treatment of man's relations to the physical earth). The adjective "geographic" came to refer to the physical character of an area. Thus a "geographic factor" was some condition of the physical environment to which human activities were to be related as "responses" or "adjustments."

Geography as the science of relationships persisted longer in the English-speaking world than elsewhere. It found few adherents in Germany, where Alfred Hettner was developing the ideas associated with the main stream of geography. It was effectively attacked by the French geographers under the leadership of Paul Vidal de la Blache. But it was given persuasive support in the United States by such scholars as William Morris Davis, Ellen C. Semple, Wallace W. Atwood. Ellsworth Huntington, Robert DeCourcy Ward and R. H. Whitbeck. Yet this approach to geographic study proved to be a dead end. As Griffith Taylor, an eloquent supporter of the ideas of environmental determinism, wrote, such relationships between man and his environment are nowhere more clearly seen than when one looks at the world as a whole. Yet when one looks at the world as a whole all the aspects of the iace of the earth, physical as well as human, are highly generalized. Only when the earth is examined in topographic detail—that is, on maps large enough to permit the plotting of specific ieatures of human occupance—can generalization be kept to such limits that results can be checked. At mid-20th century detailed field studies had yet to demonstrate through proper historical and comparative methods the validity of the concept of environmental determinism. Modern geographers, on the contrary, insist on the principle that the significance to man of the features of the physical earth is a function of the attitudes, objectives and technical abilities of man himself. In other words, the physical and biotic environment has different meaning for different persons; and further, geography examines the relationships not only between man and the physical or biotic aspects of the environment but also between man and the variety of cultural ieatures resulting from economic, social and political processes. Only thus can the relative significance of areal differences be weighed and evaluated. Geography can no longer be divided neatly into physical and human geography, and a geographic factor is any factor of location or areal association that is relevant to a problem.

Study of Landscape.— The idea that geography should be restricted to an examination of the visible character of the landscape appeared as another deviant in 19th-century Germany, especially in the works of Otto Schliiter. In the United States this approach to geography was introduced by Carl O. Sauer in a paper entitled "The Morphology of Landscape" (1925). The immediate popularity of this point oi view among the younger geographers of that period represented a reaction against the idea that geography was restricted to a study of the relationships between man and his physical environment. Sauer's paper shows the results of experience in detailed field mapping and field study, the influence of ideas irom German geographic literature and the challenge of concepts presented by the rapidly developing field of anthropology. Sauer was concerned with the significance to man of the physical and biotic conditions of a small area or site, and also with man's transformation of the site. Perhaps it was the iollowers of Sauer rather than Sauer himseli who tried to restrict geographic attention to form and structure alone to the neglect of function—in other words, to the anatomy of the visible landscape rather than to its physiology.

As in other attempts to provide a limited definition of the field of geography, this proved to be a dead end. Geography, according to the concepts developed by Kant and restated by Sauer, is one aspect (along with history) oi the whole range oi perception; Sauer called it a "nai'vely-given sector of reality." Geography, then, is not subject to definition or limitation; geography is not what geographers do, for much work in this sector of reality is done by persons who are not professional geographers and who are not especially competent in the use of geographic methods.

Geopolitics.— Another deviant from the main stream of geographic science is that known by the popular term "geopolitics." The great popularity of geopolitics as a practical field oi study in which human geography and applied political science are used for the examination of certain problems in international relations had its great development as a result of World War II. Karl Haushoier, a German geographer, was credited with the iormulation of ideas that had a profound effect on the strategic policy of Adoli Hitler. Whether Haushoier's ideas had the greater influence on Hitler or Hitler's on Haushoier has not been established. The iact is, however, that the German school of geopolitics was used to provide a pseudoscientific rationalization of Nazi policy. In the United States and Great Britain another school of geopolitics was developed which sought to go back to H. J. Mackinder and A. T. Mahan rather than to Haushoier.

Geopolitics, as distinguished irom political geography, combines the concepts and techniques of a variety oi disciplines ior the purpose oi iormulating strategic policy in international relations. But strategic policy as formulated by the leaders of any one state has the basic purpose of advancing the interests of that state; every state has a somewhat different set of purposes and these are oiten in conflict with the purposes of other states. Geopolitics, then, is an applied field which would seem inevitably to be divided into as many schools as there are independent states. Geography may be used, along with other disciplines, in working out the plans of geopolitics; but geography is not the same as geopolitics, nor is geopolitics a field of scholarship by itself. *(See* also GEOPOLITICS.)

GEOGRAPHY IN THE 20TH CENTURY

Two outstanding books were published in the United States discussing the field of geography. One by Richard Hartshorne, *The Nature of Geography* (1939), reviewed the main course of geographic thought and the various deviants that had irom time to time become important. It was a historical work, with emphasis on the ideas formulated by the Germans. It presented the chorographic viewpoint in its many aspects and as developed over many centuries. The other book involved the work oi more than 100 proiessional geographers; *American Geography, Inventory and Prospect* (1954), edited by Preston E. James and Clarence F. Jones, brought together the experience of hali a century in the formulation of the concepts of geography and in the development of acceptable procedures of geographic research.

Geography is recognized as a single discipline, unified not by its subject matter but rather by its point of view and its method. The point of view is defined in terms of the regional concept: the method of all geographic study is the regional method. The term "region," however, is defined somewhat differently irom the definition given in the dictionary. Popularly the word "region" denotes a relatively large area having some general quality of homogeneity but with boundaries not precisely defined. In *American Geography, Inventory and Prospect* a region is an area of any size that is homogeneous in terms of specific criteria and that is distinguished from bordering areas by a particular kind of association of areally related ieatures. The old distinction between topical (or systematic) geography and regional geography is not considered valid. Topical geography is defined as the study oi a particular group of features produced by one kind of process wherever these ieatures may occur in the world (Varenius' general geography); regional geography is defined as the study oi all kinds of features as they occur in particular areas (Varenius' special geography). At mid-20th century, however, it was recognized that in so iar as all regions had to be defined in terms of specific criteria the approach to regions had to be a topical one; and since the study of any topic involves the definition of homogeneous areas, all topical study had to make use of the regional method.

The new concept of the region stemmed irom experience in detailed field studies. It is clear that no two points on the iace of the earth are identical. On the other hand, if the complexity of the iace of the earth is to be brought within manageable limits for the purpose oi examining the causes and consequences of areal differentiation, to examine each spot separately would deieat the endeavour. Geographers must always generalize; they must define categories of phenomena that are meaningiul in that they are associated in area with other phenomena; they must seek associations of phenomena, defined as regions, that are significant in that they are related to a particular process or group of processes. In all science as iormulated by Kant there are two kinds of generalizations: one that deals with the classification of phenomena into categories of greater or lesser degree oi generalization; and another that describes the ideal operation of a process, or a chain of cause and effect relations. Geography traditionally deals with the former; but modern geography classifies phenomena on the basis oi systematic knowledge of process.

Conceived in this way the region is a device for illuminating the factors of a problem which otherwise would be less clearly understood. It is not an objective fact; rather it is an intellectual concept. A region is justified if it illuminates the elements of a problem; it is not justified ii it obscures these elements. There is no such thing as a "true region'!; there are, in iact, as many regional systems as there are problems worth studying by geographic method.

The regions which a geographer defines and observes on the iace of the earth are plotted at a reduced scale on maps. With modern methods of field observation, including air photography, geographers can achieve a degree of precision never before possible; maps can be even more exact than statistics, only the iorm of precision is geometric rather than arithmetic. When a homogeneous area is defined and plotted on a map, its outline is matched against the outlines of other kinds of phenomena. Oi course every phenomenon has some kind of areal relationship to every other phenomenon on earth, but some relationships are accordant and some discordant. Accordant areal relations are found by matching maps and noting where regional outlines coincide or correspond. This is the regional method.

Two kinds of concepts are developed by the application of geographic procedures. One concept has to do with the make-up of regions. Since the phenomena on the face of the earth are the result of such a variety of processes, ii significant regional systems are to be developed it would seem that either the broader, more highly generalized multiple-feature regions must be careiully analyzed to bring out their components, or else the broader regions must be built up by the matching of maps of numerous very small single-ieature regions. A topographic study is now defined as a study carried out on maps of sufficiently large scale to permit the plotting of the specific ieatures of the human occupance—large enough, that is, to show specific fields on a farm. When the map scale is too small to permit the plotting of specific ieatures, so that these ieatures must be generalized in categories of greater areal spread, the study is defined as chorographic. The whole Ptolemaic system in which geography is defined as that scale which deals with the world as a whole is no longer commonly in use. The adjective "geographic" refers to patterns of areal differences on the earth and to the regional systems that are used to reveal them.

The other kind oi concept developed by modern geographic study is that of causal relationships, as distinguished from areal relationships which are revealed by the regional method. Even when two phenomena occupy exactly the same space (that is, their outlines coincide) this does not demonstrate a causal connection between them. A causal connection can be demonstrated only by tracing the operation of a process through time. Coincident areal relations may indicate a probability of some kind of causal connection; but to prove that such a connection exists, the nature of the process or processes that have produced the observed phenomena must be described.

This means that geography cannot be strictly contemporary. All geographic study must be approached historically if it is to be complete. Historical geography is understood to be concerned with the recreation of past geographies and with geographical changes through time. A full understanding of contemporary geographic phenomena requires the full perspective of past geographies, ior the operation of any one process at a particular place and time is to a certain extent modified by the total environment with which the process is involved. The systematic sciences work to unravel all these disturbing connections with the environment and to describe the ideal operation of the process in isolation; geography seeks to put the process back in its earthly setting and to see its connections both in space and time.

SUBDIVISIONS OF GEOGRAPHY

Obviously no one scholar could become thoroughly competent in all branches of so broad a field. In the first place, a considerable amount of geographic work is actually done by persons who are not professional geographers. In the second place, those who hope to become professional geographers must select a group of topical fields and certain areas of the world in which they intend to specialize. There are as many topical fields, at least potentially, as there are kinds of processes acting to differentiate one part of the earth irom another. The following brief outline of topical fields is not definitive.

Population geography is a field that was still inadequately developed in the 1950s. The mapping of the distribution of people, as J. Brunhes pointed out, is one of the primary tasks of geographic study. The data, on which maps must be based, are numbers of persons, summed up in enumeration areas. But the enumeration areas are usually too large or include arbitrary segments of a national territory that obscure the facts of population distribution. Population geography also includes the study of the movements of people and of such population characteristics as age and sex structure, ethnic composition, religious and linguistic groupings and a variety of other matters. The geographer's contribution consists of finding ways to portray more effectively the patterns of distribution on maps and to analyze more effectively the areal relations of population to other ieatures.

Settlement geography is closely related to population geography in that one of the methods oi locating persons within enumeration areas is to observe the distribution of houses. Settlement geography, however, goes beyond this to study all the iacilities men build in the process of occupying an area: the iorms and functions of buildings, the road and property patterns and the groupings of these things. Much has been done with settlement patterns since August Meitzen in 189; examined the settlements of eastern Germany. Studies of the rural habitation in France and oi house types in the United States have brought to light important relationships not only of houses to building materials but of houses to cultural traditions.

Urban geography includes the urban part of settlement geography, but goes beyond the problems commonly considered in rural areas. Cities are examined not only in terms oi their patterns oi arrangement, their internal structure and the arrangement of functional areas within them, but also in terms oi the services they perform and of the movements of goods and persons that are involved. Urban geography provides an essential background for city planning.

Political geography iocuses attention on politically organized areas or political regions. The purpose is to show how the effective administration of a political area is related to the geographic arrangement of the various parts of the state—the capital city, the industrial core, the areas of concentrated settlement, the boundaries, the dependent areas and the sources of raw materials. It is recognized that any successful state operates on the basis of a "state-idea"; that is, a body of principles or traditions which can command the loyal support oi a considerable majority of the people. Where the state-idea is poorly developed, or where different state-ideas are held in different parts of the national territory, the effective iunctioning of the state is imperilled. The arrangement of these nonmaterial aspects of the political life, examined in relation to material aspects such as those enumerated above, offers many problems and opportunities.

Economic geography is a much-developed part of geography, especially in Great Britain and the United States. So much attention has been given to the study of the significance of likenesses and differences among places in terms of economic processes that economic geography can no longer be considered as a field of specialization of itseli. Among the more important subdivisions of economic geography are: (1) the study of resources and the inventory and evaluation of the resource base of an area; (2) the geography of mining and minerals; (3) the geography oi agriculture and land utilization; (4) the geography of manufacturing industry, involving the principles of industrial location and the factors in industrial site selection; (j) the geography of transportation, involving not only the movements of goods from place to place but also analysis of the arrangement of iacilities such as railroads, docks, airfields or shipping lines; (6) marketing geography, or the application of geographic methods to the analysis oi actual and potential markets, including sales territories, salesmen's routes and all the numerous factors involved in estimating the potential sales of a given site. There are many other topical specialties within the general field of economic geography that might be mentioned, such as the geographic study of recreation, or the geographic study of service occupations, or any number of other ways of making a living.

Physical geography is a subdivision of the whole field of geography which, like economic geography, is too broad to be cultivated as a whole. In each of the topical specialties dealing with physical processes on the earth there have been many important contributions during the 19th and 20th centuries, and in each of these specialties, concerned with areal differentiation, there are close connections with the bordering systematic fields in which study oi process is the primary aim. Physical geography is divided into a number of specialties, of which the more important are: (1) climatology, closely connected with synoptic meteorology; (2) geomorphology, closely connected with various aspects of geology; (3) the geographic study of soils, closely connected with studies in agronomy and related subjects; (4) the geographic study of water on the land, closely connected with hydrology; (5) the geographic study of the oceans, a vast potential field of geographic study only little developed, since most of the work in oceanography has been done irom the point of view of physical or biological science. Of these topical fields some have been better developed than others by geographers. Much has been done in climatology, especially in the construction oi broad regional systems such as those formulated by A. J. Herbertson, Emmanuel de Martonne, W. Koppen and C. W. Thornthwaite. At the beginning of the 20th century in Great Britain and the United States most oi the scholars w-ho called themselves geographers were specialists in geomorphology. the study oi land forms. In the United States the geographic profession mas established by such notable masters as William Morris Davis. Rollin D. Salisbury and Wallace W. Atwood. Davis' formulation of the cycle of land iorm development from youth through maturity to old age stimulated much attention to suriace ieatures in America and in Europe and the application of similar ideas to other topical fields. Davis' concepts were challenged by Walter Penck, with the result that by mid-20th century a new and stronger geomorpbology was emerging from the co-ordination oi the ideas of two quite different approaches: one (Davis') through the study oi erosion along valley lines, the other (Penck's) through the study oi the development of slopes. In the study of soils, Curtis F. Marbut introduced the concepts developed by the Russian scientists of the 19th century and combined them with an application of the cycle idea oi Davis. Geographers made great advances in the whole theory of classification oi phenomena on the earth's surface through the study of soils.

Biogeography is still another subdivision oi geography. Especially in the study of vegetation have geographers made important contributions. To be sure, the 19th-century "life-zone" ideas of C. H. Merriam proved to be too highly generalized to throw much light on the actual arrangements of plants and animals. Yet the classification of vegetation and the preparation of maps of vegetation suitable for geographic uses have been notably advanced,. especially by such scholars as F. Shreve, Homer L. Shantz, H. M. Raup, J. W. Harshberger, F. E. Egler and A. W. Küchler. There has been some application of geographic method, also. to the study of animal geography or zoogeography. In the general field oi biogeography there is also the topical branch known as medical geography, which deals with the geographic arrangement oi diseases and with the factors relevant to the incidence and spread of disease. Notable in this development have been the studies carried on by Jacques M. May at the American Geographical society. During World War II, also, there was a considerable advance in physiological climatology, a field in which the effect of climate on the healthy human being is examined. As a result of experimental studies of human activity under controlled conditions of temperature and humidity, much new light was thrown on human behaviour. The older. and stimulating but not always provable suggestions of Ellsworth Huntington regarding climate and man were greatly modified by the new knowledge gained irom controlled experiment. A practical result of these studies was the development of new kinds of clothing and new kinds of houses.

Military geography was a field especially developed during World War II. All aspects of geographic study were applied to military problems. In no field is precise geographic knowledge regarding particular places more essential than in the field of military planning, whether tactical or strategic.

Techniques of geographic study have also been given much attention, especially since 1920, when the detailed field study of small areas began to bring in striking results. Geographic information is derived irom iour kinds of sources: (1) documents, including not only written records, but also maps, photographs and statistics; (2) vertical air photographs; (3) direct observation in the field; and (4) the interview of iniormants. Geographic data once brought together are analyzed: (1) by expository methods, using word symbols; (2) by statistical methods, using mathematical symbols; (3) by cartographic methods, using map symbols; and (4) by the interpretation of air photographs. Most geographic studies require competence in all these methods oi gathering and analyzing data. There has been a considerable amount of experimentation, especially in the Gnited States, with the methods of field study in small areas. The methods of recording direct observations in uritten notes, in field sketches, with ground photography and on maps have all been made vastly more effective. After World War I vertical air photography began to play a more and more important role as a geographic technique, and during the 1940s and 1950s the development of new cameras, new film and better planes made this entirely new source oi information one of prime importance. It is much less costly and also much more accurate to derite maps of homogeneous areas irom the interpretation of air photographs than it ever could be from ground observation alone However, the interpretation of the photographs requires a certain irreducible minimum of ground work; and the study of all the nonvisible features of an area that cannot be photographed demands actual examination in the field. Air photography raises geographic study to a new level of exactness.

Cartography.—Cartography is a field which overlaps between geography and geodesy. The traditional interest in mathematical geography, as carried iorward by Ptolemy and Apianus, is now to be found among the geographic cartographers, who are still experimenting with new projections, valuable for specific purposes. The actual field construction of detailed maps, once a laborious job carried out with measuring tape and plane table, during the 1940s was greatly speeded and rendered less costly through the application of air photography to photogrammetry. Most topographic maps after mid-20th century were made by the methods of photogrammetry. Most of the world had been covered at least once by vertical air photographs. The use of such photographs for purposes of map construction involves quite different techniques than does the use of the photographs to bring out the geographic patterns of areal likenesses and differences. Geographic cartography was also enormously advanced during World War II when many new kinds oi maps, using different colours or different black-and-white symbols, were tried out. This field included also the construction of detailed terrain models, oi which one notable example was the model of the United States at the Babson institute in Wellesley, Mass., made under the direction of Wallace W. Atwood, Jr. As a result of the war new map libraries made their appearance, and the whole new field of map intelligence (the collection of information about map series and the evaluation of maps for different purposes) was developed. Cartography, which is recognized as an essential part of geographic study and which at one time constituted a major interest among geographers, in the mid-20th century was brought back to its proper position as a major geographic interest. (*See* also MAP.)

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(P. E. J.)

GEOGRAPHY, SOCIETIES OF. *More than* 150 *organizations* have primary interests in geography *and the related* fields *of exploration and travel.* Most *are centred in and serve individual* cities and their environs. Many are regional, more than 20 are national in scope and 3 are international. They differ greatly in *membership.* status *and objectives.*

The predecessor of modern geographical societies is commonly considered to be the Association for Promoting the Discovery of the Interior Parts of Africa (1788). In 1805 the Palestine association was founded in London, and these two organizations were merged into the Royal Geographical society, which originated at London in 1830 and was incorporated by royal charter in 1859. Meanwhile the Société de Géographes was founded at Paris in 1821 and the Gesellschaft für Erdkunde at Berlin in 1828. Gradually other societies came into existence, in Mexico (1839), in Russia (1845) and in the United States (1851). During the latter half of the 19th century the number of geographical societies increased rapidly, and their growth in membership was accelerated during the first half of the 20th century, especially following World Wars I and II.

Of the various types of geographical societies, the most numerous are semiscientific-semisocial organizations composed of merchants, military personnel, government employees, teachers and laymen interested in geography and travel. Among the better known in this category are the National Geographic society (Washington, D.C.), the Canadian Geographical society (Otta a), and local societies in Berlin, Rome, Paris, Philadelphia and Chicago. They maintain libraries and map collections, sponsor lectures and publish periodicals of mixed popular and professional interest.

Other organizations such as the Alpine club (England). Explorers club (U.S.) and Hakluyt society (England) are concerned primarily with organizing expeditions and publishing accounts of exploration and travel in little-known areas.

Some societies, such as the Royal Geographical society (London), have partial support from government sources. Others. such as the American Geographical society (New York city), supplement their income from dues by soliciting gifts, obtaining foundation grants and operating under research contracts. They have employed professional staffs, enlarged their research facilities and produced journals of high scholarly value, among them the *Geographical Journal* and the *Geographzcal Review*. In addition. they sponsor popular lectures, scientific expeditions and publication of reports, monographs and books.

Societies for teachers of geography, such as the National Council for Geographic Education (U.S.) and the Geographical association (England), are dedicated to the improvement of the techniques and scope of geographical education. College and university professors divide their support between the educational societies and the strictly professional associations whose members are formally trained and employed as geographers. Examples of such associations, fundamentally concerned with basic research in geography and its application for the advancement of the profession, are the Association of American Geographers, the Institute of British Geographers, the Association de Géographes Français and the Zentralverband der Deutschen Geographen. Their journals are devoted almost exclusively to the results of original research, although some also publish news journals in addition to scholarly periodicals and monographs.

Somewhat more limited in scope but equally professional in character are geographical institutes, usually associated with university departments, or specialized divisions of large associations and scientific bodies such as the Geography and Map division of the Special Libraries association (U.S.), Section E of the American Academy for the Advancement of Science, Section E of the British Association for the Advancement of Science, the Division of Earth Sciences in the National Academy of Sciences–National Research Council (U.S.), and the Institut Geografii Academiia Nauk (U.S.S.R.). Government agencies which are primarily geographic, such as the Institut Géographique National (France), the Conselho Nacional de Geografia (Brazil) and the Geographic branch, department of mines and technical surveys (Canada), often support research projects in institutes and societies.

Some of the national, regional and even local geographical societies have members in foreign countries, but only three are organized on an international basis. International meetings of geographical societies date back to the Congrès International pour les Progrès des Sciences Géographiques at Antwerp, Belg , in 1871. Subsequent congresses were held at London (189j), Geneva (1908) and Rome (1913). In 1922 the International Geographical union was created at Brussels. Member countries are affiliated through their academies of science or their principal geographical organizations. The headquarters of the union changes with the election of new secretaries at general assemblies, usually held every four years. Research and organizational work of the union is carried out by more than a score of commissions. International geographical congresses, held under the auspices of the union, are attended by official delegations from member countries and by individual geographers who present and discuss research papers.

The Pan American Institute of Geography and History was created as an organ of the Organization of American States in 1928. The headquarters is in Mexico City, and 21 American republics are members. The institute is composed of three commissions on cartography, geography and history, which meet independently at consultations about every two years and jointly at general assemblies every four years. Between assemblies the business of the institute is carried on by a directing council consisting of one official delegate from the government of each member state.

The International Society of Geographical Pathology originated at Geneva in 1931. It is composed of national committees and of individual members concerned with the geographical distribution of diseases.

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GEOLOGICAL SURVEY (U.S.), a bureau of the U.S. department of the interior. was established by act of congress on March 3, 1879, following recommendations of the National Academy of Sciences, to classify the public lands and to examine the geologic structure, mineral resources and products of the national domain. Additional duties assigned since then require the bureau to supervise mineral lease development and to collect, publish and distribute data concerning the physical features and mineral and water resources of the United States, its territories and possessions. Responsibility for the performance of these functions is distributed among the topographic. geologic, conservation and water resources divisions.

Topographic Division.—This division is responsible for delineating the physical features of the United States as quadrangles of the National Topographic Map series. These multipurpose three-dimensional maps provide basic information for mineral and water resources studies, engineering projects, national defense and industrial and community planning. By the second half of the 20th century the geological survey had published about 20,000 different topographic quadrangle maps. However, many of these maps needed revision or remapping for publication at a larger scale. so that about 40% of the country was covered by maps that had been prepared at a scale and with a basic accuracy adequate for modern needs. The map information office was established by bureau of the budget directive in 1946 as the central source for map information in the U.S. government to answer inquiries and fill requests for maps, aerial photos and related data. During a single year, more than 3,000,000 maps were sold or distributed.

Geologic Division.—The geologic division maps and studies the surface and bedrock geology of the United States and appraises its mineral and mineral fuel resources, and conducts research in geology, geophysics, geochemistry and allied earth science disciplines with special emphasis on their application to discovery and development of natural resources. The work also includes geologic mapping and research to obtain basic data for engineering construction planning, for military geology, for soils surveys and for advancing the science of geology. The results of investigations have been published in bulletins, professional papers, circulars, and geologic and related map series, in reports printed by co-operative agencies and in trade and technical journals.

Conservation Division.—This division supervises the development of certain minerals under leases on federal and Indian lands according to the applicable federal laws and examines and classifies federal lands as to mineral and water-power values. In this way the proper development and use of resources on these lands is assured. Early in the second half of the 20th century the value of mineral production on such lands supervised by the geological survey had exceeded $840,000,000 annually, enriching the United States treasury, reclamation fund, Indian beneficiaries and the various states by more than $98,000,000 in annual royalties.

Water Resources Division. — The water resources division investigates and describes the quantity, distribution, chemical and physical quality, sediment content, availability and uses of water. Reports published by scientists and engineers of the division provide essential background knowledge for use by the public, by industry and agriculture and by government agencies responsible for water conservation. development and use.

Additional information on the work of the geological survey as reflected in the director's *Annual Report;* index maps of each state and of Hanaii and Puerto Rico showing areas covered by survey topographic mapping; and a list of publications of the U.S. geological survey with latest supplement are available to the public free upon request. *See* also GOVERNMENT DEPARTMENTS: *United States*. (H. B. N.)

GEOLOGY (ARTICLES ON). The basic simplicity of geology has been obscured by the giant proportions in which it works — particularly its time scale, in which the whole of recorded history figures as a mere tick of the clock. However, natural processes on so great a scale as, for example, the movement of a continental ice cap, the uplift of a submerged land mass or the formation of the sedimentary rock known as coal. can hardly fail to leave traces. Some of these were observed in antiquity, but, since they failed to fit in with any pattern of accepted theory, they were dismissed as inscrutable whims of nature. The survey article GEOLOGY summarizes the history of the reduction of these processes to terms of cause and effect, and gives an over-all view of modern earth science.

Individual articles are devoted to the major subdivisions of geology and of geological time. GEOCHRONOLOGY discusses the methods by which the age of the earth's crust as a whole and of various rock strata have been estimated. PALAEONTOLOGY explains how fossils are used as keys to the sequence of the sedimentary deposits that encased them in the processes of petrification; it reaches about 500,000,000 years into the past, to fossils of the earliest animals known to have been equipped uith bony structures or shells. PALAEOBOTANY traces plant fossils as far back as about 1,500,000,000 years — almost half the estimated age of the earth's crust.

These articles, and sections in the articles on geological epochs, describe forms of life that may seem grotesque but that were adapted to their environment before the occurrence of geological events that involved changes in climate and other factors. Each of these articles includes a survey of a phase of organic evolution. For example, CRETACEOUS SYSTEM tells of "the time of the great dying" of the dinosaurs; the article on the ensuing epoch. EOCENE AND PALEOCENE, reviews the evidence of the rapid advance of mammals from crude and miniature forms to their position of dominance in the animal world. Another example of the articles on geological time units is PLEISTOCENE EPOCH, dealing with the stretch of time in which a large part of the earth's surface was subject to alternate periods of glaciation and interglacially mild climate. It includes a summary of the geological history of man, as written in the strata of this comparatively recent epoch. This subject is developed more fully in MAN, EVOLUTION OF, which links the findings of geology with those of biology and anthropology.

The imprints left on the earth's crust by such geological agents as water, wind and glaciation, and the methods of recognizing these traces, are described in the article which deals with the source of 85% to 90% of the world's mineral wealth—SEDIMENTARY ROCKS. This is supplemented by WIND EROSION AND DEPOSITION. In PETROLOGY the emphasis is on igneous rocks; metamorphic rocks are dealt with in METAMORPHISM. Among other articles closely linked to this subject are MINERALOGY; ORE DEPOSITS: and SOIL. Individual articles are devoted to important rocks and minerals, such as CONGLOMERATE; SANDSTONE; SCHIST; IRON; COPPER; etc.. and the gems.

Sections of descriptive geology are included in each of the articles on continents, nations and other major geographical units. The basic principles of stratigraphical geology. by which the order of origin of rock strata can be determined in spite of forces that have upset and entangled them, are discussed in STRATIFICATION and STRATIGRAPHY. GEOPHYSICS is devoted to the science that studies the earth as a body of matter subject to the laws of dynamics. gravitation, etc.; the practical applications of some of these theories are treated in GEOPHYSICAL PROSPECTING. The methods by which the size, shape and internal structure of the earth are determined are discussed in GEODESY.

Continents, mountains and oceans. like bodies constructed on a smaller scale, rise and fall in response to variations in their weight and in the strength of counterbalancing forces, although adjustment to a change such as the melting of an ice cap is a process measured in many thousands of years. The workings of this principle are explained in ISOSTASY. Various manifestations of it are discussed in GEODESY; EARTH; and EARTHQUAKES.

VOLCANISM discusses the geophysical background of volcanic eruptions. TIDES deals with the effects of gravitational pull on the earth's crust and its atmosphere as well as on its waters. GEOCHEMISTRY explores the process of geochemical evolution that prepared the way for organic evolution.

In COSMOGONY, the Brobdingnagian proportions of geology shrink to those of Lilliput. Linking geophysics and geochemistry with astronomy, this science traces the common origin of the chemical elements of our earth and those of millions of planetary siblings in its galactic family.

GEOLOGY, the study or science of the earth, is a broad and diverse subject with many subdivisions and several closely allied fields. Geologists are concerned primarily with rocks that form the outer part of the solid earth; but an understanding of these materials, and of changes that have occurred and are now going on in their compositions and arrangements. involves principles and techniques of physics and chemistry. Geophysics and geochemistry, both important and fast growing scientific disciplines, are a logical outgrowth of this overlap in interest which extends beyond the visible rocky shell to deeper zones of the earth. Biology also plays an essential role in the study of rocks. great masses of which show profound effects of biologic processes and contain clear records of animals and plants that lived in past ages. Paleontology, the study of this fossil evidence, is an essential part of geology: and the aid of organic chemistry is required for study of the interactions among rock materials and organic substances.

Air and water are major agents in geologic processes; but the atmosphere is the special realm of another science, meteorology, and study of the earth's waters is shared by hydrology and oceanography, two fields closely associated with geology. Inquiries into the origin and formative stages of the earth have developed the special subject cosmogony. which is related to astronomy. Geodesy supplies basic information on the form of the earth, on precise geographic locations and on values of gravity. Physical geography. concerned with surface features of the globe and giving large attention to maps, likewise has close kinship with geology as another in the group of subjects to which the term geoscience has been applied.

Geology has developed several main branches which for a brief survey may be classified as follows: (1) physical geology, including mineralogy, the systematic study of minerals; petrology, the study of rocks, their physical and chemical properties and modes of origin; geomorphology, the study of land forms and processes of their development; sedimentation, the origin and deposition of modern sediments; structural geology, a study of the geometry of rock masses, with emphasis on crustal deformation; economic geology, the study of valuable mineral deposits; and (2) historical geology, including stratigraphy, the systematic study of bedded rocks and their relations in time; paleontology, the study of fossils and their location in the total sequence of bedded rocks; and mapping of bedrock units defined by physical characteristics and geologic age. This classification does not list specifically a number of important subjects that receive attention below. Moreover. like most brief classifications this one appears to draw sharp boundaries that are not real. For example, stratigraphy is part of the study of sediments, a subject that has both physical and historical aspects. Actually a rigid separation of all geology into physical and historical facets does not bear close analysis. Nearly all geologic study seeks to determine an order of events, and a main objective of the science is to work out the full history of the earth and its inhabitants.

For a guide to the various articles dealing with the science of geology *see* GEOLOGY (ARTICLES ON), above. *See* also articles on: the various branches of science referred to, as BIOLOGY; METEOROLOGY; etc.; geologic processes, as EROSION OF LAND; METAMORPHISM; etc.; rock bodies, as BATHOLITH; SILL; etc.; eras, systems, periods and epochs, as CENOZOIC ERA; CARBONIFEROUS SYSTEM AND PERIOD; PLEISTOCENE EPOCH; rocks and minerals, as GRANITE; CONGLOMERATE; CASSITERITE; CLAY AND CLAY MINERALS; etc.; and CRYSTALLOGRAPHY; MINERALOGY; PETROLOGY. The plates accompanying this article illustrate many of the processes and formations discussed.

For proper perspective an explanation of geology starts with a summary description of the entire earth and its major physical features. The development of human knowledge and concepts regarding the earth is summarized in a final section of this article.

Following are the main divisions of this article:

I. GENERAL VIEW OF THE EARTH

Geodetic studies have determined that the earth has the form of an oblate spheroid with polar radius about 21.6 km. (13.4 mi.) shorter than the equatorial radius. The circumference following the equator measures a little over 40,000 km. (about 24,900 mi.). Relief features of the surface. large from the human viewpoint, are relatively small; Mt. Everest, with its summit nearly 9,000 m. (29,028 ft.) above sea level. would appear to scale on a globe with a diameter of 40 cm. (16 in.) as a projection only 0.3 mm. (0.012 in.) high. The visible part of the earth consists of three spherical envelopes: atmosphere, hydrosphere and lithosphere. Though gases of the atmosphere extend outward in detectable quantity many hundreds of miles, fully three-fourths of the gaseous matter, by weight, is in a zone 15 km. (about 9 mi.) thick directly above the earth's surface. The great bulk of water making the hydrosphere is in the interconnecting ocean basins covering nearly 71% of the earth's surface; but water is widely distributed on the lands also. in streams and lakes and as ground water filling openings in soil and bedrock. The lithosphere is the solid outer part of the earth.

Information on sea floors is building up rapidly through use of echo sounding and other recently perfected methods of study. Greatest depths of the oceans exceed 10,800 m. (more than 35,000 ft.). If all surface irregularities could be leveled off. the sea would be universal with a depth of almost 2.5 km. (about 1.5 mi.). The continental surfaces vary widely in height and configuration; Asia, the highest and most rugged, has average height about 1,000 m. (3,200 ft.) above the sea. All continents have mountainous belts, some youthful and rugged. others old and subdued. The topography of ocean floors, like that of continents, varies from wide planar areas to high and steep mountain ranges, some of which project above the sea as island chains whereas others are wholly submerged. with shoal water over the highest portions. Recent oceanographic studies reveal that ocean floors generally are as uneven as continental surfaces. Conspicuous among major mountain belts rising from deep waters are those forming the islands of Indonesia in the Pacific. and the Antilles in the Atlantic. Many islands have been built up on ocean floors by volcanic eruptions; examples are the Hawaiian Islands in a deep part of the Pacific and Ascension and St. Helena in mid-Atlantic. Some other islands, such as Great Britain and Ireland, are merely parts of continental areas cut off by shallow channels from their mainlands Many more such islands would be formed if sea level should rise about 100 ft., as would result if there were an increase in temperature sufficient to melt the ice caps that cover much of Antarctica and Greenland.

II. PHYSICAL GEOLOGY

A. MINERALOGY AND PETROLOGY

As these subjects are treated at length in separate articles, only a summary of their employment in general geology is appropriate here. Minerals are the basic units in the composition of most rocks. and therefore they are in a real sense the geologist's alphabet. Many hundreds of distinct mineral species are recognized, but comparatively few are important in the kinds of rocks that are abundant in the outer part of the earth. Thus a few related minerals known as the feldspars, together with quartz, are the essential ingredients in granite and its near relatives; and limestones, widely distributed on all continents, consist largely of the one mineral calcite. Many rocks have a more complex mineralogy, and in some the mineral particles are so minute they can be identified only through highly specialized techniques. For example. several clay minerals important in rocks known as shales or claystones cannot be resolved by the most powerful optical microscopes.

Under exceptional conditions mineral substances grow into nearly perfect crystals that have distinctive external forms. Silicon dioxide forms clear crystals of quartz that are hexagonal prisms with terminations shaped as pyramids; iron sulfide forms perfect cubes of pyrite, the faces marked with parallel lines. But when a substance crystallizes in bulk, crowding of grains growing from neighbouring centres prevents formation of recognizable crystals, though each mineral is formed with its peculiar internal atomic structure. Modern laboratories have varied and highly effective devices for working out the mineral content of rock materials. Standard equipment is the petrographic microscope, constructed for viewing thin sections of rock that are ground uniformly to about .001 in. thick. No matter how fine the grain, so long as the rock is crystalline its essential minerals can be determined by their peculiar optical properties as revealed in transmitted light under high magnification. Opaque minerals, such as those with a high content of metallic elements, require a different technique that uses reflected light from polished surfaces; this kind of microscopic analysis has particular application to metallic ore minerals. Another device exposes mineral grains to X-rays which, on emerging, outline on a photographic film a pattern that represents the atomic structure peculiar to a given mineral species. Substances such as the clays are made up of particles so minute they are submicroscopic in relation to ordinary petrographic microscopes: but these particles become clearly visible under the electron microscope, which gives images with diameters enlarged by a factor of tens of thousands. The several clay minerals are identified also by a technique known as thermoanalysis which takes advantage of pronounced differences in thermal properties. The instrument used in the analysis automatically draws a graph that is recognized as peculiar to a given mineral composition.

Analytical chemistry plays a major role in the study of minerals and rocks. An exact quantitative analysis is a valuable supplement to other techniques, and for many specimens the chemical examination plays a major role. Rocks with glassy texture have no atomic organization and therefore give no response to microscopic study. Natural glasses are common in rocks of volcanic origin. In many such specimens small mineral grains scattered through a glassy groundmass can be recognized under a microscope, giving information to supplement the chemical study; but the quantitative analysis is of first importance. Thousands of such analyses made by reliable laboratories are on record for comparative study. Comparing the composition of a glassy specimen with compositions of crystalline rocks whose minerals are known will give much essential information.

Spectroscopic study of rock specimens is an important recent development, and a complex instrument known as the mass spectrometer is used in an increasing number of petrographic laboratories This device detects the presence of elements in extremely small quantities; it also isolates and measures quantitatively the several isotopes of elements such as lead and carbon. The mass spectrograph is indispensable in analyses used for determining ages of minerals on the basis of progressive atomic changes in such elements as uranium and thorium. See also MASS SPECTROSCOPY.

1. The Earth's Crust.—The term crust, which geologists commonly apply to the outer part of the solid earth, is inherited from a speculative concept, once widely held, that our globe was once a molten mass nhich slowly cooled and solidified from the surface downward, and that the major part of the volume is still molten, below a comparatively thin shell of solid rock. This latter view is now untenable. whether or not the earth passed through a molten stage; hut, as explained later. we are convinced that an outer part of the earth, no more than a few tens of kilometres thick, differs in physical properties from deeper zones (see GEOCHEMISTRY; EARTHQUAKES), though the change is not marked by passage from solid to fluid materials. It is convenient, therefore, to keep the term crust for the distinctive outer zone.

The rocks of the earth's crust are exposed to view only on continents and islands. which comprise about 30% of the earth's surface. The known rocks are divisible into three main groups: igneous rocks, which have solidified from molten matter called magma: sedimentary rocks. those made up of fragments derived from pre-existing rocks. of materials precipitated from solution or of organic products: and metamorphic rocks. which have been derived from either igneous or sedimentary rocks under conditions that caused changes in composition. texture and internal structure.

2. Igneous Rocks.—The igneous rocks are formed as either extrusive or intrusive masses. Extrusive rocks are products of volcanic action; they appear at the surface as molten lavas which spread in sheets and harden, or they are made up of fragments, large and small, blown from vents by violent gaseous explosions. Intrusive rocks have formed by slow cooling of molten masses below the earth's surface; many such bodies are now exposed to view because long continued erosion has removed the older rock cover. Some of these bodies doubtless were reservoirs that supplied volcanoes in the past.

The grain size or texture of igneous rocks is closely related to the mode of origin. Lavas generally are fine grained, even glassy, because rapid loss of heat, with resulting solidification, allowed little or no opportunity for mineral grains to grow. But the same kind of magma, under a cover of solid rock thousands of feet thick, has lost heat very slowly; accordingly the grains have had, from the human point of view. long ages for growth, and the resultant rock is coarse grained. Examples are ordinary granites, in which all grains of the essential minerals can be distinguished with the unaided eye. A rock with similar chemical composition that formed in a lava flow may have a uniform appearance. with no distinguishable grains; but magnification up to 50 or 100 times under a petrographic microscope may reveal a texture and mineral composition strikingly like that of the granite. Such a rock. known as rhyolite, is said to have aphanitic (*i.e.,* invisible) texture.

In a general way the textures of igneous rocks vary according to the depth at which the bodies were formed. Deep-seated (abyssal or plutonic) bodies are coarse grained; intrusive bodies that cooled at shallower depths (hypabyssal masses) generally have medium to fine grains; and extrusive rocks are fine grained to glassy. There are, however, some complexities in this general rule. Many sheets of rhyolitic lava have large and well-formed crystals of feldspar and quartz isolated in an aphanitic groundmass; the rock is called rhyolite porphyry, and the crystals are phenocrysts. Presumably these formed in a quiescent magma body underground, part of which was erupted in a volcanic outbreak, whereupon the magma enclosing the crystals cooled quickly to form rock with fine grain. Porphyritic texture is common also in bodies of intrusive rock, of both the shallow- and deep-zone types; in such rocks the groundmass has visible grains which are much smaller than the enclosed phenocrysts. The contrasting grain size in all porphyries suggests an abrupt change in physical-chemical conditions while the parent bodies were forming.

Exposed intrusive bodies are most numerous in great mountain zones for two reasons: (1) the mountain belts have been zones of major deformation, and abundant evidence indicates that igneous action is favoured by crustal disturbance; and (2) great uplifts in mountain belts have set the stage for erosion to the depths at which plutonic masses have formed. Logically the best displays of large intrusive bodies are found not in youthful chains such as the Alps, but in much older mountain units—for example, the Riesengebirge of Germany—where the deep cores have been exposed by erosion through long ages.

Bodies of intrusive rock are classified according to their locations. sizes and shapes. The general term pluton is used for any large intrusive body. An abyssal mass of major size is appropriately called a batholith (literally "deep stone"). Commonly, such a body is exposed over an area measuring hundreds or even thousands of square miles; the Coast range batholith of British Columbia is more than 1,000 mi. long. These large bodies are not simple units with uniform structure and texture; they are complex assemblages of crosscutting and intertnined masses that indicate a long and varied history of development, with recurrent episodes. The major batholiths commonly are elongate parallel to the associated mountain belts. Intrusive bodies formed at shallow or intermediate depths have varied sizes and forms; most common are dikes, which are tabular, elongate bodies that cut across the enclosing rocks. and sills, generally similar in form to dikes but emplaced parallel to pre-existing layers of sedimentary or volcanic rocks. Sizes of both dikes and sills have a wide range. Some measure only a few feet in greatest dimension of exposure; but in northern England the Cleveland dike, essentially vertical, is traced more than 100 mi. and the Whin sill, nearly horizontal, extends fully 80 mi., with an average thickness about 90 ft.

Knowledge of intrusive igneous bodies has been built up slowly by comparative studies, some in regions where erosion has brought to light only the masses that developed at shallow depths, others in profoundly eroded belts where "only the bones of the extinct mountains" can be seen. Eeneath growing mountain chains around the Pacific ocean igneous intrusive action is doubtless now in progress, though beyond the range of direct observation. Study of extrusive activity and the resulting rocks is more favourable. Active volcanic centres are widely distributed. and some of these are under continuous observation. The behaviour of Vesuvius and other Mediterranean volcanoes has been watched through many centuries; and well-equipped scientific stations have been in operation for some decades at a number of active centres. Study of active volcanoes is supplemented by observations made on great volumes of older volcanic products which, because they accumulated on the earth's surface, are much more accessible than the intrusive bodies which have come into view only through chance exposure by erosion.

Volcanic materials are erupted through openings of two general types — central vents and long fissures. Around a central vent, which is essentially a great vertical pipe, products of eruption are built up to form a cone which may grow into a high mountain with a crater at its top; well-known examples are Vesuvius in Italy, Mayon in the Philippine Islands and Fujiyama in Japan. Two kinds of products issue from a vent: fragments known as ash and cinders, which are blasted violently upward by gaseous explosions; and lava or liquid rock, which commonly breaks through the side of the cone and spreads beyond its base. In a fissure eruption, lava wells upward and pours outward along an opening miles or even tens of miles in length. An eruption of this kind was observed in Iceland in 1783, Ancient outpourings of molten rock, in part along great fissures, built up widespread lava fields to form plateaus thousands of square miles in area; outstanding examples are in the Deccan region of India, the Columbia plateau of northwestern United States and the Paraná basin of South America. Commonly the outflow along a fissure has become obstructed except at a few favoured points where central eruptions have built up cones along a nearly straight line. The Hawaiian Islands, each constructed by long continued volcanic eruptions, are arranged along a line that probably represents a great zone of weakness in the floor of the, Pacific ocean.

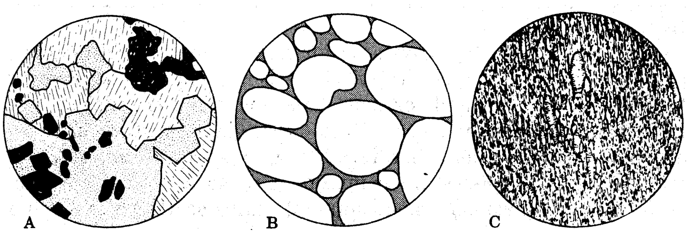
Old volcanic rocks, exposed haphazardly and without relation to vents from which they issued, are distinguished from intrusive rocks by several criteria. Quantities of gas escape freely from molten lava, and in late stages of cooling the gas, expanding under compression in the stiffening fluid, forms rounded openings or vesicles in the upper part of a flow. These vesicles, many of which in old flows have been filled with minerals deposited from solution, serve to distinguish the flow from a sill which may be similar in general form. Moreover, most assemblages of volcanic rocks contain an abundance of distinctive fragmental products of explosive action and associated glassy materials.

In volcanic rocks the chemical composition, matching that of known intrusive bodies, ranges between wide limits. Silica, the most distinctive ingredient, varies from about 40% to more than 75%. The high-silica rocks are generally light coloured and their excess of silica is expressed in abundant grains of quartz. Low-silica rocks range in colour from gray to brown and nearly black; they are rich in minerals containing iron and magnesium. Intermediate types are numerous, representing a complete gradation between the low-silica and high-silica rocks. Granite and its near relatives in chemical and mineral composition are commonly grouped as granitic rocks; they are predominant in the continents. Basalt, accepted as typical of the low-silica rocks, appears to be predominant in ocean floors. Basaltic flows that have built up wide plateaus in several continents have remarkably uniform composition. According to a favoured concept these lavas have risen from a zone of dark, heavy rock that extends continuously from the ocean floors beneath the granitic rocks in all the continents.

Igneous rocks yield minerals that are important economically, others that have large scientific value. The most reliable determinations of age are obtained by analysis of certain minerals, notably those containing uranium, that have been sealed in igneous bodies since their formation. From these analyses the oldest igneous masses are known to be more than 2,000,000,000 years old. Such quantitative determinations are in accord with much qualitative evidence in the geologic record, all testifying to the vast length of geologic time.

3. Sedimentary Rocks. — Rock materials exposed to air and moisture are subject to continual change, both physical and chemical. Bedrock is broken into pieces, large and small, which are moved by running water and other agents to lower ground and spread in sheets over lake bottoms, flood plains and sea floors. Dissolved matter is carried to seas and other water bodies and some of it is precipitated either chemically or by the action of organisms. The deposited material becomes compacted and in time much of it is cemented into firm rock. Generally the process of deposition is not continuous but sporadic, and sheets of material representing separate episodes come to form distinct layers of rock. As a result the sedimentary rocks are stratified; the individual layers are beds or strata.

Large parts of every continental mass are covered with sedimentary rocks that represent deposits formed during many periods of the earth's history. In part these bedded rocks are nearly



FROM LONGWELL AND FLINT, "INTRODUCTION TO PHYSICAL GEOLOGY"

FIG. 1. — TEXTURES OF ROCKS MAGNIFIED ABOUT 8 TIMES. (A) DIORITE (CRYSTALLINE IGNEOUS ROCK); (B) SANDSTONE; (C) PHYLLITE (METAMORPHOSED SHALE)

horizontal, as they were originally; but in large areas, particularly in mountain belts, they show various degrees of deformation. The principal kinds of sedimentary rocks are conglomerate, sandstone, siltstone, shale, limestone and dolomite.

Conglomerate, made up of fragments derived from older rocks, more or less rounded by wear and ranging in size from boulders (diameters 25 cm or more) down to pebbles (minimal diameters 2 mm.); interstices generally are filled with sediments of finer grain, more or less firmly cemented.

Sandstone, consisting of sand grains (diameters 2 to $\frac{1}{16}$ mm.), predominantly quartz. Interstices generally hold still finer particles and cementing material.

Siltstone, consisting chiefly of silt particles (diameters $\frac{1}{16}$ to $\frac{1}{256}$ mm) more or less well cemented.

Shale, consisting chiefly of clay arranged in thin layers or laminae. If lamination is lacking, the term claystone is appropriate.

Limestone, made up of mineral grains consisting chiefly of the mineral calcite. Commonly has numerous fragments of shells, microscopic or larger, from marine animals.

Dolomite, similar to limestone, but has a high content of magnesium.

Although the kinds of rock listed above are most important quantitatively, many others are recognized, some of large practical value. Among these are beds of common salt, gypsum, phosphate and iron oxide. Coal, in extensive beds, has developed from plant materials accumulated in swampy areas and later buried under large thicknesses of ordinary sediments.

4. Metamorphic Rocks. — Metamorphism means literally transformation, and logically the term might be applied to any profound change. In geology the meaning is restricted; it does not include the decay of rock materials exposed to the weather, nor the fusion of rocks by igneous processes. Metamorphic rocks have been developed from earlier igneous and sedimentary rocks by heat and pressure, at some depth and most effectively in the great mountain zones. Resultant changes are in texture, in mineral composition and in structural features of the rock. Survival of some characteristics of the original rock indicates that fusion has not played an essential part in the change.

Two general kinds of metamorphic effects are recognized: (1) dynamic metamorphism resulting from strong compression, perhaps aided by some increase in temperature from friction; and (2) thermal metamorphism caused by high temperature in rocks adjacent to intrusive igneous bodies. Effects are accentuated through introduction of elements by fluids that move from a molten mass into the surrounding rock. Susceptibility of different rocks to either type of metamorphism varies greatly. Thus in part of the Appalachian mountain belt in Pennsylvania, coal in strongly crumpled beds was changed to anthracite, a type of coal from which nearly all volatile matter has been expelled; but the shale beds adjacent to this coal are unchanged except for the crumpling. By contrast, in a more strongly deformed belt in

Rhode Island coal has been changed into graphite, and in the enclosing shale beds shearing has developed thin cleavage plates lined with flakes of mica. Near an intrusive igneous mass in South Africa shale was altered to hornfels. a hard metamorphic rock studded with crystals of minerals that grew during the period of high temperature. Beds of sandstone alongside the altered shale are unchanged except for firmer cementation of the quartz grains.

Extreme metamorphism in some mountain zones has resulted from combined dynamic and thermal effects. Fluids rising from deep-seated plutons have combined with rock material in deformed sedimentary rocks, and the resultant product is indistinguishable from granite that has crystallized from magma. To some extent: therefore, granitic rocks may be a product of metamorphic as well as igneous processes.

Many of the metamorphic rocks consist of flaky minerals. such as mica and chlorite, set in parallel arrangement. These minerals cause the rock to split into thin sheets, and the rocks are said to be foliated (fig. 1[C]).

The commonest kinds of foliated metamorphic rock are slate, phyllite, schist and gneiss. Marble and quartzite are nonfoliated metamorphic rocks.

Slate, a rock with remarkably plane cleavage cutting across folded beds of the original rock and dividing it into thin plates. Surfaces of the plates are lustrous, but no minerals are distinguishable without high magnification.

Phyllite, an exceptionally lustrous rock representing a higher stage of metamorphism than slate. The cleavage plates commonly are wrinkled or sharply bent.

Schist, a well-foliated rock in which the flaky minerals, usually mica or chlorite, are plainly visible. Quartz is abundant, and many schists are studded with garnets.

Gneiss, a coarse-grained rock with imperfect foliation. Granite gneiss is a strongly banded rock with the mineral composition of granite.

Marble, recrystallized limestone, wholly granular. Dolomite marble is recrystallized dolomite. Either rock may be studded with minerals formed irom impurities.

Quartzite, iormed from quartz sandstone by complete filling of all spaces between grains with quartz.

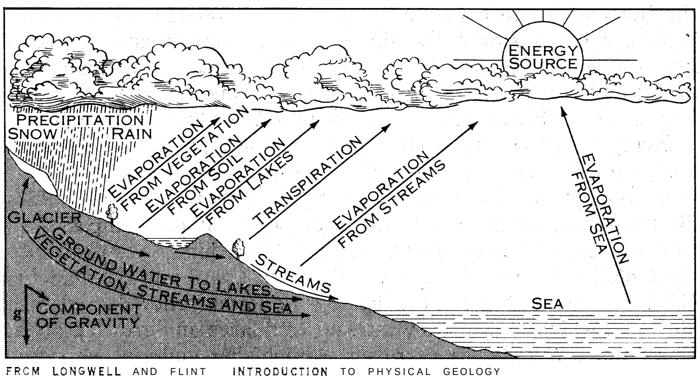
B. Geomorphology

Land forms are features of slow but continuous development. Wide distribution on the lands of sedimentary rocks that had their origin in former seas suggests clearly that the present mountains, plateaus and other landscape features owe their beginning to widespread uplift. Evidence that these features are being steadily modified is compelling. though parts of this evidence become clear only with special study. Engineers charged with the problem of controlling the flow and checking channels for navigation in large streams supply convincing quantitative data. Even casual observers of the Colorado river in the Grand canyon of Arizona are impressed with the amount of visible sediment in the stream, especially at flood stage. Measurements show that the river carries past a given point an average of 11,000 tons per hour, or nearly 100,000,000 tons per year. This annual load, most of it brought from the Rocky mountains and the high plateau country, has over a long period built an immense delta at the head of the Gulf of California. Many other great rivers, such as the Mississippi, the Amazon. the Niger, the Nile. the Ganges and the Hwang-ho. are carrying vast quantities of rock matter from continents to seas, as indicated by their large and growing deltas. Countless smaller streams that flow directly into the sea swell the total mass of transported sediment, much of which does not go into construction of deltas but is spread widely on sea floors by action of waves and currents. Moreover the water flowing into the seas carries a great total load that is invisible, dissolved from rocks on the lands.

The ultimate forces responsible for wearing down land masses are solar energy and gravity. Heat from the sun evaporates sea water; and. using the atmosphere as its agent. the solar heat causes circulation of water vapour, part of which is precipitated as rain and snow on the lands. The water returns toward the sea. much of it by circuitous routes (fig. 2). This continuous movement of water between sea and land is the hydrologic cycle. which performs a vast amount of work. Water and air react with rock materials, changing them chemically and breaking them into small pieces; this complex action is weathering. Running water moves the loose rock debris and in the process causes further breakup of bedrock. At high altitudes and in polar regions snow is compacted into masses of ice, which move slowly downslope as glaciers and add their energy to that of running water in wearing down the land. Water makes its way underground and slowly moves seaward, dissolving rock material as it goes. Winds and waves join the attack on the lands. All these activities are included in the composite process of erosion, which sculptures the continents in great detail and tends to reduce them toward sea level. Thus gravity, aided by solar energy, strives to establish equilibrium by leveling out all irregularities on the earth's surface. At the present rate of erosion. which is reasonably well known, the continents would be worn to sea level within a small fraction of the time that has elapsed since life on the lands began. This suggests strongly that the work of erosion is opposed by another process; and there is abundant evidence that the lands have been elevated repeatedly, on a large scale. Therefore the landscapes of today represent a stage in the conflict between two sets of forces: one set strives to reduce continents to featureless plains; the other set. within the earth. rejuvenates the lands by forming mountain chains and broad upwarps. The processes of uplift are given special attention in a later section. Weathering and erosion merit further discussion here.

1. Weathering.— Blocks of stone in walls of very old buildings are discoloured, many have irregular surfaces from spalling and some are visibly crumbling. Bedrock in the hills has been exposed to weather vastly longer and shows much greater change unless it is situated where running water or some other agent carries away the products of decay as they are formed. Such a situation is a nearly vertical cliff with a stream near its base; but as a rule even there blocks of rock, fallen from the cliff and in various stages of decay, form great heaps of slide-rock. Nearly level fields back from the cliff normally have a cover of soil which, as shown by careful study, was produced by decay of the underlying bedrock. Commonly the blanket of soil is several feet or even tens of feet thick; and an artificial shaft penetrating it reveals a gradation from soil downward through decayed rock into unaltered bedrock.

Changes in rock through weathering are partly mechanical, partly chemical. In regions that have cold seasons an effective mechanical agent is frost wedging. Water penetrates crevices in rock, and expansion in freezing, repeated time after time. displaces grains and even large blocks. Growing roots of plants produce similar effects, but rooted plants can grow only where chem-



FROM LONGWELL AND FLINT INTRODUCTION TO PHYSICAL GEOLOGY

FIG 2 — THE HYDROLOGIC CYCLE POWERED BY SOLAR HEAT AND GRAVITY

ical action has made food available to them. The most effective chemical reagent is water that carries in solution carbon dioxide, a gas universally present in the air in minute quantities. Rain carries some of the gas to the ground. and hence much of the water that comes in contact with rocks is a weak solution of carbonic acid, which reacts slowly with some of the minerals. Feldspars. the chief minerals in granitic rock. eventually yield clay which is the basic material in ordinary soils. Clay is a complex mixture of silicate minerals, in themselves a large field for study. Potassium carbonate, another product of weathered feldspar, is a nourishing food for plants. Once a soil with a plant cover is started the chemical breakdown of underlying bedrock is accelerated because decaying plant tissues supply carbonic acid to percolating water. Soils are best developed under warm, humid climates, which favour plant growth and the accompanying chemical decay of bedrock. In arctic and desert lands chemical weathering is weak, plants are few, soils are generally poor and nearly unaltered bedrock is exposed over large areas. (See SOIL EROSION AND CONSERVATION.)

Large daily variations in temperature, especially pronounced in deserts, were once credited with effective breaking of exposed bedrock. According to this concept expansion from heating during the day, followed by contraction from rapid cooling at night, would explain the separation of thin slabs from large blocks of rock at the surface. This view has been discredited by careful experiments with use of an electric heating and cooling device equipped with automatic control. Thousands of alternations between temperatures considerably higher and lower than those measured in deserts have failed to produce in samples of rock any fractures detectable even under high magnification. Study of thin shells that separate from rock exposed to the weather reveals as a common cause of the separation the slow development of clay minerals, which involves an increase in volume. The outer surface of exposed rock dries rapidly after wetting; but moisture that penetrates into minor crevices stays until some decay is started, and the resultant swelling causes flakes to spall off. Separation of successive thin shells from massive rock such as granite is called exfoliation. This is a common form of weathering in regions that have moderate rainfall.

2. Erosion by Running Water. — Rain water falling on a sloping field that has been freshly plowed may wash away quantities of soil. No area of ground is perfectly even, and the water, controlled by gravity, becomes concentrated along local sags in the surface of the field, where stream channels are developed. If the rainfall is of short duration only a few nearly parallel channels may develop, separated by wide, ungullied areas; but if hard rainfall is prolonged, or if the field is left undisturbed through successive rains, channels tributary to those first formed start and grow longer headward; these tributaries in turn become branched, and the process continues until the entire surface is covered with a network of steep-walled gullies. As water continues to flow the gullies are in general continuously deepened. But cutting down of a main channel may be checked where it crosses from the plowed area into a meadow protected by sod; this channel cannot then carry away all the sediment delivered into it by tributary gullies, and the excess material is deposited at the bottom of the main stream to form a widening alluvial flat. With continued growth the alluvial deposit may extend backward into the lower reaches of tributaries, thus decreasing their gradients and limiting their power to cut down and to carry sediment. Gullies in the higher parts of the slope retain their vigour longest.

Every land area with abundant or moderate precipitation has an integrated drainage system. In the Alps, a mountain mass that was uplifted late in geologic history, a network of deep valleys directs the drainage toward the four points of the compass into four principal streams: northward into the Rhine; westward into the Rhône; southward into the Po; and eastward into the Danube. Each of these major streams has a wide lower valley floored with alluvium which extends downstream to a large and growing delta. Upstream the valley is narrower, with higher and steeper sides; and in the mountains each large tributary is a deep gorge, many with nearly vertical sides. The gradient of the stream bed near the delta is only a few inches per mile; upstream it steepens progressively, and many of the mountain tributaries are raging torrents with stretches of rapids and some vertical falls. Such a stream is actively deepening its valley, though it is floored with bedrock. The swift water is armed with sediment ranging in size from sand grains to coarse rubble; scrubbing of this material over the stream bed breaks and wears the particles themselves, but the constant abrasion also wears the bedrock floor. Moreover much of the bedrock is divided into blocks by intersecting joints, and many such blocks are loosened and dislodged by the force of the swift stream to become part of the abrading load.

Study of numerous stream valleys in various stages of growth reveals a general progression in development of form, both longitudinally and in cross section. Nearly all large rivers flow into the sea, and sea level limits the depth to which they can cut. In any segment of a valley that is far above sea level the energy of the stream is used mainly in cutting down to establish a graded profile, an ideal slope on which the stream can transport its load of sediment without either cutting or depositing. The large rivers that receive drainage from the western Alps are essentially at grade in their lower courses; but in the high mountain country the profiles are excessively steep, downcutting is active and valleys are deep and narrow. When the profile in a considerable segment of a valley approaches the graded form the stream, deflected from one side to the other, erodes laterally to make the valley floor much wider than the stream channel. This tendency to cut laterally is of course present at earlier stages in valley development; but so long as active downcutting continues the stream is not at a given level long enough for lateral erosion to be effective. After a wide, flat floor is developed the stream at high flood stage spreads beyond its normal channel and deposits sediment to form a flood plain, which grows in width as the widening of the valley continues. On a well-developed flood plain the sluggish stream, diverted laterally by small obstacles, characteristically develops a sequence of wide, looping bends, or meanders, many of which impinge against the valley sides.

Deepening of a valley does not end abruptly with the formation of a flood plain. Slow downcutting continues; and with lateral shifting of the stream, remnants of earlier valley floors may be preserved as terraces. Commonly these terraces are at different heights on opposite sides of a valley, each being the only remaining part of a former floor. On the other hand some paired terraces, well above the present stream, suggest recent rejuvenation of the stream by uplift of the land or by lowering of sea level. Such terraces in the Mississippi valley probably indicate downcutting by the stream caused by subtraction of water from the seas in formation of the present icecaps of the polar regions; the river has regraded its valley to the lower sea level.

Lateral cutting by mature streams has been an important factor in the planing down of wide land masses. But the general lowering of a land surface is begun as soon as the surface is occupied by a network of functional stream channels. Streams in the Alps, aided by glaciers, have removed the vast quantity of rock material that once occupied the vacant spaces of the present valleys. Moreover, the divides between adjacent valleys are being reduced slowly as material is eroded from the opposed slopes.

Some wide and high continental areas are not fully covered with stream channels because of deficient rainfall. Permanent streams that cross the Colorado plateau in western United States receive most of their water supply in the Rocky mountains to the east and north; and valleys cut into the plateau by these streams are deep, steep-walled canyons that have few large tributaries. Erosion is proceeding far more rapidly in the Alps than in the Colorado plateau. Many arid regions have no drainage to the sea; examples are the Dead sea basin, areas in central and western Australia and the Great basin of western United States. The Dead sea depression is far below sea level and is being filled slowly with sediments brought in chiefly by the Jordan river, which has its source in mountains to the north. The Great basin, like other regions with interior drainage, receives many streams, some from mountain blocks within its area, others from bordering highlands. Sediments eroded from the high areas are filling the many separate depressions. The tendency is for some depressions, as they are filled, to spill over into lower areas; ultimately the entire region will be reduced nearly to a featureless plain well above sea level unless crustal movements or a change in climate may interrupt the present trend.

3. Erosion by Mass Movements. — Transport of rock debris on land surfaces is not confined to channels of active streams. On every slope a component of gravity exerts a pull which results in large-scale migration of soil, broken rock and even large masses of bedrock. Abrupt landslides are the most familiar and spectacular example of such movement. Every year large numbers of slides occur in mountainous country—the Alps, the Himalayas, the Rocky mountains and other belts of steep topography; the sliding masses range in volume from a few square yards to a cubic mile or more. Some large slides, starting without any warning and moving at high speed, have overwhelmed towns and caused other catastrophes. Commonly a sliding mass blocks a large stream to form a lake, thus complicating the routine of erosive action. In a region subject to strong earthquakes, a sharp shock often has started a number of landslides involving masses that probably were nearing the point of release.

Chronic landslides, which move slowly and intermittently on steep slopes, are more common than the catastrophic kind. Masses of soil and broken rock move partly by slow flowage, partly by slipping over a firmer basement. In cold seasons such masses may be frozen and practically stationary; thawing in spring causes saturation with water and renewed flowage or sliding on a lubricated base. Differential movement creates a hummocky surface; forest trees growing on the slope are tilted at various angles and locally they are uprooted. Chronic slides represent all gradations between regular landsliding and imperceptibly slow downslope movement known as creep, which operates on every slope covered with loose, weathered material. Even soil covered with close-knit sod creeps downslope, as indicated by slow but persistent tilting of poles, gravestones and other objects set into the ground on hillsides.

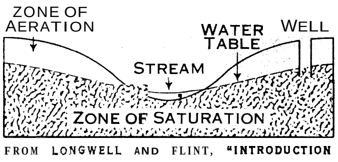
The several forms of mass movement on land surfaces are comprised under the general term mass wasting. All such movements tend to bring loose rock material within reach of streams. which continue the transport to lower ground or to the sea. In high country the cutting of deep valleys by streams creates steep slopes on which mass movements are especially effective. Thus stream erosion and mass wasting co-operate in the wearing down of land masses.

4. Erosion **by** Ground Water.—Of the average annual precipitation on all land areas about 25% runs off directly down slopes into stream channels; a considerable part evaporates; the remainder, half or more of the total, sinks into the ground where it brings about many physical and chemical changes. The weathering processes produce soluble substances which are carried by percolating ground water, some to be deposited in open spaces in bedrock, more to be delivered to streams and carried eventually to the sea. A considerable fraction of the total load carried by rivers is invisible, in dissolved form. One common ingredient, usually in small amount, is sodium chloride, familiar as common salt; another is calcium carbonate, an important part of which is derived from limestone bedrock, another part from decomposed feldspar minerals. Ordinary limestone and dolomite underlie great areas of every continent. Under humid climates with warm seasons the ground water, charged with carbon dioxide supplied mainly by vegetation, dissolves vast quantities of these carbonate rocks. In Yugoslavia, Kentucky and many other large areas the subsurface solution has had profound effects on topography. Roofs of caverns have collapsed to form large numbers of steep-walled sinks; streams, large and small, have been drawn into a network of caverns, leaving dry valleys formed at an earlier stage. Remnants of collapsed cavern roofs known as natural bridges are a common feature. A landscape dominated by the effects of ground-water solution is said to have karst topography, from a region in Yugoslavia where such effects are prominent.

Whether or not the bedrock of a region is highly soluble, ground water plays a major part in weathering and erosion. It provides the perennial supply for stream flow; immediate surface runoff causes flash floods, whereas the trickling of water from soil and from openings in bedrock continues at a nearly uniform rate. After a period of rainfall the water settles along openings to the water table, a more or less definite surface, higher under hills than under lowlands, at the top of the zone of permanent saturation; wells sunk below this depth are assured a steady flow (fig. 3). Above the water table is a zone of varied thickness known as the zone of aeration because air enters openings after water from the surface settles to the zone of permanent saturation. Weathering is active in the zone of aeration, where air is in contact with rock materials that usually are wet with water bearing carbonic acid from plants. Freezing and thawing of shallow ground water, together with its lubricating effect in soil, plays an essential part in movement by creep.

Thus ground water has a major role in weathering and in mass wasting and is the chief agent in delivering to streams vast quantities of dissolved mineral matter. Masses of dripstone formed in many caverns represent local and incidental deposition from the dissolved load in transit.

5. Erosion **by** Glacier Ice.—In some high mountains and in large parts of the arctic regions snowfall exceeds melting. Accumulating snow becomes compressed into ice; and on reaching a critical thickness masses of ice move under their own weight by solid flow; such a moving mass is a glacier. In the Alps, the Himalayas, the Coast range of British Columbia and many other mountain chains the high valleys are filled with glaciers, some of them tens of miles long. Movement of a glacier down its valley is too slow to be seen directly; but accurate instrumental measurements record speeds ranging from a few inches to several tens of feet per day. At temperate latitudes the lower end of a glacier is at fairly high altitude determined by the balance between rates of movement and of melting. Some glaciers in northwestern Canada flow directly into the sea. Greenland and Antarctica have enormous icecaps in which flowage is radially outward; great masses become separated from the margins and drift away as icebergs.

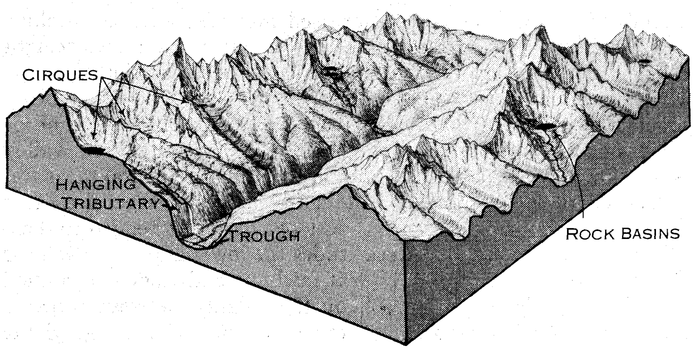


FROM LONGWELL AND FLINT, "INTRODUCTION TO PHYSICAL GEOLOGY

FIG 3 — DIAGRAM OF GROUND-WATER ZONES

Information about glaciers as erosive agents comes from study of active glaciers supplemented by observations in valleys from which glacier ice has almost or entirely vanished. At the lower end of a vigorous valley glacier a ridge, or complex group of ridges, extends across the valley. This end moraine is made up chiefly of coarse rubble containing many blocks of rock with one or more faces smoothed and scratched. Similar blocks are frozen in the ice exposed at the glacier front; evidently the morainal ridge was built up slowly by accumulation of rubble as the ice released it by melting along a front that has varied little in position through a long period. Water in streams of meltwater issuing from the glacier is gray-white and has been called glacier milk; it carries in suspension quantities of silt-size particles made of fresh rock ground up by abrasion as the lower surface of the glacier, armed with blocks of rock, grinds over the valley floor. Moraines on top of the glacier are formed of rubble gathered from the valley walls partly as a result of lateral grinding action by the moving ice.

The features of a valley recently cleared of glacier ice testify to vigorous erosive action. Areas of bedrock on the floor are polished and marked with grooves and scratches generally parallel to the axis of the valley. Rugged surfaces, both on the walls and on the floor, represent forcible removal of blocks bounded by joints. The cross section of the valley suggests a wide U in contrast to the V form of a mountain valley fashioned by a stream. Lateral erosion by the moving ice caused widening by removing not only the points of spurs that normally jut into a main valley between tributaries, but also considerable parts of the tributary valleys. Walls of the glaciated valley are remarkably steep and straight and are marked by numerous high falls from tributary streams that would normally join the main stream at grade but now are in hanging valleys (fig. 4). The head of the ice-freed valley has the form of a wide semicircular amphitheatre (cirque), caused by continual plucking action as ice forming in the snow field became part of the moving glacier. At a divide from which two or mofe glaciers moved in different directions, the growing cirques have partly intersected to form a sharp, jagged ridge. The Matterhorn is a pyramid-shaped mass that has survived destruction between cirques slowly growing together; and numerous similar peaks in the high Swiss Alps testify to the magnitude of erosion by glaciation of that mountain mass. Although the number of glaciers now in the Alps exceeds 1,200, formerly there were many more; and the existing glaciers were much longer than now, as indicated by the glaciated forms of valleys and the abundance of characteristic glacial deposits extending many miles below the present terminal moraines. Long and careful study in the Alps has determined that the valleys were fashioned by stream erosion; onset of a cooler world climate brought development of glaciers that reached to a low level in all Alpine valleys; and increased temperatures have reduced the glaciers to their present status. This general history applies to high mountain valleys in both the northern and southern hemispheres.



FROM LONGWELL AND FLINT, "INTRODUCTION TO PHYSICAL GEOLOGY"

FIG. 4.— FEATURES IN GLACIATED MOUNTAINS

The deep, steep-walled fiords in Norway, British Columbia, New Zealand and some other lands are valleys fashioned by glaciers and now occupied by the sea.

Study of modern glaciers has brought realization that at the time of maximum glaciation in the Alps great ice sheets covered wide areas of continents within the temperate zones. In Europe an icecap extended from the Arctic ocean to central Germany, and the British Isles were covered with ice, in North America all of Canada and the northern part of the United States were glaciated. Much of the soil was removed from the glaciated areas, and the bedrock was polished, grooved and locally eroded by plucking action. Wide belts marginal to the ice sheets were mantled with characteristic glacial deposits, including the unassorted and unstratified till deposited under the ice and in end moraines, and the stratified drift laid down by meltwater flowing from the icecaps during stages of their growth and decay.

6. Erosion by Waves.—The assault on shore areas by storm waves can be observed at margins of large lakes; and effects of sea waves on open coasts are much more pronounced. Historical records show that wave erosion has made appreciable inroads in some coastal areas; for example, along a 30-mi. stretch of the Yorkshire coast in eastern England waves have cut inland $2\frac{1}{2}$ to 3 mi. since the Roman occupation, sweeping away the sites of many villages. On the other hand some stretches of British and other coasts have been extended seaward through deposition by currents, waves and streams. Whether wave work is effective in reducing a land area depends on exposure of a shore to prevailing storm winds, kind of bedrock, depth of water near shore, location and direction of currents, relation to streams that carry large volumes of sediment and other variables. So long as sea level remains constant the extent to which wave erosion can advance inland is limited. Wave motion extends to a moderate depth known as wave base, and in the lower part of the layer of agitated water there is little energy. As storm waves plane inland. energy is absorbed by friction on the wave-cut platform. Hence with each advance the ability to erode decreases and the eroded surface slopes upward to an intersection with sea level. If sea level rises slowly. as it did while the great ice sheets of the past were melting, the extent to which waves can plane inland is increased. Northern lands that have been elevated since the ice vanished (see below) have conspicuous wave-cut surfaces on resistant bedrock, terminating inland against unmistakable sea cliffs and remnants of beaches.

Like streams, waves require tools for effective cutting. Blocks dislodged from cliffs by direct impact of the water are then used for abrasion, together with rock fragments brought from the land by streams and shifted along shore by currents. High cliffs commonly are undercut by wave action, and eventually the overhanging parts collapse, to be broken up completely. Some more resistant parts of the bedrock are bypassed temporarily and stand above water as isolated stacks.

7. Erosion in Arid **Regions.**—No sharp demarcation can be made between climates classed as arid and humid; but by a common definition, regions with less than 25 cm. (10 in.) average annual precipitation are arid. In these regions the surface of the ground is dry much of the time, there is little or no protective vegetation and strong winds are an effective eroding agent. Coarse particles swept along the ground have sandblast action, wearing and polishing facets on loose stones and on bedrock. Window glass exposed to such storms quickly becomes frosted, and unprotected wooden telephone poles are within a short time worn through near the base. Finer particles are carried away in great quantities and to large distances; during and following strong windstorms in the deserts of north Africa, appreciable amounts of dust settle on decks of ships in the Mediterranean and even in countries of southern Europe. In grazing and farming regions classed as semiarid, strong winds carry away vast quantities of soil, particularly during periods of exceptional drought. During the early 1930s a wide belt east of the Rocky mountains in the United States lost much valuable topsoil in windstorms known as black blizzards, which carried dust as far east as the Atlantic seaboard.

Although abrasion by wind-blown sand is important locally, the chief work of the wind is in transportation of rock materials broken up by other agents. In contrast to running water, wind carries quantities of sediment from lower to higher ground. (See also DESERT; DUNES; WIND EROSION AND DEPOSITION.)

8. **Net** Results of Erosive Processes.—Each of the eroding agents—surface water. ground water, glacier ice, wave action and wind—is fashioning distinctive landscape features. These land forms are ephemeral, slowly but constantly changing, and the tendency is toward gradual lowering of the lands. The ideal result if erosion on lands continued without interruption would be reduction of every continent to a low, featureless surface, or peneplain; and by wave action such surfaces might eventually be brought below sea level. Profound effects of erosion are widespread. Very old mountain chains have been brought to low or moderate altitudes; examples are the Caledonian chains of Scandinavia and Britain, the mountains of eastern Australia and the Appalachian belt of eastern North America. Still older chains have been entirely destroyed and only their roots remain as evidence ***(see*** below). In each continent wide surfaces that bevel indiscriminately across resistant and weak bedrock represent close approaches to peneplains; but these surfaces have been uplifted and are now being dissected by streams. The forces causing uplift have been persistent, and erosion keeps refashioning land forms that never are brought to completion.

C. PRINCIPLES OF SEDIMENTATION

An understanding of sedimentary rocks is all-important in geology, and sediments now being deposited provide the essential key. The sedimentary processes are a vast and complex subject for study; kinds of materials are numerous, they are worked on by several kinds of agents, the environments of deposition are diverse and many of them hidden from direct view. Many investigators are devoting their attention to problems of sedimentation not only by systematic field observations but also in special laboratories equipped with devices for mechanical and chemical analyses. Attack on difficult aspects of the study is made increasingly effective by co-operative pooling of information won by workers in a number of disciplines: for example, soil scientists; engineers concerned with problems of flood control, reclamation and water-power development; well drillers interested in kinds of material encountered by their tools; companies laying transoceanic cables; and biologists studying the various habitats of organisms that live in swamps. on lake bottoms or at different depths on the sea floor.

On the basis of environment of deposition sediments are broadly assigned to the three categories: terrestrial, those laid down on the lands; marine, those deposited on sea floors though they may have come from the lands; and mixed terrestrial-marine, those deposited in transitional environments such as deltas, marine estuaries and areas bet een high and low tide. In each major group the sediments are further described as clastic (consisting of rock fragments) and chemical (formed either as inorganic precipitates or at least in part through the agency of organisms). Further classifications recognize the particular environments of deposition on land or in the sea, and the several agents that emplace the sediments.

1. Terrestrial Sediments.—Running water is the chief agent for transporting and sorting clastic sediments on land, and vast deposits are accumulating in stream valleys. Bars of sand and gravel in stream channels are a familiar example; but such features are ephemeral, shifting with successive floods. Far more important are deposits on flood plains. Maximum loads are carried by a stream at flood stage; in large floods the sediment-laden water spreads beyond the channel, velocity of flow is much decreased and a layer of sediment, chiefly sand, silt and clay, is spread over the nearly level plain. In a major valley, such as that of the Amazon, the Mississippi or the Hwang-ho, flood waters cover a belt tens of miles wide; over much of the area the water, nearly stationary, is present for days or even weeks until the finest clay particles may settle out. Although flood-plain sediments are chiefly fine grained, gravel and coarse sand included locally may represent lateral migration of the channel in the growth and shifting of meanders. Tributaries that enter from hilly country commonly mix coarse deposits with finer sediments of the main valley.

In general the grain size of sediments along a large stream valley decreases steadily downstream. Abundant gravel in headwater areas has angular fragments, many of boulder size. These become smoothed and reduced in diameter by abrasion in transport; careful measurements show a constant increase in average roundness and decrease in average size of grain with distance of travel. The prospective goal of these stream-borne particles is the sea; but there are long delays for quantities of sediment spread over a flood plain. A stream in its slow lateral migration across its valley eventually cuts into these temporary deposits and carries them farther; but they are subject to the chance of redeposition on the wider plain farther downstream. Moreover below a critical point along the course of every major stream the flood plain is steadily building up. burying older deposits to increasing depth, because the stream must adjust its grade to increasing length as the delta grows seaward. The Mississippi river once entered the sea far north of its present mouth; it has deposited flood-plain sediments hundreds of feet thick to maintain a slope of a few inches per mile as the delta front migrates southward.

The profiles of many streams are interrupted by lakes in their paths. Thus the Rhône river floas into the Lake of Geneva, in Switzerland, deposits its suspended load and flows out a clear stream. Eventually the lake will be filled with sediment into which the river will then cut to establish a normal grade. Deposits in lakes generally are coarse grained near the margins, progressively finer grained inward, though preponderant contributions by a large stream make the pattern asymmetric. Known lakes represent various stages in filling by sedimentation; and some old lake deposits have been well exposed to view by erosion. Chemical deposition of calcium carbonate and other mineral substances occurs in the interior parts of some lake basins, especially those in lands with deficient rainfall. In humid regions lakes in the last stages of filling with sediments become swamps in which accumulating plant materials may form beds of peat like those common in Ireland, Scotland and many other lands. Formation of peat, an early stage in the development of coal, has required accumulation of the plant substances in swampy basins protected from detrital sediments. followed by complex biochemical changes.

Lakes and swamps, nith their peculiar kinds of sedimentary accumulations. are especially numerous in the wide continental areas that were covered with glacier ice in the recent past. The unassorted deposits (till) formed by the ice and the stratified drift laid down by meltwater from the icecaps are described briefly above in connection with erosion by glaciers. Other types of unstratified rock waste that are widespread on the lands are the materials moving by creep, landsliding and other forms of mass wasting; and residual material on low, flat areas where intensive weathering is in progress but there is no appreciable movement. In some tropical countries the deeply weathered residuum has a pronounced red colour from concentration of ferric oxide (*see* LATERITE).

Distinctive fine-grained sediment accumulated by wind action is called loess. In wide areas of China such material, wholly unstratified, is spread over hilly country without regard for topography. The grains are of silt size or smaller, in large part unweathered and with angular shape.

Apparently this material was carried by winds from the arid regions of central Asia. Similar loess in many parts of the Rhine and Mississippi valleys may have had its source on barren plains formed by fine sediments washed from melting icecaps. Another common kind of wind deposit is dune sand, abundant in arid regions but widespread also near sandy shores of seas and large lakes, where a constant supply of sand is provided by the action of waves and currents.

2. Mixed **Terrestrial-Marine** Deposits.—Great deltas provide the most imposing visible exhibits of waste products moved from lands to seas. Exposed surfaces of the Ganges-Brahmaputra and Nile deltas measure about 80,000 $km.^2$ (50,000 sq.mi.) each; that of the Hwang-ho is much larger; and if to these is added the surface areas of deltas of the Amazon, Orinoco, Mississippi, Colorado, Yukon, Indus, Volga, Po, Rhône, Rhine and other comparable streams, the total is over 1,000,000 $km.^2$ (600,000 sq.mi.). As all large delta surfaces slope gently outward underwater, areas at the bases of marine deltas combine to make a total several times that of the exposed delta plains. Rates at which several great deltas are growing seaward are estimated from frequent measurement of sediments delivered by their streams and from repeated checks on positions of shore lines. The amount of sediment added to the Mississippi delta averages about 2,000,000 tons per day. Locally the exposed surface has grown seaward several miles within 50 years; but in situations exposed to storm waves the shore line has been cut back. Precise geodetic work has determined that in much of its area the delta is subsiding at rates of two or three metres per century, a movement that is partly or wholly compensated by continued upbuilding. Data from deep wells drilled for oil, supplemented by geophysical studies, indicate that at a maximum the total thickness of the deltaic deposits exceeds 11,000 m. (36,000 ft.); presumably, therefore, crustal subsidence has proceeded as the delta grew.

Streams in crossing their deltas branch into distributary channels which diverge outward in a fanlike pattern. Because of imperfect drainage there are swampy areas and even lakes between adjacent distributaries. Sediments in large deltas are predominantly fine grained; in the Mississippi delta the percentage of clay is high and generally the largest grains are of coarse-sand size, though scattered small pebbles are reported. In parts of the deposit, sand, silt and clay are mingled in complex fashion because at flood stage the muddy water of the stream mixes with sea nater and salt causes flocculation of the clay, which in sinking carries coarser particles with it. Moreover the distributaries continually change their courses. carrying sand and silt into swampy areas to be mixed with clay and decaying vegetable matter. With outward growth of the delta plain, stream deposits of continental type come to overlie marine sediments; later subsidence or a rise in sea level may result in marine deposition over the continental beds. This constant interplay makes deltaic sediments extremely complex.

Most small streams that enter the sea cannot build deltas because waves and currents sweep away the sediments as fast as they are delivered. In some situations areas between the limits of high and low tides—the littoral zone—acquire a mixture of continental and marine deposits. Along some coasts strong waves breaking on a sandy bottom heap the sand into an offshore bar which may grow into an extensive barrier island. Long lagoons protected by such barriers accumulate sediments from the land, as well as sediments brought in by waves during exceptional storms. Another environment for mixture of land and sea deposits is provided by estuaries in which the water changes from salt to fresh with the rise and fall of the tides.

3. Marine Sediments. — Marine basins occupy much more than half the earth's surface. and their situations lower than the lands have made them the receptacles of sediments through long ages. Sediments washed from the lands are continually being spread over sea floors, supplementing vast deposits of directly marine origin. These processes are for the most part concealed from direct human observation. Effective and rapidly improving methods of studying marine sedimentation belong in the field of oceanography (see OCEAN AND OCEANOGRAPHY), but their value in geology justifies a brief summary here. The techniques most essential in geologic study of sea floors are those for determining depths and for bottom sampling. Until well into the 20th century both these operations were slow and inaccurate and the resulting scattered observations gave little basis for reliable conclusions. The development of equipment for echo sounding made it possible to obtain an accurate continuous profile of the floor beneath a vessel moving at its normal speed. Until the second half of the 20th century devices used for collecting bottom samples penetrated to very shallow depths and either mixed the sediments indiscriminately or caused distortion and compaction of individual layers. Coring cylinders were developed that have recovered cores up to 23 m. (75 ft.) long in which the layers of sediment are essentially undisturbed. Large numbers of such samples, taken at various depths and representing a wide range in distance from land, are studied in laboratories to determine the physical and chemical compositions of the sediments, thickness and arrangement of layers, content of organic remains and other significant facts.

Marine sediments commonly are classified according to their depth below sea level, and also according to their origin. Three depth zones are recognized in the first classification: the shallow or neritic zone, the deep or bathyal zone and the very deep or abyssal zone. These subdivisions are in general those recognized on a profile from a continental margin into an ocean basin. Continents and large islands are bordered by comparatively shallow water on a shelf which slopes gently outward to a depth ranging from 100 to 200 m. (325 to 650 ft.); sediments of this shelf are classed as neritic. At the outer edge of the shelf the slope steepens appreciably on the continental slope, which extends to the deep ocean floor; sediments of this slope are bathyal, and those of the ocean floor are abyssal. A classification according to source of sediments is as follows:

- I. Derived from lands and contributed by
  - A Streams
  - B. Wave erosion of coasts
  - C. Winds
  - D. Floating ice
- II. Formed in the sea by:
  - A. Shells and skeletons of marine animals and plants
  - B Chemical precipitation
- III. Fragmental material erupted by volcanoes
- IV Paiticles ot meteorites from outside the earth

As the shelf seas border continents and islands, a large part of the neritic sediments is made up of clastic materials derived from the lands. Generally these materials become well sorted according to size; waves agitate the sediments near shore and currents separate fine particles from coarse and carry them to depths below wave action. In a simple system the coarse materials, spread out near shore, would grade seaward into silt and clay. Actually the movements of sea water are extremely complex because of coastal irregularities, varied directions of storm winds. uneven bottom topography, proximity of great ocean currents and other variables. Accordingly the coarse sediments are carried out much farther in some places than in others. Moreover sea level has not remained fixed and on the gently sloping shelf a moderate shift in the water level results in a large shift of the shore line. During the glacial ages when vast quantities of water were locked up in ice sheets on lands sea level was as much as 90 m. (300 ft.) lower than at present. As the level shifted gradually, downward and upward nith growth and wasting of icecaps, shore lines migrated tens of miles on the wide shelves. As a result coarse clastic sediments were deposited far out at times of maximum glaciation, to be covered with fine-grained deposits when waning glacier ice restored the higher sea level.

Great quantities of land-derived clastic sediments are spread beyond the shelves onto the continental slopes and parts of the deep ocean floors. Recent geophysical work has determined that thick deposits lie on these floors at the bases of the slopes; probably much of this material is carried out by sliding of loose, water-saturated sediments on the unstable sloping surfaces. Transatlantic cables have been broken by such sliding masses; and studies indicate that swift currents generated by the sliding carry loads of clay, silt and sand far out on the ocean floors. These currents move along the bottom because the exceptional loads of sediments make them turbidity currents, much heavier than the clear water above.

Of the sediments with marine origin an overwhelming percentage is contributed by animals and plants, for the most part small floating or swimming forms, many of them microscopic or nearly so. In tropical and temperate zones the surface waters teem with myriads of these organisms, some of which form shells of calcium carbonate (commonly called lime), others of silica, extracted from sea water. The discarded shells settle to the ocean floors and slowly build a deposit over wide areas. In warm regions the calcareous shells are predominant, and great expanses of the ocean floors are covered with calcareous ooze. This deposit is absent from the deeper parts of ocean basins, however, because the cold water at great depth, containing much carbon dioxide, dissolves the slowly settling flakes of calcium carbonate. Siliceous ooze, much less soluble, covers large areas in deep oceans; but in wide tracts the siliceous particles are mingled with fine clay, probably supplied by winds carrying dust from lands or from volcanic eruptions. Through oxidation the clay has acquired a distinctive red colour. The red-clay deposits in deep oceans contain more particles of meteorites than are found elsewhere. probably because accumulation of the clay is so slow the meteoritic materials are relatively concentrated and conditions on the ocean floors protect these materials from rapid chemical decay.

Some cores brought up from deep ocean floors, far from land, consist chiefly of clastic materials, including fairly coarse sand, with only a thin cover of ooze or of red clay. Probably the clastic sediments were derived by sliding from a continental slope and carried far out by turbidity currents.

Marine organisms are abundant over the continental shelves, but generally the organic materials are masked by clastic sediments that accumulate more rapidly in most parts of the neritic zone. But there are notable exceptions to this general rule. Along some low coasts that are protected from sediment-laden currents the shells of mollusks and other large shelled animals accumulate in widespread layers. In coastal belts of southern Florida and the Bahama Islands such accumulations are being cemented rapidly into firm rock. On shelves in the tropical zone corals and other reef-forming animals are building immense calcareous deposits, many of them near coasts. Calcareous ooze also is forming on some shelf areas from which clastic sediments are diverted. Precipitation of lime around coasts of some low-latitude islands is explained as the result of oversaturation on loss of carbon dioxide through increase of temperature or lowering of pressure.

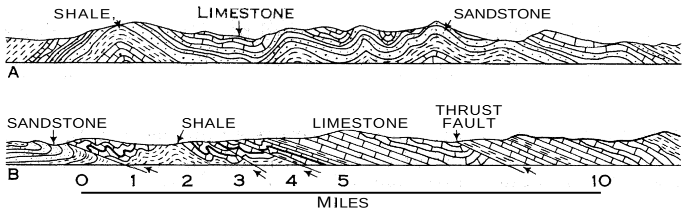
The neritic sediments are of particular interest in geology, because in large part the marine sedimentary rocks now exposed on land have features that indicate their origin in the shelf zone. Some rocks exposed in mountain belts, however, have characteris; tics peculiar to sediments in deeper parts of the oceans.

4. Conversion of Sediments to Sedimentary Rocks. — Cementation and compaction convert deposits of loose clastic sediments and soft oozes into firm rocks. some of them as strong as granite. Layers of clay and line silt become compacted more and more under the weight of overlying beds, and much water in the original mud is expelled. Calcareous ooze loses excess water in the same way, and slow crystallization of the carbonate minerals produces firm limestone and dolomite. Water moving through pores between sand grains and pebbles in the coarser clastic layers slowly deposits dissolved mineral matter, such as calcium carbonate, .which binds the particles together; layers of sand become sandstone, those made of larger particles—pebbles to boulders—become conglomerate. In the change from loose sediment to strong rock many distinctive features are preserved: tracks of animals made on muddy surfaces; forms of ripples molded in loose sand beneath oscillating waves; cracks formed on muddy surfaces from drying; and, particularly important, shells and bones of animals and tissues and impressions of plants which give reliable information on the environments under which the sediments were laid down.

D. Structural Geology

Geometric study of rocks recognizes primary structures—those acquired in the genesis of a rock mass—and secondary structures that result from later deformation. Familiarity with primary features is essential for effective study of deformed masses. The many significant features in sedimentary rocks make them especially valuable for detecting and evaluating later changes in form. Of outstanding importance is the nearly horizontal attitude of true sedimentary beds when they are deposited; such beds that now have steep attitudes clearly record later distortion. In many belts of strong disturbance the beds have been overturned, even completely inverted. as shown by positions of animal tracks, plant roots, mud cracks and other features that mark tops of sedimentary layers. Volcanic rocks also have distinctive features, such as vesicles in the upper parts of lava sheets, which give them value in structural studies.

Such studies may result in purely factual descriptions of de-



BY COURTESY OF U.S. GEOLOGICAL SURVEY

FIG. 5.— (A) FOLDED MARINE STRATA IN WESTERN VIRGINIA: (B) STRATA IN SOUTHWESTERN VIRGINIA. FOLDED AND SLICED BY THRUST FAULTS

formed rocks; but a broad view of the subject considers possible causes of deformation, and inquires into the structure of entire continents and of the earth as a whole.

1. Evidence **of** Crustal **Movements.**—Within historic time abrupt and large-scale displacements of bedrock have occurred. In 1899 part of the Alaskan coast was raised instantaneously as much as 14.5 m. (47 ft.) ; the movement was attended by a major earthquake. Other extensive breaks in bedrock. coinciding with earthquakes, have been recorded in Chile. California, Japan, Italy and many other lands. Movements of another kind, slow and affecting wide areas, are revealed in evidence partly historic and partly older. Marks made at high tide level along the Norwegian coast more than a century ago are now several feet above the reach of tides. Uplift of Scandinavia has been long continued, as shown by a succession of wide benches bearing marks of shore lines, the highest about 27j m. (goo ft.) above present sea level. Evidence of similar broad uplift is conspicuous in Newfoundland. and in Canada along the St. Lawrence river and around Hudson bay. **A** movement of this kind. involving gradual bending of a wide surface, is known as crustal warping. Ancient warping at many dates is recorded in broad bending, both upward and downward, of sedimentary beds; the structural evidence remains though the land surface that must have been deformed has been destroyed by erosion.

In addition to broad warps, the principal kinds of structural features that record deformation are folds, joints, faults, cleavage and unconformities.

Folds occur in a more or less regular sequence of upbends or anticlines and downbends or synclines. In major mountain chains folding has affected belts tens of miles wide and hundreds of miles long; individual folds are continuous for tens of miles and the largest measure several miles between crests of adjacent anticlines. Folds of smaller scale are superimposed on the sides or limbs of the major folds. The general pattern may be imitated in miniature by placing a stack of cloths or of thin paper sheets on a table and compressing from opposite edges. Folding can occur only in layered rocks and is best developed in thick sections of sedimentary beds, although some volcanic rocks consisting of lava flows and beds of volcanic ash also are strongly folded. This **kind** of deformation inditates large-scale compression.

Joints, or breaks along which no perceptible movement has occurred, are present in nearly all large exposures of bedrock. Only in exceptional places can quarrymen find good stone sufficiently free from joints to provide perfect monoliths 50 to 100 ft. long. In igneous rocks many joints have formed by contraction on cooling. Joints cutting rocks of all kinds probably have resulted from stresses set up by warping, folding and other deformation.

Faults are breaks in bedrock along which displacement has occurred parallel to the fractures. Abrupt slips on active faults cause earthquakes; such movements on a given fault may occur at intervals of years or tens of years to relieve stresses that build up slowly. Dimensions of faults range from inches to hundreds of miles, and amounts of displacement vary widely. The San Andreas fault in California on which movement caused the earthquake of 1906 can be traced at the surface nearly 1,000 km. (600 mi.) ; displacement in 1906 was horizontal, as much as 21 ft.—roads and fences were sharply offset to that extent. Earlier movements account for a total displacement of many miles. On some other faults the displacement has been chiefly vertical. producing a high cliff or scarp. Most faults are inclined, some steeply, others at a low angle. **If** displacement is relatively downward on the side toward which the break is inclined, the fault is called normal; if that side has moved relatively upward, the fault is reverse. Reverse faults with low angles of inclination and large displacement are called thrust faults, or simply thrusts. Such faults commonly are associated with folds in mountain belts. The great majority of known faults are dead—that is, movement on them apparently ceased long ago.

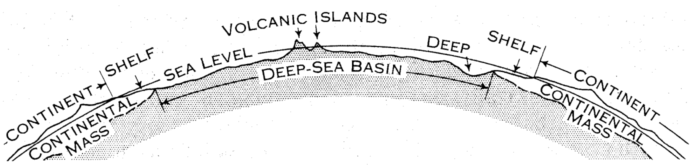
Cleavage has been developed in many large masses of rock under high compressive stress. In nearly all large mountain belts shale in closely folded beds has been transformed into slate. Cleavage, cutting sharply across the original bedding, divides the slate into thin plates with remarkably plane surfaces. In many zones of extreme deformation the slate has passed into lustrous phyllite, or even into mica schist, in which the cleavage surfaces commonly are much crumpled.

Many old crustal movements are recorded by interruptions in sequences of sedimentary beds. For example in the walls of the Grand canyon of Arizona a thick section of beds containing fossils of marine animals is almost horizontal; but the base of the section rests on the edges of tilted older beds, some of which also yield marine fossils. **A** general succession of events is clearly indicated: the older beds were deposited on a sea floor; they were deformed, lifted above the sea and partly destroyed by erosion; the region later subsided. a new section of marine beds was laid down and the present land was formed by widespread uplift but with little deformation of the younger beds. The two sequences of beds are unconformable. and because of the angular divergence they are said to be separated by an angular unconformity. Many unconformities represent interruptions in sedimentation by broad warping movements that left the older beds essentially horizontal; successive sequences of beds then have no perceptible angular divergence, though the surface separating them may represent a long history of erosion.

Discordant contacts between masses of rock result also from large-scale faulting and from igneous intrusion; but the term unconformity is applied only to a relation that involves erosion and deposition of layered rocks, either sedimentary or volcanic in origin.

2. Mountain Structure.— Kinds and structure of rock masses exposed in mountain lands are highly varied; but in every great mountain belt exceptionally thick sedimentary sections have been deformed by folding and faulting. Erosion has truncated folds over wide areas and exposed complete sections of the beds, which have maximum total thicknesses as great as 10 to 13 km. (6 to 8 mi.). The beds. consisting of conglomerate. sandstone. shale and limestone. are largely of marine origin as shown by included fossils. and in considerable part the sediments resemble modern deposits in shallow water and at moderate depths: therefore the basins of deposition must have subsided slowly while the sediments accumulated. In many places the marine beds intertongue laterally with coarse littoral and deltaic deposits. As this relationship extends through large thicknesses, the lands that supplied the clastic sediments must have been rising while the sedimentary basins mere sinking. Therefore the site of a mountain belt was a zone of disturbance for a long time before the mountains were formed. Lavas and other volcanic materials commonly are included with sediments in parts of the section.

Generally the zone of subsidence and sedimentation marking the early stages of mountain history was situated near the margin of a continental mass. hluch of the clastic sediment, however, has



FROM LONGWELL AND FLINT, "INTRODUCTION TO PHYSICAL GEOLOGY"

FIG. 6.— MAJORFEATURES OF RELIEF ON A SEGMENT OF THE EARTH, WITH VERTICAL SCALE EXAGGERATED ABOUT 8 TIMES

come from land on the seaward side. as shown by the direction of gradation from coarse to fine materials. Thus in parts of the Appalachian mountains coarse-grained sediments grade westward through shale to limestone. The land that supplied pebbles, sand. and silt lay east of the present coast, and perhaps consisted of islands in a chain similar to the present island arcs of the Caribbean region and many parts of the Pacific basin. Modern island arcs are in zones of volcanic activity. with products similar to volcanic rocks found in the deformed sections of mountain belts. The areas of thick sedimentary sections vary in width but generally are no wider than the mountain belt. In the Appalachian mountains the total section of beds is six to eight times as thick as the section of the same age in the wide Mississippi valley region directly to the west. Therefore before deformation occurred the base of the thick section curved gently downward in the form of a broad trough, the result of slow subsidence as the sediments accumulated. Because of this troughlike form the area of thick sediments is called a geosyncline—a downbending of global scale —and the long period of sedimentary accumulation before the development of mountain structure is referred to as the geosynclinal stage.

Deformation of a large belt to form mountain structure is called orogeny, literally the genesis of mountains. In a general way orogeny has follon-ed the geosynclinal stage; but the history has been complex in every great mountain unit. Within parts of the Appalachian belt angular unconformities record repeated deformation, erosion that beveled the resulting folds and faults. then continued subsidence and sedimentation. But a final paroxysm of deformation ended the geosynclinal stage, mountainous topography became the rule and later history has been a contest between erosion and renewed uplift. Apparently the Alps and related mountain units. which are much younger than the Appalachians and Crals, are in an early stage of their history following deformation of the geosynclinal deposits. Erosion has proceeded far enough to reveal spectacular effects of folding and faulting. Great folds, overturned toward the north, have repeated the beds in complex fashion; further repetition has resulted from low-angle thrust faults on which great slices of the deformed rock, piled one above another. have been moved many miles northward. Similar structure is found in older mountain belts. where erosion has exposed also great masses of metamorphic rock and large intrusive bodies of granitic rock emplaced during the orogeny,

Sites of the oldest great mountain units are in present lowlands, and are recognized in elongate belts of contorted and faulted sedimentary rocks, much metamorphosed, partly engulfed in large granitic batholiths. Such "roots" of mountains are conspicuous in parts of Canada, Fennoscandia. Siberia, central Africa and Brazil, in areas that through long ages have been above sea level, subject to weathering and erosion. .Other well-known mountain belts. forming a sequence from old to comparatively young, have generally similar structure and the heights of the belts increase with decreasing age; examples representing four dates in a long span of time are the northwest Highlands of Scotland. the Xppalachian chain, the Rocky mountains and the Alps. Some island arcs in the Pacific basin and in the Caribbean region appear to be mountain units now growing. Therefore orogeny has been continuous or recurrent through much of geologic time. The cause and the mechanism of orogeny and of broad warping movements that repeatedly have lifted and depressed continental areas are matters of much interest and active study; but the subject is too involved and speculative for treatment here. Some physical principles involved in the history of persistent mountain uplifts merit brief attention.

3. Balance in the Earth's Crust.--Old mountain units such as the Appalachian chain, the ranges of South Africa, and the Rocky mountains of Colorado have been brought to subdued relief by erosion but have regained much of the lost altitude by repeated upwarping. This behaviour is generally similar to that of an iceberg \\-hich. though its emerged portion is subject to continuous melting. maintains much of its height by buoyant rise of the greater mass under water. The comparison is a reminder that rocks exposed in the continents are on the average appreciably less dense than the basaltic rocks common in the ocean floors. Though wide continental surfaces have been submerged repeatedly. the resulting seas have been shallow; all known evidence indicates that continents and deep ocean floors never have exchanged places. Therefore a favoured concept regards the continents as the upper surfaces of crustal plates with comparatively low density that are buoyed up on a subcrust of higher density; high mountain chains logically represent thickened parts of the continental plates (fig. 6). This concept is strongly supported by geophysical data related to the study of earthquakes. Elastic waves traveling from an earthquake centre or from the location of a large artificial explosion move at higher speeds through basaltic rocks than through the granitic rocks common in continental masses. Instrumental records of these waves at many stations indicate that the average thickness of continental plates is 25 to 40 km. and that beneath a high mountain unit such as the Alps the thickness is 60 km. or more. Thus the large irregularities of the earth's surface are not haphazard but are controlled by gravity; the general state of balance between segments of the crust that differ in density is called isostasy (equal standing).

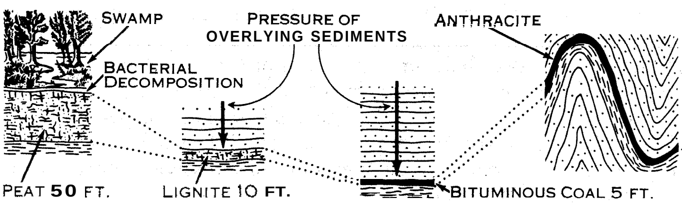
The concept of isostatic balance is in accord with the behaviour of areas that were covered with icecaps during the great Ice Age, or Pleistocene epoch. Since the ice disappeared the glaciated areas have been warped upward, as shown by elevated shore lines; in Scandinavia and Canada the highest marine terraces are hundreds of feet above sea level and probably much more uplift occurred while the wasting ice kept the sea from contact with the land. Presumably the icecaps, many thousands of feet thick, disturbed the isostatic balance and caused downwarping; this may have involved slow flowage of rock materials: at great depth. outward from the loaded areas. Wasting of the ice has brought readjustment and rise of land surfaces toward preglacial levels.

E. Economic Geology

The minerals on uhich our civilization is heavily dependent are obtained from the earth's crust and therefore have a prominent place in the study and practice of geology Although the term mineral ordinarily suggests solid substances water also is a mineral resource of primary importance. A major part of the water supply developed for private, public and industrial use is obtained directly or indirectly from underground sources; even streams and lakes used in systems of nater supply receive their steady replenishment from ground water. Therefore some knowledge of the kinds and structure of local bedrock is essential in plans for developing, conserving and insuring the sanitary quality of an adequate water supply, particularly for a large community. Many wide areas on the flanks of highlands are favoured with artesian conditions.

The solid economic minerals are grouped in two general categories: metallic and nonmetallic. Deposits of metallic minerals—those from which are extracted common metals such as iron, copper, zinc and lead, and many that are less common—are extremely diverse in their occurrence and origin. Many large masses of metalliferous ore are connected, directly or indirectly, nith bodies of igneous rock. Masses that apparently separated directly out of molten magmas are illustrated by the magnetic iron ores at Kiruna, Swed. Some metallic ores were formed at contacts of igneous bodies with older rocks; others by hydrothermal action that extended from the bodies of magma far out into the adjacent older rock; still others in veins built up by crystallization from solutions that migrated outward from magmas along joints and faults in older rocks. Imuortant metalliferous deuosits of sedimentary origin include the Clinton iron-ore beds that are widespread in the Appalachian region, and the iron ranges of the Lake Superior region. The latter deposits, the largest and richest bodies of hematite discovered by the second half of the 20th century, were enriched by circulating waters which dissolved silica and other substances, leaving a residue with a high content of iron oxide. Many other bodies of metalliferous ores! varied in origin, have been enriched by dissolving of mineral matter in the zone of aeration and redeposition below the water table. Another type of concentration has been performed by running water on the surface; the lighter rock materials have been washed away, and heavy substances such as gold, platinum and tin oxide have accumulated in placer deposits. (For further information on metalliferous deposits *see* the articles MINING, METAL; ORE DEPOSITS; and articles on various metals and metallic ores.)

Of outstanding importance among nonmetallic deposits are the mineral fuels—coal: petroleum and natural gas—which are rich in solar energy locked up in chemical compounds by plants and animals of past ages. Coal originated in vast swamps; plant materials, accumulated in large thickness, were compressed under the weight of sediments deposited over them, and slow chemical changes with attendant loss of gas have resulted in fuels of several grades from peat to anthracite (fig. 7). Petroleum is a product of slow chemical change in organic material, much of it contributed by small marine plants and animals to sediments as they accumulated on sea floors. Oil and gas generated in the source beds have migrated into adjacent porous layers, where generally water has forced the lighter fluids into various kinds of traps, sealed by beds of shale or other impervious rock (fig. 8). Occurrence of some



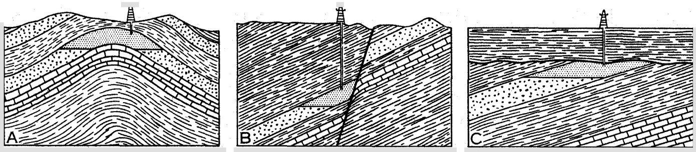
FROM LONGWELL AND FLINT, "INTRODUCTION TO PHYSICAL GEOLOGY"

FIG. 7.— CONVERSION OF PLANT MATTER INTO PEAT AND THREE GRADES OF COAL

extensive gas deposits free from oil is explained by escape of the more mobile gas from an earlier common trap to a location under more impervious rock. Exceptionally the migrating oil and gas have come to rest in volcanic rocks, or even in metamorphic rocks that have some porosity; but nearly all oil and gas pools of commercial value are in sedimentary rocks. Geologic principles and information are important aids in the search for new producing localities and a large majority of trained geologists find employment in the petroleum industry. Geophysical principles and techniques for finding favourable structures also are employed extensively in the continuing search for oil. Many important discoveries have been made by drilling to depths considered impractical in earlier exploration; some producing wells are as deep as 6,000 m. (20,000 ft.). (For further information *see* GEOPHYSICAL PROSPECTING; COAL AND COAL MINING; PETROLEUM; GAS INDUSTRY.)

Other nonmetallic deposits include a large number of mineral concentrates, some of which originated as chemical precipitates in seas and lakes; prominent among these are gypsum and common salt.

Economic development of deposits in the earth's crust applies



FROM LONGWELL AND FLINT, "INTRODUCTION TO PHYSICAL GEOLOGY"

FIG. 8.— THREE TYPES OF OIL TRAPS. POROUS SANDSTONE IS SHOWN BY DOTS. IMPERVIOUS SHALE BY PARALLEL LINES. OIL FILLS THE PORE SPACES IN ROCK

principles of geology to practical ends. On the other hand, information revealed in mining operations and in the world-wide search for petroleum has contributed much to the growth of geologic science.

III. HISTORICAL GEOLOGY

A major part of the legible history of the earth is read from sedimentary rocks, which record an order of events, changing environments, developments in animal and plant life and effects of crustal movements. Important supplements to the record are found (1) in volcanic rocks, which in many places are interlayered with and grade into sedimentary deposits; (2) in relations of intrusive igneous bodies to older and younger rocks; and, (3) in surfaces resulting from erosion, some of them exhibited in present landscapes, others in large part buried under sedimentary or volcanic accumulations. The high lights of known earth history, viewed in human perspective, make a lively record of a vacillating contest between sea and land; the development, rise and wasting away of great mountain systems; the waxing, waning and shifting of volcanic belts; and above all the miracle of evolving life in seas and on lands, leading to modern floras and faunas and the rise of man. Relative dates through a vast lapse of time are clearly indicated in the stratigraphic record and reliable absolute dates are becoming available from geochemical studies of critical isotopes.

The comprehensive study of stratified rocks is stratigraphy. The study of fossilized plants and animals with regard to their distribution in time is paleontology. These two disciplines are complementary and in geologic practice they are inseparable. In the interest of clear explanation they are here introduced separately, though fossils are discussed only in their relation to stratified rocks.

A. STRATIGRAPHY

Study of sedimentary rocks begins logically with consideration of materials that make up the various rock types. This aspect of the subject, sedimentary petrography, is outlined briefly under *Mineralogy and Petrology,* above, though only the commonest kinds of rock are listed. In a descriptive study it becomes clear that the key to an understanding of sedimentary rocks is supplied by the many kinds of sediments now accumulating; this aspect of the subject is discussed above under *Principles of Sedimentation.* The third step in the study considers the over-all relations of the stratified rocks in space and time and the history recorded in them; this broad view of the subject is stratigraphy. A fundamental principle in the study, known as the law of superposition, is that in a sequence of layered rocks as they were laid down, any layer is older than the layer next above it. This seems elementary for rocks that have not been disturbed; but commonly in mountain zones very thick sections of strata have been overturned, even completely inverted. and can be correctly understood only through criteria that indicate tops of beds and thus establish the sequence of deposition. Another requirement for useful interpretation of strata is recognition of physical conditions under which they were laid down. Again comparison is made with sediments now being deposited. Close matching of the diverse kinds of modern sediments with materials in sedimentary rocks representing an immense span of time gives strong support to the uniformitarian principle, which states that processes now acting on the earth have operated continuously and rather uniformly through long ages. This principle. resting on world-wide inductive studies, is one of the most fundamental in geology.

1. Sedimentary Facie% — Sedimentslaid down by a stream on its flood plain are readily distinguished from the unassorted till in the end moraine of a glacier. Each environment of sedimentary deposition puts its stamp on the deposits, and the distinctive marks are preserved in the consolidated sediments. Thus we distinguish marine from terrestrial strata, partly by inherent physical differences and partly by contained fossils. But marine beds are of many kinds: near-shore or littoral deposits of sand and gravel grade outward into muds, which in turn may grade into limy ooze; along many coasts the sand heaped up by breaking waves to form barrier islands grades shoreward into muds rich in black carbonaceous matter from decaying plants. Each distinctive type of sedimentary deposit is a facies (from the Latin for "face"). The term is used flexibly, in relation to broad as well as more specific distinctions in stratified rocks. A littoral facies, representing deposition between high and low tide, differs broadly from a distinctly marine neritic facies deposited below the lowest tides; but within the littoral zone a lagunal facies, common behind the great offshore bars of the Carolina coast, is very different from a sand-beach facies that is widely developed along the Florida coasts. Moreover the great differences in physical conditions are reflected in kinds of animals and plants living in the diverse environments. In many sections of sedimentary rocks beds of sandstone are seen to grade laterally into and interfinger with beds of shale. Clearly the two types of deposit were formed at the same time; but fossil shells and other remains of animals in the two kinds of rock are very different, indicating that in the past different environments were suited to different forms of life, as is true today. Thus a given biofacies as represented by an assemblage of fossils may be recognized as in harmony with a lithofacies represented by rocks in which the fossils occur.

2. Broad Stratigraphic Patterns. — Sedimentary deposits of past ages, as of the present, are endlessly complex; but from detailed studies in all continents a few outstanding patterns emerge. Each continent has at least one wide lowland that has been repeatedly invaded by seas and is now mantled with marine strata, little deformed and with small or moderate total thickness. These areas are known as stable platforms; examples are the central part of European Russia. central Siberia. a large part of the Sahara, central and southern Brazil, the central United States and Canada, northern and northwestern Australia. On each of these wide regions the encroaching seas left nearly level beds of limestone, shale and clean quartz sandstone. Erosion following withdrawals of seas made irregular surfaces on which the next succeeding strata were laid down unconformably but without angular discordance. The total deposit on each platform averages at most a few thousands of feet thick but represents a long span of time. Along one margin of each platform, however, deposits of the same general age are much thicker, more varied in character and strongly deformed. Thus the strata of the Russian platform thicken eastward into the Ural mountains. and the little-deformed beds that are widely exposed in the Mississippi valley pass into the folded, faulted and far thicker sections of the Appalachian mountains. These deformed belts went through eventful geosynclinal histories that culminated in mountain-making disturbances.

On the broad platforms the distinctive stratigraphic units can be traced widely and their relations to each other are generally clear. In the geosynclinal belts the relations are more complex because conditions of sedimentation were locally turbulent and deformation has broken the continuity of beds. Many stratigraphic problems in these disturbed belts would be insoluble without the aid of paleontology. which plays a major role in the study and practical use of stratified rocks.

B. Paleontology and the Scale of Time

Paleontology, in its own right a broad science dealing with the remains of animals and plants preserved in rocks. is treated at length in another article Its critical importance in geology arises from the use of fossils as time markers in stratified rocks. Near the start of the 19th century independent workers in England and in France discovered that units of sedimentary rocks can be traced over wide areas by means of distinctive fossils in each unit. In England these classical studies involved marine limestones replete with well-preserved shells of clams. cephalopods and other

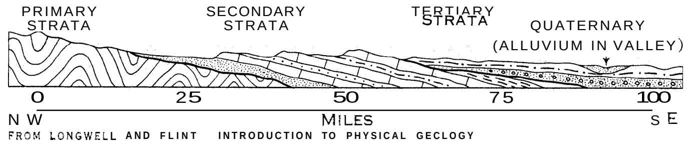
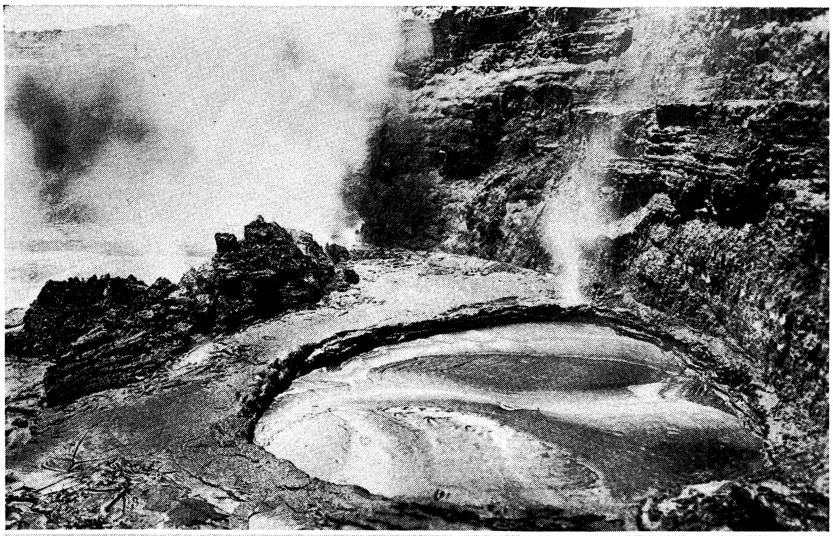


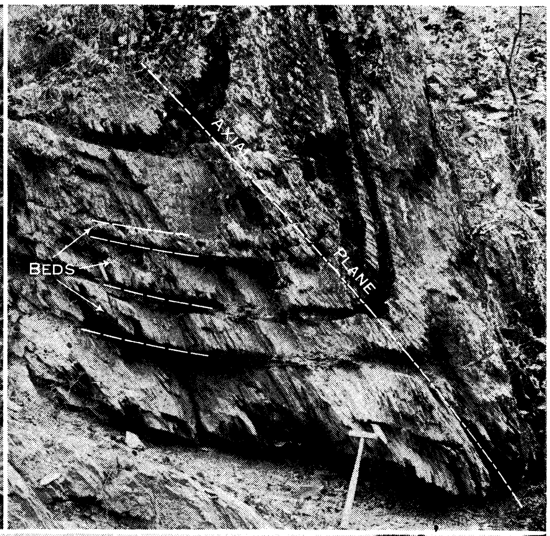
FIG. 9. — DIAGRAMMATIC SECTION ACROSS PART OF WALES AND SOUTHERN ENGLAND TO SHOW GENERAL RELATIONSHIP OF FOUR DISTINCT GROUPS OF SEDIMENTARY ROCKS

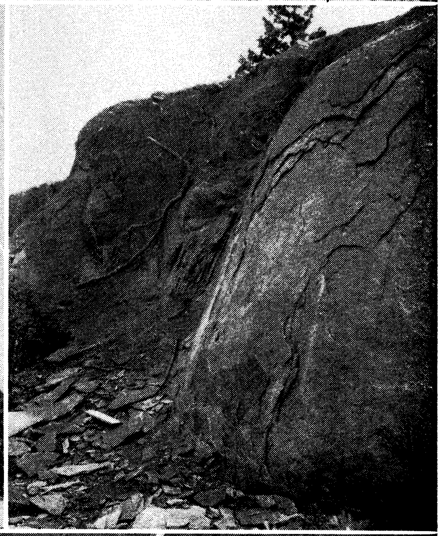
invertebrates. representing orders and some families common in present-day seas but strikingly different from any known species or genera now living. Moreover some of the fossil species were found only in single beds or a few successive beds; and those ranging through somewhat greater thicknesses were seen to be replaced in higher beds by different species. Such changes seem commonplace under present concepts of evolution; but the discoverers accepted the facts merely as a rule of thumb to aid in classifying and mapping the thick sections of sedimentary rocks. Within a few decades the work of field classification had progressed widely in Britain and continental Europe and was under way in North America and other continents. The pioneering stages of the study made most rapid strides in Britain. and accordingly many of the widely accepted terms used in stratigraphic classification are of British origin. In its general structure the southern part of Great Britain is rather ideal for an over-all view of the stratigraphic sequence; the bedrock is tilted downward to the southeast and long continued erosion has exposed the strata in general sequence, with progressively older units toward the northwest (fig. 9). (See also PALAEOSTOLOGY .)

The early work on fossil-bearing strata was done northwest of London in the central part of England, where the structure is simple and fossils are fairly abundant. Farther northwest the beds are much folded and faulted, and fossils are scarce in some thick units. Pioneer workers recognized that the deformed strata in western England and in Wales are much older than the beds with simpler structure farther east; and in a first crude classification the deformed rocks of the western sector were designated Primary, the next-younger series Secondary. The pioneers saw. furthermore, that a distinctive thick sequence in southeast England overlies the Secondary sequence and generally has been less tilted; this third major group was called Tertiary. In more recent years the latest deposits of the region, largely unconsolidated alluvium above the Tertiary rocks. were grouped under the designation Quaternary. But meanwhile research on the older fossil-bearing rocks found that the assemblages of fossil forms are progressively more primitive downward in the total sequence, and three eras were recognized. with names based on the comparative biologic records. The Primary rocks were assigned to the Paleozoic (ancient-life) era; the Secondary rocks to the Mesozoic (medieval-life) era; and all younger rocks to the Cenozoic (recent-life) era.

The contagion of stratigraphic research spread widely; large areas in France. Switzerland and Germany were studied and mapped, and subdivisions of the eras gradually took form. In Britain the Paleozoic era was first divided into five periods, each represented by a system of rocks deposited during the time interval. The two oldest of the Paleozoic periods and corresponding systems, named Cambrian and Silurian. had their types in deformed rocks of Wales and the names are of Welsh derivation; the third. Devonian. was named for a section of the rocks in Devonshire; the fourth mas called Carboniferous because the section includes widespread beds of coal; the fifth is not well represented in Britain, and







BY COURTESY OF (TOP LEFT) U.S. GEOLOGICAL SURVEY, PHOTO BY T. A. JAGGAR, JR.; (TOP RIGHT, CENTRE LEFT. CENTRE RIGHT] JOHN WILEY & SONS, INC. FROM (TOP RIGHT. CENTRE LEFT) LONGWELL AND FLINT. .INTRODUCTION TO PHYSICAL GEOLOGY.' (CENTRE RIGHT) LONGWELL, XNOPF AND FLINT, "PHYSICAL GEOLOGY," (BOTTOM LEFT) THORNBURY, "PRINCIPLES OF GEOMCRPHOLOGY'; (BOTTOM RIGHT) GEOLOGICAL SLRYEY OF CANADA

GEOLOGIC PROCESSES AND PRODUCTS

Top left: Two "lakes" of fluid lava (foreground and in background at left) on the floor of the great pit Halemaumau, Kilauea volcano, Hawaii

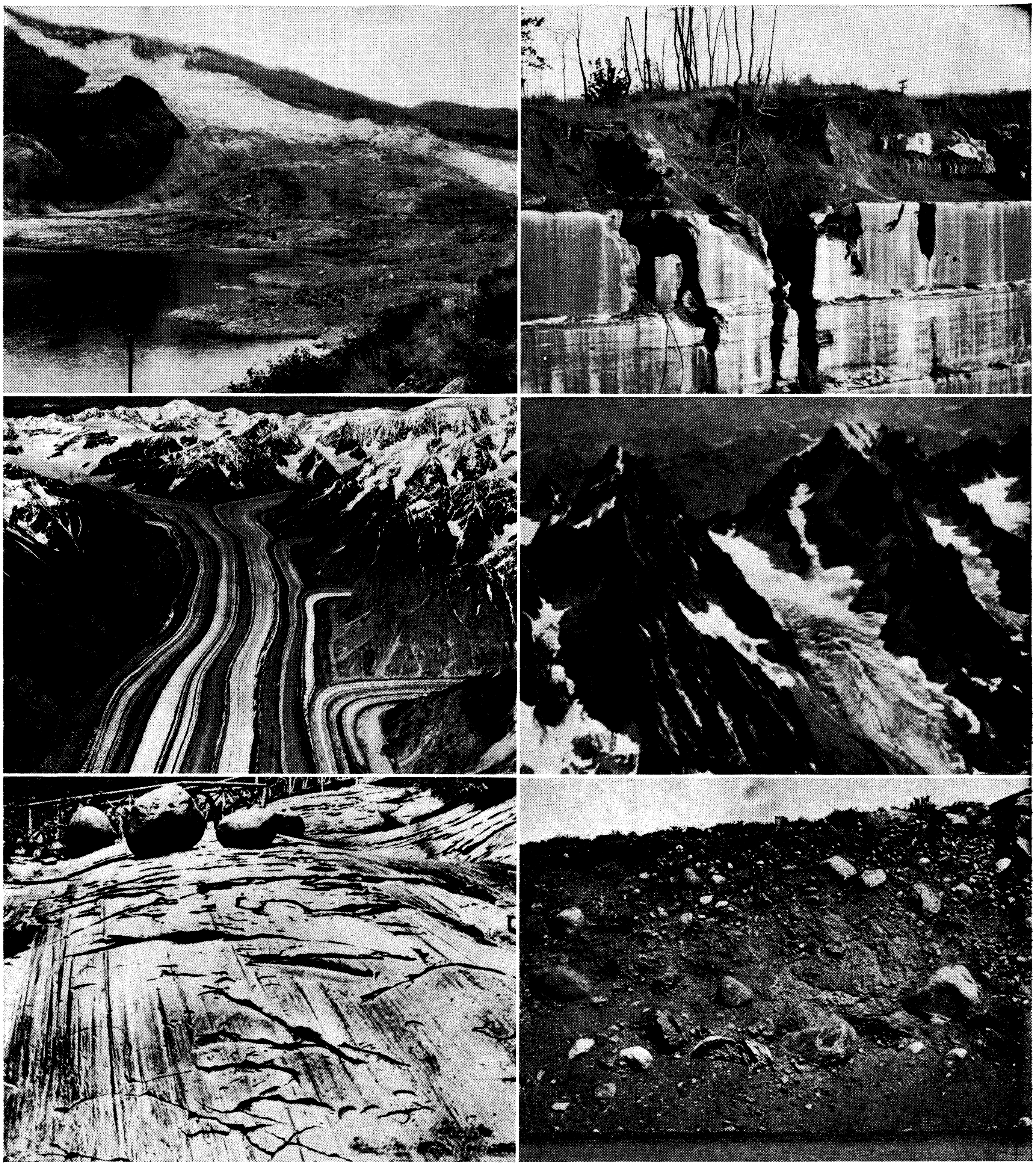
Top right: Slaty cleavage which developed nearly parallel to a plane bisecting a sharp fold in beds of shale

Centre left: Slide-rock on a slope below a cliff in the Northwest Territories, Canada

Centre right: Exfoliation of granite in a climate with moderate temperatures and rainfall. Sierra Nevada, California

Bottom *left:* Upland surface almost completely dissected by a network of streams, though some flat divides remain. The Lammerlaws, near Otago, New Zealand

Bottom right: Stream meandering on its flood plain. Forms of out-off meanders persist, some as oxbow lakes. Koyukuk river, Alaska



BY COURTESY OF (TOP LEFT, TOP RIGHT, CENTRE LEFT) JOHN WILEY & SONS, INC. FROM (TOP LEFT) LONGWELL AND FLINT, "INTRODUCTION TO PHYSICAL GEOLOGY." (TOP RIGHT) THORNBURY, "PRINCIPLES OF GEOMORPHOLOGY," (CENTRE LEFT) FLINT, "GLACIAL AND PLEISTOCENE GEOLOGY"; (CENTRE RIGHT, BOTTOM LEFT) MCGRAW-HILL BOOK COMPANY, INC. FROM EMMONS, THIEL, STAUFFER AND ALLISON, "GEOLOGY"; (BOTTOM RIGHT) ELIOT BLACKWELDER; PHOTOGRAPH, (CENTRE LEFT) BRADFORD WASHBURN

EROSION BY GLACIERS AND OTHER AGENTS

Top left: Part of rubble heap and scar made by landslide in Gros Ventre range, Wyoming, 1925. Resulting lake extends three miles upstream (left)

Top right: Cavities in limestone caused by ground water solution and now exposed in a stone quarry

Centre left: Valley glacier and tributaries. Lateral moraines of the branches become medial moraines of the main glacier. Barnard glacier, Alaska

Centre right: Rugged topography in the Swiss Alps between valley glaciers which head in cirques. Sharp peaks are called horns

Bottom left: Bedrock polished and grooved by a vanished glacier. Boulders were left when the ice melted. Lucerne, Switzerland

Bottom right: Till exposed in road cut, east slope of the Sierra Nevada range, California. Largest blocks, enclosed in fine-grained matrix, are three to four feet long

ERODED AND DEFORMED BEDROCK

Top left: Platform cut by waves across steeply inclined sedimentary beds and exposed at low tide. Remnant projecting above platform forms a stack at high tide. Aberystwyth, Wales

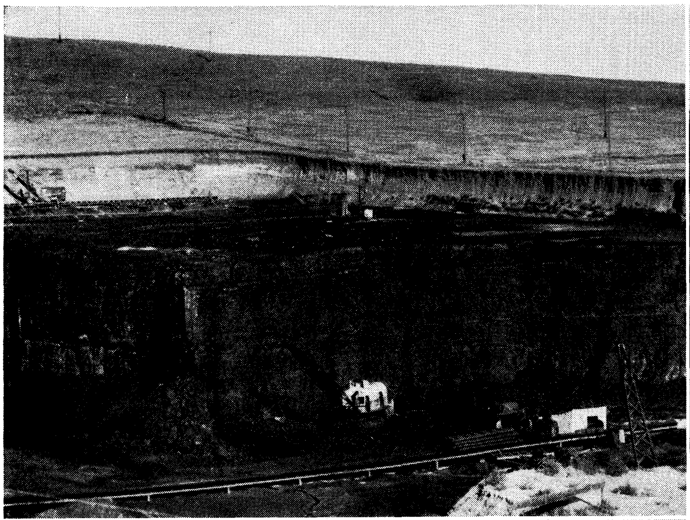
Top right: Cliff formed on horizontal beds of weak chalk by active wave erosion. View at low tide. Sussex, England

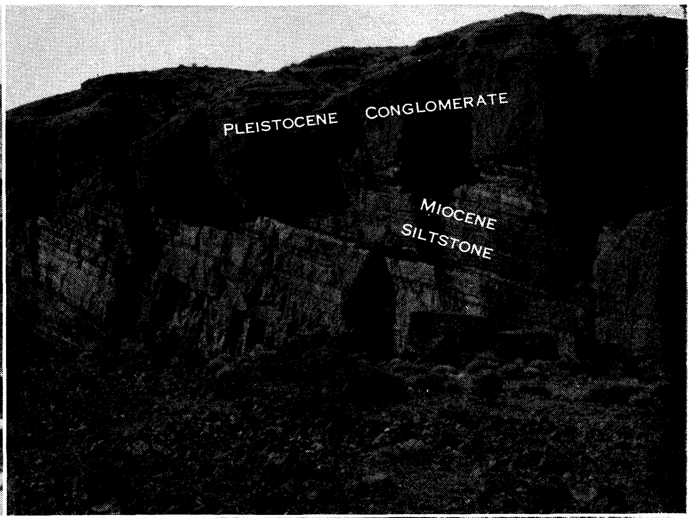
Centre left: Even terrace, cut by waves on resistant rock, shows by its position 100 ft. above sea level that the land was uplifted in recent times. Islay, Inner Hebrides, Scotland

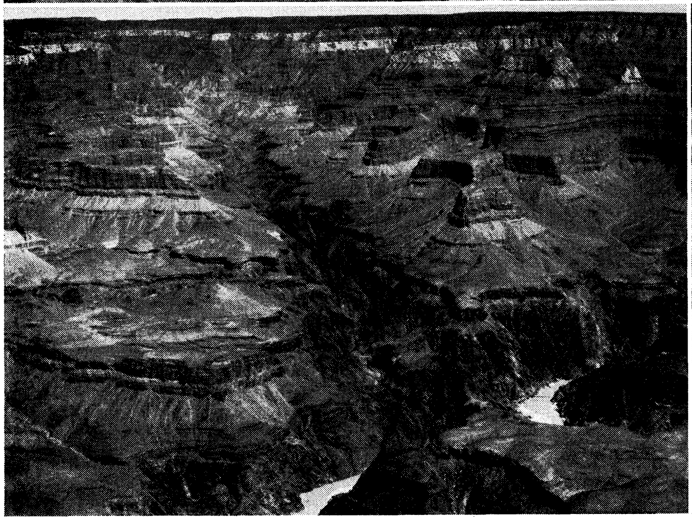
Centre right: Two sets of vertical joints, nearly at right angles, cutting horizontal beds of limestone. Drummond Island, Michigan

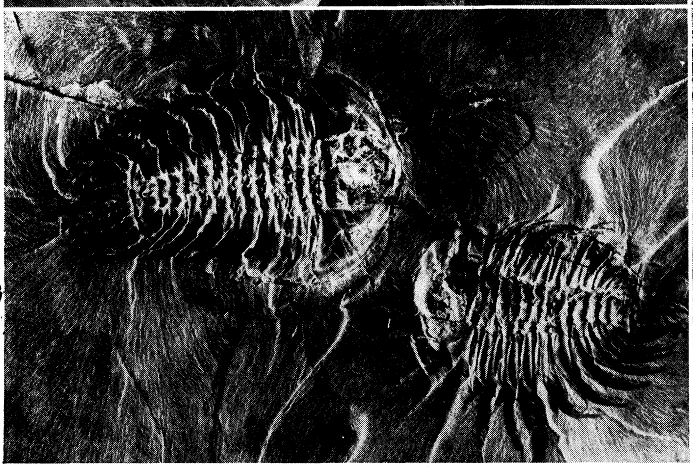
Bottom left: Original top of a bed clearly indicated by pattern of filled mudcracks in shale, Maryland

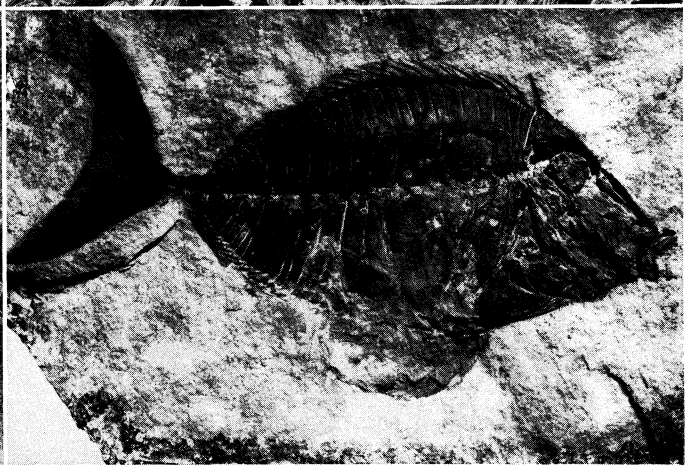
Bottom right: Strata in overturned folds along Buffels river, Cape ranges. Union of South Africa











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RECORDS IN SEDIMENTARY ROCKS

Top left: Strip mining of a soft coal bed 60 to 90 ft. thick, Wyodak, Wyoming

Top right: Angular unconformity between two sets of sedimentary beds. The Miocene beds were tilted from an original horizontal attitude and beveled by erosion before the Pleistocene gravels were deposited. Nevada

Centre left: Paleozoic strata about 4,000 ft. thick, Grand Canyon, Arizona. The inner gorge, in granitic rocks, is 1,000 ft. deep

Centre right: Part of a large reef of marine algae in Cambrian limestone, exposed on a surface polished by glacier ice. Saratoga, New York

Bottom left: Forms of two trilobites on a slab of Cambrian shale. Alberta, Canada

Bottom right: Fossil fish on a slab of shale formed in a lake during Eocene time. Southwestern Wyoming its name. Permian, is based on a section in the province of Perm in European Russia. Continued research showed the need for some revisions of the scheme for Paleozoic subdivisions. The Silurian system as first defined was disproportionately complex, and the terms Lower and Cpper Silurian came into use. Eventually Ordovician. another term derived from Wales, was substituted for Lower Silurian, and this usage has met general approval. Likewise Carboniferous was split into Loner and Upper divisions, a usage still followed in many countries though in the United States, and generally in North America. corresponding terms are Mississippian and Pennsylvanian. Thus the Paleozoic era has come to have seven recognized subdivisions; each represented by a thick system of strata.

The section of rocks representing the Mesozoic era. less formidable than the Paleozoic section. was divided into the three systems. Triassic, Jurassic and Cretaceous, each representing a period bearing the same name. The term Triassic comes from Germany, where the system is tripartite with a marine unit separating two nonmarine units. The name Jurassic recognizes a prominent development of marine strata in the Jura mountains of France and Snitzerland. Cretaceous, from the Latin *creta,* "chalk," mas first applied to the extensive deposits of chalk forming the prominent white cliffs on both sides of the English channel; eventually the name was applied to the entire thick sequence of strata between the Jurassic beds and those classed as Cenozoic. The Cretaceous is one of the greatest geologic systems, represented by thick marine beds in all continents.

The Cenozoic era in which we live is commonly divided into two periods to which the old terms Tertiary and Quaternary are applied. As in human history. the records in the latest geologic periods are best preserved; accordingly each Cenozoic period is divided into epochs. represented by series of deposits in ahich fossils of species now living increase steadily in number from the oldest epoch to the youngest.

1. Records Earlier Than Paleozoic. — Every continent has wide exposures of rocks older than Paleozoic; generally the Cambrian beds, the oldest of the Paleozoic, are unconformable on the older rocks, nhich in large part are much metamorphosed and intruded by igneous bodies. No basis has been found for systematic classification of these older rocks, which generally are lumped together as Pre-Cambrian. In many places thick sections of unmetamorphosed sedimentary rock are unconformable below Cambrian beds. but nowhere in these Pre-Cambrian sections have any distinctive fossils been found by continued and exhaustive search. Life existed before Cambrian time, but apparently the living forms were simple and without hard parts, such as shell, bone or woody tissue. that could be readily fossilized. The most abundant Pre-Cambrian fossils are deposits of calcareous algae. primitive microscopic plants that gron- in moldlike masses and precipitate from sea water calcium carbonate to build up characteristic globular structures with fine lamination. Trails and burrows of wormlike creatures are found in the Pre-Cambrian Beltian rocks of Montana, objects resembling sponge spicules and an impression suggesting a jelly fish are reported from beds below the Cambrian in the Grand canyon, and abundant carbon. some of it'metamorphosed to graphite, is disseminated through Pre-Cambrian beds in all continents. Geochemical tests of the carbon in rocks of Finland give evidence considered conclusive that the carbon is the residue of organic matter. Apparently life was abundant, at least in the later part of Pre-Cambrian time, but few if any forms had developed the ability to secrete mineral matter for protective parts.

Physical processes operated in Pre-Cambrian just as in later time. The sedimentary rocks. where they have escaped metamorphism, resemble in all respects the deposits of sediments now forming. Marine, deltaic and terrestrial facies are clearly distinguished. Crustal movements were similar to those of later eras; thick sedimentary sections were intensely deformed, metamorphosed, intruded and in part engulfed by igneous bodies. Several successive mountain belts, all eroded to low relief, are recognized in Canada: Finland and other areas with wide exposures of Pre-Cambrian rocks. Dating by radioactive minerals collected in those old mountain zones shows that four-fifths or more of the earth's history had elapsed at the start of the Cambrian period.

2. Logic of the Time Chart. — Boundaries between successive eras. periods and epochs are of course not rigidly fixed. Time runs continuously; we subdivide it. for convenience only. into hours and months, into medieval and modern parts of human history and into geologic periods. If the subdivisions of the time chart had been designed in south Africa instead of Europe, doubtless there would be material differences. Rock exposures are restricted to continents, which have had varied histories of submergence. emergence and orogeny. If the Paleozoic periods had been based solely on evidence found in Great Britain, the limited section there now classed as Permian might have been included with the Carboniferous. In some areas consecutive systems are conveniently separated by unconformities that record uplift and erosion: elsewhere, even on the same continent, rocks of these systems have no sensible physical boundaries and are distinguished only by fossil criteria in comparison with sections taken as standard. Correlation of strata from one continent to another rests in most cases on fossil evidence, which is most trustworthy where sizeable groups of fossil forms are available. Floating forms. like some of the tiny foraminifera. are particularly good time markers as a given species had a brief span of life and became widely distributed by ocean currents. One of the most reliable fossils for correlation in Ordovician rocks was the graptolite, a distinctive floating animal. In later geologic time, species of fishes and other swimming forms were distributed more rapidly than bottom-dwelling animals. Most species of animals have been short lived in a geologic sense?and occurrence of several identical species in widely separated fossil faunas indicates nearly contemporaneous formation of the enclosing rocks.

3. Developments in Life Through Geologic Time. — In the Cambrian period the seas were populated with invertebrate animals of many kinds, all comparatively small and strikingly different from forms now living. though all major groups were represented. The dominant animal was the trilobite. a swimming arthropod. Primitive plants lived in the seas, but apparently the lands were without plants or animals. Primitive fishes appeared in Ordovician time, and in the Silurian period lowly plants and animals made a beginning on land. In Devonian time amphibious animals developed, and the first recorded forests were made up

Geologic Column and Scale of Time

(Ages increase from top downward, as in a sequence of sedimentary rocks)

System and Period	Series and Epoch	Distinctive Records of Life	1000 Years*
		CENOZOIC ERA	
Quaternary	Recent	Modern man	*11*
			>44
	Pleistocene	Early man	1,000
Tertiary	Pliocene	Large carnivores	
	Miocene	Whales, apes, grazing forms	(21,000)
	Oligocene	Large browsing mammals	
	Eocene	Rise of flowering plants	(58,000)
	Paleocene	First placental mammals	70,000
		MESOZOIC ERA	
Cretaceous		Extinction of dinosaurs, floras with modern aspects	130,000
Jurassic		Dinosaurs' zenith, primitive birds, first small mammals.	160,000
Triassic		Appearance of dinosaurs	200,000
		PALEOZOIC ERA	
Permian		Conifers abundant, reptiles developed	(230,000) 235,000
Carboniferous			
Upper (Pennsylvanian)		First reptiles, great coal forests	260,000
Lower (Mississippian)		Sharks abundant	285,000
Devonian		Amphibians appeared, fishes abundant	320,000
Silurian		Earliest land plants and animals	350,000
			(380,000)
Ordovician		First primitive fishes	400,000
Cambrian		Large faunas of marine invertebrates	(440,000) 500,000
		PRE-CAMBRIAN TIME	
		Plants and animals with soft tissues, few fossils	(620,000)
No known basis for systematic division			(1,420,000) (1,800,000) (2,680,000) (3,310,000) 3,500,000-4,000,000

*Italicized figures are from radiocarbon analyses; figures in parentheses are reliable values from radioactive minerals found in rocks that belong in time divisions indicated; plain figures give estimated dates at start of corresponding time units.

of primitive scale trees and large ferns. From that time on the land plants evolved rapidly, and the widespread coal beds of Carboniferous (Pennsylvanian) time are a product of lush forest growth. The first fossils of small reptiles are found in Pennsylvanian beds, and the Permian record shows rapid development of larger reptilian forms. The Mesozoic era was the age of reptiles; dinosaurs appeared in the Triassic period, developed to huge size through Jurassic time, and became extinct before the era ended. Fossils of small mammals are found in Jurassic rocks. and primitive birds with teeth appeared during that period. Forest trees with modern aspect flourished in late Mesozoic time and evolved profusely through the Cenozoic. The Cenozoic era is the age of mammals; many large forms became extinct during the era, and others — notably the horse, elephant, camel and several carnivores — reached their zenith in Quaternary time. The development of man began late in the Tertiary period and proceeded rapidly through the Great Ice Age (Pleistocene epoch).

4. Absolute Dates. — The oldest known fossils of fishes are in Ordovician rocks; mammals first appeared late in the Triassic period; orogeny in the Alpine belt began near the start of the Cenozoic era. These statements give relative dates, but how long ago in years did the events occur? Methods have been developed that can give the answer provided suitable materials can be found in critical places. Radioactive elements, notably uranium and thorium, emit helium gas at a uniform rate. and the end product of disintegration is an isotope of lead. If a uranium mineral taken from fresh granite is analyzed precisely, the ratio between the uranium and its lead isotope uill give the length of time since the granite crystallized. As many as six methods of age determination that involve the element lead are in use. Another method uses the elements potassium and argon; still another, preferred for dating the older Pre-Cambrian rocks, is based on strontium-rubidium ratios. Large numbers of determinations have been made, most of them on minerals in igneous rocks. One rare occurrence of a uranium mineral in a marine sedimentary formation exposed in Sweden dates that formation exactly. The ages of most sedimentary beds can be only approximated by dating igneous bodies older and younger than the beds.

Sample values that fit into the time scale are shown in the time chart. Many granitic bodies cutting Pre-Cambrian rocks have supplied exceptionally good material for analyses. and in the research there is particular interest in exploring the earliest available record of the earth's history. As the studies continue the early frontier is pushed steadily back; within a few years the oldest determined dates increased from a little more than 2,000,000,000 to well over 3,000,000,000 years. These values of course apply to local parts of the crust and are minimal for the age of the earth itself.

Because rates of radioactive disintegration are very slow the methods based on these rates are not suitable for determining dates late in the Cenozoic era. A technique was developed making use of the carbon isotope C^{14}, known as radiocarbon, small amounts of which are present in the carbon dioxide of the atmosphere. Growing tissues of plants and animals incorporate carbon, and durable tissues such as wood retain measurable quantities of radiocarbon long after death of the organism, though the activity of this isotope declines at a known rate. Analyses of carefully selected materials give reliable ages up to about 40.000 years. This method is used for dating events late in the Pleistocene epoch, involving the declining stages of the great ice sheets and some activities of prehistoric man. (See also GEOCHRONOLOGY.)

C. Geologic Mapping

Programs of geologic study and mapping under way in nearly all countries rest on many practical considerations such as soil conservation. water supply. flood control. development of hydroelectric poner, location and recovery of economic mineral deposits. Government bureaus as well as commercial and scientific organizations are active in these geologic programs. In some European countries mapping of the surface geology has been completed to reasonably large scales. though many important details remain for further study. Geologic maps nith scale six inches to the mile are available for a large part of Great Britain; but in all continents great areas are still unexplored geologically or have been mapped only in reconnaissance fashion. Preparation of good topographic base maps is a preliminary to satisfactory geologic study of an area. On such a base the geologist plots boundaries of the important bedrock units which on the completed map are shown with distinguishing patterns or colours. Accurate mapping and description of a complex area usually requires co-operative efforts of students with specialized qualifications; for example, petrologists to study the igneous and metamorphic rocks and paleontologists to identify critical fossils in sedimentary strata. A large organization such as a government geological survey has personnel with diversified training, laboratories equipped for varied analyses and special equipment for use in the field. A development highly useful to field geologists is a wide coverage of air photographs, both vertical and oblique, which serve as a guide in field study and also help in making accurate locations on maps. Many details of bedrock that are obscure on the ground, especially in wooded country, are shown with remarkable clarity on vertical photographs. A technique known as photogeology uses photographs for constructing preliminary geologic maps, which are then checked and corrected by geologists working on the ground.

A completed geologic map identifies the lithology and so far as possible the geologic age of each important unit of bedrock; it represents also important structural details such as directions and degrees of inclination of strata. locations of faults and axial traces of folds. Ordinarily the map is supplemented by vertical sections on which structural features seen at the surface are projected to limited depth, thus helping users of the map to visualize the underground relations. The amount of detail shown on map and sections of course depends on the scale. Small-scale maps may represent the sedimentary rocks merely according to the period and system to which they belong; *e.g.,* Cambrian, Jurassic, Tertiary. But generally each distinct lithologic unit large enough to be shown clearly to the scale of the map is represented. A mappable unit is a formation; ordinarily it consists dominantly of one kind of rock — conglomerate, sandstone, shale, limestone, et~. — and represents an episode in the sedimentary history of the region. One geologic period may be represented on a given map by several prominent formations, each with distinctive physical characteristics and with critical fossils that assign it to a lower, middle or upper position in the parent system.

Thorough study and mapping of the bedrock in a wide region provides a basis for reconstructing physical conditions as they changed from epoch to epoch and period to period of geologic time. Marine strata with distinctive lithologies and fossils reveal the distributions of former seas on modern lands. Margins of those seas are indicated by lateral gradation of marine sediments into littoral or deltaic facies. Advance of a sea across a wide lowland is evident in continuous overlap of littoral and terrestrial sediments by marine deposits; overlap in the reverse order is evidence of a retreating shore line. Emergence of a land for considerable time resulted in erosion, evident in an unconformity at the base of any younger deposits. Fossil records in beds above and below a surface of unconformity may indicate emergence of the land through a short interval or during geologic periods.

Paleogeographic maps are constructed to show the distribution of seas, lands and mountain systems at given geologic dates. Such maps cannot be accurate in every detail, but they show with assurance the major geographic elements and a series of such maps is helpful in tracing the evolution of continents from early Paleozoic time to the present. Some maps show, in addition to geographic outlines. the distribution of rock masses and of major structural elements. such as belts of folding. at given geologic dates; these maps are properly called paleogeologic maps. Such constructions help appreciably in reading the history uritten in rocks of the earth's crust, the chief objective of geologic study.

IV. DEVELOPMENT OF THE SCIENCE

A number of ancient scholars did remarkably accurate reasoning about some aspects of geology, but their individual efforts led to no sustained progress. In the 5th century B.C. the Greek philosopher Herodotus deduced from deposits on the flood plain of the

Nile that "Egypt is the gift of the river"; and from the large number of fossil shells and beds of salt in Egypt that much of the present land had once been under the sea. A century later Aristotle voiced the same conclusion. and offered as an explanation of earthquakes and volcanism the violent escape of winds pent up nithin the earth. These ideas have at least the merit that they attribute such phenomena to natural instead of supernatural causes. Another Grecian philosopher who had the correct scientific attitude was Eratosthenes. who in the 3rd century B C. announced a first approximation of the earth's circumference and correctly cited the abundance of sea shells on land as proof of earlier extensions of the sea. Similar ideas were voiced by Strabo and other Roman scholars. But these brilliant early views did not rest on a solid foundation of detailed inductive study, and they were all but forgotten in the prolonged intellectual hibernation of the middle ages. The world was not yet ready for these advanced ideas. All the fundamentals had to be rediscovered during the intellectual surge that began with the Renaissance. Additional information will be found in biographical entries on persons referred to below.

A. Formative Stage

Leonardo da Vinci, the Italian engineer and artist (1452–1519), was an outstanding representative of the formative stage in geologic science. His views are well reasoned and clearly expressed, they concern a wide range of natural phenomena, and they are based on original observations. He saw evidence that salt is being carried irom lands to the sea, and concluded that "the sea would be more salt in our times than it has been at any time previously.'? He observed that muddy water flowing into marshy ground emerges clear, and reasoned that the sediment would in time change the marsh into dry ground. Marine shells in bedrock iar from the sea and at high altitudes claimed his special attention. In his time a favourite doctrine, dating back to the ancient philosopher Theophrastus (4th century B.C.), held that fossils are merely imitative iorms produced by a "plastic force" in the earth. But Da Vinci observed that fossil shells include representatives of several major groups of living marine animals; that individual shells exhibit all minute details, such as muscle scars, found in shells of living iorms; and that the rock matrix enclosing iossils consists of sedimentary material identical in all respects with deposits now accumulating. He saw no escape from the conclusion that the layers in which the fossils occur represent deposits on an old sea floor. A tenacious doctrine, of his day and later, recognized that fossil shells are indeed the remains of organisms that once lived, but held they were deposited in their present positions during the Noachian flood. Da Vinci exposed the fallacy of this comiortable view by pointing out the shells are not related to the surface of the land but lie in many superposed layers that are consolidated and extend underground, beneath the mountains.

Da Vinci's scientific powers were far in advance of his day; but the spirit of original research that he typifies reappeared at intervals and in different lands, and finally became dominant in geology nearly three centuries aiter his notes were written. Georgius Agricola (1494–1jj5), a German who studied medicine in Italy, saw evidence that mineral veins had been deposited by rising solutions and on returning to the mining community of Joachimsthal, Bohemia, he made a systematic study of ore deposits as a basis for his published works, *De re metallica*. In the following two centuries several able men were concerned with the earth's interior, and speculations in cosmogony became popular. Descartes (1596–16jo) published a classical diagram showing the earth with layered structure based on the postulate of an earlier molten stage. A curious feature of the diagram is the representation of vast water bodies in the earth's crust, in keeping with biblical statements about "waters under the Earth"; presumably this common concept arose from attempts to explain the source of springs, the steady flow of streams and the origin of volcanic vapors. Principles oi ground-water circulation mere not firmly established until the 19th century, although John Ray (1627–1705), an English scientist nearly contemporary with Descartes, published a remarkably accurate treatise on the mechanism of springs. Descartes recognized that great dislocations of the crust had been required to produce the steep inclinations of strata in mountain regions. Though his representation of these movements appears crude irom present viewpoints, at least his interpretation of inclined strata was much more astute than that taught in A. G. Werner's school of mining and geology at Freiberg, Ger., more than a century later.

In spite of difficulties in communication, during the 17th century scholars in several countries of Europe developed geological ideas that were remarkably alike in their modern aspect. The English physicist Robert Hooke (1635–1703) analyzed and discarded the popular doctrine that fossils were "sports of Nature." He demonstrated convincingly that shells in sedimentary rocks are remains of marine organisms, and expressed his conviction that Great Britain and Ireland were uplifted from former positions on the sea floor. At almost exactly the same time Nicolaus Steno (1638–86), a brilliant Dane who spent much oi his life in Italy, was drawing similar conclusions from his observations in lands bordering the Mediterranean. Steno represents the high-water mark in the development of geologic thought in his century. He went far in the study and description of minerals; he understood clearly the meaning oi fossils and the implication of crustal movements given by beds containing marine shells in high mountains; he saw in ancient stratified rocks the analogues of sedimentary deposits then iorming (thus he was a pioneer in stating fundamentals of stratigraphy); and he recognized that running water had been the chiei agent in sculpturing landscapes.

B. 18th-Century Advances

In the 18th century there were increasing signs of maturity and co-ordination in thinking about the earth. Reliance on new field observation rather than time-honoured speculation was coming to be a basic concept. Improved evaluation of evidence was becoming possible through developments in physics, chemistry and biology. Comprehension of the real significance of sedimentary rocks was slowly dawning. French mineralogist Jacques Guettard (1715–86) observed that definite bands of these rocks, each with its own peculiarities, are disposed in a roughly concentric pattern in the Paris basin of France; with patient labour through a large part of his career he traced outcrops of these formations, which he called mineral hands, and delineated them on maps. These may be considered the first true geologic maps, though apparently they were constructed without real appreciation of the sequence in iormations and were not accompanied by sections to show the geologic structure. In connection with his field work—in which he was assisted for a time by the chemist Lavoisier—Guettard collected hundreds of fossils which he made accurate drawings of and described. So iar as we know, however, it did not occur to him that certain fossils characterized each of his mineral bands, or that the fossils mere arranged in a sequence according to age.

Guettard found another problem in the course of field work ior his map in the Auvergne region of central France, which has one of the most superb exhibits of volcanic rocks. Though he had not seen an active volcano, Guettard had read descriptions of Vesuvius and had seen specimens of its dark lava. With this background he recognized the fresh cinder cones and flows oi ropy basalt that are common in the Auvergne landscapes. He identified also older flows, weathered and considerably eroded but still traceable to vents from which they issued. But still he failed to grasp the full implication of the widespread basaltic rocks in central France. Vast quantities of the basalt, older than the cinder cones and forming extensive plateaus, cannot be connected with any visible vents. This older basalt is in nearly horizontal sheets, some of them interbedded with layers of shale. and sandstone that contain marine fossils. In accord with an interpretation common in his day Guettard concluded that basalt was formed primarily by deposition irom aqueous solution; and that local fusion of the primary rock by subterranean combustion of coal was responsible for the cones and lava flows in Auvergne. Fortunately another French scientist, Nicholas Desmarest (1725–181j), closely followed Guettard in study of the region and compared features there with those in volcanic areas of Italy from Padua in the north to Naples in the south. By this comparative study he demonstrated that all the Auvergne basalt is of igneous origin. But Desmarest also made an error that appears glaring from the present point of view. He found that granitic rocks form the basement beneath the basalts of Auvergne, and suggested that the basalt resulted from fusion of the granite. Analytic chemistry of rocks had not pro'gressed far enough to guide him in this aspect of his problem. Not until much later mas it demonstrated that granite and basalt are at opposite poles in a great series of igneous rocks.

Some co-ordination of efforts in geologic research had begun in the 18th century, but one of the major controversies in the history of the science also raged in that period. The school led by A. G. Werner (1750–1817), known as the Neptunists, maintained that nearly all rocks were formed as precipitates from the water of a primitive universal ocean which held in solution great quantities of mineral matter. According to this theory the first precipitate from this ocean crystallized as granite, which thus was the oldest of the rocks in the visible part of the crust; later precipitates formed gneiss, slate, basalt, porphyry and syenite, all of which were classed with granite as Primitive rocks, with world-wide distribution. Later the level of the ocean was lowered (by what mechanism is not made clear), and Transition rocks, including limestone and certain kinds of sandstone, were precipitated. Wherever these deposits were laid down against slopes of emerging mountains, the resulting layers were steeply inclined. As the waters continued to subside, rocks called the *Flötz* ("flat," in contrast to the tilted Transition beds) were deposited at lower altitudes. As Werner soon came to recognize basalt in rocks as young as *Flötz,* his theory provided for recurrent precipitation of basalt. This Wernerian theory, which now seems preposterous, was widely accepted ior several decades; the author was a magnetic teacher, and students from many lands flocked to his classrooms. 'The first geologic map of the eastern United States, published in 1809 by William Maclure, represents the rocks in fcur classes that are essentially Werner's, although Secondary is used instead of *Flötz*.

Geologists in the school opposed to the Neptunists were known as Plutonists because they regarded granite, basalt and rocks of several other kinds as igneous or plutonic in origin. Desmarest belonged to this school, but the real leader mas James Hutton (1726–97) of Edinburgh, whose influence in shaping geologic thought grew as Werner's declined. Hutton spent much of his life making field observations and building inductive concepts which he checked by discussions with acquaintances. The contributions he made to correct understanding of igneous rocks is large; but his outstanding achievement was iormulation oi the uniformitarian principle, which states that natural agents now at work on and within the earth have operated with general uniformity through immensely long periods of time. This principle, accepted as a basic tenet in geologic thought, is diametrically opposed to the doctrine of catastrophism commonly held in Hutton's day, according to which every major feature such as a mountain chain or a deep chasm was formed abruptly, by catastrophic iorces. This roncept was taken for granted during centuries dominated by teaching that only a few thousands of years had elapsed since the earth was created Hutton, reasoning inductively from a wealth oi evidence, concluded that the earth dates from the remote past; he could see "no vestige of a beginning—no prospect oi an end." He recognized that erosion, which is fashioning the valleys oi present landscapes, must have destroyed generations of mountains, and that in the beveled edges oi iolded strata we view "the ruins oi an older world"

Two Germans of the 18th century, J. G. Lehmann and G C. Fuchsel, held advanced views on the meaning oi sedimentary rocks Both realized that the older strata were iormed by water action, and that they must have been nearly horizontal at the time of deposition like their modern representatives These two workers reasoned correctly that strata now steeply inclined indicate large-scale deformation—a view that contrasts favourably with Werner's concept of the Transition rorkc.

C. Strides in the 19th Century

The next great advance in geologic thought and method started with discoveries made independently in England and France near the year 1800. William Smith, a surveyor working on canals in central England, observed that in strata now classified as Jurassic anv limited group of beds had the same assemblage of fossil forms, in whatever part oi England he found it. Higher and lower distinctive units could be recognized in the same way. Using this relationship as a guide, he constructed first a table of stratigraphic units (1799) and later a complete geologic map of England, Wales and part of Scotland, accompanied by a section showing the general structure. About the same time Georges Cuvier and Alesandre Brongniart, two French zoologists well trained in comparative anatomy, worked together in Guettard's old field, the Paris basin; there they found that "fossils are generally the same in corresponding beds, and present tolerably marked differences in species from one group of beds to another." By use of this principle they separated the Tertiary strata of north-central France into natural units, arranged these in chronologic sequence and described them (1808). Three years later they represented the distribution of these units and their structural relations by a geologic map and section.

Discovery oi a vital scientific principle generally is followed by phenomenal progress in research. At the start of the 19th century geology was ripe for the practical application oi paleontology, and the succeeding decades witnessed an amazing development of the science. Christian Leopold von Bucb, one of Werner's ablest students, brought out a geologic map of all Germany in 1824; Élie de Beaumont began a similar map of France; an improved map of England and Wales, and maps of Scotland and Ireland, were published within 20 years. During this period the chart of geologic time divisions and systems of rocks was worked out, geological surveys were established in countries of Europe, and work begun in other continents demonstrated that the stratigraphic principle of Smith and Cuvier has world-wide application. Geology had progressed from a field of large speculation to a science building solidly on factual data. The vast field of paleontology continued its development as an ally of stratigraphy, and doubtless the vista into the past revealed by the study of fossils made some contribution to biological researches on which were based the concept of evolution set forth by Darwin in 1859. At least the reverse effect was dynamic; the doctrine of evolution changed paleontology irom a rule-oi-thumb technique, as practised by some of its devotees, into a science with a firm philosophic foundation. The development of vertebrate paleontology, largely after Darwin's concept was announced, contributed a great store oi favourable evidence.

All aspects of physical geology made great progress in the 19th century. Techniques for studying minerals and rocks were steadily improved; as an example, H. C. Sorby's development of thin-section equipment (*see* Petrology) was a major aid in the systematic analysis and classification of rock materials, leading to fundamental research on problems of their genesis. Swiss students cited evidence that the Alpine glaciers were once much more extensive, and Agassiz went on to demonstrate that Pleistocene icecaps covered great areas in northern Europe and North America. Study of the structure in mountain belts focused attention on the geosynclinal stage in mountain history, first pointed out by James Hall of New York and elaborated by J. D. Dana. Analysis oi the complex structure of the Swiss Alps, begun by Arnold Escher von der Linth, was continued by Albert Heim and others. Charles Lapworth, B. N. Peach and John Horne made their classic study in the northwest Highlands of Scotland. The systematic study of land iorms was advanced and stimulated by the explorations of J. W. Powell and G. K. Gilbert in the Colorado plateau, a region with exceptional exposures oi bedrock with comparatively simple structure. This briei list of distinguished workers and achievements could be amplified many times without recording the full century of accomplishment in geology, which included unspectacular but useful exploration and mapping of large areas in several continents, an appreciable start toward the eventual goal—thorough geologic study of all land areas.

D. Progress in the 20th Century

During the 20th century geology has advanced at an accelerating pace; it has assured foundations, it is aided by growth of kindred sciences and it has the advantage of constantly improving techniques. The discovery of radioactivity and the rapid advances in knowledge of atomic structure have revolutionized some aspects of geologic research. B. B. Boltwood's suggestion in 1905 that lead might be the final disintegration product of uranium started developments in methods for determining ages of minerals. Several independent methods, giving results that can he checked one against another, lead to confident values. X-ray equipment, the mass spectrometer, devices for thermoanalysis and the electron microscope are used for accurate analyses that mould have seemed magical to workers in the 19th century. Geophysicists, using seismic, gravimetric and magnetic equipment, detect important structural elements in the crust. The survey of ocean floors (*see* Ocean and Oceanography), a highly important field in geologic research, is bringing radical changes in some traditional concepts.

See also Geochemistry; Geopiipsics; Geology (Articles on).

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See also special bibliographies at the end of articles dealing with the subdivisions of geology. (C. R. L.)

GEOLOGY, SOCIETIES OF. This article listing selected geological societies in the world also lists geological surveys in various countries. 'The surveys are agencies of government departments, though in the U.S.S.R. there is a ministry of geology. Societies are free associations of geologists, but in Communist countries they are under government supervision. In some countries there is only a geological survey and no society; in some others there is a society but no survey. The Geological Society of London, founded in 1807, is the oldest association of its kind in the world. The first International Geological congress took place in Paris in 1878, and sessions have been held at intervals ever since. In Britain also was founded the first government geological survey as a result of Charles Lyell's recommendation in 1835. This example was followed by Austria-Hungary (1849), Norway and Sweden (1858) and Italy (1868). In the U.S., the first systematic surveying was started in New York in 1824. The Massachusetts survey of 1830 was imitated by other states, until these schemes were taken over by the U.S. Geological survey in 1879.

Africa.— Egypt has a geological survey which has published reports since 1900; South Africa's survey publishes reports (1910) and its society produces transactions (1896). Surveys in other territories produce similar publications, the Belgian Congo since 1945, French Equatorial Africa (1943), French West Africa (bulletin, 1938; also reports! 1946), Ghana (1925; also memoir since 1929), Kenya (1933), Nigeria (1921), Algeria (publications in six series, since 1885), Mozambique (1937), Federation of Rhodesia and Nyasaland (1917).

Asia.— China has a survey (bulletin and memoirs, 1919) and an institute of geology (bulletin, 1956); India a survey (bulletin, 1950; memoirs, 1856) and a society (journal, 1926); Pakistan a survey (records, 1950); Japan a survey (with reports, 1922; also bulletin, 1950) and a society (journal, 1894); the Philippines also has a society (publishing since 1947).

Australasia and **Oceania.**—In Australia there is a bureau issuing a bulletin (1932) and reports (1948) and a society issuing a journal (1953). New Zealand has a survey which produces reports

(1907) and memoirs (1928).

Europe.—Societies and surveys are to be found in most countries. In Austria there is a geological union with a yearbook (1850) and a society with reports (1908); in Belgium a royal geological society with annals (1874) and memoirs (1898); in Czechoslovakia an institute with bulletin (1921) and transactions (1929). Denmark has a survey (with four series of publications, 1890) and a society (transactions, 1894); France has a survey publishing a bulletin (1889) and memoirs (1893), and a society (bulletin, 1830; memoirs, 1833); the German Federal Republic has an institute (yearbook, 1880) and a society (reports, 1955), and the German Democratic Republic has a service with transactions (1872). In Hungary, the survey publishes annals (1872) and the society journals (1871); Italy's national service and society bring out bulletins (1870, 1882); Norway's survey publishes reports (1891) and its society publishes a journal (1905). Poland has a state institute with a bulletin (1920) and a society with a yearbook (1921); Rumania an institute (annual reports, 1907; also memoirs, 1924); Spain an institute (bulletin, 1874; memoirs, 1873); Sweden a survey, (reports and bulletin 1868) and a society (proceedings 1872); Switzerland a commission (reports, 1899) and a society (notes, 1888); Turkey an institute (publications in five series, 1936) and a society (bulletin. 1947). The United Kingdom's survey produces reports (1896), special reports on mineral resources (1915) and a bulletin (1939); its society publishes transactions (1811), proceedings (1834), a journal (1845) and memoirs (1958). The U.S.S.R. has a ministry of geology and an institute which publishes transactions (1938) and journal (1939).

North America.—The Canadian survey and association publish reports (1904) and proceedings (1947) respectively. Mexico has an institute (bulletin, 1895; and annals 1917) and a society (bulletin, 1905). The United States survey publishes bulletins (1883), water-supply papers (1896), professional papers (1902) and monographs (1890). The Geological Society of America publishes bulletins (1889) and memoirs (1934).

South America.—Argentine's survey publishes a bulletin (1913) and annals (1947), and its society a review (1926). Brazil and Colombia each have a survey with bulletins (1920, 1932). In Peru there is a survey (bulletin, 1945) and a society (bulletin. 1925) and in Venezuela a survey (bulletin, 1951).

GEOMAGNETISM

GEOMAGNETISM (or TERRESTRIAL MAGNETISM) is the natural magnetism of the earth and its atmosphere.

The marvelous property of the magnetism of the earth and its materials has stirred man's imagination since the time of the ancients, when magnetized rocks (loadstones) created wonder and awe as a magical manifestation. Magnets were also an early industrial product of the smithy's forge, since they were made by hammering a piece of steel over an anvil while this steel gradually cooled in the geomagnetic field.

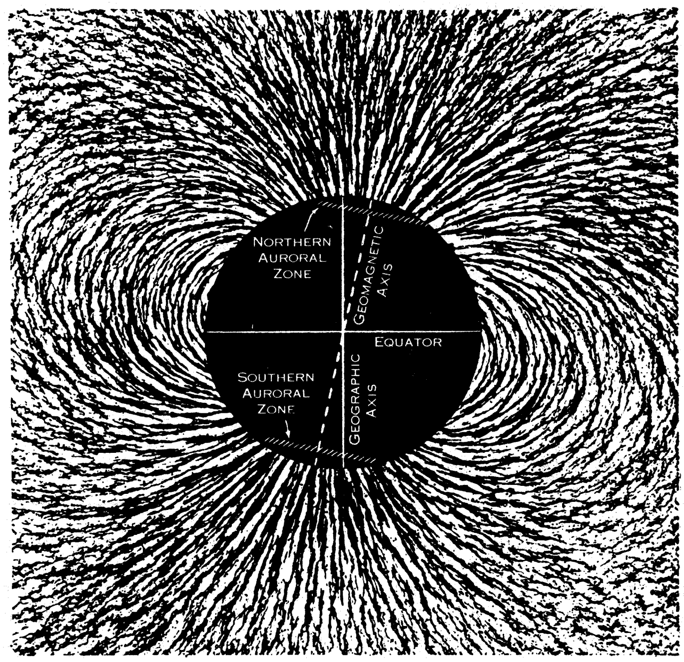
The geomagnetic field is the familiar influence which directs the compass needle. (See COMPASS.) The compass was used for the navigation of ships in quite early times. During the period 1200 to 1600 it gradually became clear that the compass needle directed by the geomagnetic field does not in general point true north, nor does it point to the north magnetic pole. instead it attempts to set itself parallel to the lines of force of the field. These facts and their understanding evolved slowly, according to Crichton Mitchell. but were firmly established by the time of the appearance of the first book on terrestrial magnetism in 1600. This book *De magnete*, by Sir William Gilbert, physician to Queen Elizabeth I is famous because it was also one of the first modern scientific treatises nritten on any subject.

The geomagnetic field also bends the rays of the aurora, and changes in the field are accompanied by changes in the quality of radio transmission.

Since the mid-1930s new techniques available for the study of rock or fossil magnetism have renewed interest in geomagnetism. It has been shown that rocks today still retain some of the magnetism acquired at the time of their formation, perhaps several hundred million years ago. The new data thus made available assist in reconstructing the history of the earth. It is argued that some of these data show how the continents drifted and rotated relative to one another, and relative to the earth's axis of rotation during many millions of years. Lava beds laid down one above the other sometimes show alternating directions of magnetization downward or upward. indicating possible great changes in the geomagnetic field during periods as short as 500 000 years. It has even been suggested on this basis that the earth's magnetic field sometimes reverses itself.

The geomagnetic field may be distorted over mineralized areas, and over oil- or gas-bearing geological structures. This distortion can be measured from low-flying aircraft. The information obtained helps locate new natural resources.

Gilbert showed that geomagnetism arose mainly from inside the earth, and the great German mathematician K. F. Gauss was able to prove this mathematically over 200 years later, about 1830. The character of this field is such as might be expected if it arose mainly from a short, powerful magnet near the earth's centre. The axis of this theoretical magnet is inclined to the earth's axis of rotation, and penetrates the earth's surface at about latitude 78.6° N.. and longitude 289.9° E. in the northern hemisphere, and at latitude 78.6" S., longitude 109.9° E. in the southern hemisphere. These points are called geomagnetic poles, and these theoretical poles, of importance to scientists in studies of the aurora and cosmic rays, should be carefully distinguished from the magnetic poles located by compass or other measurements made on polar expeditions. Because of irregularities in the earth's magnetism the actually ob-



FROM "TERRESTRIAL MAGNETISM AND ELECTRICITY," BY J. A. FLEMING (MCGRAW-HILL BOOK COMPANY, INC., 1939)

FIG. 1.— IDEALIZED MODEL OF EARTH AND ITS MAGNETIC FIELD SHOWING ZONES WHERE AURORAL DISPLAYS ARE MOST FREQUENT

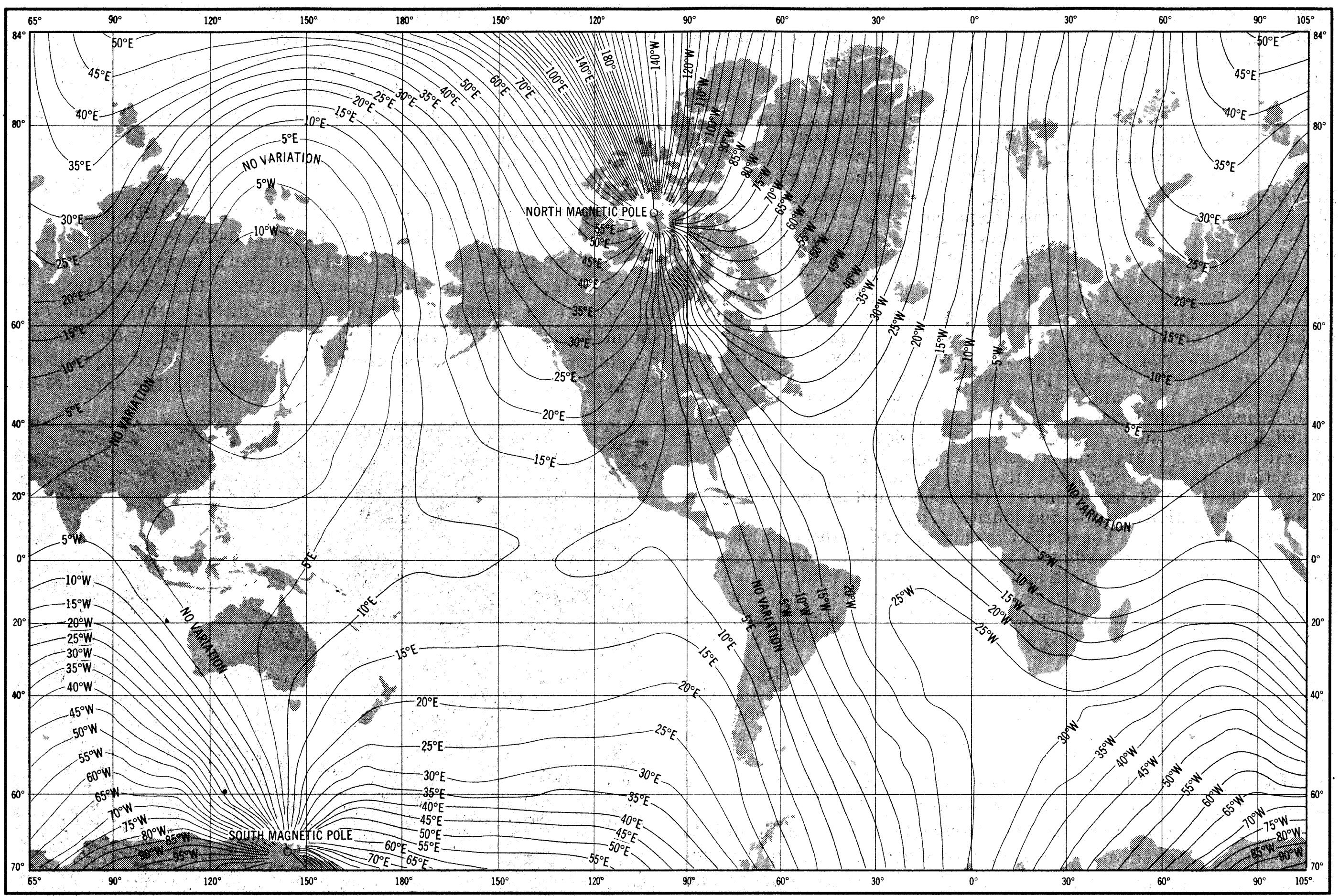
served magnetic poles are located 1,000 mi. or more away from the theoretical geomagnetic poles.

The magnetic compass needle tends to align itself vertically at the observed magnetic pole. so that the magnetic pole is a region where the compass loses its directive force. The north magnetic pole in 1948 was at about latitude 73.0° N.. longitude 260.0° E., on Prince of Wales Island. North America, and was moving northwest at about 5 mi. per year. The south magnetic pole in 1945 was estimated to be near latitude 68.2" S., longitude 145.4° E., near the coast of Antarctica.

At the north magnetic pole the magnetic force is about 0.59 centimetre-gram-second (c.g.s.) unit. Magnetic force has been demonstrated by almost every schoolboy causing a compass needle to move by the action of a steel pocketknife. At the pole this force is directed downward toward the earth's centre. At the south magnetic pole the force is about 0.71 c.g.s. and is directed away from the earth's centre. At the magnetic equator, very roughly about halfway between the magnetic poles. the magnetic force is directed approximately northward. and is roughly half of the polar values, though varying from about 0.30 to 0.40 c.g.s.

The north-seeking end of a compass magnet tends to align itself in the general direction of the north magnetic pole. Local effects caused by magnetic rocks and other irregularities in the earth's magnetism usually are responsible for the fact that the compass direction varies somewhat from magnetic north

The iron or magnetite content of rocks is highly variable and



BY COURTESY OF U.S. HYDROGRAPHIC OFFICE

FIG. 2.— WORLD MAP OF MAGNETIC DECLINATION (D); LINES CONNECT POINTS OF EQUAL VARIATION OF COMPASS FROM GEOGRAPHIC NORTH. 1955

may produce local distortions of the geomagnetic field called magnetic anomalies. Changes in electric currents flowing deep within the earth produce geomagnetic secular or long-term variations, changing the direction and force of the geomagnetic field slowly over the centuries. Secular changes in direction of the compass as great as 30° in 400 years have been recorded. Small changes of compass direction of the order one-fifth of a degree daily in low latitudes also occur, due to electric currents flowing in the ionosphere (*q.v.*). These currents acquire their energy from variable winds produced by the heating action of the sun, and from the lunar and solar tides in the upper atmosphere (see ATMOSPHERE). Magnetic storms, which are irregular changes in magnetic field, sometimes appear on a world-wide scale. They occasionally disrupt radio programs and communications. and are associated to some degree with actively changing sunspots or flares on the sun.

Elements of the Geomagnetic Field.—The magnetic elements comprise D, declination (or variation of the compass), the angle between the direction of an ideal compass and true north, measured positively from north around by east; H, horizontal intensity, the maximum strength of the magnetic force in the horizontal plane; Z, vertical intensity, strength of the force in the geographic vertical; F, total intensity, maximum strength of the force, regardless of direction; I, inclination or dip, angle between direction of field and the horizontal plane; X, strength of the force toward geographic north; and Y, strength of the force toward geographic east. X, Y and Z are vectors, since they have both scalar magnitude and direction. H and F are scalars, and D and I are angles. X is reckoned positive when directed toward the north; Y and D when directed toward the east; and Z and I when directed downward. Also $Y/X = \tan D$; $Y/H = \sin D$; $X^2 + Y^2 + Z^2 = F^2$; etc. The elements usually measured are D, I and H, but possibly D, I and F aboard aircraft or nonmagnetic ships.

Declination (D) is measured by noting the deviation from true north of a magnetic needle suspended by a fine fibre. The direction of true north is obtained from observation of the sun to a precision of 0.1′ or less. using observatory or field type instruments.

Horizontal Intensity (H) is measured by means of a magnetometer (see MAGNETOMETER) in units of length, mass and time (centimetre-gram-second units). The magnet used for D (see above) may be set in motion and its oscillation timed, and then used to deflect another magnet from a known distance. The period of oscillation $T = 2\pi\sqrt{K/MH}$, where K is the moment of inertia of the oscillating system, M its magnetic moment and H the horizontal intensity. When deflecting. the angle of deflection, u, is given by $\sin u = 2M/Hr^3$ in which r is the distance between the two magnets. This gives two equations for solving for M and H, and H is expressed in terms of length, mass and time. Laboratory tests determine necessary small corrections so that H is measured fairly readily to about 0.0001 c.g.s. unit or better. The customary unit is the gamma= 10^{-5} c.g.s. unit.

Inclination (I) is measured with an earth inductor (inclinometer) consisting of a coil of wire rotatable about its transverse axis and connected through a commutator to a sensitive galvanometer. The earth inductor is mounted with its axis of rotation in the magnetic meridian, and is rotated. It is then tilted in this meridian into the direction of dip. in which case no deflection of the galvanometer is noted. The angle of tilt, measured downward from the horizontal plane, is the inclination.

Observation Stations.—At about 100 special stations called magnetic observatories measurements are made as described above. Additional measurements may involve accurately mounted and standardized coils in which components of the geomagnetic field may be neutralized and measured. Total intensity F can be measured using a nuclear magnetic-resonance magnetometer. The magnetic moments of the protons in a material precess about a magnetic field F with an angular frequency $\omega = \gamma_p F$, where γ_p, the gyromagnetic ratio of the proton. is equal to 2.67528 ($\pm$ 0.00006) $\times 10^4$ sec^{-1} per gauss. A coil carrying a surge of current jolts the protons in the material and the frequency of precession is picked up as a signal in the same or associated coil winding to measure the field F. This type of instrument is preferred for measurements made in motion, such as aboard satellites of the International Geophysical year.

At magnetic observatories. widely scattered over the earth, though greatly concentrated in Europe, photographic records of time variations in D, H and *Z* are obtained by means of magnetic variometers. These are calibrated about once a week by means of magnetometers. The D-variometer consists of a magnet usually suspended by a vertical quartz fibre with negligible torsional restraint. The H-variometer is similar, but uses a vertical fibre ahich can be twisted so that the magnet is perpendicular to the magnetic meridian. In the vertical or *Z*-variometer the magnet is balanced against gravity about a horizontal fibre. or consists of a weighted magnet free to rotate on knife edges about a horizontal axis. Electromagnetic versions of these instruments also exist. Portable observatories in highly compact form measure D, H and Z aith accuracy comparable to the permanent observatory type.

Special magnetic survey instruments have been designed and used aboard nonmagnetic survey ships like the "Carnegie," a famous sailing ship destroyed in 1929, and the present day nonmagnetic ship, the "Zarya," used by the U.S.S.R. Special devices have also been developed to facilitate the search for minerals by magnetic methods of geophysical prospecting. These devices note changes in the magnetic field with distance over the earth's surface both at the ground and in aircraft aloft. Extensive surveys by air have been made over both continental and ocean areas.

The geomagnetic field, as part of our natural environment, has been measured at intervals of from 5 to 20 years at some 2,000 stations. called repeat stations. About 80,000 observations of declination (D) have been made at many thousands of points. Probably several million closely spaced observations of other components of the field have been made in connection nith geophysical exploration.

Studies of geomagnetism, as a global phenomenon, are facilitated also by special years in which magnetic observatories are operated at additional and usually less accessible locations, such as in the polar regions. Thus a small network of about 12 stations was added temporarily in 1882–1883, the first International Polar year, many more in 1932–1933 during the second International Polar year and over 100 additional stations during the International Geophysical year, 1957–58.

The Earth's Main Magnetic Field. — Contour lines drawn on maps of the world are prepared at five or ten year intervals by Great Britain, the United States and the Soviet Union, to indicate points of equal magnetic declination, horizontal intensity, vertical intensity. inclination or dip and total intensity. By far the greater part of the magnetic field can be interpreted as due to a short strong magnet at the earth's centre, directed from the north to the south geomagnetic pole. This magnet is tilted at an angle of about 11.5° to the earth's axis of rotation. so that it lies along the geomagnetic axis intersecting the earth's surface in northwest Greenland. in the meridian 69° W. of Greenwich. The approximation to the earth's surface magnetic field, using the same magnet can be improved by moving the magnet, parallel to itself, toward a point determined to be at about 6.5° N. latitude and 162° E. longitude in 1922. It is known that this eccentric dipole has been drifting slowly westward since 1830. This has sometimes been regarded as indicating that the earth's central metallic core. of radius about 2,900 km., does not rotate as fast as does the surface of the earth. In fact, some irregularities in the rotation of the

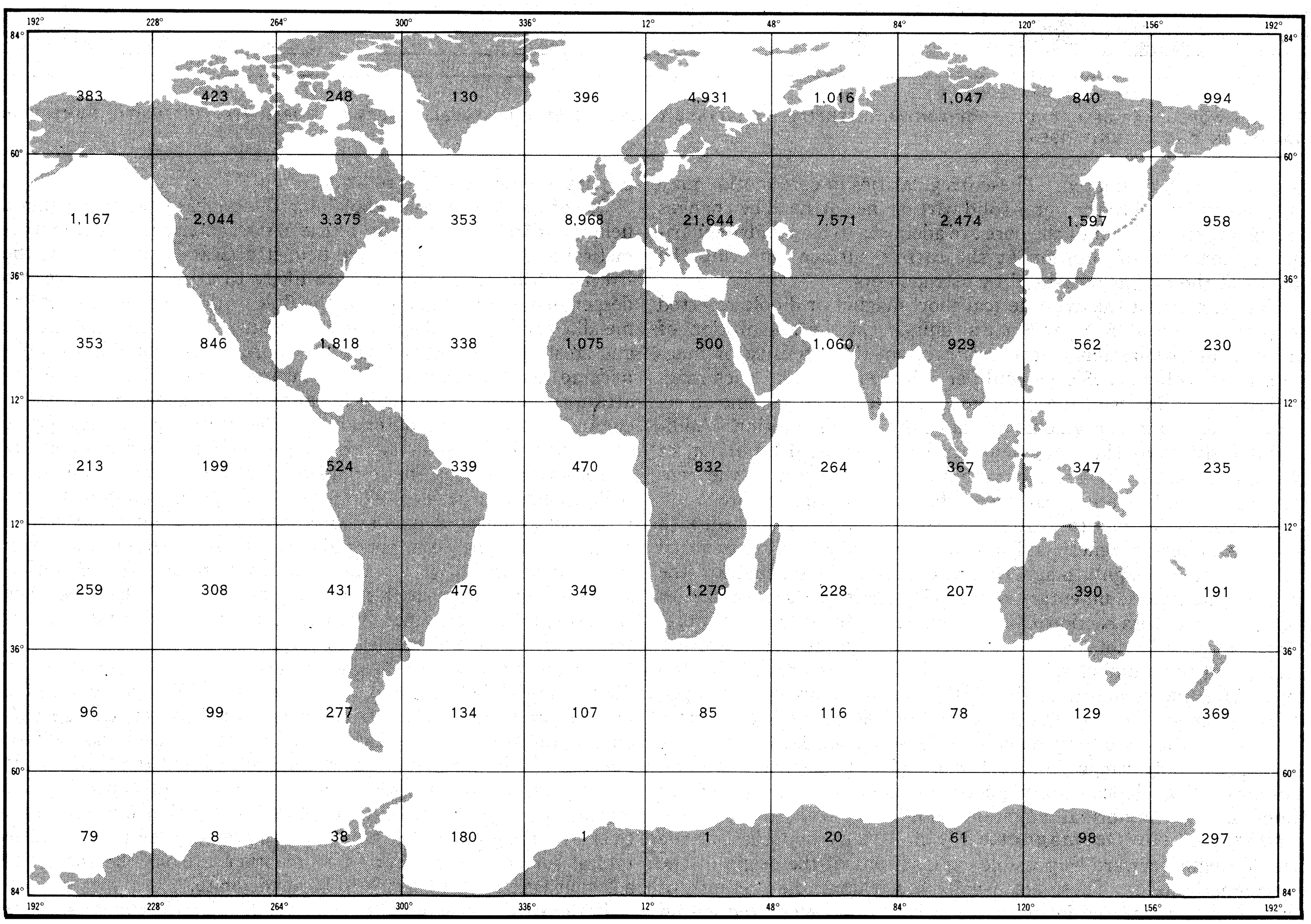
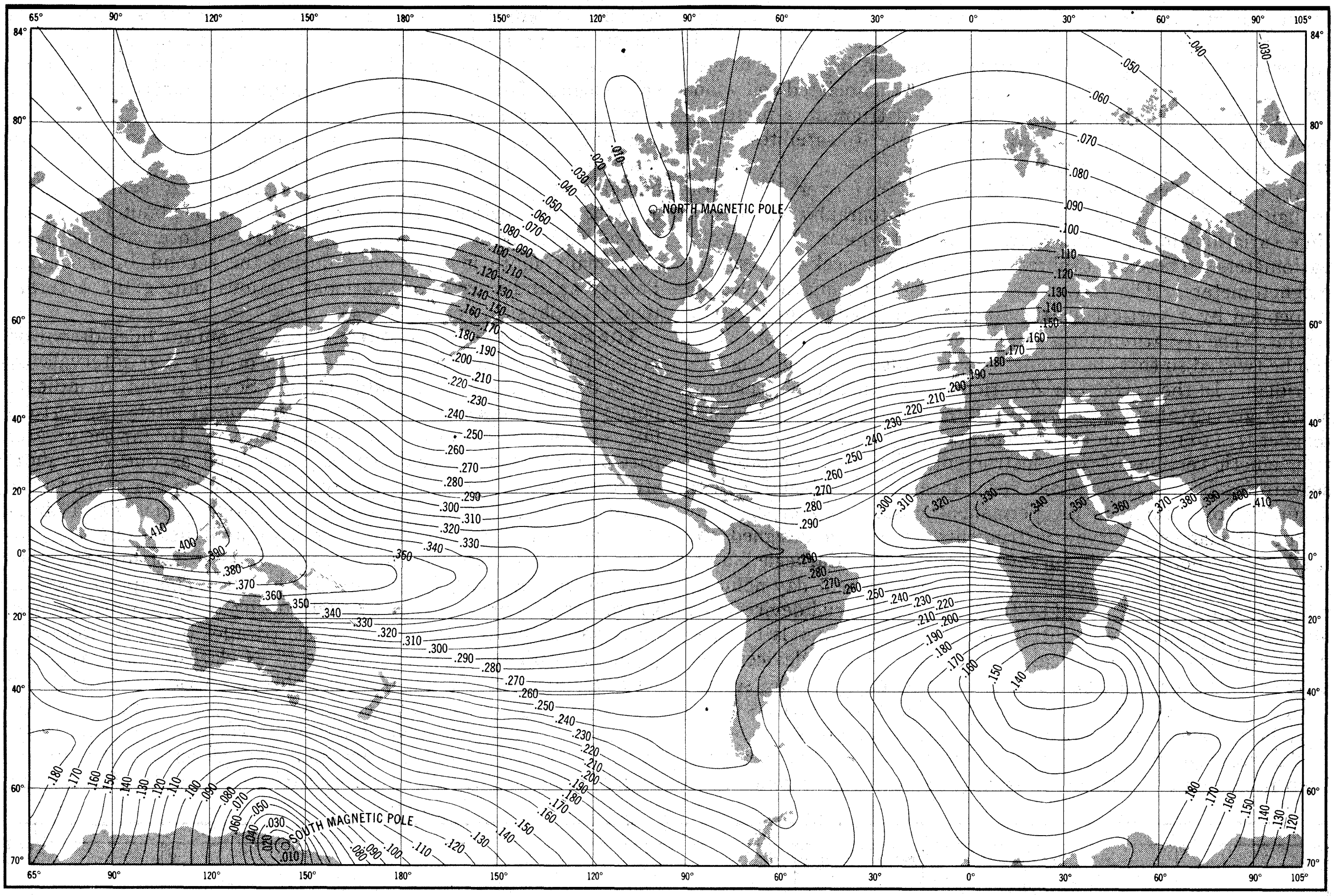


FIG. 3.— WORLD MAP SHOWING APPROXIMATE NUMBER OF OBSERVATIONS OF MAGNETIC DECLINATION TO 1955



BY COURTESY OF U.S. HYDROGRAPHIC OFFICE

FIG. 4.—WORLD MAP OF MAGNETIC HORIZONTAL INTENSITY (H); LINES CONNECT POINTS OF EQUAL VALUES OF HORIZONTAL INTENSITY, NUMERICAL VALUES IN C.-G.-S. UNIT, 1955

core have been estimated. These irregularities in core motion may be communicated to the outer solid part of the earth. The changes in angular momentum of the core are adequate to explain irregularities in the rate of rotation at the earth's surface, affecting the length of the day as measured by astronomers.

The strength of the hypothetical short magnet or dipole referred to above is about 8×10^{25} c.g.s. units. On the assumption of uniform magnetization of the entire earth, the intensity of magnetization is about 0.08 c.g s. unit per cubic centimetre. Such magnetization would result if a saturated steel magnet of volume 80 cc. were imbedded in every cubic metre of the earth's interior. Additional features of the main field can be represented by about 12 radially directed dipoles, each about $\frac{1}{80}$ the strength of the central dipole. and located near the surface of the earth's core.

The anomalies due to crustal rocks are usually associated with deposits of ferromagnetic substances. Anomalies are also caused when relatively highly magnetic igneous extrusions penetrate the weakly magnetic sedimentary rocks. The scale of these anomalies may range in cross section from a few metres to 100 km. or more. They are usually not shown on world maps because they are too small, and the number of magnetic observations are usually too few. This fine structure of the earth's surface is about as complicated as the surface topography to which it is usually not related. Local anomalies due to igneous intrusions or irregularities in basement rocks may range from a few hundred to several thousand gammas. Near deposits of magnetic ore values may rise to several times that of the normal magnetic field.

Origin of the **Geomagnetic** Field.—illany hypotheses have been brought fonvard as possible explanations of the origin of the geomagnetic field. These are usually based upon the presence of ferromagnetic material in rocks, electric currents generated within the earth's interior or very tentative suggestions related to the physics of large bodies in rotation.

One of the difficulties of explaining the origin of the geomagnetic field is our lack of knowledge of the earth's interior. From mathematical analysis of the surface field it appears that many of the irregular features of the field are likely to arise from sources no deeper than the outer layers of the fluid within the earth's central metallic core. According to one prevailing set of ideas the mantle and crust surrounding the core are more or less solid and cannot undergo rapid changes within a century or two. For this reason attempts are made to assign the cause of geomagnetism mainly to energy changes in the outer half of the central core. Elaborate calculations have been made showing that if the fluid motions are of suitable type a magnetic field originally quite small might be built up into a large one. The process is fundamentally similar to that in an ordinary dynamo. Heat necessary to move the fluid is supposed to come from the radioactivity of uranium and other metals, and about 1% of the concentration of these materials known to exist in the earth's crust might suffice. It has also been suggested many times that thermoelectric currents might arise, at the junction between mantle and core.

The theory of a ferromagnetic earth. originally proposed by Sir William Gilbert in 1600, seems defective because only a thin outer layer of the earth, about 20 km. thick or so, can be cool enough to be magnetic. Below 20 km. or so the rocks will be nonmagnetic because the temperature will exceed the Curie point of temperature (of the order 400° C. for some substances). The amount of magnetic materials required in this thin crust in order to explain the geomagnetic field is much greater than that found in typical surface rocks. For this and other reasons the theory of a ferromagnetic earth seems to be inadequate.

If the earth's magnetic field is due to electric currents, these have to be more or less continuously generated and maintained.

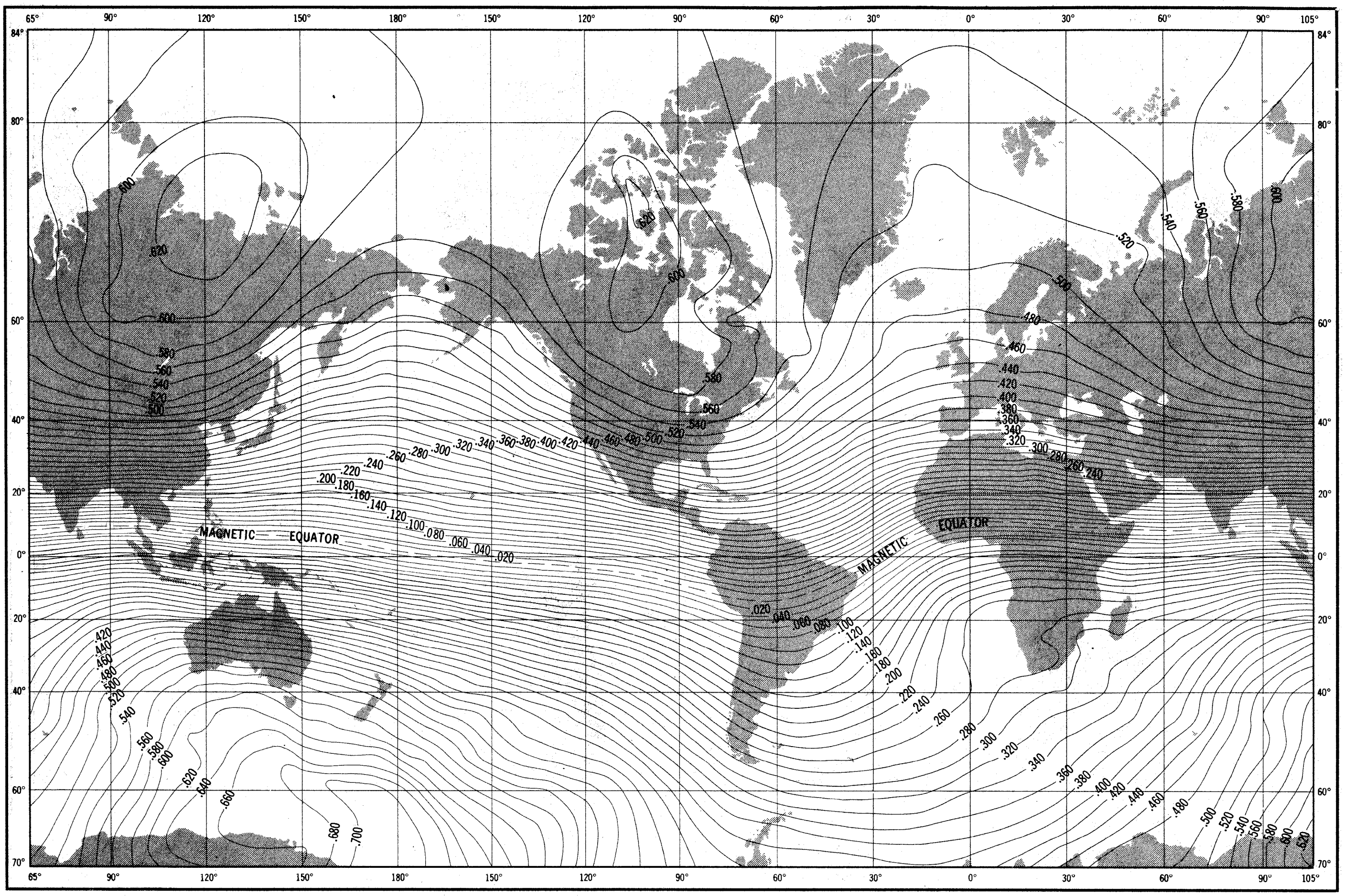


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FIG. 5.— WORLD MAP OF VERTICAL INTENSITY (Z); LINES CONNECT POINTS OF EQUAL VALUES OF VERTICAL INTENSITY. NUMERICAL VALUES IN C.-G.-S. UNIT. 1955

Otherwise once created they would decay to insignificance in the earth's core within a few tens of thousands of years.

Hence it appears that while a part of the earth's magnetization arises from ferromagnetic materials in the earth's crust, it seems likely that the larger part is caused by electric currents flowing near and within the earth's central core, as a consequence of the fluid motions and thermal changes taking place.

Secular Variation.— The geomagnetic field changes continuously with time. The field components may increase or decrease locally. a little each year for a few hundred years. For instance, from 1600 to 1800 the declination in London changed from 11° E. to 24° W.

Horizontal intensity in South Africa decreased about 6,000 gammas from 1843 to 1943, or by an amount almost equal to half the present value of the geomagnetic field there today. Substantial changes with time also occur in other areas, often on a continental or greater scale.

Changes of this kind are too localized to be explained only by motions of the magnetic poles of the earth. and are most simply explained as due to localized changes nithin the earth's interior.

The central dipole term since about 1830 has also been gradually decreasing at a rate of about $\frac{1}{2,000}$ annually. When the surface field of the central dipole is subtracted from the observed surface magnetic field a residual magnetic field is indicated. The pattern of the residual field somewhat resembles that for secular change in general character. This is because the additions year by year of the secular change build up or greatly modify the residual field. Both main and residual field patterns could arise from sources near the surface of the earth's central core. Since secular change in some components of field may be greater than 100 gammas increase or decrease in one year. it Is clear that a substantial residual field can be built up in a few hundred years, if the rate of change is maintained. One possible explanation is that the permanent magnetic field in the fluid core is linked to and participates in the motion of the electrically conducting fluid. This could give rise to a residual magnetic field undergoing continuous change in the core. the magnetic field at the surface of the core being able to penetrate the rigid mantle above so that it is observable at the earth's surface.

Secular Variation in the Geologic Past.— Ferromagnetic particles of rock are loosened by weathering and carried in rivers to the ocean, where they are aligned magnetically parallel to the geomagnetic field as they settle to the bottom. As time goes on the layer thickens and the particles become sedimentary rock. Under special and favourable circumstances the direction of the geomagnetic field millions of years in the past may be determined by laboratory experiments on specimens of the rock. Annual bottom layers or varves may also develop, sometimes in glacial lakes, and from them the direction of the geomagnetic field tens of thousands of years ago may sometimes be estimated. A cooled lava bed may also indicate the direction of the geomagnetic field millions of years ago.

If one accepts the results of this fossil magnetism (and many arguments have been urged favouring such acceptance, as well as many to the contrary) it appears that the geomagnetic field has undergone quite substantial changes in the past. According to some of these measurements the magnetic poles have usually remained not far removed from the earth's axis of rotation. In times earlier than 100,000,000 years ago there is some suggestive evidence of motion of the magnetic poles almost to the equator, which has caused some to speculate that the continents may have drifted and rotated relative to the axis of rotation. There are also indications from the directions of magnetization observed in ancient successive lava flows that the geomagnetic field may even

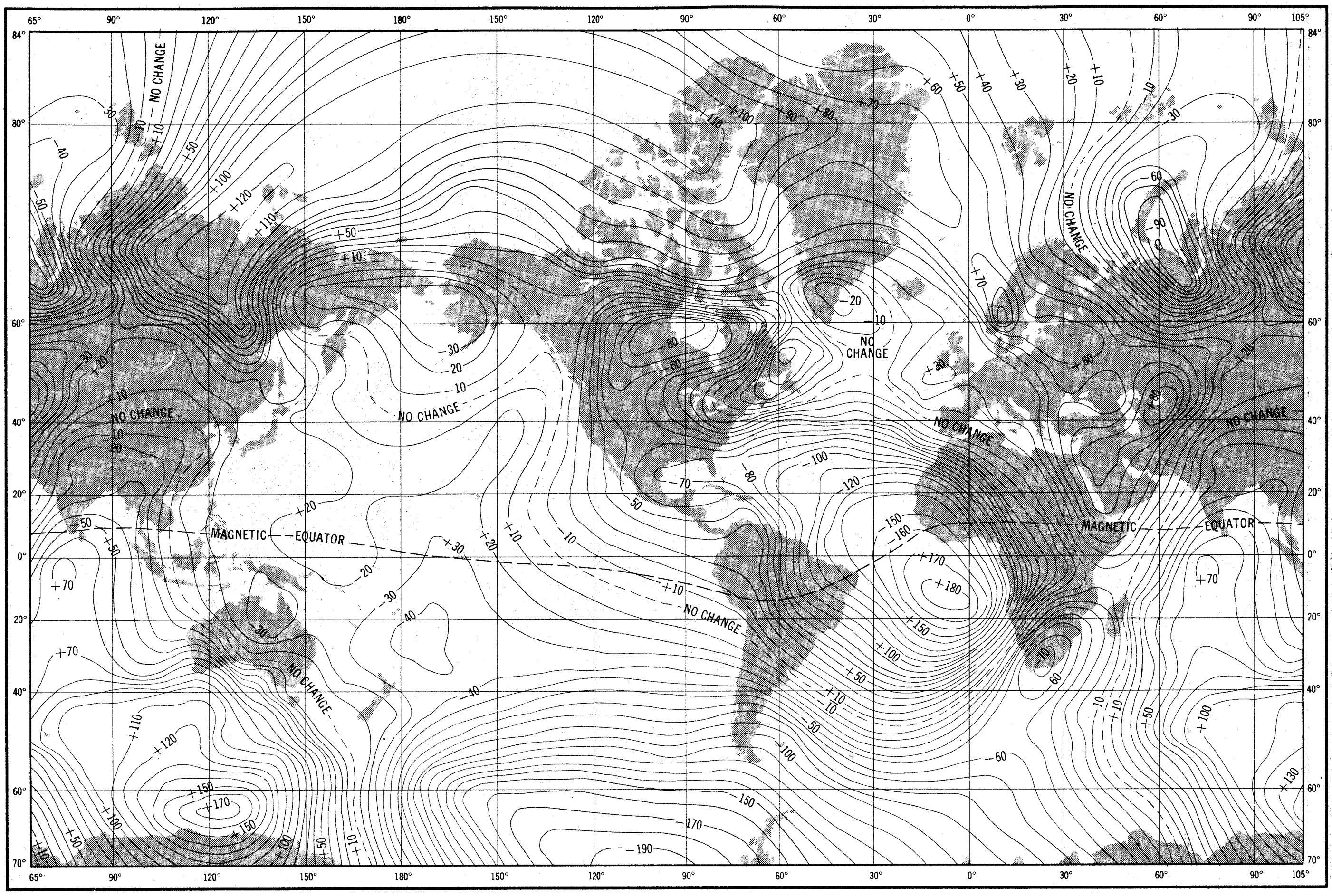

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FIG 6.— WORLDMAP OF SECULAR VARIATION IN VERTICAL INTENSITY. 1889–1955; LINES CONNECT POINTS OF EQUAL CHANGE PER ANNUM. NUMERICAL VALUES IN C.-G.-S. UNIT TIMES 10^{-5}

have reversed at intervals of some hundreds of thousands of years. Independent checks of these conclusions have been hard to find, so that the conclusions though exciting are highly tentative. In any event, the results based upon fossil magnetism provide considerable material for interpreting the remote as well as the immediate past of the earth.

The Solar and Lunar Daily Magnetic Variations.— Besides the large and slowly appearing secular changes there are smaller more rapidly appearing changes during intervals as short as a day or less. Of special interest is the change associated with the position of the sun throughout the day. known as the solar daily magnetic variation, and a somewhat smaller similar effect associated n·ith the position of the moon, known as the lunar magnetic variation. On successive days these variations are usually similar. since the phenomena show regular and typical features. The variations depend mainly on local time, and upon latitude and longitude. The variations also show local features related to the earth's main magnetic field. There is also an important dependence on season related to the position of the sun.

The solar daily variation appears to be caused by two major electric current circulations flowing mainly in the sunlit portion of the upper atmosphere, clockwise in the southern hemisphere (as viewed from outside the atmosphere! and counterclockwise in the northern, moving about the earth n·ith the sun so that their centres remain about 15° longitude ahead of the noon meridian and at about 40° of latitude from the equators. On the dark side weaker and reversed vortices can be designated. These current circulations induce weaker current systems within the earth which may contribute as much as 40% to the horizontal component of the solar daily variation at ground level. In the northern hemisphere these currents produce an increase in the eastward component (Y) of the magnetic field (amounting to more than jo gammas) in the forenoon in middle latitudes and a decrease in the afternoon. The northward component (X) increases to a maximum (of somewhat higher magnitude) just before noon at the equator. undergoes little change in middle latitudes and decreases to a minimum just before noon in high latitudes. The vertical component (Z) shows little change near the equator and in high latitudes but sinks to a minimum just before noon in middle latitudes. In the southern hemisphere these variations are antisymmetric in Y and Z and symmetric in X.

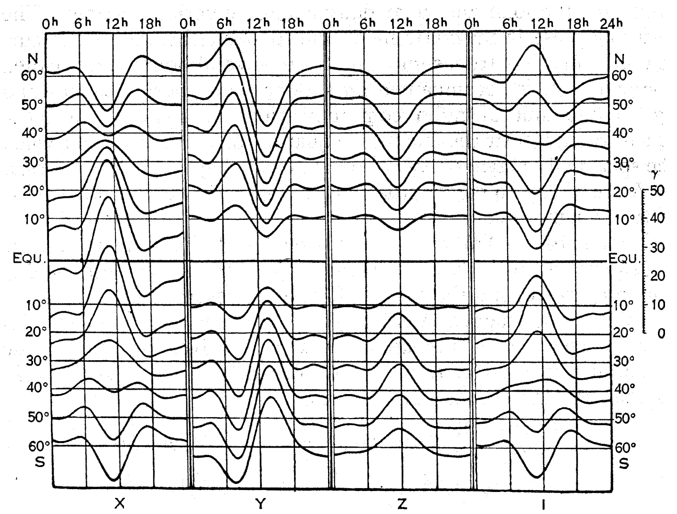
In the northern summer the solar daily variation in the northern hemisphere is about 50% larger in amplitude than the yearly average. this condition being repeated in the southern hemisphere about six months later. At the equinoxes the amplitude is about the same in both northern and southern hemispheres. There frequently appear day-to-day differences which may be as great as 100% in amplitude at any given station and as much as several hours in phase. The amplitude also varies with sunspot cycle and may be as much as 60% greater at sunspot maximum than at sunspot minimum. No connections between fluctuations in the variation field and weather have ever been demonstrated because weather is primarily a local phenomenon and fluctuations in the magnetic variation are more widely manifested.

The solar daily variation also shows irregularities which depend upon regional anomalies of the earth's main field. Because of induced currents diiferences can probably be detected between effects noted over the oceans as compared with less highly electrically conducting land areas. In addition there are effects related to the position of the magnetic equator and to the general lack of symmetry of the geomagnetic field about the earth's axis of rotation.

The lunar daily magnetic variation is also due to electric current circuits within the ionosphere. These circuits migrate about the earth with the apparent motion of the moon, together with their induced current systems flowing within the earth. Instead of the four current circulations noted for the solar daily magnetic variation. eight are noted in the lunar case. of average strength about $\frac{1}{20}$ that of the solar variations. However, the strength of current flow in the current circuits for the lunar variation is greatest on the sunlit side of the earth.

Magnetic Storms.— Strong and erratic variations in geomagnetism known as magnetic storms may last for from a few hours up to several days. During very great storms the compass direction may change by a degree or more in direction and by as much as 2.000 gammas in intensity in middle latitudes; in the polar regions fluctuations in compass direction may be much greater nith changes in horizontal intensity as great as 5,000 gammas in areas beneath intense auroral displays.

Magnetic storms often start suddenly, simultaneous to within a minute or even some seconds over the entire earth. They often start soon after the onset of active solar changes, such as those related to actively changing sunspots. Marked ionospheric storms also occur at times of magnetic storms, and may seriously disrupt radio communications. Polar aurora migrate to lower latitudes and have even been seen from equatorial locations such as India and Samoa. A storm may discharge energy at the rate of more than 2,000,000,000 horsepower for a period of from one to several



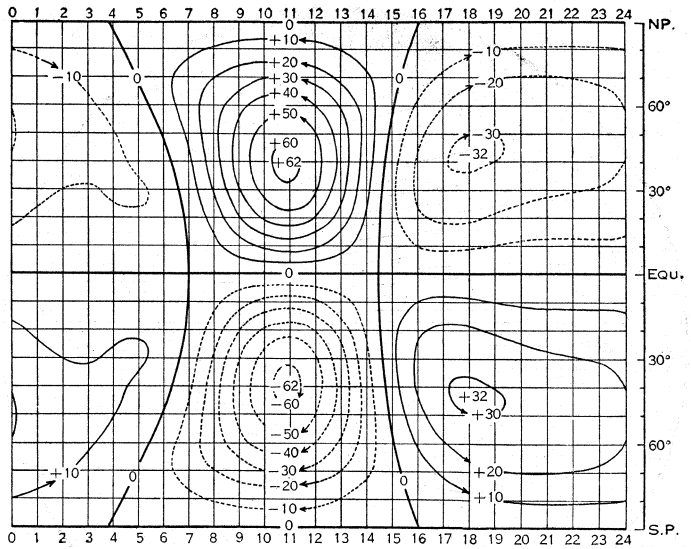
FROM "TERRESTRIAL MAGNETISM AND ELECTRICITY," BY J A FLEMING (MCGRAW-HILL BOOK COMPANY INC 1939)

FIG 7 — SOLAR DIURNAL VARIATION OF EARTH'S MAGNETISM IN NORTH COMPONENT, *X*, EAST COMPONENT. *Y*, VERTICAL INTENSITY, *Z*, AND INCLINATION, *I*, FOR VARIOUS LATITUDES, WORLD-WIDE AVERAGE FOR SUNSPOT MINIMUM YEAR

hours. Field changes at the rate of 10 to 20 gammas per second have been observed. Telegraphic and telephonic communication over long lines is often interrupted. Under extreme conditions electric power lines have become overloaded, and power transformers burned out by the electric currents produced in transmission lines by the magnetic field changes.

Field of Magnetic Storms.—Magnetic field changes minute by minute are recorded photographically as magnetograms at magnetic observatories. During magnetic storms the field changes with time are particularly irregular, complex and erratic. In spite of this. certain main systematic features are noted when departures in field from normal are averaged at a number of stations, grouped in various latitude belts around the earth.

Data averaged for many storms according to time, beginning with the time of sudden commencement of a storm, provide estimates of the storm-time variation in various geographical belts. The same data averaged according to local time give an apparent diurnal effect. This daily variation varies in amplitude with storm time, more or less in unison with the average storm-time variation. The average storm shows an increase in horizontal magnetic intensity during the initial phase of the storm, followed by a much larger diminution to a minimum in about 24 hours. This minimum

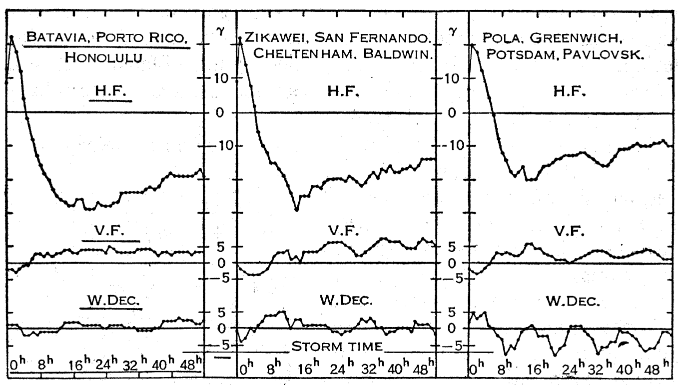


FROM "TERRESTRIAL MAGNETISM AND ELECTRICITY,') BY J. A. FLEMING (MCGRAW-HILL BOOK COMPANY, INC., 1939)

FIG 8.— MAP OF CURRENT SYSTEM IN OUTER ATMOSPHERE CAUSING SOLAR DIURNAL VARIATIONS SHOWN IN FIG. 7: VERTICAL SCALE SHOWS LATITUDE. HORIZONTAL SCALE SHOWS LOCAL TIME HOURS OR LATITUDE, NUMERICAL VALUES SHOW THOUSANDS OF AMPERES

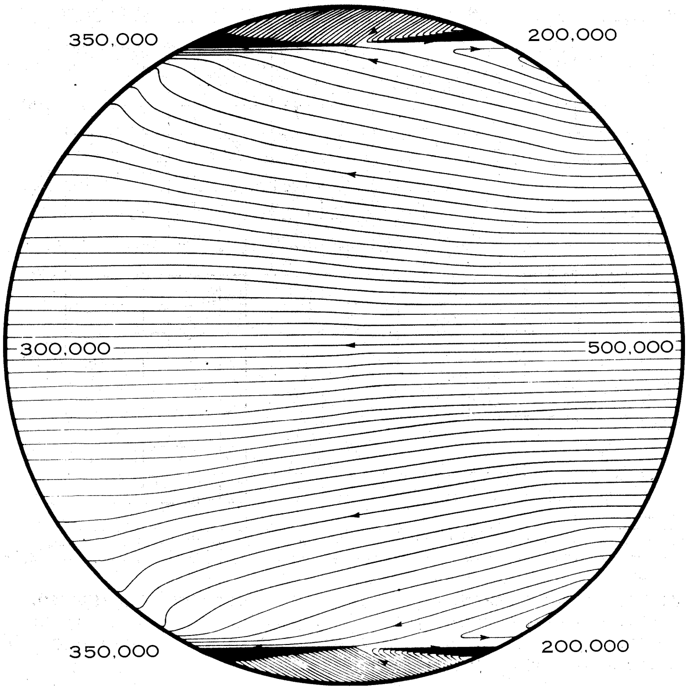
is called the main or negative phase of the storm. There is then usually a slow recovery to a normal value in the course of a day or two. In the vertical intensity (Z) the changes are smaller, and reversed in sign in low and middle latitudes. The average changes in declination (D) are usually smaller and more localized.

The daily variation of disturbance is associated with opposed current circulations. In the northern hemisphere during storms an electrojet (electric current, limited laterally) is directed westward, centred near an early morning hour meridian, near the auroral zone at 60°–70° north latitude. Another electrojet is similarly centred in south latitude. Roughly diametrically opposite at the other side of the polar cap a weaker eastward directed electrojet may be in evidence. along the auroral zone. Electric currents circulate within the ionosphere completing their current circuits in low latitudes and across the polar caps. The height of current near the auroral zone has been found to be near the 100 km. level; and this has been confirmed directly by rocket by J. A. Van Allen during the International Geophysical year, 1957–58. The height of the storm-time currents may be partly at the same level. and is the subject of further investigation. It is clear from associations with cosmic rays that some substantial electric currents flow at very high levels, and beyond the atmosphere. Some very intense storms have current patterns enduring for only a few hours, and it seems to be established that the very great magnetic storms tend to go through their initial, main and recovery phases more rapidly.



FROM "TERRESTRIAL MAGNETISM AND ELECTRICITY, BY J A FLEMING (MCGRAW-HILL BOOK COMPANY, INC, 1939)

FIG. 9.— AVERAGE STORM-TIME VARIATION DURING MAGNETIC STORMS IN HORIZONTAL INTENSITY, VERTICAL INTENSITY AND DECLINATION



FROM "TERRESTRIAL MAGNETISM AND ELECTRICITY," BY J. A. FLEMING (MCGRAW-HILL BOOK COMPANY, INC., 1939)

FIG. 10.— IDEALIZED ATMOSPHERIC CURRENT SYSTEM FOR MAGNETIC STORMS AS VIEWED FROM DIRECTION OF SUN: NUMERICAL VALUES INDICATE TOTAL CURRENT IN AMPERES FLOWING IN VARIOUS PARTS OF CIRCUIT

Other Forms of Magnetic Disturbance.— In addition to the daily variations and magnetic storms geomagnetic phenomena include sudden commencements. bays, pulsations and solar-flare effects on the geomagnetic field known as crochets.

Sudden commencements appear more or less simultaneously over the entire earth, within one minute or less. The sudden commencement consists mainly of an abrupt increase of horizontal intensity of from several to several hundred gammas, effects usually being largest in equatorial and especially in the polar regions. Examination of some cases from the Polar year, 1932–33, have shown that the effect can be traced or associated with a polar electrojet, at least in part. In equatorial regions, as in the solar daily magnetic variation, an added electrojet at the magnetic equator is sometimes noted on the sunlit side of the earth. In many cases the polar effects are predominant, and in others there may be a preliminary reversed impulse. In some locations, such as the magnetic equator, the average amplitude of sudden commencements is closely related to the amplitude of the solar daily variation. In some cases, at least, polar electrojets seem to provide a fairly localized current distribution during sudden commencements.

Other electrojets appear in the polar regions near or along the auroral zone, where they grow to maximum strength in about an hour and then decay. These current sources produce an intensification of the geomagnetic field lasting a few hours and called magnetic bays. They are often accompanied by local blackout of radio communications, and sometimes but not always appear fairly closely linked with auroral displays.

The geomagnetic field also undergoes sinusoidal or nearly sinusoidal pulsations. Those of higher frequency, of the order several thousand cycles per second, originate in lightning discharges, and are propagated from northern to southern hemisphere, or vice versa, via the lines of force of the geomagnetic field, usually being several earth radii above the earth at the highest point in the plane of the magnetic equator. They are reflected successively from northern to southern hemisphere, each time they reach ground level, with some reduction in frequency following each reflection. They show a diurnal variation in frequency of occurrence according to universal or Greenwich time, and are believed associated with the world-wide distribution of thunderstorms. When heard as an auditory signal on radio earphones the pitch is reduced after each transmission and return from the opposite hemisphere. For this reason they have been called whistlers. They provide a means of study of regions several earth radii above the earth.

Other pulsations of much lower frequency occur with periods of some seconds to several minutes. The trains of signals may last for minutes or for hours. In some cases these are world nide and may be manifestations of hydromagnetic naves. In others they appear to correspond to locally intense fluctuations in the intensity or distribution of strongly localized sources such as the electrojets along the auroral zone; in fact. they sometimes precede the appearance of the electrojets of magnetic bays. and depend upon local time. Other pulsations are more frequent at certain hours of universal time, and therefore conditions favouring their occurrence may depend upon the orientation of the terrestrial dipole to the sun.

During solar flares the increased solar radiation augments the electric conductivity of the region in which electric currents producing the solar and lunar daily magnetic variations flow. The resulting pulse in magnetic field, due to strengthening of the current systems lasts from some minutes to several hours and is called a crochet. It is accompanied by sudden ionospheric changes and by the fade-out of radio communications at some frequencies. Since crochets near the magnetic equator appear to be larger when the solar daily magnetic variation is larger they provide statistical evidence of day-to-day fluctuations in upper air winds, on the basis of the dynamo theory.

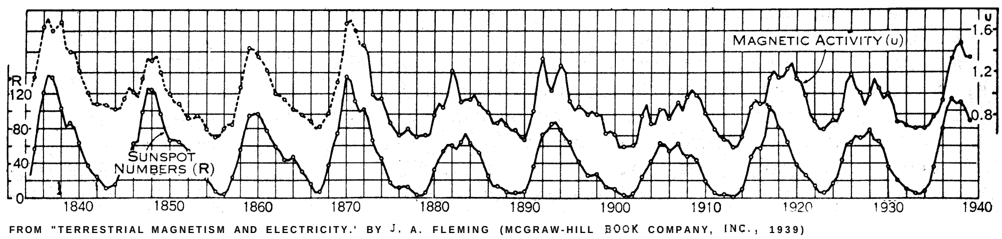
Mathematical Analysis of the Field.—Mathematical analysis has shown conclusively that the major part of the magnetic field is due to causes within the earth. It may be assumed that the components of the magnetic field may be expressed to a sufficient degree of accuracy as the appropriate derivatives of a magnetic potential expressed in terms of a spherical harmonic series *(see* SPHERICAL HARMONICS) of the form

$$V=a\sum_{n=0}^{\infty}\sum_{m=0}^{n}[(a/r)^{n+1}(I^m_{n,c}\cos m\lambda+I^m_{n,s}\sin m\lambda)\\ +(r/a)^n(E^m_{n,c}\cos m\lambda+E^m_{n,s}\sin m\lambda)]P^m_n$$

a being the radius of the earth; P^m_n, the associated Legendrian of degree n and order m; the I's and E's. the coefficients of the particular harmonics; and r and λ, with θ, the spherical co-ordinates, radius, longitude and polar distance, respectively. In this expression the portion containing a/r (and including the coefficients I) satisfy Laplace's equation everywhere outside the sphere $r=a$ and hence must be due to magnetic origins within that sphere. The portion containing r/a (and including the coefficients E) satisfy Laplace's equation everywhere inside the sphere $r=a$ and hence must be due to magnetic origins outside that sphere.

The magnetic elements most frequently used in mathematical analysis, evaluated at the earth's surface where $r=a$, are given by

$$X=(1/a)\partial V/a\partial\theta=\sum_{n=0}^{\infty}\sum_{m=0}^{n}[(I^m_{n,c}+E^m_{n,c})\cos m\lambda+\\ (I^m_{n,s}+E^m_{n,s})\sin m\lambda]\partial P^m_n/\partial\theta$$



FROM "TERRESTRIAL MAGNETISM AND ELECTRICITY," BY J. A. FLEMING (MCGRAW-HILL BOOK COMPANY, INC., 1939)

FIG. 11.— VARIATION IN SEMIANNUAL MEAN VALUES OF MAGNETIC ACTIVITY (UPPER CURVE) COMPARED WITH CORRESPONDING VARIATIONS IN SUNSPOTS (LOWER CURVE), 1835–1940

$$Y=-(1/a\sin\theta)\partial V/\partial\lambda=-\sum_{n=0}^{\infty}\sum_{m=0}^{n}[-m(I^m_{n,c}+E^m_{n,c})\sin m\lambda+m(I^m_{n,s}+E^m_{n,s})\cos m\lambda]P^m_n/\sin\theta$$

$$Z=\partial V/\partial r=\sum_{n=0}^{\infty}\sum_{m=0}^{n}\{[-(n+1)I^m_{n,c}+nE^m_{n,c}]\cos m\lambda+[-(n+1)I^m_{n,s}+nE^m_{n,s}]\sin m\lambda\}P^m_n$$

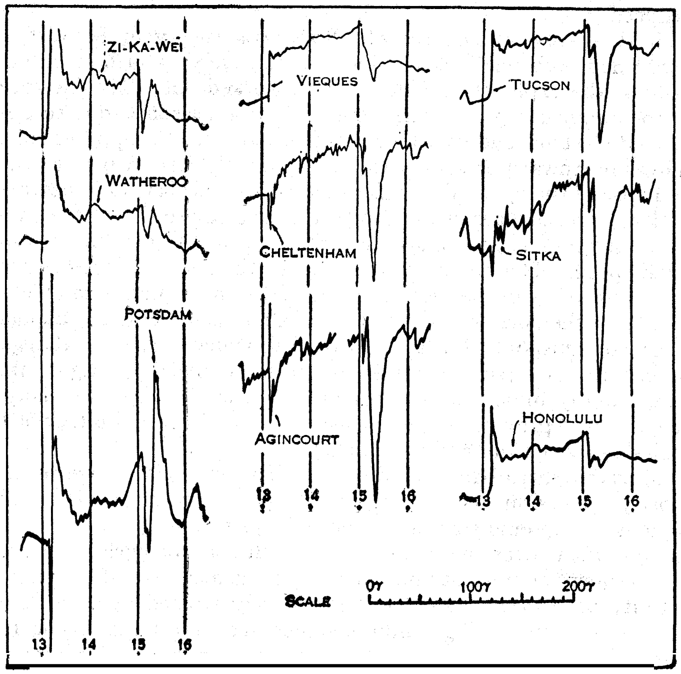
The sums of the coefficients $I^m_{n,c}+E^m_{n,c}$ and $I^m_{n,s}+E^m_{n,s}$ may be obtained by fitting either the observed values of X or of Y by least squares or some other method. If the field is derivable from a potential the values obtained from either the X or the Y data should be identical. Similarly the values of the differences $-(n+1)I^m_{n,c}$ and $-(n+1)I^m_{n,s}+nE^m_{n,s}$ may be obtained from the observations of Z. Thus, by an analysis of the observations of X or Y and of Z, a means is afforded for separating the field into portions due to internal and external causes by solution of simultaneous equations involving the above-mentioned sums and differences.

Gauss concluded from an analysis of the data available in 1835 that the main field was predominantly, if not entirely of internal origin. Later analyses by A. Schmidt (1885), L. A. Bauer (1922) and F. Dyson and H. Furner (1922) showed an external field amounting to several per cent of the internal field although the latter investigators attributed the results to uncertainties in the observations. Assumption that the external field is purely a mathematical fiction would require the admission of errors in the magnetic data amounting to about 1° in inclination and consistent with regard to sign. Since external magnetic fields are definitely present in the diurnal variation and magnetic disturbance fields (*see* following sections) there is no reason to doubt they may be present in the permanent field as well. However, considerable uncertainty must be attached to the assigned magnitudes of the external field. E. H. Vestine and I. Lange in their analysis of the main field for 1945 found an external part of less than 1% of the whole as did H. F. Finch and B. R. Leaton in 1957.

In the more recent analyses differences appear in the values of the coefficients, accordingly as they were determined from the observations of X or of Y, which appear to be too large to be attributed to errors of observation. But if the earth's field is derivable from a potential the two sets of coefficients should agree to within the accuracy of the observations. This discrepancy is sometimes interpreted as indicating the presence of a nonpotential field, that is one in which curl $H\neq O$. Such a field might be due to vertical electric currents flowing between the earth's surface and outer space. Magnitudes of these hypothetical currents are about 0.2 amperes per square kilometre at their maxima, 10^4 times as great as the normal atmospheric electric currents (*see* ELECTRICITY, ATMOSPHERIC). Great irregularity exists in the distribution of these currents; in some regions they are directed upward and in others downward. Their existence has not been verified by other physical observations. Present thought is inclined to regard them as mathematical results arising in attempting to fit faulty data to a rigid mathematical frame; in fact, there is a trend among magnetic cartographers to adjust their maps so that curl H = O, thus implicitly denying existence of the so-called nonpotential field, a procedure used in the U.S. hydrographic office charts for 1945.

Other applications have been made of potential analyses to the solar and lunar daily magnetic variations by many writers. Since the number of stations is not great enough to describe the details of the dependence of the solar daily variation upon longitude. dependence upon local time is assumed. The time variations at the available stations are expressed in amplitude and phase by Fourier series. The coefficients found are then conveniently expressed in spherical harmonics as in the case of the earth's main field, using least square methods for obtaining the best fit.

It was found that both the solar and lunar daily variations originate mainly above the earth, with a minor portion, about one-third originating within the earth. The latter is ascribed to induced earth currents, and its time phase and amplitude used in conjunction with the observed external part derived from the spherical harmonic analysis has yielded estimates of the electric conductivity deep within the earth's interior. At about 250 km. depth this comes out



FROM "TERRESTRIAL MAGNETISM AND ELECTRICITY," BY J. A. FLEMING (MCGRAW-HILL BOOK COMPANY INC 1939)

FIG. 12.— PHOTOGRAPHIC RECORDS OF SUDDEN COMMENCEMENT OF GREAT WORLD-WIDE MAGNETIC STORM AT 13 HOURS 09 MINUTES GREENWICH MEAN TIME, MAY 13, 1921; VERTICAL LINES SHOW HOUR MARKS

to about 4×10^{-13} electromagnetic unit. There is an increase with depth, as inferred from similar studies of storm data, so that values are reached as great as 10^{-11}, near 1,000 km. depth, and about as conducting as sea water. This is much higher than the electric conductivity of surface rock, which is as low as 10^{-16}, and much lower than copper, which is 6.1×10^{-4} electromagnetic unit.

The first satisfactory explanation of the solar daily variations was offered by Balfour Stewart in his article in the *Encyclopædia Britannica* in 1878, which was a classic in geomagnetism. His ideas have been elaborated further by A. Schuster in 1889 and 1908, and by S. Chapman in 1919, and it appears now certain that upper air winds produce the solar and lunar magnetic variations. These are partly a consequence of solar heating, and of tidal action (*see* METEOROLOGY; TIDES). These winds move electrically-conducting air across the lines of force of the geomagnetic field, thereby generating currents producing the daily variations. In a narrow belt above the magnetic equator the motion of the ions and electrons is such that the transmission of current is more efficient, thereby giving rise to an electrojet directed from west to east, centred near the 11 A.M. meridian. By firing a rocket carrying a magnetometer through this current layer, the height of the overhead current layer, near the equator, has been found to be around 95 km.

At the magnetic equator the day-to-day differences in the solar daily variation are shown to depend mainly upon the size of the electrical driving forces in the E-region, and not upon day-to-day differences in electric conductivity. This is because these driving forces are shown to lift the ions upward in unison in higher ionized regions known as the F-region as predicted by the dynamo theory. The day-to-day variability of these generating winds does not seem to vary much with sunspot cycle. A similar but smaller effect of this kind is noted in the E-region itself.

The height of the current layer responsible for the lunar daily variation is not established, but may be near the same level as for the solar case, which is the E-region. The upper more extensive F-region is less suited ordinarily to the generation of electric currents because the geomagnetic field there is able to seriously restrict the flow of current across this field. In the denser E-region the electric current carriers collide so frequently with the gas constituents that continuous effects of the geomagnetic field are much reduced.

It thus appears that the old *Britannica* theory of Stewart is confirmed both qualitatively and quantitatively, though some details of the explanation remain to be worked out. The increase in the amplitude of the variations with local season is due to improved electric conductivity in the ionosphere as the apparent sun moves northward or southward. and probably also in part to the response of the upper air winds to the associated changes in heating action. The changes in amplitude from one day to the next, sometimes as great as 100%, are mainly due to day-to-day changes in wind speed. The dominant influence of the sun is attested since the correlation of the yearly mean of the noon minus midnight values of the solar daily variation is about 0.99 with the annual means of sunspots. For this reason the magnetic changes, though of interest as a part of our environment in their own right, are continuously monitored as an index of solar activity. Actually, they seem to provide a direct measure of the X-ray and ultraviolet emission by the sun and its corona.

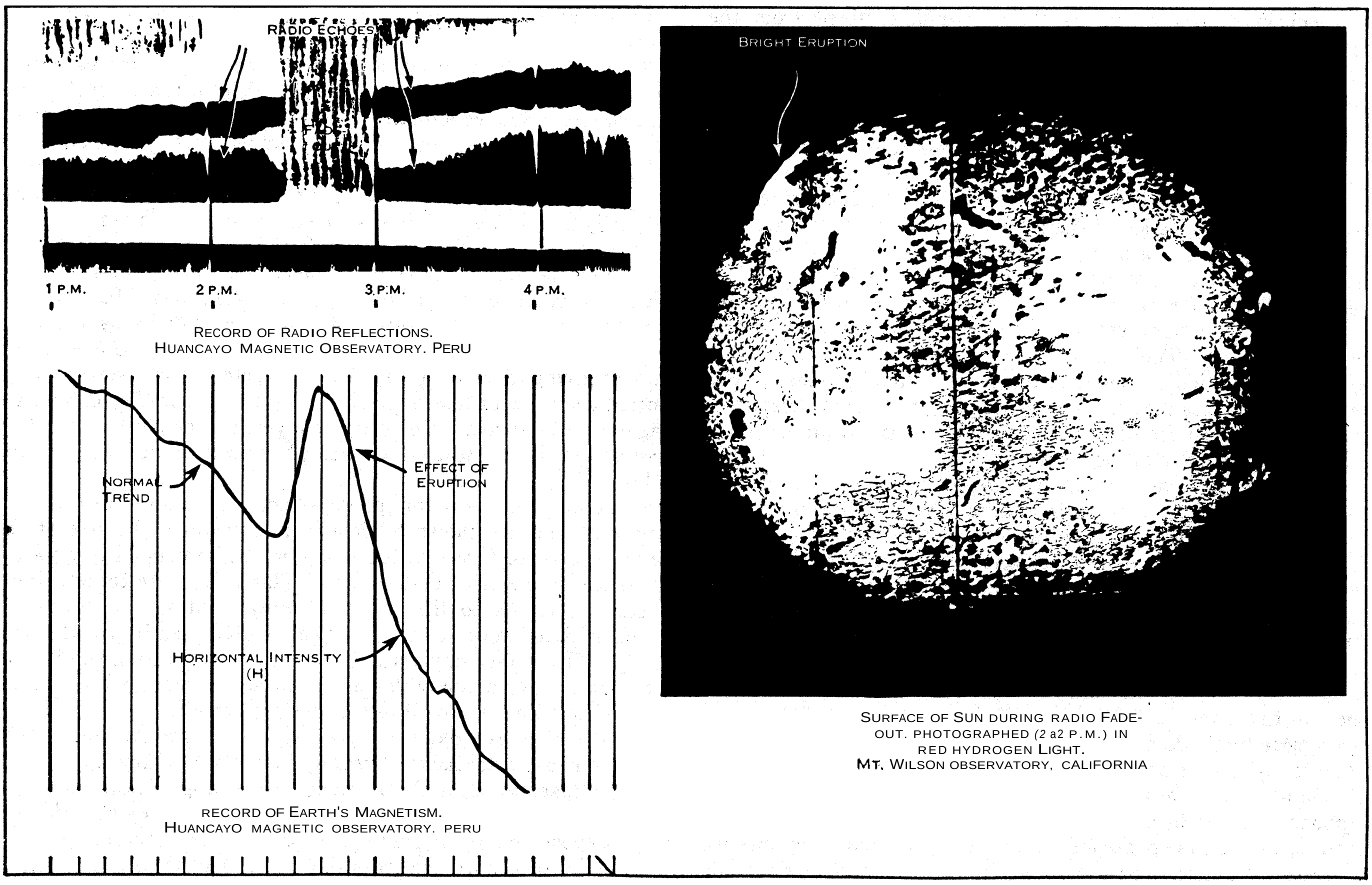
Magnetic disturbance manifests itself over a wide range in intensity; the term magnetic storm designates the more disturbed periods. Magnetic storms are more frequent and intense around or somewhat after the maximum of each sunspot cycle, and are less frequent at sunspot minimum. Various measures of magnetic activity have been devised and extensively studied because they are useful in predicting conditions affecting radio transmission to great distances. For instance, use is made of an international magnetic character figure C. C is 0. 1, or 2 according to whether or not the photographic record or magnetogram for the day is magnetically quiet, slightly disturbed or greatly disturbed, and becomes the international figure when averaged for many stations. A more quantitative measure is the u-measure based on successive day-to-day differences in horizontal intensity averaged for equatorial stations. A third measure is the K-index, introduced by J. Bartels in which one of a series of numbers from one to nine is given to each three-hour interval of each day at each participating magnetic observatory, according to the departure of any element from smooth undisturbed conditions. A fourth measure is the Q-index, rather similar to the K-index, except for being based upon ranges observed during 15-minute intervals. It is found that K-indices from 0 to 4 show little or no correlation with sunspots, whereas larger K-indices are correlated.

Magnetic disturbance is more marked at the equinoxes, the value being about 30% higher than at the solstices. Storms also tend to recur every 27 days, a consequence of the solar rotation period. Some sequences have persisted for as many as 17 solar rotations.

In 1896 K. Birkeland proposed that magnetic storms and aurora were caused by solar particles penetrating the earth's atmosphere. C. Stormer computed many paths of such solar particles in the earth's neighbourhood. Chapman and Ferraro calculated the magnetic effects of solar streams near the earth, as affected by their motion and interaction with the geomagnetic field. They concluded that the earth's magnetic field would carve out a hollow in the advancing solar stream.

Electric currents induced in the face of the advancing stream would provide geomagnetic effects, during the initial phase of a magnetic storm. Later a current ring formed from the solar stream at a distance of several earth radii, might contribute during the main and recovery phases of the storm.

It seems to be generally agreed that particles in motion along the geomagnetic field contribute to the aurora and polar disturbances. The polar electrojets show that electrically polarized gases appear in the auroral regions, but the manner in which this electric driving force is generated is obscure. However, it seems likely that positively and negatively charged particles are maintained in a slightly separated state along both a vertical and horizontal direction, in the low ionosphere. The electric field produced can contribute substantially to the production of electric currents throughout the ionosphere during storms, and serve to raise, lower and otherwise transport the higher ionosphere, as



RECORD OF RADIO REFLECTIONS. HUANCAYO MAGNETIC OBSERVATORY. PERU

RECORD OF EARTH'S MAGNETISM. HUANCAYO MAGNETIC OBSERVATORY. PERU

SURFACE OF SUN DURING RADIO FADE-OUT. PHOTOGRAPHED (2 a2 P.M.) IN RED HYDROGEN LIGHT. MT. WILSON OBSERVATORY, CALIFORNIA

FROM "TERRESTRIAL MAGNETISM AND ELECTRICITY,' BY J. A. FLEMING (MCGRAW-HILL BOOK COMPANY, INC., 1939)

FIG. 13.— PHOTOGRAPHIC RECORDS OF FADE-OUT OF RADIO SIGNALS AND MAGNETIC DISTURBANCE AND THE BRIGHT CHROMOSPHERIC ERUPTION CAUSING THEM ON AUG. 28. 1937; HEAVY VERTICAL LINES SHOW TIME IN HOURS

well as contribute to the motion and shifting of auroral rays. Differential penetration of incoming particles, accompanied by X-rays penetrating levels of only a few tens of kilometres is undoubtedly important near the auroral zone, and possibly elsewhere as well; as a very simple partial theory of storms and disturbance the vertical polarization can produce surges of storm-time type, and horizontal polarization can produce many changes in the form of bays or of the diurnally varying type. In addition, there appear to be fields of storm-time variation type originating in regions beyond the atmosphere.

There may also be dynamo effects associated with winds in auroral regions, due to heat transport from solar streams and the hot solar corona enveloping the earth.

During the International Geophysical year (*q.v.*) measurements made by earth satellites and lunar probes showed that the earth was encircled or ringed by radiation belts. An intense equatorial belt about 2,000 km. above the earth is caused by high-energy radiation from space. An outer belt, mainly of energetic electrons is of greatest strength at about 6 earth-radii. The electrons and protons in these belts undergo spiraling motions along the lines of force of the geomagnetic field, itself believed to be distorted at times by clouds of hot solar gases exerting a dragging action upon the field lines. The electrons and protons also drift across the field, and around the earth, and may penetrate into polar regions at times. An explosion of an atomic bomb in the ionosphere confirmed this conclusion. Solar gases also may compress or drag terrestrial field lines to produce an accelerating action upon protons and electrons. This may cause them to leave the radiation belts and penetrate into auroral regions, especially at about the observed local midnight. *See* also MAGNETISM; METEOROLOGY.

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(E H. V.)

GEOMETRES, JOHN (JOHN KYRIOTES) (fl. 10th century), Byzantine poet, official and bishop is known for his short poems in classical metre. He held the post of protospatharios ("officer commanding the guards") at the Byzantine court, and later was ordained priest, finally becoming metropolitan of Melitene in eastern Asia Minor. His poems, on both contemporary politics and religious subjects, are distinguished by considerable charm and appreciation of natural beauty. His prose works, largely unpublished, include a life of the Virgin Mary, consisting of a series of sermons for her feast days, and an encomium of the apple.

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(J. M. HY)

GEOMETRIC PERIOD, in architecture. the earlier of the two sections into which the Decorated period (*q.v.*) of English Gothic (see GOTHIC ARCHITECTURE) is usually divided, comprising roughly, the last half of the 13th century.

GEOMETRIC SOLIDS: see SOLIDS, GEOMETRIC.

GEOMETRIES, FINITE. The incidence axioms of projective geometry require that every line contain at least three points. If the number of points on one line is a finite number, say $n+1$, then every other line contains the same number of points and we say that the geometry is of order n. If the geometry is of dimension three or higher, then from the basic theory of projective geometry, it is Desarguesian and may be represented by co-ordinates from a division ring D. In a geometry of order n, the division ring contains exactly n elements. By a well-known theorem of J. H. M. Wedderburn, D must be a finite field, $GF(p^r)$, where $n = p^r$, p being a prime. In the k-dimensional geometry over $GF(p^r)$, designated as $PG(k,p^r)$, a point has a homogeneous representation $(\lambda x_0, \lambda x_1, \ldots, \lambda x_k)$ where $x_0, \ldots, x_k$ are fixed elements of $GF(p^r)$, not all zero, and λ ranges over all nonzero elements of $GF(p^r)$. The points whose co-ordinates satisfy a linear equation

$$c_0x_0 + c_1x_1 + \ldots + c_kx_k = 0$$

where the equation is not identically zero, form a subspace of $k-1$ dimensions; those satisfying m independent linear equations form a subspace of $k-m$ dimensions. (See ALGEBRAS [LINEAR]).

Finite projective planes include the Desarguesian planes $PG(2,p^r)$ but there are also a number of types of non-Desarguesian finite planes. All known planes are of prime power order. These include planes described by O. Veblen and Wedderburn in a paper written in 1907. In these planes there is a system of co-ordinates V with n elements. In V there is an addition $a+b$ and a multiplication ab satisfying the following conditions:

- $V1$. Addition is an Abelian group with a zero element 0;
- $V2$. $(a+b)m = am + bm$;
- $V3$. If $a \neq 0$, equations $ax = b$ and $xa = c$ have unique solutions for x;
- $V4$. There is a unit 1 such that $1b = b1 = b$ for every b;
- $V5$. If $r \neq s$, then $xr = xs + t$ has a unique solution for x.

From V we may construct a plane a whose points consist of $n+1$ infinite points designated as (m), m running over the n elements of V and a further point (∞) and also n^2 finite points (x,y) with x and y running over all elements of V. The lines are: L_∞ containing the $n+1$ infinite points; for each c of V a line containing (∞) and all points (x,y) with $x = c$; for each m and b of V a line containing (m) and all points (x,y) whose co-ordinates satisfy $y = xm + b$. The above conditions imply that $n = p^r$, p a prime, since multiplication induces automorphisms on the additive group permuting all nonzero elements transitively. A nearfield is the special case of a Veblen-Wedderburn system in which multiplication forms a group. The fields $GF(p^r)$ are of course special cases of nearfields. Replacement of the distributive law $V2$, $(a+b)m = am + bm$, by the other distributive law $V2'$, $m(a+b) = ma + mb$, gives the family of planes dual to the Veblen-Wedderburn planes.

The plane of order 2 (known as the Fano plane) contains seven points. If the points are represented appropriately by the numerals 1, 2, 3, 4, 5, 6, 7 then the lines are given as the columns of the following array:

$$\begin{array}{ccccccc} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 2 & 3 & 4 & 5 & 6 & 7 & 1 \\ 4 & 5 & 6 & 7 & 1 & 2 & 3 \end{array}$$

This is the Desarguesian plane and may be co-ordinatized by $GF(2)$ the field of the residues 0 and 1 modulo 2. Here we may take $1 = (\infty)$ $2 = (0)$, $4 = (1)$ $3 = (0,0)$, $5 = (1,0)$ $6 = (1,1)$ $7 = (0,1)$. The line $y = x + 1$, for example, contains the points 4, 5 and 7. It will be noticed that, permuting the points 1, . . . , 7 cyclically in this order, the lines are also permuted cyclically. This permutation is, therefore, a collineation. This is an instance of a general theorem proved by J. Singer, namely, that every $PG(k,p^r)$ possesses a cyclic collineation of order $(q^{k+1}-1)/(q-1)$, $q = p^r$, permuting points and hyperplanes regularly.

A nearfield of order 9 exists whose elements are of the form $au + b$, a, $b \in GF(3)$, *i.e.*, a, b residues modulo 3. Addition is given by the rule $(a_1u + b_1) + (a_2u + b_2) = (a_1 + a_2)u + (b_1 + b_2)$. The multiplication of the eight nonzero elements is the quaternion group and is determined by the rules $(au+b)c = c(au+b) = acu + bc$, $c \in GF(3)$, $(au+b)^2 = -1$, $a \neq 0$ together with the distributive law $V2$. This yields by the rules above the Veblen-Wedderburn plane (and with the opposite distributive law $V2'$, also the dual plane). This plane and its dual are distinct and are non-Desarguesian.

There is known one other non-Desarguesian plane of order nine, which is self-dual. This mas given originally by Veblen and Wedderburn in their 1907 paper and in 1957 Hughes found an infinite family of finite planes including this one. The 91 points are A_i, B_i, C_i, D_i, E_i, F_i, G_i, $i = 0, 1, \ldots, 12$ modulo 13. Seven representative lines are:

L_0	A_0	A_1	A_3	A_9	B_0	C_0	D_0	E_0	F_0	G_0
M_0	A_0	B_1	B_8	D_3	D_{11}	E_2	E_5	E_6	G_7	G_9
N_0	A_0	C_1	C_8	E_7	E_9	F_3	F_{11}	G_2	G_5	G_6

R_0	A_0	B_7	B_9	D_1	D_8	F_2	F_5	F_6	G_3	G_{11}
S_0	A_0	B_2	B_5	B_6	C_3	C_{11}	E_1	E_8	F_7	F_9
T_0	A_0	C_7	C_9	D_2	D_5	D_6	E_3	E_{11}	F_1	F_8
U_0	A_0	B_3	B_{11}	C_2	C_5	C_6	D_7	D_9	G_1	G_8

The rest of the 91 lines are given by adding 1, . . . , 12 modulo 13 to the subscripts of both points and lines.

The most striking result known on finite planes, without any further hypothesis, was found by R. H. Bruck and H. J. Ryser in 1949. This asserts that if $n = 1, 2 (\text{mod } 4)$, there cannot be a plane of order n unless n can be expressed as a sum of two integral squares, $n = u^2 + v^2$. In particular no plane of order 6, 14, 21, 22 exists and infinitely many other orders are excluded by this rule. In 1956 A. M. Gleason proved that a finite plane, in uhich every set of four points not on a line lies in a Fano subplane, is necessarily Desarguesian. T. G. Ostrom and A. O. Wagner have shown that if the collineation group of a finite plane is doubly transitive on points, the plane is necessarily Desarguesian.

See also GEOMETRY: Projective Geometry; PROJECTIVE GEOMETRY.

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GEOMETRY, one of the three principal branches of mathematics (the other two being algebra and analysis), may be described as the branch which deals with the properties of space. Its most elementary part is known to every schoolboy under the name of plane and solid geometry, the former dealing with the properties of figures in a plane, the latter nith the properties of figures in space (of three dimensions). These two subjects form. however, only a small part of geometry as the term is now understood.

The present article attempts, first, to describe briefly these two elementary topics in geometry, and secondly, to give the reader some conception of the content of geometry as a whole with references to other articles where more detailed information on the various topics may be found.

The first section of this article, a general survey of the field of geometry, covers subjects such as Greek geometry, construction problems, spaces of more than three dimensions, imaginary elements, differential geometry, projective geometry, inversion geometry, topology and primitive elements of space.

'The section on the history of geometry discusses ancient empirical and demonstrative geometries. developments during medieval times and the Renaissance. the invention of analytic geometry, modern synthetic geometry and the foundations of geometry.

The final section deals with the subject of non-Euclidean geometry

See also ANALYTIC GEOMETRY; CIRCLE; CONIC SECTION; CURVES; CURVES. SPECIAL; DESCRIPTIVE GEOMETRY; DIFFERENTIAL GEOMETRY; ELLIPSE; HYPERBOLA; INVOLUTE; LINE GEOMETRY; MANIFOLDS; MATHEMATICS, FOUNDATIONS OF; MENSURATION; PARABOLA; PROJECTIVE GEOMETRY; RIEMANNIAN GEOMETRY; SURFACE; and TOPOLOGY, GENERAL.

GENERAL SURVEY

Like most other branches of knowledge, geometry arose originally in response to man's practical needs. The word "geometry" (Gr. $\gamma\eta$, earth and $\mu\epsilon\tau\rho o\nu$, measure) means "earth measurement."

Indeed, the subject seems to have had its birth in ancient Egypt. where the periodic inundations of the Nile made the surveying of the land for the re-establishment of boundary lines a necessity. This early empirical geometry consisted merely of a number of crude rules for the mensuration of various simple geometric figures; for the laying out of angles, especially right angles, etc. (See below for details as to history.)

The ancient Greeks developed this crude beginning into the science which is now studied in the schools under the name of demonstrative geometry, the plane and solid geometry already mentioned. This form of geometry depends on the observation that the propositions of geometry are logically inter-related; *i.e.*, that, if certain propositions are granted, certain others can be proved as logical consequences of those assumed. This suggests the possibility of arranging all the propositions in a sequence such that every proposition in the list, after a certain one, is a logical consequence of some or ail the propositions that precede it. The first comprehensive and systematic attempt to exhibit the propositions of geometry in such a sequence, which has come down to us, is one of the most famous works in all literature, the *Elements* of Euclid (*q.v.*) of Alexandria (*c.* 300 B.C.). This work consists of 13 books, the first six and the last three of which are devoted to plane and solid geometry respectively. More or less literal translations of this ancient work were used to within a generation ago as textbooks in the public schools of England. The textbooks of the present time in all countries are adaptations of Euclid's Elements designed to meet the pedagogical needs of young pupils; they may claim pedagogical advantages, but at the sacrifice of some logical rigour and comprehensiveness.

The *Foundations of* Geometry.—If the propositions of geometry have been arranged in a strictly logical sequence, as above indicated, it is evident that a certain number at the beginning of the list are not logical consequences of the preceding ones. The first proposition is, of course, not a logical consequence of a preceding one; nor is it likely that the second is a logical consequence of the first. The question then, naturally, arises as to the logical status of these unproved propositions on which all the others depend. Moreover, these propositions involve certain terms, such as point, straight line, circle, etc. What meaning attaches to such terms? A definition defines a term in terms of certain others, the meaning of which is supposed known. In order to avoid defining in a circle some terms must remain undefined. The foundations of geometry must then consist, from the purely logical point of view, of a set of undefined terms and a set of unproved propositions concerning them, such that every new term can be defined in terms of the undefined, and such that every new proposition can be proved a consequence of the unproved. The unproved propositions are usually called axioms (*q.v.*) or postulates. Are these to be regarded as self-evident truths? Are they imposed on our minds a *priori,* as Kant (q *v.*) taught, and is it impossible to think logically without granting them? Or are they, in accordance with the teaching of John Stuart Mill (*q.v.*) of experimental origin? Do the undefined terms denote primitive notions, the meaning of which is clear without definition to everybody? Prevailing opinion regards a geometric theorem as true beyond possibility of doubt by a reasonable being. Will a critical inspection bear out this opinion? The answer is in the negative. Indeed, Bertrand Russell has said: "Mathematics may be defined as the science in which we never know what we are talking about nor whether what we say is true." ("Recent work on the Principles of Mathematics," *The International Monthly,* 1901.) Many a reader. in looking back on his school days, may heartily agree with this definition. Modern work on the foundations has shown that Kant was wrong and that Mill was only partly right. Logically considered, the axioms and postulates are mere assumptions. A certain writer has considered the dethroning of the "self-evident" as analogous to the change from an absolute monarchy to a democracy. The "self-evident truth," which ruled by the Divine right of the alleged inconceivability of the opposite, has been replaced by the "assumption," which is elected for its qualifications to serve (the reference is obviously to an ideal democracy).

Greek Geometry.—The more elementary part of Greek geometry is too well known to warrant a detailed exposition here. The reader will recall with pleasure or pain, but without difficulty, the theorems on the equality or congruence (to use the more modern term) of triangles, on parallel lines, on the circle, on the measurement of angles by various circular arcs, on the similarity of triangles and other figures, on regular polygons, on proportion, on perimeters and areas, etc , in plane geometry; and the various properties of planes and lines, dihedral, trihedral, and polyhedral angles, the mensuration of pyramids, prisms, cones, cylinders, and the sphere, etc., in solid geometry.

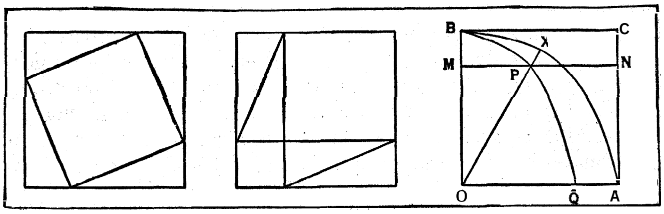

FIG. 1 FIG. 2

Among the high spots of this material we may mention the famous so called Pythagorean proposition (the square on the hypotenuse of a right triangle is equal to the sum of the squares on the other two sides) of which many proofs have been published. Among them the visual proofsare of special interest, one of which is reproduced herewith. A mere comparison of the two drawings in fig. 1 establishes the theorem. The theorem is of interest also for the problems to which it gave rise. Even in ancient times the problem of finding right triangles with integral sides, *i.e.*, to find three whole numbers x, y, and z, such that $x^2+y^2=z^2$, engaged the attention of mathematicians and was completely solved by them. The generalization to the solution in whole numbers of the equation $x^n+y^n=z^n$ is still one of the unsolved problems in the theory of numbers (see NUMBERS, THEORY OF), no solutions existing for any value of n greater than two and less than 100. Certain other famous problems deserve mention on account of their influence on the development of geometry and of mathematics in general.

The Duplication of the *Cube*.—The Athenians, so the story goes, appealed to the oracle at Delos to know how to stay the plague which visited their city in 430 B.C. The oracle replied that they must double in size the altar of Apollo without changing its shape. The altar being in the form of a cube, the problem was to find the size of a cube whose volume was twice that of a given cube. In modern notation, if a is the side of the given cube, the problem is to construct x such that $x^3=2a^3$. It must be remembered that, to the Greeks, "construct" meant construct with *ruler* and compasses only. With this limitation on the means to be employed the problem is now known to be impossible. But the attempts to solve it led to the invention of numerous new curves (*see* CURVES; CURVES, SPECIAL) and was a powerful stimulus to mathematicians through many centuries.

The Trisection of an Angle.—TO construct the bisector of any angle is one of the easiest problems in plane geometry. It was inevitable that a construction for dividing any angle into three (or more) equal parts should be sought. Again, if the construction is to apply to any angle (certain special angles such as a right angle are, of course, readily trisected) and if ruler and compasses only may be used, the problem is impossible; *i.e.*, there is no such construction. Many new curves, however, have been invented for the purpose of solution. Among these we may mention the curve that was later known as the *quadratrix*, because it furnished a solution also for the problem of squaring the circle (see below). In fig. 2 OX rotates at a uniform rate through one right angle from the position OB to the position OA, in the same time that the line MN, always parallel to OA, moves at a uniform rate from the position BC to the position OA. The intersection P of the line OX and MN then traces the curve in question. The use of this curve in trisecting an angle is almost trivially simple Let XOB be the angle to be trisected. Divide BM into three equal parts and draw lines through the points of division parallel to OA. These lines meet the quadratrix in points which if joined to O yield the required trisectors.

The Squaring of the *Circle*.—This problem, perhaps the most famous one of all, consists in constructing a square equal in area to the area of a given circle. It, too, is impossible if ruler and compasses are the only instruments permitted. The use of the quadratrix in the solution of this problem depends on the following relation. In the preceding figure it may be proved that the length of the quadrant BXA satisfies the following proportion:

$$\frac{BXA}{OA}=\frac{OA}{OQ}.$$

This makes it possible to construct a line equal in length to the circumference of the circle, from which a square equal in area to that of the circle is easily constructed. In spite of the fact that the solution of these problems by means of ruler and compasses alone has been known to be impossible for over 100 years, angle-trisecters and circle-squarers continue to appear. The best that can be said of these deluded individuals is that their enthusiasm has outstripped their scholarship. A later section of this article is devoted to the modern aspect of construction problems, and another section to developments arising from Euclid's parallel postulate.

The Conic Sections.—Partly under the stimulation of the problems just mentioned, the ancient Greeks investigated a class of curves known as the conic sections (*q.v.*), or more briefly the conics, and developed a large number of their properties. These curves arise as the plane sections of a right circular cone and have three distinct forms, the ellipse, the parabola, and the hyperbola. They have played a fundamentally important rôle in the development, not only of pure mathematics, but also in the applications. The reader may find further information in the article referred to (see also PROJECTIVE GEOMETRY). Suffice it to say that, had the conic sections not been previously studied, Kepler could not have discovered his famous laws concerning the motion of the planets, nor would we to-day have the benefit of searchlights with their parabolic reflectors. With the work of Apollonius on conics and the work of Archimedes on certain spirals and his remarkable determination of certain areas—he succeeded in finding the areas of an ellipse and of a parabolic segment—we reach the limits of ancient Greek geometry. No essential progress was made in this subject for over 1,000 years. We may, however, at this point say a few words about a more modern development, which is largely in the spirit of ancient geometry.

The Geometry of the Triangle and Circle.—This development relates to a detailed study of the triangle (*q.v.*) and circle (*q.v.*). It consists largely of the discovery of numerous points and lines connected with a triangle or circle and the discussion of their properties. Some of the latter are very remarkable. As an example, we may mention the nine-point circle related to a triangle, so-called because it passes through (a) the three midpoints of the sides, (b) the feet of the perpendiculars drawn from the vertices to the opposite sides, and (c) the mid-points of the lines joining the intersection of the three altitudes to the three vertices. This circle is tangent to the inscribed circle of the triangle, and also to the three circles which are each tangent to one side and the other two sides produced.

Descartes and the Invention of Analytic Geometry.—A new stimulus came to the development of geometry by the introduction through Descartes (1637, *q.v.*) of the so-called analytic methods. By representing a point in a plane by means of two numbers (co-ordinates), giving the distance and direction of the point from two intersecting lines (axes) of the plane, it was found possible to translate any geometric situation into an algebraic situation, whereby the powerful methods of algebra became available as a means of geometric investigation. The resulting analytic geometry (*q.v.*) is distinguished from the older or synthetic geometry by its method rather than by its content. Analytic and synthetic geometry do not then constitute two different branches of geometry; they denote, rather, two distinct methods of studying geometry. There seems to be no need, therefore, to give further details as to this method at this point; the reader should consult the article just mentioned. We may, however, try to characterize briefly the effect on the development of geometry of the introduction of these new methods.

In the first place, it provided a systematic plan for further progress A curve in the plane is represented by an equation in the variable co-ordinates (x, y) of a point on the curve. The straight lines are represented by equations of the first degree. Equations of the second degree turn out to represent the conic sections (*see* above). It was therefore natural to study next the curves represented by equations of the third degree (cubic curves); then those of the fourth degree (quartic curves); and so on. It was possible even to develop a general theory of curves of degree n. Some curves, such as the quadratrix previously mentioned. lead to equations that are not algebraic but transcendental (see EQUATIONS, THEORY OF). Similar remarks apply to the geometry of space (of three dimensions). A point in space is represented by three co-ordinates (x, y, z); an equation in these three variables represents a surface; and surfaces may then be classified according to their degree (those of the first degree being the planes), and then systematically studied.

Construction Problems. — In the second place, and closely related to the preceding, the new method gave a means of classifying the construction problems inherited from the ancients, as well as new ones. A construction problem, when formulated analytically, is found to be equivalent to the solution of an equation or to that of a system of simultaneous equations. A construction with ruler and compasses is possible only when the corresponding equations can be solved by means of the rational operations (addition, subtraction, multiplication, division) and the extraction of square roots. The equations underlying the problem of duplicating the cube and that of trisecting an angle cannot be solved without introducing irrational operations of higher order than square roots (in both these cases cube roots suffice). These problems are, therefore, impossible with ruler and compasses, as previously stated. Another problem that had a great influence on the development of algebra was that of constructing a regular polygon of a given number of sides. The ancient Greeks were able, with ruler and compasses, to construct regular polygons of three, four, five, six, eight, ten, . . . , sides; but failed in their attempts to construct one of seven sides. The determination of those values of n for which a regular polygon of n sides can be constructed with ruler and compasses led to a detailed study of the so-called cyclotomic equations, $x^n - 1 = 0$. As a result it was shown that the problem is possible only when n has the form $n = 2^k p_1 p_2 p_3 \ldots$, where each p represents a prime number of the form $2^{2^T}+1$. Since seven is not of this form, the problem is impossible when $n = 7$. It will be noted that the first prime of the required form greater than 5 is 17; the next 257. The general result given is due to K. F. Gauss (1796) (*q.v.*).

Spaces of More Than Three Dimensions. — In the third place the analytic formulation of geometry led naturally, almost inevitably, to a vast extension of the domain of geometry. Since the points of a plane could be represented by pairs of co-ordinates (x, y). the points of a space of three dimensions by triples (x, y, z) of co-ordinates, the question arises as to the geometric interpretation of a set of four independent co-ordinates (x, y, z, u) of a set of five, . . .; in general, of a set of n such co-ordinates. This led to the conception of a space of four, five, . . . , or in general of n dimensions. The precise formulation of the idea of dimension (q *v.*), as here used, need not concern us at this place. We may note, however, that the notion of a space of four or more dimensions is not, as is generally supposed, necessarily beyond our powers of concrete representation. True, a space of points of more than three dimensions is an abstract generalization to visualize which is beyond the present po ers of our imagination. But, if we use other elements than points with which to build our space, no such difficulty arises. Thus the totality of straight lines in ordinary space (of three dimensions) is four-dimensional; *i.e.*, constitutes a four-dimensional space (of lines). The totality of all spheres in ordinary space is a four-dimensional space of spheres. The corresponding geometries (line geometry and sphere geometry, see below) are just as concrete as the ordinary point geometries in the plane or in ordinary space. Nevertheless, point spaces of more than three dimensions are the ones usually thought of when n-dimensional spaces are being considered. Strangely enough, they find a large part of their interest in the field of applied mathematics. The four dimensional space-time manifold of Einstein-Minkowski is one that has recently aroused considerable popular interest in connection with the theory of relativity (*q.v.*). In the field of applied mathematics the conception of a space of more than three dimensions is generally of value in that it makes possible the application of geometric language to a problem that is essentially analytic. This language is of great convenience and is often suggestive of the relations sought. As an example we may cite the dynamical theory of gases. Suppose a gas consists of a (very large) number, N, of molecules. The dynamical condition of each of these molecules is represented by six co-ordinates, three to specify its position in space and three more to give the three components of its velocity. To describe completely the state of the gas at any instant $6N$ co-ordinates would be necessary. Jeans, in his *Dynamical* Theory of Gases, says: "We can suppose this dynamical system represented in a generalized space of $6N$ dimensions." A space of $6N$ dimensions, where N is the number of molecules in a certain volume of a gas! After this, it will cause no surprise to learn that spaces of an infinite number of dimensions have also been defined and their properties investigated. Indeed, there are several different kinds of such spaces. Before leaving this topic, it should perhaps be noted that, while we have chosen to introduce the concept of an n-dimensional space on an analytic basis, the same can be done equally well on a purely synthetic basis.

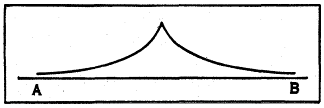

FIG. 3

Imaginary Elements. — In the fourth place, the introduction of analytic methods led to the conception of imaginary points, lines, etc., a conception which proved very fruitful. Not only did it make possible a greater generality in the statement of theorems and give a deeper insight into geometric relations, as, for example, the characterization of a circle as any conic which passes through certain two imaginary points at infinity, but it also opened up a new field of enquiry. A complex variable $x = x' + ix''$ ($i^2 = -1$) depends on two real variables x', x''. A complex line has then two real dimensions; a complex plane of points (x, y), where x and y each depend on two real variables, is a space of four real dimensions. The discussions of the one-dimensional loci on the complex line, and the one-, two-, and three-dimensional spreads in the complex plane constitutes a new world for the geometer to explore.

Finally, we should mention the fact that the introduction of the analytic method contributed largely to the idea of the unity of mathematics. There have been several instances in the preceding paragraphs not merely illustrating the possibility of regarding every geometric situation from an analytic point of view, which is, of course, the very essence of analytic geometry, but also exemplifying the fact that analytic situations may be given a geometric interpretation. It becomes increasingly difficult to distinguish analysis from geometry; these two branches of mathematics appear rather as different aspects of the same thing.

Differential Geometry. — The introduction of the differential and integral calculus (Newton and Leibniz, *qq.v.*) only a half century after the introduction of analytic geometry, greatly increased the power of the latter. The application of the fundamental ideas of the calculus to geometry introduced many new and valuable concepts. The resulting discipline is known as differential geometry (*q.v.*). Among the more elementary concepts referred to we may cite, by way of example, the curvature of a plane curve. The curvature at a point on a curve is a number which measures the sharpness of bending at that point. More precisely, if the curve is thought of as traced by a point moving with uniform speed along the curve, and this speed is taken as unity, the curvature at a point is proportional to the rate at which the tangent to the curve is turning at the instant when the moving point is at the given point. The curvature of a straight line is zero, the curvature of a circle is the same at every point and is equal to the reciprocal of the radius of the circle. This conception leads to a very beautiful theorem in the general theory of surfaces. The line drawn through a point on a surface perpendicular to the tangent plane at that point is called the normal to the surface. Let us consider the plane curves obtained as sections of our surface by planes passing through this normal — the so-called normal sections. Each of these plane curves has a curvature at the point. Among all these normal sections there will, in general, be one for which the curvature is a maximum, and'one for which the curvature is a minimum. (The exception is when all the curvatures are the same, in which case the surface is a plane or a sphere, or the point is some sort of exceptional point. We shall consider only "general" points, *i.e.,* points that are not exceptional.) The theorem referred to states that these two normal sections are always at right angles to each other. (The theorem is true, as stated, for all respectable surfaces other than planes or spheres; the exceptions may be disregarded in a survey of this kind.) Further, this theorem makes possible the definition of the so-called total curvature of a surface at a point as the product of the maximum and minimum curvatures of the normal sections just referred to. The investigation of surfaces of constant total curvature leads to the result that the only such surfaces are the plane whose total curvature at every point is zero; the sphere whose total curvature at every point is a positive constant (equal to the reciprocal of the radius squared); and the so-called pseudo-sphere whose total curvature at every point is a negative constant. (A negative total curvature indicates a saddle-shaped surface.) The pseudo-sphere is obtained by revolving about the line ***AB*** the curve (known as the tractrix) in fig. 3. These surfaces of constant curvature are of interest in connection with non-Euclidean geometry. ***(See*** below.)

Projective Geometry.— Early in the 17th century Desargues (1593–1662) proved the theorem that, if the vertices of two triangles lie on three lines meeting in a point, then their sides meet in three points lying on a line (see fig. 4). This theorem, it will be observed, has nothing to do with measurement, while the theorems of the older geometry are metric. Such theorems occur singly in the 17th century; they were not recognized as forming part of a new kind of geometry until about the beginning of the 19th century, when the so-called projective geometry *(q.v.)* was developed as a self-contained body of doctrine. If we take a photograph of a straight railroad track, with equally spaced ties, the parallel lines of the track appear in the photograph as converging, the equal distances between the ties appear unequal in the photograph, getting shorter and shorter as they recede in the picture. The right angles between the ties and the track appear as acute angles. If the landscape contains a circular pond it appears in the photograph as an ellipse. And yet the picture represents the scene; something of the actual relationships of the scene must be preserved, even though distances and angles are distorted, and parallel lines are no longer parallel. The properties of the scene that are preserved in the photograph, *i.e.,* the properties that are unchanged ("invariant" is the technical term), under the transformation produced by taking the photograph, are the properties studied by projective geometry. If the mechanism of this transformation is analysed, it is readily seen to consist of the following: Given any plane geometric figure (we confine ourselves to plane figures for the sake of simplicity), let O be any point not in the plane of the figure and think of straight lines drawn from O to every point of the figure. Let this set of lines be cut by any other plane not passing through O. This plane section of the lines through O gives a new figure in the cutting plane which is said to have been obtained from the original figure by the process of projection and section. It will be noted that in the case of our photograph the original scene is our first figure, the photographic plate is the cutting plane, while the point O is the point in the camera in which the light rays from the scene converge. Corresponding to every point of the original figure there is by this process determined a definite point in the new figure; corresponding to every straight line in the original there is a straight line in the new; if a point P in the original lies on a line l, the corresponding point P' in the new figure will lie on the line l' corresponding to l. A projective transformation consists of such a transformation by projection and section or of the result of a sequence of any number of such projections and sections. A projective transformation then transforms points into points, and straight lines into straight lines, and preserves the property of the incidence of points and lines. It does not preserve distances or angles; the latter, therefore, have no place in projective geometry as such. Its nature is to some extent characterized by calling it the geometry of position (*Geometrie* der *Lage*). It is, as to structure, a very simple geometry and an extraordinarily symmetric one. Further details must be sought in the article referred to above. Projective geometry, moreover, furnishes a scientific basis for descriptive geometry *(q.v.)* which is a branch of applied rather than of pure geometry.

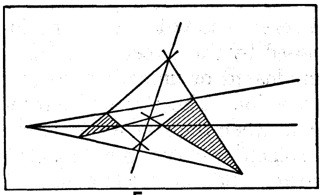

FIG. 4

The set of all projective transformations (in a plane or in space) form what is known as a group of *transformations* by virtue of the fact that the result of performing any two of the operations of the set in succession is equivalent to a third transformation of the set. Projective geometry is characterized completely by the fact that it studies those properties of figures which are invariant under the group of all projective transformations. Similarly, the set of all rigid motions in space form a group (see GROUPS). Ordinary elementary metric Euclidean geometry is then the geometry which studies those properties of figures that remain invariant under the group of all such motions. These are special cases of a fundamental principle, first enunciated by Felix Klein in 1872, to the effect that corresponding to every group of transformations in space there is a geometry consisting of those properties of space which are invariant under the given group. This principle provides at once a general classification of geometries; it also provides a systematic method of procedure in studying geometry as a whole, by the systematic investigation of all possible groups of transformations. In this project Sophus Lie *(q.v.)* laid the foundations in his theory of continuous groups. The group of motions just referred to is a sub-group of the general projective groups; other sub-groups are equivalent to the non-Euclidean (hyperbolic or elliptic) displacements; so that ordinary Euclidean and the two forms of non-Euclidean geometry are all implicitly contained in projective geometry, from which they are obtained by specialization. Furthermore, non-projective transformations may be defined by means of the projective, so that Arthur Cayley *(q.v.)* was led to exclaim: "Projective geometry is all geometry."

Inversion Geometry.—Among other geometries that have received extensive study, and in which the point is still the primary element of space, we may mention the inversion geometry in which the fundamental transformations are the so-called inversions with respect to a circle (plane inversion geometry), or with respect to a sphere (inversion geometry in space), or with respect to a hyper-sphere (in spaces of more than three dimensions).

Topology.—The set of all possible continuous transformations, *i.e.,* roughly speaking, the set of all twistings, bendings, stretchings or contractions without tearing anything apart, also form a group. The corresponding geometry is known as analysis situs. It must consider, by what has been said, those properties of figures that remain invariant under any continuous transformation whatever. Are there such properties? A simple closed curve in a plane divides the plane into two regions, an inside and an outside. This is a theorem of analysis situs. A surface may be either one-sided or two-sided (a simple one-sided surface may be obtained by taking a strip of paper and fastening together the two ends, having previously turned one of the ends over through an angle of 180°; see fig. 5) and this property is invariant under any continuous transformation. If a map is drawn on any simple closed surface, say a sphere, by any set of intersecting lines on the surface dividing the surface into a set of regions (countries), and if the number of regions is denoted by r, the number of sides (the portions of the lines between two points of intersection) by s and the number of vertices (the points of intersection of the lines) by v, then the relation $v+r=s+1$ always holds. This, too, is a theorem of analysis situs (due to L. Euler, *q.v.*). It has been stated that, given any such map, four different colours are sufficient to colour the countries in such a way that no two countries with a boundary line in common shall have

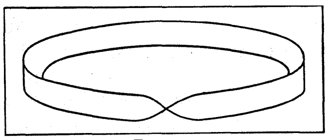

FIG. 5

the same colour. The proof of this apparently simple theorem, however, presents serious difficulties; it is still one of the unsolved problems of analysis situs.

Primitive Elements of Space.—We have hitherto assumed the point as the primitive element of space, except that once or twice we have hinted at the fact that this is not essential. In fact, the idea that some other geometric entity might be used as the primitive element, immediately opens up a new and vast field of geometric investigation. If, for example, we think of ordinary space as made up of all the straight lines in it, and study the properties of these lines and of systems of these lines, we enter the field of line geometry (*q.v.*), which, as has been said, is four-dimensional. If the sphere is taken as the primitive element of space, we obtain the so-called sphere geometry, and so on.

There are other aspects of geometry which it might be thought desirable to include in this general survey. For example, some may seek here a reference to such matters as curves without tangents, or to the so-called "crinkly" or surface-filling curves. But these are essentially problems of higher analysis in geometric garb. Others may look in vain for a discussion of the very important concept of elements at infinity in the various geometries; such a discussion will be found in the articles devoted to the geometries in question. Enough has been said, it is hoped, to give the reader some notion of the scope of geometry as a whole, and some idea of its fundamental conceptions and of the type of problem with which it deals.

BIBLIOGRAPHY.—Any one of the numerous school texts on plane or solid geometry will serve to refresh the reader's memory on these subjects. The standard edition of Euclid's *Elements* in English, is that by T. L. Heath in 3 vols. (Cambridge, 1908). For bibliographies of the various branches of geometry the reader should consult the articles referred to in this article. On certain special topics the following may be helpful: J. W. Young, *The Fundamental Concepts of Algebra and Geometry* (New York, 1911), for brief discussions of non-Euclidean geometry, construction problems, foundations of geometry, *n*-dimensional space, etc. This book presupposes no mathematical preparation beyond elementary algebra and geometry. Somewhat more mathematics is presupposed in *Monographs on Topics of Modern Mathematics*, edit. by J. W. A. Young (New York, 1911). It contains chapters on *The Foundations of Geometry* by O. Veblen; *Modern Pure Geometry* by T. F. Holgate; *Non-euclidean Geometry*, by F. S. Woods; *Constructions With Ruler and Compasses*, by L. E. Dickson. For imaginary elements in geometry *see* J. L. Coolidge, *Geometry in the Complex Domain* (Oxford, 1924). (J. W. Y.)

HISTORY OF GEOMETRY

The history of geometry may be considered under separate heads as follows: Ancient empirical geometry, ancient demonstrative geometry, sporadic developments during mediaeval times and the Renaissance, analytical geometry, modern synthetic geometry and, finally, the foundations of geometry.

Ancient Empirical Geometry.—Early Babylonian records disclose the use in auguries of triangles, quadrangles and parallel lines; drawings of Babylonian carriages indicate the division of a circumference into four and six equal parts. For angular measurement the circumference was divided into 360 equal parts or degrees, each degree into 60 minutes, and each minute into 60 seconds. Like the Hebrews (I. Kings vii. 23), the Babylonians took $\pi = 3$. One tablet reveals the approximate computation of the diagonal of a rectangle, expressed in the sexagesimal notation. More attention to geometry was given in Egypt. Greek writers state that land surveying was practised in Egypt because frequent overflows of the Nile obliterated landmarks. More reliable information is obtained from papyri and from inscriptions on the walls of temples. The Ahmes papyrus written about 1550 B.C. or, according to others, about 1700 B.C., is the most important ancient mathematical manuscript known. In this more stress is laid upon arithmetic and algebra than upon geometry. Ahmes calculates the areas of squares and rectangles; he approximates the area of an isosceles triangle by multiplying the slanting side by half the base, and of an isosceles trapezoid by multiplying half the sum of the two bases by the slant height. Remarkable is the rule for finding the area of a circle: From the diameter subtract one-ninth of it, and square the remainder. This rule implies that π nearly equals 3·16. Examples on the measurement of pyramids in Ahmes are of doubtful interpretation, but in another nearly contemporaneous papyrus (see *Ancient Egypt*, 1917), a calculation is given yielding the exact volume of the frustum of a rectangular pyramid—an astounding achievement in early Egyptian times.

The Greek geometry of Thales and his school, about the 7th century B.C., was only just emerging from the empirical stage; it dealt with such cases as the equality of vertical angles, the equality of the base angles of an isosceles triangle and the bisection of a circle by a diameter. This was a geometry of lines; Egyptian geometry was mainly one of areas and volumes. Thales's measurements of the heights of the pyramids by their shadows and of the distance of ships at sea presupposes the use of similar triangles.

Ancient Demonstrative Geometry.—The transition from empirical to rigorous demonstrative geometry was necessarily very slow. The discovery by the Pythagoreans in Italy of the existence of incommensurable magnitudes (such as the side and diagonal of a square) marks a long step toward reasoned conclusions. The story of the slaughter of a hecatomb of oxen in celebration of the discovery of a proof of the "Pythagorean theorem" of the right triangle is probably a myth, but it indicates a high appreciation of an intellectual achievement in pure geometry. Another indication of progress was the proposing, by the Sophists of Athens, of the three famous problems of construction—the squaring of the circle, the trisection of any given angle, and the duplication of a cube. These are now known to be impossible under the restrictions imposed by the Greeks—the use of a pair of compasses and an ungraduated or unmarked ruler in a finite number of steps of construction. The Greeks themselves found solutions of these problems when the above restrictions were abandoned. Hippias of Elis invented a curve, the "quadratrix," by which angles could be trisected and the circle could be squared. But the drawing of the quadratrix involved theoretically an infinite number of steps. Hippocrates of Chios, evidently hoping eventually to achieve the quadrature of the circle, successfully "squared" certain lunes and thus furnished the earliest example of a curvilinear area for which under the Greek restrictions an exactly equal area could be constructed in a plane which was bounded by straight lines. The duplication of the cube which, algebraically expressed, means constructing $X = \sqrt[3]{2S}$, where S is the side of a given cube, was solved "mechanically" by the aid of the conchoid of Nicomedes and by other means. Progress in giving definitions of fundamental concepts like "point," "line," "surface" and in giving explicit expression to axioms, was made by Plato and his pupils. The theory of proportion as related to magnitudes was developed by Eudoxus and Theaetetus. Eudoxus is credited also with the "method of exhaustion" which is not the same as the modern theory of limits, even though it involves the concept of a variable and a constant. The procedure as found in Euclid's *Elements*, bk. xii., Prop. 2, involves a part of our modern process of showing that a constant is the limit of a variable, but the Greeks did not actually pass, as we do, from the variable to its limit, but resorted, instead, to a process of *reductio ad absurdum*.

A most interesting phase in the development of the Greek philosophy of mathematics is seen in Zeno of Elea's arguments on motion. As explained in Aristotle's *Physics*, Zeno tried to prove that motion is impossible. Swift-footed Achilles could not catch a tortoise, the arrow in its flight is at any moment at rest, etc. For centuries Zeno was branded as a paralogist, but such recent writers as Paul Tannery and Bertrand Russell (*Principles of Mathematics*, 1903) advance the view that Zeno was misunderstood and that his arguments were sound and involved profound questions which have been successfully resolved only by the theory of the continuum as developed in recent mathematics. The paradoxes of Zeno, as well as Antiphon's attempt to square the circle by inscribing a series of regular polygons of an increasingly greater number of sides, the ultimate polygon coinciding with the circle, convinced Greek mathematicians that a clear and logical science of geometry could not be attained, except by eliminating the seemingly mystic concepts of infinity and of fixed infinitesimals. And thus we find Euclid excluding the infinitely little from his *Elements* by a definition (bk. v., def. 4): "Magnitudes are said to have a ratio to one another, when the less can be multiplied so as to exceed the other"; if the less were infinitely small, any finite multiple of it would still be infinitely small and could not satisfy this definition. Likewise, Archimedes, in the preface to his *Quadrature of the Parabola,* gives a postulate which he attributes to Eudoxus: If a and b are magnitudes, such that $a< b$, it shall be possible to find a finite number n, such that $na>b$. Thus in the classical writings of Euclid, Archimedes, and Apollonius of Perga, the infinitely small is carefully avoided.

Euclid was the author of several works, the most important of which is his *Elements,* written between 330 and 320 B.C. It contained 13 books, of which the first six and the last three were devoted to geometry (plane and solid), the seventh, eighth and ninth to arithmetic, and the tenth to irrationals. The proof of the theorem of Pythagoras on the right triangle is the only part of the geometry which Greek commentators definitely ascribe to Euclid. The geometrical theorems and the methods of proof (the method of exhaustion and the definition of proportion of magnitudes) appear to be due to earlier investigators. The great achievement of Euclid was the arrangement of the material handed down to him into a coherent, logical system. He ranks as a great systematizer. It is one of the marvels in the history of mathematics that the *Elements,* written in the 4th century B.C., should have established and maintained itself as a text-book in geometry for over 2,000 years. In England it was the authorized text down to the opening of the present century.

Euclid eschewed all practical applications of geometry. This attitude was abandoned by Archimedes who found the relation, $3\frac{1}{7}>\pi>3\frac{10}{71}$, needed in computing the area of a circle, and who discovered theorems on the areas of the surface of a sphere and of a cylinder, as well as on the volumes of a sphere and cylinder.

Besides the development of ordinary elementary geometry, the Greeks must be credited with the study of the conic sections (the ellipse, parabola, and hyperbola). The beginnings were made in the time of Plato; the culmination was reached in the work called the *Conic Sections,* written by Apollonius of Perga.

With Euclid, Archimedes and Apollonius, geometry reached the highest development during ancient times. Later Greek writers discovered certain curves (the conchoid of Nicomedes and the cissoid of Diocles); Pappus reached certain theorems and view points which were more fully developed in modern times. But these were the afterglow following the sunset of Greek geometry.

Mediaeval Times and the Renaissance.—The Hindus of this period did not excel in geometry. Their creative work is limited to theorems on the area and diagonals of a quadrilateral inscribed in a circle, theorems developed mainly by Brahmagupta (c. 628). The outstanding Arabic achievement was the geometric solution of cubic equations, by the method of intersecting conics, a process which had been foreshadowed by Archimedes. The fullest Arabic exposition of this topic was given by the poet Omar Khayyam. In Europe creative work began with Johann Kepler, who made use of the concepts of infinitely small and infinitely great quantities, which Euclid and Archimedes had carefully avoided in their classical writings. Kepler looked upon a circle as a polygon having an infinite number of sides, and upon a sphere as consisting of an infinite number of pyramids. He arrived at the areas and volumes of figures generated by curves revolving about a line as axis. The Italian, Bonaventura Cavalieri, a pupil of Galileo, developed the *Geometry of Indivisibles,* and succeeded in solving many of the problems on volumes which had been proposed by Kepler for solution. Researches which foreshadowed the great achievements of a more modern period are found in the work of Evangelista Torricelli, Vincenzo Viviani, Gilles P. de Roberval, and especially of Gérard Desargues and Blaise Pascal on modern synthetic geometry.

The Invention of Analytic Geometry.—Analytic geometry was created by two Frenchmen, René Descartes and Pierre de Fermat. The chief credit is rightly awarded to Descartes, who promptly published his results in his La *ge'ome'trie,* 1637; Fermat's treatise *Ad locos planos et solidos isagoge* appeared posthumously in 1679. The two main ideas involved in analytical geometry are the location of points in a figure by the use of co-ordinates and the algebraic representation of a curve or surface by an equation involving two or three variables. Of these only the latter was new in the 17th century; co-ordinate representation was practised in ancient times by Apollonius and others. Descartes's La *ge'ome'trie* does not contain a systematic development of analytical geometry in the manner found in modern texts. The method must be constructed from isolated statements occurring in different parts of the treatise. Nevertheless, it is a work of genius occupying a conspicuous place in the history of geometry. The words "abscissa" and "ordinate" were not due to Descartes. In the technical sense of analytical geometry they were first used by Leibniz in 1692, in the *Acta Eruditorum.* An important example solved by Descartes in his *La ge'ome'trie* was the "Problem of Pappus": Given several straight lines in a plane find the locus of a point such that the perpendicular drawn from the point to the given lines, shall satisfy the condition that the product of certain of them shall be in a given ratio to the product of the others. This problem afforded an excellent example of the power of the analytical method, a power which Boltzmann more recently described by saying that the formula appears at times cleverer than the man who invented it.

The cultivators of analytical geometry in the 18th century were Jean Paul de Gua de Malves, Gabriel Cramer, Leonhard Euler and, in general, the mathematicians who developed the differential and integral calculus. Thus Newton in 1704 published a classification of cubic curves. The calculus offered a general and expeditious method of finding tangents at any point of a continuous curve having derivatives.

During the 19th century, new principles were introduced into analytic geometry which afforded greater power and generality to the science. Thus the principle of duality was applied by Julius Plücker to equations of lines and curves. The duality consisted in a double interpretation of one and the same equation so that $ux+vy+1=0$, for example, could be interpreted as having two variables x, y representing co-ordinates of points, u and v being constants, or the equation could be interpreted as having two variables u, v representing lines, x and y being constants. In the first case the equation represents a straight line, in the second case, a point. By this duality, one and the same process would yield two theorems. But for the full analytic application of duality, Augustus F. Möbius and Plucker found it necessary to abandon the ordinary Cartesian co-ordinates and to introduce the more general homogeneous co-ordinates. Plucker studied the singularities of plane curves and developed four equations (the "Plucker equations") expressing the relations between the number of double points, double tangents, stationary points, and stationary tangents of a curve of a given degree and class. The discovery of these relations Arthur Cayley considered "the most important one beyond all comparison in the entire subject of modern geometry."

Etienne Bobillier and Plucker introduced an "abridged notation." J. J. Sylvester and Otto Hesse showed how processes of elimination could be simplified by the use of determinants. Particularly prominent in elaborating the higher fields of the science were Alfred Clebsch, Henri Halphen, and Jean Gaston Darboux. Curves and surfaces of higher order afford fields of never-ending research. *(See* CURVE; CURVES, SPECIAL.)

Modern Synthetic Geometry.—This was cultivated in the 19th century simultaneously with analytic geometry. The two movements occupied the same field of study, but differed in method of exposition. Rivalry existed between the followers of the two methods, which was usually but not always friendly. The continual direct viewing of figures as existing in space adds exceptional charm to the study of synthetic geometry, but the equation of the analytic method may outrun thought itself and constitutes a powerful tool in research. Jean Victor Poncelet and others used both the synthetic and the analytic methods; Jakob Steiner used only the former, Plucker only the latter. Modern synthetic geometry was first cultivated by Gaspard Monge, L. N. M. Carnot, and J. V. Poncelet in France, and by Mobius and Steiner in Germany and Switzerland, and was developed to still higher perfection by Michel Chasles in France and von Staudt in Germany. Monge in 1795 was the first to stress the "descriptive geometry" used in engineering. The principle of duality was advanced by J. D. Gergonne and Poncelet for the study of descriptive properties without reference to the analytic processes elaborated by Plücker. The use of the anharmonic or cross ratio was stressed by Steiner and Chasles.

The Foundations of Geometry.—The parallel postulate of Euclid (according to which two lines in a plane meet if the sum of the two interior angles on the same side of a transversal is less than two right angles) seemed unsatisfactory even to some of the ancient mathematicians. Proofs of it were attempted on the assumption of the other Euclidean axioms, but were always found invalid. After many failures, certain investigators tried to build up a geometry in which the postulate does not hold, in which, in other words, the angle sum in question may be less than two right angles and yet the lines may not meet, no matter how far they are produced. The result was a non-Euclidean geometry, perfectly consistent with its assumptions, developed independently by the Russian, Nicolai I. Lobachevski (1829) and the Hungarian mathematician, János Bolyai (1834). So novel were these creations that they failed to secure general attention for many years. With reference to the assumptions about parallel lines, there are now recognized three principal geometties—the "parabolic" or Euclidean based on Euclid's parallel postulate, the "hyperbolic" or Lobachevskian based on the denial of that postulate, and the "elliptic" or Riemannian geometry in which parallel lines do not exist at all. Felix Klein considered two forms of "elliptic" geometry. Two-dimensional geometric figures in the first of these geometries are visualized when drawn in a plane; those in the second geometry are partly visualized on a saddle-shaped surface like the pseudosphere; those in the third geometry are visualized on a sphere. Recently, these geometries have assumed importance in cosmological speculations. According to Albert Einstein, the universe is finite and its geometry is "elliptic."

The question of the number of dimensions has agitated mathematicians and philosophers since the time of the Greeks. The first to assume definitely the existence of a fourth dimension of space was the Platonist, Henry More, of Cambridge, England, a contemporary of Isaac Newton. But not till the 19th century did mathematicians enter upon an extensive study of geometries of higher dimensions. As a rule it was not claimed that these higher dimensions had real existence in our physical space; they were ideal creations of the human mind. However, as early as the 18th century, D'Alembert and Lagrange looked upon time, which appeared as a fourth variable in mechanics, as a fourth dimension. This idea was developed in more recent time by Hermann Minkowski and Einstein in a manner leading to a fourth dimensional world, a "fusion of geometry and physics." Said Minkowski (1908): "Nobody has ever noticed a place except at a time, or a time except at a place."

The foundations of geometry are the last part of the geometric structure to be firmly established. Italian and German mathematicians (Giuseppe Peano, 1880; Moritz Pasch, 1882; Mario Pieri, 1899) were the first to enter upon a minute study of independent, consistent and complete sets of axioms enabling the different geometries to be built up without borrowing anything from intuition. It was recognized that Euclid, who for centuries had been admired for the rigour of his demonstrations, does depend here and there upon facts not deduced from the axioms but obtained from visual inspection of the figures. Thus, in Euclid's Elements, in the very first proposition, it is assumed without proof that two circles drawn in the figure intersect each other. The study of the foundations of different geometries was continued in Germany, by David Hilbert, in France by Henri Poincaré and in the United States mainly by Oswald Veblen.

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(F. CA.)

NON-EUCLIDEAN GEOMETRY

The various metrical geometries are concerned with the properties of the various types of congruence-groups, which are defined in the study of the axioms of geometry and of their immediate consequences. But this point of view of the subject is the outcome of recent research, and historically the subject has a different origin. Non-Euclidean geometry arose from the discussion, extending from the Greek period to the present day, of the various assumptions which are implicit in the traditional Euclidean system of geometry. In the course of these investigations it became evident that metrical geometries, each internally consistent but inconsistent in many respects with each other and with the Euclidean system, could be developed. A short historical sketch will explain this origin of the subject, and describe the famous and interesting progress of thought on the subject.

History.—In 1621 Sir Henry Savile called attention to the existence of two blemishes (duo *naevi*) in geometry, namely, the theory of parallels and the theory of proportion. In both respects the work of later scholars has given rise to important branches of mathematics, while at the same time showing that Euclid is in these respects more free from blemish than had been previously credible. It was from endeavours to improve the theory of parallels that non-Euclidean geometry arose; and though it has now acquired a far wider scope, its historical origin remains instructive and interesting. Euclid's "axiom of parallels" appears as Postulate V. to the first book of his Elements, and is stated thus, "And that, if a straight line falling on two straight lines make the angles, internal and on the same side, less than two right angles, the two straight lines, being produced indefinitely, meet on the side on which are the angles less than two right angles."

To Euclid's successors this axiom had signally failed to appear self-evident, and had failed equally to appear indemonstrable. Without the use of the postulate its converse is proved in Euclid's 17th proposition, and it was hoped that by further efforts the postulate itself could be also proved. The first step consisted in the discovery of equivalent axioms. Christopher Clavius in 1574 deduced the axiom from the assumption that a line whose points are all equidistant from a straight line is itself straight. John Wallis in 1663 showed that the postulate follows from the possibility of similar triangles on different scales. Girolamo Saccheri (1733) showed that it is sufficient to have a single triangle, the sum of whose angles is two right angles. Other equivalent forms may be obtained, but none shows any essential superiority to Euclid's. Indeed plausibility, which is chiefly aimed at, becomes a positive demerit where it conceals a real assumption.

Saccheri.—A new method, which, though it failed to lead to the desired goal, proved in the end immensely fruitful, was invented by Saccheri, in a work entitled Euclides ab *omni* naevo *vindicatus* (Milan, 1733). If the postulate of parallels is involved in Euclid's other assumptions, contradictions must emerge when it is denied while the others are maintained. This led Saccheri to attempt a reductio ad *absurdum,* in which he mistakenly believed himself to have succeeded. What is interesting, however, is not his fallacious conclusion, but the non-Euclidean results which he obtains in the process. Saccheri distinguishes three hypotheses (corresponding to what are now known as Euclidean or parabolic, elliptic and hyperbolic geometry), and proves that some one of the three must be universally true. His three hypotheses are thus obtained: equal perpendiculars *AC, BD* are drawn from a straight line AB, and *CD* are joined. It is shown that the angles *ACD,* BDC are equal. The first hypothesis is that these are both right angles; the second, that they are both obtuse; and the third, that they are both acute. Many of the results afterwards obtained by Lobachevski and Bolyai are here developed. Saccheri fails to be the founder of non-Euclidean geometry only because he does not perceive the possible truth of his non-Euclidean hypotheses.

Lambert.—Some advance is made by Johann Heinrich Lambert in his Theorie der *Parallellinien* (written 1766; posthumously published 1786). Though he still believed in the necessary truth of Euclidean geometry, he confessed that, in all his attempted proofs, something remained undemonstrated. He deals with the same three hypotheses as Saccheri, showing that the second holds on a sphere, while the third would hold on a sphere of purely imaginary radius. The second hypothesis he succeeds in condemning, since, like all who preceded Bernhard Riemann, he is unable to conceive of the straight line as finite and closed. But the third hypothesis, which is the same as Lobachevski's, is not even professedly refuted.

Three Periods of non-Euclidean Geometry.—Non-Euclidean geometry proper begins with Karl Friedrich Gauss. The advance which he made was rather philosophical than mathematical. It was he (probably) who first recognized that the postulate of parallels is possibly false, and should be empirically tested by measuring the angles of large triangles. 'The history of non-Euclidean geometry has been aptly divided by Felix Klein into three very distinct periods. The first—which contains only Gauss, Lobachevski and Bolyai—is characterized by its synthetic method and by its close relation to Euclid. The attempt at indirect proof of the disputed postulate would seem to have been the source of these three men's discoveries; but when the postulate had been denied, they found that the results, so far from showing contradictions, were just as self-consistent as Euclid. They inferred that the postulate, if true at all, can only be proved by observations and measurements. Only one kind of non-Euclidean space is known to them, namely, that which is now called hyperbolic. The second period is analytical, and is characterized by a close relation to the theory of surfaces. It begins with Riemann's inaugural dissertation, which regards space as a particular case of a manifold (see MANIFOLDS); but the characteristic standpoint of the period is chiefly emphasized by Eugenio Beltrami. The conception of measure of curvature is extended by Riemann from surfaces to spaces, and a new kind of space, finite but unbounded (corresponding to the second hypothesis of Saccheri and Lambert), is shown to be possible. As opposed to the second period, which is purely metrical, the third period is essentially projective in its method. It begins with Arthur Cayley, who showed that metrical properties are projective properties relative to a certain fundamental quadric, and that different geometries arise according as this quadric is real, imaginary or degenerate. Klein, to whom the development of Cayley's work is due, showed further that there are two forms of Riemann's space, called by him the elliptic and the spherical. Finally, it has been shown by Sophus Lie, that if figures are to be freely movable throughout all space in ∞^6 ways, no other three-dimensional spaces than the above four are possible.

Gauss—Gauss published nothing on the theory of parallels, and it was not generally known until after his death that he had interested himself in that theory from a very early date. In 1799 he announces that Euclidean geometry would follow from the assumption that a triangle can be drawn greater than any given triangle. Though unwilling to assume this, we find him in 1804 still hoping to prove the postulate of parallels. In 1830 he announces his conviction that geometry is not an a *priori* science; in the following year he explains that non-Euclidean geometry is free from contradictions, and that, in this system, the angles of a triangle diminish without limit when all the sides are increased. He also gives for the circumference of a circle of radius r the formula $\pi k(e^{r/k}-e^{-r/k})$, where k is a constant depending upon the nature of the space. In 1832, in reply to the receipt of Bolyai's Appendix, he gives an elegant proof that the amount by which the sum of the angles of a triangle falls short of two right angles is proportional to the area of the triangle. From these and a few other remarks it appears that Gauss possessed the foundations of hyperbolic geometry, which he was probably the first to regard as perhaps true. It is not known with certainty whether he influenced Lobachevski and Bolyai, but the evidence we possess is against such a view.

Lobachevski.—The first to publish a non-Euclidean geometry was Nicholas Lobachevski, professor of mathematics in the new university of Razan. In the place of the disputed postulate he puts the following: "All straight lines which, in a plane, radiate from a given point, can, with respect to any other straight line in the same plane, be divided into two classes, the intersecting and the non-intersecting. The boundary line of the one and the other class is called *parallel* to the given *line*." It follows that there are two parallels to the given line through any point, each meeting the line at infinity, like a Euclidean parallel. Hence a line has two distinct points at infinity, and not one only as in ordinary geometry. The two parallels to a line through a point make equal acute angles with the perpendicular to the line through the point. If p be the length of the perpendicular, either of these angles is denoted by $\Pi(p)$. The determination of $\Pi(p)$ is the chief problem; it appears finally that, with a suitable choice of the unit of length,

$$\tan\tfrac{1}{2}\,\Pi(p)=e^{-p}.$$

Before obtaining this result it is shown that spherical trigonometry is unchanged, and that the normals to a circle or a sphere still pass through its centre. When the radius of the circle or sphere becomes infinite all these normals become parallel, but the circle or sphere does not become a straight line or plane. It becomes what Lobachevski calls a limit-line or limit-surface. The geometry on such a surface is shown to be Euclidean, limit-lines replacing Euclidean straight lines. It is, in fact, a surface of zero measure of curvature. By the help of these propositions Lobachevski obtains the above value of $\Pi(p)$, and thence the solution of triangles. He points out that his formulae result from those of spherical trigonometry by substituting ia, ib, ic, for the sides a, b, c.

Bolyai.—John Bolyai, a Hungarian, obtained results closely corresponding to those of Lobachevski. These he published in an appendix to a work by his father, entitled Appendix Scientiam *spatii* absolute veram *exhibens:* a veritate aut falsitate Axiomatis *XI.* Euclidei (a *priori* haud unquam decidenda) independentem: *adjecta* ad *casum falsitatis,* quadratura circuli geometrica. This work was published in 1831, but its conception dates from 1823. It reveals a profounder appreciation of the importance of the new ideas, but otherwise differs little from Lobachevski's. Both men point out that Euclidean geometry is a limiting case of their own more general system, that the geometry of very small spaces is always approximately Euclidean, that no a *priori* grounds exist for a decision, and that observation can only give an approximate answer. Bolyai gives also, as his title indicates, a geometrical construction, in hyperbolic space, for the quadrature of the circle, and shows that the area of the greatest possible triangle, which has all its sides parallel and all its angles zero, is πi^2, where i is what we should now call the space-constant.

Riemann.—The works of Lobachevski and Bolyai, though known and valued by Gauss, remained obscure and ineffective until, in 1866, they were translated into French by J. Hoiiel. But at this time Riemann's dissertation, *Über* die Hypothesen, *welche* der Geometrie *zu* Grunde liegen, was already about to be published. In this work Riemann, without any knowledge of his predecessors in the same field, inaugurated a far more profound discussion, based on a far more general standpoint; and by its (posthumous) publication in 1867 the attention of mathematicians and philosophers was at last secured.

Riemann's work contains two fundamental conceptions, that of a manifold and that of the *measure* of' *curvature* of a continuous manifold possessed of what he calls flatness in the smallest parts.

There are four points in which this profound and epoch-making work is open to criticism or development—(I) the idea of a manifold requires more precise determination; (2) the introduction of coordinates is entirely unexplained and the requisite presuppositions are unanalysed; (3) the assumption that ds is the square root of a quadratic function of dx_1, dx_2, . . . is arbitrary; (4) the idea of superposition, or congruence, is not adequately analysed. The modern solution of these difficulties is properly considered in connection with the general subject of the axioms of geometry.

Helmholtz.—The publication of Riemann's dissertation was closely followed by two works of Hermann von Helmholtz, again undertaken in ignorance of the work of predecessors. In these a proof is attempted that ds must be a rational integral quadratic function of the increments of the coordinates. This proof has since been show? by Lie to stand in need of correction. Helmholtz's remaining works on the subject are of almost exclusively philosophical interest.

Beltrami.—The only other writer of importance in the second period is Eugenio Beltrami, by whom Riemann's work was brought into connection with that of Lobachevski and Bolyai. As he gave a convenient Euclidean interpretation of hyperbolic plane geometry, his results will be stated at length. The *Saggio* shows that Lobachevski's plane geometry holds in Euclidean geometry on surfaces of constant negative curvature, straight lines being replaced by geodesics. Such surfaces are capable of a conformal representation on a plane, by which geodesics are represented by straight lines (see ANALYSIS, COMPLEX). Hence if we take, as coordinates on the surface, the coordinates of corresponding points on the plane, the geodesics must have linear equations.

Transition to the Projective Method.—The *Saggio* gives a Euclidean interpretation confined to two dimensions. But a consideration of the auxiliary plane suggests a different interpretation, which may be extended to any number of dimensions. If, instead of referring to the pseudosphere, we merely define distance and angle, in the Euclidean plane, as those functions of the coordinates which gave us distance and angle on the pseudosphere, we find that the geometry of our plane has become Lobachevski's. All the points of the limiting circle are now at infinity, and points beyond it are imaginary. If we give our circle an imaginary radius the geometry on the plane become elliptic. Replacing the circle by a sphere, we obtain an analogous representation for three dimensions. Instead of a circle or sphere we may take any conic or quadric. With this definition, if the fundamental quadric be $\Sigma xx=0$, and if $\Sigma xx'$ be the polar form of Σxx, the distance ρ between x and x' is given by the projective formula

$$\cos(p/k)=\Sigma xx'/\{\Sigma xx\cdot\Sigma x'x'\}^{\frac{1}{2}}.$$

That this formula is projective is rendered evident by observing that $e^{-2ip/k}$ is the anharmonic ratio of the range consisting of the two points and the intersections of the line joining them with the fundamental quadric. With this we are brought to the third or projective period. The method of this period is due to Cayley; its application to previous non-Euclidean geometry is due to Klein. The projective method contains a generalization of discoveries already made by Laguerre in 1853 as regards Euclidean geometry. The arbitrariness of this procedure of deriving metrical geometry from the properties of conics is removed by Lie's theory of congruence. We then arrive at the stage of thought which finds its expression in the modern treatment of the axioms of geometry.

The Two Kinds of Elliptic Space.—The projective method leads to a discrimination, first made by Klein, of two varieties of Riemann's space; Klein calls these elliptic and spherical. They are also called the polar and antipodal forms of elliptic space. The latter names will here be used. The difference is strictly analogous to that between the diameters and the points of a sphere. In the polar form two straight lines in a plane always intersect in one and only one point; in the antipodal form they intersect always in two points, which are antipodes. The antipodal form may be called a "quasi-geometry." Similarly in the antipodal form two diameters always determine a plane, but two points on a sphere do not determine a great circle when they are antipodes, and two great circles always intersect in two points. Again, a plane does not form a boundary among lines through a point: we can pass from any one such line to any other without passing through the plane. But a great circle does divide the surface of a sphere. So, in the polar form, a complete straight line does not divide a plane, and a plane does not divide space, and does not, like a Euclidean plane, have two sides. But, in the antipodal form, a plane is, in these respects, like a Euclidean plane.

Finally, it is of interest to note that, though it is theoretically possible to prove, by scientific methods, that our geometry is non-Euclidean, it is wholly impossible to prove by such methods that it is accurately Euclidean. For the unavoidable errors of observation must always leave a slight margin in our measurements. A triangle might be found whose angles were certainly greater, or certainly less, than two right angles; but to prove them *exactly* equal to right angles must always be beyond our powers. If, therefore, any man cherishes a hope of proving the exact truth of Euclid. such a hope must be based, not upon scientific, but upon philosophical considerations.

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For expositions of the whole subject, *see* F. Klein, *Nicht-Euklidische Geometrie* (1893); *R*. Bonola, *La Geometria non-Euclidea* (1906); *P*. Barbarin, *La Géométrie non-Euclidienne* (1902); *W*. Killing, *Die nicht-Euklidischen Raumformen in analytischer Behandlung* (1885). The last-named work also deals with geometry of more than three dimensions; in this connection *see* also G. Veronese, *Fondamenti di geometria a pi3 dimensioni ed a più specie di unità rettilinee* . . . (1891, German trans., 1894); G. Fontene, *L'Hyperespace à (n–1) dimensions* (1892); A. N. Whitehead, *Universal Algebra* (1898); *E*. Study, "Über nicht-Euklidische und Liniengeometrie," *Jahr. d. Deutsch. Math. Ver.* (1906); W. Burnside, "On the Kinematics of non-Euclidean Space," *Proc. Lond. Math. Soc.* (1894). *A* bibliography on the subject up to 1878 was published by G. B. Halsted, *Amer. Journ. of Math.* vols. i. and ii.; and one up to 1900 by R. Bonola, *Index operum ad geonzetrianz absolutam spectantiurn* . . . (1903).

GEOPHYSICAL PROSPECTING (GEOPHYSICAL EXPLORATION, APPLIED GEOPHYSICS) is the application of the principles of physics to the study of subsurface geology, particularly as related to exploration for ore, oil and gas deposits. Geophysical exploration is used for other purposes, including (1) the location of ground water supplies; (2) the determination of thickness and type of soil; (3) the kinds of rock and their depths and surface configurations; (4) the in situ determination of the physical and dynamic properties of soils and rocks; (5) the thickness of ice at sea and on the polar ice caps; (6) the depth of water in oceans and lakes and the nature and thickness of bottom sediments; and (7) the structure and composition of the earth's crust.

The techniques of measurement employed are based on the fundamental principles of those fields of physics represented by gravity, magnetism, electricity, light, sound, heat and radioactivity. The measurements are usually conducted at ground level: but may be made in bore holes or in underground mine workings. In water-covered areas the instruments are either placed on bottom or suspended in the water, and some of the measurements can be made from aircraft.

The success of all geophysical methods depends upon there being a contrast between the physical properties of the material being investigated or sought and those of the surrounding material. The properties exploited are magnetic susceptibility, density, elasticity, electrical conductivity. thermal conductivity and radioactivity. If a substance, such as oil, does not in itself provide a marked enough difference from its surroundings to be detected, then it frequently can be located indirectly through an association with some stratigraphic or structural geologic condition (anticline, fault, buried valley, etc.) which can be geophysically mapped. In the case of disseminated ore minerals where there is no well-defined lode of material, indirect location may be achieved through being able to map the subsurface extent of the host rock, such as an intrusive or associated buried structure. (*See* GEOLOGY.)

METHODS

In accordance with the physical properties of geologic materials that can be utilized for measurements, the methods of applied geophysics can be subdivided into gravitational, magnetic, seismic, electrical, electromagnetic, geothermal and radioactive methods. In nearly all cases the results obtained must be interpreted geologically. Hence, the analysis of the results plays just as important a role in the successful use of geophysical studies as does the choice of measurement used and the care with which the measurements are made.

From the standpoint of interpretation geophysical methods can be subdivided into two groups: (1) methods without depth control; and (2) methods having depth control. In the first group the measurements incorporate spontaneous effects from many sources, both local and distant, over which the observer has no control. For example. a gravity measurement is affected by the change in earth radius with latitude and the earth's rotation, the elevation of the site relative to sea level, the local topography, the thickness of the earth's crust. the configuration of the underlying crystalline rock complex and the density of the intervening rocks, as well as by any abnormal mass variation that might be associated with a mineral deposit. Therefore, the successful interpretation of gravity data depends on: (1) the accuracy with which the effects

	Method		Field	Geologic Application	
Spontaneous Action	I. Gravitational	A. Torsion balance B. Pendulum C. Gravimeter	Oil, mining, geodesy	Anticlinal structures; buried ridges, salt domes; faults, intrusions; ore; bodies; reefs; major structural trends	No depth control
Spontaneous Action	II. Magnetic		Oil, mining	Anticlinal structures; buried ridges; intrusions; faults; iron, pyrrhotite; and associated sulfide ores; gold placers	No depth control
Spontaneous Action	III. Electrical	A. Self-potential	Mining	Sulfide ore bodies	No depth control
Reaction to energizing fields	III. Electrical	B. Galvanic application of primary energy 1. Potential distribution of secondary field, measured a. Equipotential line methods b. Resistivity c. Potential drop ratio	Mining, civil engineering, oil	General stratigraphic and structural conditions; bedrock depth on dam sites; ground water; oil structures; sulfide ore bodies; highway problems; electrical logging	Control of depth of penetration
Reaction to energizing fields	III. Electrical	2. Electromagnetic field, measured	Mining	Iron formation; sulfide ore bodies	Control of depth of penetration
Reaction to energizing fields	III. Electrical	C. Inductive application of primary energy	Oil, mining	Faults; anticlinal, etc., structures; sulfide ore bodies	Control of depth of penetration
Reaction to energizing fields	IV. Seismic	A. Refraction	Oil, civil engineering, crustal structure	Salt domes; anticlinal, etc., structures; faults; foundation and highway problems; ground water; marine sediments	Control of depth of penetration
Reaction to energizing fields	IV. Seismic	B. Reflection	Oil	Low-dip structures; buried ridges; faults; reefs	Control of depth of penetration

SUMMARY OF THE FOUR MAJOR GEOPHYSICAL PROSPECTING METHODS

of known controls related to position and elevation are evaluated; (2) the accuracy with which the residual obtained is subdivided into contributions from regional controls of unknown magnitude related to variations in crustal thickness, basement rock lithology, etc., and those of local origin; and (3) how well knowledge of geologic factors concerning structure or modes of ore deposition can be applied in deducing the significance of the final residual, particularly as to whether this residual represents the effect of a shallow, thin body or a deeper, thicker or more concentrated body. With so many variables it is not possible to make a quantitative analysis leading to an unambiguous solution. In the last stages the interpretation always depends upon the geologic knowledge of the interpreter and his success through trial calculations in finding a reasonable geological model whose gravity effect matches that observed. This in itself, however, is no guarantee that the interpretation is correct. It is a possible interpretation that may even be probable but never unique. The above limitations also apply to the interpretations of magnetic, electrical self-potential, thermal and radioactive measurements.

In the second group of measurements (those with depth control), energy (seismic or electric) is introduced into the ground and variations in transmissibility with distance are observed and interpreted in terms of geologic quantities. The depth of investigation with these techniques is governed by the spacing between the transmitting and reception points. It is thus possible to separate shallow effects from those having a deep origin. By the application of suitable physical theory, depths to geologic horizons having marked differences in transmissibility can be computed on a quantitative basis and the physical nature of these horizons deduced. The accuracy, ease of interpretation and applicability of all methods falling into this group are not the same, and there are conditions, both natural and economic, under which the measurements of the first group are preferable for exploration studies despite their inherent limitations.

In each group (gravity, magnetic, seismic, etc.) there are subdivisions related to variations in technique, instrumentation or quantities measured. A summary of methods and their geologic applications is given in the Table. Details on some of the methods with special reference to rock properties, instruments and interpretation procedures are given in the following sections.

Gravity Methods.— Gravity methods are based upon the measurement of physical quantities related to the gravitational field which in turn are affected by differences in densities and disposition of underlying geologic bodies.

The density values of a few minerals for which gravity prospecting has been done are: Pyrite, 4.9–5.2; pyrrhotite, 4.5–4.7; galena, 7.4–7.6; barite, 4.3–4.5; magnetite, 4.9–5.2; lignite, 1.1–1.2. Concentrations of economic value of these minerals occur in rock materials usually having a density varying from 2.6–2.8 gm/cc. In oil and gas exploration, where there is no direct density control associated with the material being sought, exploration is based on the mapping of geologic structures to determine situations that might localize the material being sought. In such cases the significant density values are: Salt, 2.1–2.2; igneous rocks, 2.5–3.0; sedimentary rocks, 1.6–2.8. The last value increases with depth due to consolidation and geologic age and as a result structural deformation associated with faults and folding can be detected. Compaction of sediments over ridges or knolls on the underlying crystalline rock surface also leads to a local increase in mass, as does the development of calcareous cap rock over the heads of intrusive salt columns. In the later situation the high density value may be superimposed upon a broader low value related to the deficiency in mass associated with the salt column as a whole. In the early days of gravity prospecting both the Eötvös torsion balance for determining gravity gradient and pendulum apparatus were extensively employed, but these have been supplanted by spring balance systems (gravimeters). The latter can be read in a matter of minutes in contrast to the several hours required for obtaining readings with the earlier instruments. While gravimeters vary in design those in common use consist essentially of a weighted boom that pivots about a hinge point. The boom is linked to a spring system so that the unit is essentially unstable and hence very sensitive to slight variations in gravitational attraction. Deflections of the boom from a central "null" position are measured by observing the change in the tension in the spring system required to bring the boom back to that position. Readings are obtained from a graduated dial on the head of the instrument which is attached to the spring system through a screw. (Gravimeters therefore do not read the force of gravity directly, and only indicate differences in gravitational attraction.) There must be an accurate calibration of the screw, reading dial and spring response for the readings to have gravitational significance. Two methods of calibration are employed: (1) a series of comparative readings is taken between sites for which the change in gravity is known from pendulum measurements; or (2) the instrument is tilted through a known angle and readings are taken for simulated changes in gravity (calculated on the basis that tilting results in an apparent decrease in gravity which varies as the cosine of the angle of tilt).

Relative gravity measurements using a pendulum can be used as a calibration standard, since these are free from side effects so long as the physical dimensions of the pendulum and environment of oscillation remain constant. The only factor having significance then is the change in a period of the pendulum in moving from one site to another.

For discussion of the design, construction, sensitivity and uses of pendulums and gravimeters see GRAVITATION: The *Measurement* of Gravitational Forces: *Measurement* of the *Intensity* of Gravity.

By placing gravimeters on bottom in shallow water areas in watertight housings with automatic leveling and electronic recording, it is possible to carry out gravimeter surveys in inundated areas as well as on land. Special gravimeters have been developed for use in submarines and on gyrostabilized platforms on surface ships! and it has been demonstrated that these instruments can be used in aircraft.

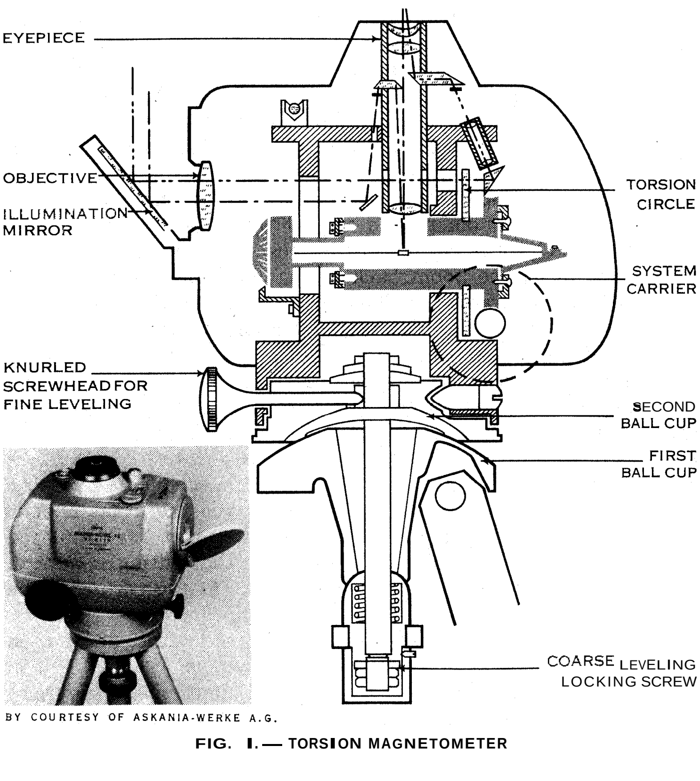
With the high sensitivity of modern gravimeters, changes in the length of the springs with time (drift) must be corrected for, as well as the fluctuation in gravity due to the tidal pull of the sun and the moon. The former can be evaluated only by a systematic series of repeat measurements at control bases; the latter can be calculated from suitable tables or determined empirically by direct observation with a stationary instrument. The final observed gravity values are then corrected for latitude, elevation, terrain, etc., to obtain residuals (anomalies), as discussed previously before they can be utilized for evaluating subsurface geologic conditions. In oil prospecting, observations usually are made at one-mile intervals; in mineral prospecting, observations may be required at intervals of 100 ft.

Magnetic Methods. — Magnetic methods are based upon measuring the magnetic effects produced by varying concentrations of ferromagnetic minerals. Of these, magnetite is the most common mineral and has the greatest magnetic susceptibility, pyrrhotite being appreciably less susceptible and the other common iron minerals are but weakly magnetic.

Instruments used for magnetic prospecting vary from the simple mining compass used in the 17th century to sensitive airborne magnetic units permitting intensity variations to be measured with an accuracy greater than $\frac{1}{10,000}$ part of the earth's field. It is possible to measure any angular or intensity component, but total intensity and vertical intensity anomalies can be most easily interpreted.

One of the most widely used magnetic instruments is the Schmidt vertical magnetometer. It consists of a pair of blade magnets balanced horizontally on a quartz knife edge.

The balance is oriented at right angles to the magnetic meridian



BY COURTESY OF ASKANIA-WERKE A.G.

FIG. 1.— TORSION MAGNETOMETER

and the deflection from the horizontal observed. Thus, magnetic vertical intensity is compared with gravity (assumed to be constant); the deflections of the system are read on an autocollimation telescope (see COLLIMATOR).

Instrument readings are converted into gammas (10^{-5} gauss units) using a calibration factor established by placing the system in a Helmholtz coil and then observing deflections for known electric currents in the coil. The torsion fibre magnetometer (see fig. 1) is another type vertical component instrument that has a greater operating range than the Schmidt type instrument It also has an advantage in that it is easier and quicker to read. The instrument values are referred to a base, corrected for temperature and diurnal variation (see GEOMAGNETISM), and corrected for the normal geographic variation of the earth's magnetic field. Since the end of World War II continuous-recording magnetic instruments have been used. These can be divided into magnetic saturation induction, earth inductor and free proton precession instruments. The magnetic saturation induction instrument has been most widely used. While designs vary, the instrument basically consists of a highly permeable magnetic core of permalloy, mumetal or the like, two opposed identical primary windings, a surrounding secondary winding and an external neutralizing coil. The action of a saturation induction element depends on the core, which becomes completely saturated in magnetic fields of only a few gauss. The core is in the form of a long wire or strip to prevent demagnetizing effect and a primary coil is wound on it; weak currents in the primary carry the core to saturation, and for each cycle of current in the primary the core goes through a so-called saturation or hysteresis cycle. The saturation induction unit measures the change in external magnetic field along the core's length axis. The unit is oriented vertically to record changes on the earth's vertical component. In this position it is subject to an error of 250 γ per degree error in level in the magnetic meridian plane and 16 γ per degree error in level perpendicular to the meridian plane. Aligned along the earth's total intensity vector the error is approximately 16 γ per degree off orientation. The unit, therefore, can best be used to measure changes in total intensity. Recording is done graphically. using a continuous chart recorder. The scale sensitivity of the resultant magnetogram can be varied by means of a selector switch and set to give a full-scale deflection on the record chart equal to 50, 100, 200. 1,500, or 5,000 gammas. The value of the base line of the record chart can also be changed in steps varying from 50 to 5,000 gammas. When used in aerial prospecting. the detector element is usually housed in a streamlined "bird" which is towed behind and beneath the plane on a cable about 100 ft. long, thus eliminating the magnetic effect of the plane. Wing tip and spar installations of the sensing head have also been successfully used.

As elevation is critical with such measurements, several methods have been used to determine the position of the plane in space. On land surveys a gyroscopically stabilized, continuous-strip camera is used together with a recording radio altimeter. The three records are co-ordinated by an electrical system and marked and numbered simultaneously by a keying device. Another method for use over water or other unmapped areas involves the use of Shoran (short range navigation) a radio navigation aid. With this system the distance from two ground stations is measured electronically and is constantly recorded and co-ordinated with the total magnetic intensity chart. Knowing the position of the ground stations, it is then possible to locate the traverse lines without maps or other information.

The Varian nuclear precession magnetometer is another continuous recording magnetic instrument which measures the earth's total magnetic field by observing the free precession (progressive movement) frequency of the protons in a sample of water. Spinning protons in a sample of water tend to orient their axes parallel to any magnetic field that is present. If the protons are reoriented by a strong magnetic field at right angles to the earth's field and the inducing field is then caused to decay quickly, the protons start to precess around axes parallel to the earth's field. They start in phase and a small electromagnetic force (e.m.f.) is induced in a coil placed near the sample. The frequency of this e.m.f. is proportional to the field causing the precession and inversely proportional to the angular momentum. If this precession frequency is accurately measured, it is possible to determine the total field to an accuracy of 2 gammas.

The interpretation of magnetic measurements is subject to the same fundamental drawbacks mentioned in connection with gravity measurements as regards the contrast in physical properties present, depth of origin and integrated contributions from many sources, plus effects related to permanent versus induced magnetization from the earth's magnetic field, changes in strength and direction of the earth's field with location and the cancelling effect related to proximity of opposite induced poles at the boundaries of finite geologic bodies. Despite the difficulties of interpretation, the method has proved valuable in exploration for magnetic mineral deposits, in the determination of geologic structural trends and in estimating the probable depth of the crystalline rock floor beneath sedimentary rock areas. *(See* also MAGNETISM: *Measurement of Magnetic Quantities.)*

Seismic Methods. — Seismic methods are based on determinations of the time interval that elapses between the initiation of a sound wave from detonation of a dynamite charge or other artificial shock and the arrival of the vibration impulses at a series of seismic detectors (geophones). *(See* also SEISMOGRAPH.) The arrivals are amplified and recorded along with time marks (.01 sec. intervals) on a moving photographic paper strip by the use of galvanometers to give a seismogram, or are first recorded on magnetic tape that can be played back and recorded as above for various filter systems. The latter system thus permits greater scope for analytical studies than is possible with the conventional seismogram. Seismic wave propagation is analogous to that defined by optical theory for the refraction and the reflection of light *(see* REFRACTION). The depths and media reached by seismic waves depend on the distance between shot point and receiving points.

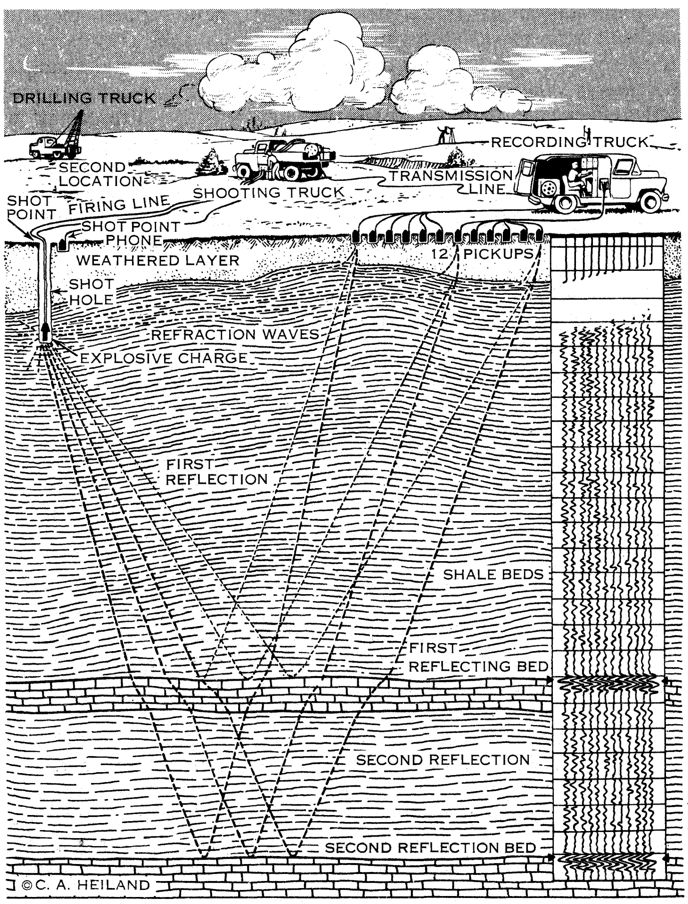


FIG. 2.— SEISMIC REFLECTION METHOD FOR GEOPHYSICAL PROSPECTING
Field equipment is shown above, seismic wave paths below and a seismogram at the right

The first impulses or "breaks" in a seismogram *(see* fig. 2) are caused by waves which have traveled via the quickest path between the shot point and any receiving point. At short distances this is usually also the shortest path, but beyond a certain distance it is quicker for a refracted pulse to travel via a longer path involving underlying layers having a higher velocity. From a plot of travel time as a function of surface distance, data are obtained for determining both the velocity of the material and number of layers present. From the distances at which changes in velocity are indicated the depth of each layer can be computed. The method depends upon (1) the velocity within each of the layers penetrated at depth being greater than that in the layers above; (2) the layers are bounded by plane surfaces; and (3) the material within each layer is essentially homogeneous Under the conditions which are commonly encountered in areas having sedimentary deposits other than limestone. these conditions are commonly satisfied. As discussed under *Gravity Methods,* above, in general the deeper, older formations as a result of higher compression have a higher density and also a higher seismic velocity than the overlying material *(see* also EARTH: *Origin, Composition* and ***Age;*** EARTHQUAKE). As the velocity values determined from the travel-time plot are governed by the slope of the underlying surfaces as well as the nature of the material itself, being greater than normal when receiving up slope and less than normal when receiving down slope, it is customary to record in opposite directions over the same surface area. Observed differences in velocity define not only the direction of slope of the rock surfaces, but also provide information for computing the degree of slope present. Where conditions of downward refraction are encountered in the sedimentary column. as is obtained when a high velocity limestone is underlain by a lower velocity sandstone, there may be no direct evidence in the arrivals of this condition and the calculated values for the depth of any horizons below the limestone will be seriously in error. For what might be termed "normal" conditions (increase in velocity with depth) the error in depths determined is usually less than 10% with this method.

For purely qualitative studies for locating marked horizontal discontinuities in transmissibility, such as are occasioned by intrusive bodies or faults of large displacement, the technique of "fan shooting." a variation of refraction shooting, is employed. Here the apparent velocities along several azimuths from a shot point are recorded. Any velocity abnormalities on one or more azimuths will thus give a bearing on disturbed structure. Cross fan recordings across the area will further define the nature and position of the structural abnormality.

Reflection impulses depend upon the reflection of seismic waves from media of greater elasticity at depth. Their time of arrival depends on the average velocity between surface and reflecting surface and the distance between the shot point and receiving points. *(See* SOUND: Sound *Measurements.)* In essence the method depends upon determining the time for an echo. As in the refraction method, a travel-time graph is plotted. Because of the geometry of the travel path a parabolic plot is obtained. The degree of symmetry of the plot about a central axis defined by the shot point with recording on cross axes portrays the degree of inclination of the buried reflecting horizons. As the travel times for reflected waves are markedly influenced by the low velocity of the near-surface material lying above water table, a correction for the so-called "weathering layer" is important in all reflection studies. This correction can be determined empirically by a short refraction measurement to determine both the velocity and thickness of this layer. The average velocity that is used in computing reflection depths is best determined from velocity measurements in bore holes. Where such control cannot be obtained a value can be derived from a plot of the square of the travel time as a function of the square of the distance. The slope of the resulting graph gives a value that defines the square of the average velocity. Where there is good velocity information and reflecting horizons, the reflection method has been found to have an accuracy of about 1% in depicting subsurface structure.

Because the surface distance required for a reflection measurement is so much less than that required for a refraction measurement in exploring to any depth, there are many advantages to be gained from using the method: (1) The short spread of instruments required eliminates the problem of getting permission to work over several tracts of land; (2) permits "spot" determination of depths rather than average values over an area as is the case in deep refraction studies; (3) requires small charges of explosives and even allows mechanical methods to be employed as a source of energy; (4) permits rapid observations, since a minimum amount of observational data is required. In general, therefore, the reflection method is employed for all deep exploration work. Resolution at depths shallower than 200 ft. is usually not possible because the time interval between the first refraction arrival and the first reflection arrival at these depths is so short that there is not time enough to damp out the first motion sufficiently for the reflection arrival to be recognized.

The refraction method is therefore commonly used for shallow engineering studies, and has also been found to be useful in deep exploration in certain areas where good reflections can not be obtained and for studies of crustal structure at depths of 10 to 50 km.

Electrical Methods. — With the exception of the self-potential method, electrical prospecting methods depend upon differences in electrical conductivity between the geological bodies under study and the surrounding rocks. Metallic minerals, particularly the sulfides, range in resistivity from 1.0 to several ohm-cm.; consolidated sediments of low water content average about 10^4 ohm-cm.; igneous rocks range from 10^4 to 10^6 ohm-cm. and saturated unconsolidated sediments, from 10^2 to 10^4 ohm-cm. The resistivity of the latter depends largely on the amount and electrolytic nature (salinity) of the included water.

The self-potential method makes use of the fact that most metallic sulfide minerals are easily oxidized by downward-percolating ground water. Because of the surface oxidation of such ore bodies the elements of a simple chemical battery are established and a spontaneous electric current flows down through the ore body and back to the surface through thk surrounding water-saturated ground, which acts as the electrolyte. It is possible to locate these localized electrical fields and hence ore bodies by mapping points of equal electrical potential at the surface using non-polarizing electrodes and a sensitive ammeter, or a milliammeter, or by measuring potential differences between successive profile stakes forming a grid over an area using a potentiometer.

In all other electrical methods, electrical energy is supplied to the ground either galvanically or inductively. Direct current or alternating current of low frequency is usually used. In the equipotential-line method, power is supplied to two points or line electrodes; the equipotential lines are traced by two search electrodes connected through an audio-amplifier with headphones in the output; one of the probes is held stationary and the other is moved until the sound disappears. The presence of a good conductor is indicated by the spreading of the equipotential lines and a poor conductor, by the drawing together of the equipotential lines (*see* fig. 3). Interpretation is largely qualitative and empirical.

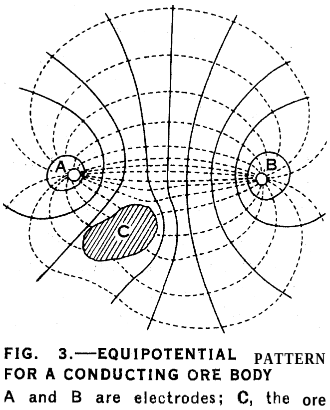
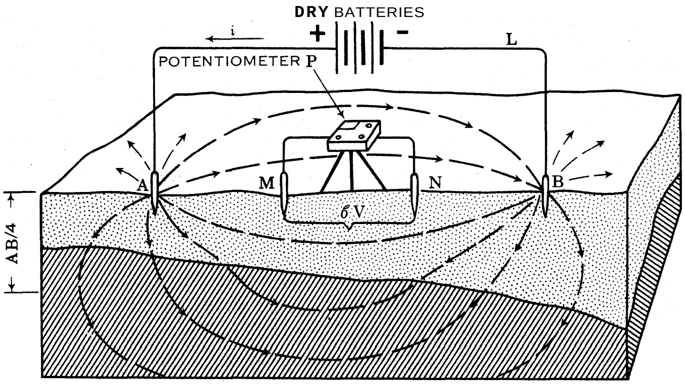


FIG. 3.—EQUIPOTENTIAL PATTERN FOR A CONDUCTING ORE BODY
A and B are electrodes; C, the ore body. Solid lines indicate equipotential; dashed lines, current flow

A potential method that is used extensively is known as the "resistivity" method. Four evenly spaced electrodes are driven into the ground; the external pair is supplied with current from batteries or an alternating current source that is read on a milliammeter, while the internal pair is connected to a potentiometer to determine the voltage difference between them (fig. 4). To avoid polarization effects, nonpolarizing potential electrodes can be used, or a commutator inserted in the circuit so that the current through the ground changes in direction every half cycle but retains the same direction through the instrument. The ratio of



FROM C AND M. SCHLUMBERGER'S "SECOND CONGRESS ON LARGE DAMS," VOL. IV (1936); REPRODUCED BY PERMISSION OF INTERNATIONAL COMMISSION ON LARGE DAMS OF THE WORLD POWER CONFERENCE

FIG. 4.— ELECTRICAL RESISTIVITY METHOD

voltage and current, multiplied by a factor depending on electrode spacing, gives the true resistivity for homogeneous ground, or the so-called "apparent resistivity" for nonhomogeneous ground. The depth of effective penetration is about one third the distance between the two outer electrodes. If the electrode arrangement is moved over the ground with constant spacing, variation of resistivity in a horizontal direction to a fixed depth is obtained. This method is quite useful for determining the presence of any horizontal discontinuities, such as, for example, rock rising near the surface along the line of a proposed highway. By keeping the centre of the electrode arrangement fixed and expanding the spacing of the electrodes about this centre point changes in resistivity with depth can be determined and their depth deduced. This method has been extensively used in subsurface engineering studies as, for example, in the determination of the depth to bedrock beneath river bottom alluvium.

Interpretation of resistivity results is handicapped by the marked effects of variations in soil moisture and the chemistry of the interstitial water as well as by vertical and horizontal changes in lithology; the potential differences measured represent accumulative effects from the entire section penetrated. Interpretation techniques employed include the matching of plots of apparent resistivity as a function of electrode spacing against theoretical "type" curves, the location of inflection points, breaks. changes in slope of logarithmic plots of the results, accumulative resistivity value plots and other methods of a somewhat more quantitative nature. Best results in the use of resistivity values for determining depths have been obtained where it has been possible to use well data to establish local empirical correlations between the resistivity plots and geologic depth data.

A special application of electrical methods is in the study of subsurface stratigraphy by measuring the potential differences between the surface and an electrode lowered in a bore hole and by also measuring variations in electrical resistivity with depth. Both measurements must be carried out before a hole is cased. The procedure is known as electrical logging. The potential log gives a measure of porosity and permeability since the measurements are markedly affected by the ability of the drilling fluid to penetrate the formations and the contrasts in electrolytic properties of the formational fluid and the drilling fluid. The resistivity measurements define the position of formational boundaries and the physical character of the lithology. Three resistivity logs usually are taken: one having shallow penetration is used for defining the location of formational boundaries and the other two, having intermediate and deep penetration, are used for determining the extent the drilling fluid has penetrated into the formations and the true resistivity of the formation present. The various measurements taken in conjunction provide a valuable tool for not only studying conditions in a given well but also for carrying out correlation studies between wells and thus defining geologic structure and horizontal changes in lithology.

Electromagnetic Methods. — The electromagnetic methods are based upon the fact that an alternating magnetic field will cause an electric current to flow in conducting material. Since most metallic minerals are good electrical conductors the method is best suited for their exploration. Measurements are carried out by connecting a source of alternating current to a coil of uire which acts as a source for a magnetic field similar to that which would be produced by a short magnet located on the axis of the coil. The magnetic field of the coil alternates in intensity in the same manner that the coil current alternates. A receiving system consisting of a second (search) coil connected to a voltmeter is mounted so as to be free to rotate about a horizonal axis. If the receiving coil is mounted so as to rotate on an axis perpendicular to that of the induced magnetic field then induced voltage will vary from a maximum when the plane of the coil is perpendicular to that of the applied field and to zero nhen the plane of the coil is parallel to that of the applied field. These are the conditions if no conductor is present. If a conductor is present the induced current in the conductor sets up a secondary magnetic field that distorts the primary field. That is, the inphase portion of the secondary field combines with that of the primary to give a resultant value that is not horizontal except directly over the conductor. The voltmeter is used only as a null detector to determine when the receiver coil is parallel to the resultant field. By using an inclinometer to record the angle of the moving search coil when in the null position, the location of a conductor can be determined as the crossover (inflection) point on a profile across the body.

Another variation of this method is to have both the receiver and transmitting coils in the horizontal plane. In this arrangement the voltage developed over nonconducting ground is a function of the construction of the coils which are usually moved across the ground with a constant separation. The presence of a conductor is indicated by changes in the voltage values from the normal values for this configuration. When both coils are outside but adjacent to a conductor the secondary field generated by the induced current in the conductor adds to the normal field and gives an increase in voltage values. When the coils straddle the conductor the secondary field opposes the primary field. giving a decrease in voltage. The conductor is therefore marked by a voltage minimum. Effective depth penetration is about one half the coil separation. The method is also adaptable for airborne operations. Here the transmitting coil is mounted on the plane fuselage and the search coil is trailed in a "bird" on a joo ft. cable.

Radioactive Methods.—In the disintegration of radioactive minerals three spontaneous emissions take place, the ejection of an electron (beta ray), a helium nucleus (alpha ray) and short-nave length electromagnetic radiations (gamma rays) (see RADIOACTIVITY, NATURAL). Radioactive measurements are based upon the detection of these natural radioactive emissions, primarily the gamma rays. The gamma rays correspond to X-rays and have sufficient penetrating power to pass through rock material several feet thick as uell as through iron several inches in thickness; it is this property which is utilized in prospecting for radioactive minerals and in radioactive logging in the underground study of oil fields.

The instruments used in radioactive exploration are the Geiger counter and the scintillometer. The gamma rays ionize the medium through which they pass by colliding with nuclear electrons and knocking them out of their orbits thus leaving the atoms ionized. The Geiger counter is a discharge tube which records the presence of gamma rays by the ionization they produce in a gas in the tube. The gas used is a mixture of argon and some polyatomic vapour. In the centre of the tube is a wire (anode) with an enclosing cylindrical tube serving as a cathode. A difference in potential (about 1.000 v.) is maintained between the anode and the cathode. When the gas is sufficiently ionized by gamma rays passing through the chamber a discharge occurs which is amplified and heard as a click. The number of clicks per minute, which is a measure of the gamma-ray radiation present, is usually indicated on a dial on the counter. Because of cosmic rays in the atmosphere there is a background count which varies with the efficiency of the instrument.

The scintillometer is a gamma-ray detection instrument whose operation depends upon the fact that certain crystal elements emit a flash of light upon absorbing gamma rays. This flash is picked up by a photo multiplier tube and amplified and a visual reading of the emission rate obtained. This instrument is almost 100 times more sensitive than the Geiger counter. Because of the efficiency of this instrument in indicating the presence of gamma rays it is possible to differentiate emanation from different mineral sources on the basis of the energy levels associated with the source elements. Scintillometer as well as Geiger counter measurements can be carried out both from a moving surface vehicle and from low-flying aircraft.

In addition to prospecting for radioactive minerals the radioactive method is extensively applied in bore hole studies of subsurface stratigraphy. Different sedimentary rocks are naturally characterized by different concentrations of radioactive material. The shales and volcanic ash give the highest gamma-ray count and the limestones the lowest. In addition to the natural gamma-ray log the same technique of measurement is used to determine neutron absorption with a neutron source lowered ahead of a gamma-ray detector. Neutrons are absorbed by hydrogen compounds and as a result a low return indicates the presence of porous formations or those with chemically-combined water, as clay and shale. Such ambiguity, however, can be resolved when the neutron log is combined with the gamma-ray log for interpretation.

From the preceding discussion it is clear that geophysical exploration techniques can not be applied indiscriminately. A knowledge of the geologic parameters likely to be associated with the mineral or subsurface condition being studied is essential both in choosing the method to be applied and in interpreting the results obtained.

For further discussion of geologic principles and concepts used in this article see GEOCHEMISTRY; GEOLOGY. See also ORE DEPOSITS; PETROLEUM.

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(G. P. W)

GEOPHYSICAL YEAR, INTERNATIONAL: see INTERNATIONAL GEOPHYSICAL YEAR.

GEOPHYSICS, the study of the earth, using the research methods of physics. The areas of interest range from the earth's deep interior where matter is at several thousand degrees centigrade and 1,500,000 atm. pressure, through the crust with its ocean basins and bewildering inhomogeneities, to the tenuous upper atmosphere. The problems are analogous to those of astronomy, in that the subject studied is seldom under direct observation and handling, forcing conclusions to be drawn primarily by the mathematical and physical interpretation of physical measurements. For discussion of the scientific study of the chemistry of the earth see GEOCHEMISTRY.

For the convenience of classification, geophysics may be divided into the following somewhat overlapping branches. geodesy, the study and theory of the earth s figure, including gravity; seismology, the study of the earth's interior layering, lateral variation, density and other physical properties by means of the reflection and refraction of elastic uaves; hydrology, the study of the movements and circulation of water in the uppermost rocks and surface channels of the earth; oceanography, the study of ocean basins, both bottom sediments and current motions; meteorology, the study of the motion and properties of the lower, primarily weather formative atmosphere; upper air physics and cosmic ray research, the study of the electrical and physical properties of the outer fringe of atmosphere and the particle bombardment of the earth from space; terrestrial electricity (geoelectricity), the study of the charge distribution and movement of currents in the atmosphere and earth; terrestrial magnetism (geomagnetism), the study of the source, figure and changes of the earth's magnetic field and the response of matter to it; and volcanology, the study of the origin and properties of volcanoes. In addition, the dating of meteorites and crustal rocks by means of analysis of their radioactive components, as well as the branch of astronomy dealing with the rotational and translational motion of the earth may be included.

For details on these branches of geophysics, *see* the articles on: ATMOSPHERE; CLIMATE AND CLIMATOLOGY; COSMOGONY; EARTH; EARTHQUAKES; ELECTRICITY, ATMOSPHERIC; GEOCHRONOLOGY; GEODESY; GEOMAGNETISM; HYDROGRAPHY; METEOROLOGY; OCEAN AND OCEANOGRAPHY; PLANET; RADIOACTIVITY, ARTIFICIAL; RADIOACTIVITY, NATURAL; SEISMOMETER; SOUND; TIDES: *Bodily Tides;* VOLCANISM; VOLCANO.

The techniques of geophysics include measurements of gravity, direction and intensity of the earth's magnetic field, electrical potential gradients, movements of fluids and motions of the solid surface, both rapid fluctuations as from earthquakes and long-term events due to gradual shifts relative to sea level. Measurements of the above properties over a period of years permit a determination of properties in the earth's interior. Much laboratory work is also done. The properties of matter are studied under extreme temperatures and pressures. Models of various features of the earth are constructed and tested to ascertain their response to given variation in physical parameters.

The primary international geophysical organization is the International Union of Geodesy and Geophysics formed in Brussels in 1919. The union consists of seven international associations: geodesy, seismology and physics of the earth's interior. meteorology, geomagnetism and aeronomy, physical oceanography, hydrology, and volcanology. Meetings are held every three years. Interrupted during World War II, they were started again in 1948. The United States affiliate of the International union is the American Geophysical union with offices in Washington, D.C.

Many universities throughout the world offer courses in the various branches of geophysics. Since geophysical methods of investigation are primarily mathematical and physical, and in addition demand a knowledge of geology, geophysics is taught chiefly at the post-graduate level. Those who wish to enter this specialty should start their mathematical training at the earliest possible time. Reviews in the various topics of geophysics appear yearly in *Advances in Geophysics*, the initial volume of which appeared in 1955.

Since geophysics deals with world-wide phenomena, the need for international co-operation is great. This has led to three International Geophysical years, in 1882–83, 1932–33 and 1957–58, the first two being termed International Polar years. The main purpose of these events is to obtain physical measurements simultaneously over large portions of the earth and to inaugurate projects which demand international participation. *See* also INTERNATIONAL GEOPHYSICAL YEAR. (J. C. JN.)

GEOPOLITICS. The term "geopolitics" was coined shortly before World War I, spread throughout central Europe between the two wars and came into world-wide use with World War II.

Meaning. — There is no universally accepted definition of the word. It is frequently and loosely used as an alternate term for "political geography," a legitimate child of human geography. The use of the term "geopolitics" is therefore not necessarily indicative of its true meaning, and careful analysis is needed in order to distinguish between an objective study of politico-geographical factors and power-political speculations in the realm of geopolitics. Anyone might rightly guess it to be a portmanteau word combining "geography" and "politics," and wrongly conclude that it is an alternate name for "political geography," one of the oldest branches of earth science. Actually, it is almost never used in this broad sense.

All the usual meanings of "geopolitics" relate to the utilization of geography in the service of national governments. Within this delimitation the term is employed in three senses: (1) As used by some special students of the subject, and sometimes by publicists and editorial writers, the word refers to the power position of the nations, insofar as their power is conditioned by nature. (2) A few careful writers make the term a synonym for "applied political geography," as distinct from the history, principles and theory of political geography. In this usage it is akin to other applied sciences, in that it treats of universally applicable conditions — the natural environments of governments — and reaches conclusions through objective and impartial study. (3) A far larger number of writers and speakers use geopolitics loosely to designate national policy as affected by the natural environment. Nearly always a single country is considered with reference to the rest of the world, and a single aspect of its position is likely to be stressed — generally either national security or foreign policy. This is the layman's commonest usage.

The momentous meaning of geopolitics is very like that last described, but is restricted to conscious special pleading to promote the interests of a particular government or to sway its national policy. This is the sole meaning of the term in central Europe, where originated both the name and the restricted definition. This narrow but indubitable geopolitics was best exemplified in the German movement between World Wars I and II which popularized the name.

It was not scientific geography and has frequently been called a pseudo science. Such geopolitics uses forms and methods of geography but its proponents assume that the natural environment determines the actions oi political groups, and many geopoliticians lack adequate understanding of earth conditions.

It would be fallacious, however. to look upon geopolitical doctrine and ideology as something exclusively rooted in central European or German soil. Not only did it spread to countries which, like Italy. Spain or Japan. sympathized with the expansionist ambitions of Germany, but it must also be remembered that the U.S. creed of "manifest destiny" between 1830 and 1860 was based on the kind of argumentation typical of geopolitics.

Origin. — The name was coined and defined by Rudolf Kjellén, a Swedish political scientist. professor at the University of Uppsala and member of the Swedish parliament. He made "Geopolitik" one of the five co-ordinate aspects of a theoretical system of government. the others being "Ekonomopolitik," "Demo-politik," "Socio-politik" and "Krato-politik." This system he called "The State as an Organism" (*Staten som Lifsform*, definitive edition, 1916).

Kjellén had been profoundly impressed by the work of natural scientists, and especially imbued with the political geography expounded by the German geographer. Friedrich Ratzel, who had been trained in the "new" biology of the middle 19th century. Geography, like all the scientific disciplines. was affected by the evolutionary view of the universe. Ratzel restated much of the theory of geography in the light of evolution and natural selection. In particular, he was the first to publish a survey of political geography analyzed as a systematic branch of the subject. In this work Ratzel compared the state to an organism, but he was careful to point out that he was using simile and metaphor.

Kjellén saw in Ratzel's treatise on political geography the logical bridge between natural science and political science. He apparently believed he was incorporating Ratzel's concepts of political geography into his own systematic treatise on the state. The name "geopolitics," which he applied to the geographic section, may well have suggested itself to his mind as the parallel form to Socio-politik and the rest of his subdivisions.

In adapting Ratzel's work, he subtly metamorphosed it. Untrained in the rigorous discipline of natural science, he disregarded Ratzel's cautions and declared flatly that the state *is* an organism, and hence endowed with biological qualities: viz., growth and decay, and differentiation of members and organs. The importance he attached to this interpretation of his source appears in the title of his book. The *State as an Organism.*

If the state is an organism. it has powers of action independent of and superior to the human groups or individuals who constitute it. This view coincides with ideas expressed a century earlier by the pre-Darwinian German philosophers Johann Fichte, Georg Hegel and Friedrich von Schlegel. One effect of Kjellén's construction was therefore to clothe German political philosophy of an earlier day with the new garment of evolutionary natural science. In an epoch when natural science was conceded by public opinion to have almost the authority of Revelation. Kjellén's claim for geopolitics handed a powerful weapon to any state disposed to use it for propaganda and as a mold for national policy. In Germany, and subsequently in Japan and Italy, the opportunity was not missed.

Kjellén's treatise was translated into German in 1917, and so at the end of World War I in 1918 lay ready to hand as a lever for rebuilding the defeated German state into a great power. It was seized upon by certain geographers. political scientists and publicists. who pushed it to the forefront of German attention, and kept it there during the 20 critical years between the two world wars.

This group was led by Karl Haushofer (1869–1946), who made himself the incarnation of geopolitics. As an officer of the Bavarian army. his career included much service on the general staff. Before World War I. he embraced the opportunity to carry his study of geography far beyond the considerable training given to all German army officers. Field studies in the orient led to the degree of Ph.D. at the University of Munich, with a dissertation on the political and military geography of the Japanese empire as it was in the first decade of the 20th century.

On his retirement from the army in 1919 he made his mission in life the regeneration of the German state by the aid of geography. He took over Kjellén's organismal theory of the state, and adopted "geopolitics" as the name for the brand of geography to which he thereafter devoted himself tirelessly. His geopolitics was compounded of facts about the earth, theories of government and items of German history.

From these sources he distilled a powerful propaganda, which strongly appealed to almost every sort of German. It was given coherence and direction by the assumption that the German state, which had been continuously growing for centuries, was an organism that must continue to spread over more and more territory until it conquered and absorbed the whole earth.

Methods and Manner. — Haushofer's first platform was in the University of Munich, where he lectured on geopolitics from 1919 — after the Nazis came to power in 1933 as professor of geopolitics. There he drew together a group of disciples who included a number of journalists who were instrumental in giving geopolitics wide publicity.

In 1924 he extended the range of his influence by launching the monthly *Journal of Geopolitics (Zeitschrift fur Geopolitik)*, of which he became and remained editor in chief. and by a long lead the chief contributor. It carried occasional articles intended to influence public opinion in those foreign countries particularly sympathetic to the German way of life, or intimately bound to Germany by economic ties. It was supplemented by a steady stream of books. Here. too, Haushofer led his devoted associates in volume of output. *(See* the bibliography for the most important books of the geopoliticians.) Nearly all writers on the subject adhered to their master's views, to the extent of copying his obscure style, often even for a German reader, and cloudy terminology.

Haushofer compounded willful ambiguity with a mystical philosophy at variance with the assumed scientific character of geopolitics. The compulsion to synthesize ideas into a universal view (*Weltanschauung*, "world outlook") is a trait common to German intellectuals, and Haushofer was no exception. His *Weltanschauung* was founded on theories of space. Thereby it retained the form of geography, but its content included extensions of geographical space into the realm of the mystical. The drive that made it a practical philosophy was political, springing from the ambition of German nationalists to dominate other peoples. The theory and the practice were welded into a national policy that was framed by the nature of central Europe. rooted in 800 years of German territorial expansion, rationalized by powerful German philosophers of the 19th century, reanimated by the biological (organismal) concept of the state and clothed in the creed of German "racial" superiority.

When the real meaning of the geopoliticians can be discerned, their world proves to be a product of environmental determinism, but chauvinistically German, disclosing a pitiless attitude toward non-German society that startles the foreigner. This attitude can be read most clearly in established writers whose manner has remained lucid, while their matter has turned geopolitical. A book by an old-line geographer. become a geopolitician, created a minor international incident when it was published in an English translation in 1934 (Ewald Banse, *Raum und Volk im Weltkriege*, 1932). For an account of the incident see the British and American editions: *Germany, Prepare for War!* (1934) and *Germany Prepares for War* (1941).

A favourite literary device of the geopoliticians was the slogan. One of the terms they adopted from Ratzel. *Lebensraum* ("living space"), has found its way into the English language. Each catchword or phrase refers to the earth, or some part of it, and most of them state or imply a political association with the earth; *e.g.*, boundary consciousness, space policy. Some two-score of these slogans were hammered into the consciousness of the German nation by unceasing repetition.

An important instrument of the geopoliticians was the map, which they used constantly and in novel ways. As geographers they well understood the impressiveness of the map and the ease with which it can be read if simple and neat. Treating it as a "weapon," they published hundreds of maps and pictographs. So far as possible, they restricted each map to a single theme, drawn to show the third dimension, and labeled succinctly. They stretched representation beyond existing facts to include aspirations, such as territorial goals. They justified omissions, and even falsifications. The *Zeitschrift fur Geopolitik* is the principal source of these maps. Reproductions of typical samples of maps and of symbols commonly used are to be found in Derwent Whittlesey, *German Strategy of World Conquest.*

Political Significance. — By gaining the widest possible publicity, the geopoliticians sought ceaselessly to win the German public to their program of national political regeneration. and to spur sympathizers in foreign countries to work for acceptance of German plans abroad. Educational propaganda was one of the two roads to the goal of German supremacy that they never lost sight of.

The other road was laid out to reach directly as many responsible officials of the government as possible, and to aid the state to regain its position as a great power through existing or newly created governmental agencies.

Haushofer made contact with Adolf Hitler very early — during the months of 1923–24 when the future *Fuhrer* of Germany was in prison near Munich. That enforced retreat was spent in writing *Mein Kampf*, reportedly with Rudolf Hess as amanuensis. Hess had become an early disciple of Haushofer's. It is due to these influences that geopolitics can be credited with a number of the ideas that appear in *Mein Kampf*, especially in the sections on foreign affairs.

Haushofer's long and reputable connection with the army general staff gave him personal access to the men who in the 1920s were undertaking to rebuild *sub rosa* the German military power. The general staff needed no persuasion as to the importance of geography in tactics and in strictly military strategy. The geopoliticians showed the necessity of a comprehensive and thorough knowledge of world geography for successful prosecution of the political strategy (sometimes called grand strategy) which is an essential component of total war. This they named "geo-strategy" (*Wehr-geopolitik*).

In theory a branch of geopolitics, geo-strategy was the resilient core of the larger subject. Haushofer espoused geopolitics as a means of "renovating" Germany and he viewed a state of war as the normal condition of mankind. Geo-strategy treated warfare as total, embracing the entire populations and resources of the contesting states. It recognized the psychological effects of the geography of the war theatre on fighting forces. It helped to make Germany the first country to realize that air power could take a position alongside sea power and land power. It may fairly be said that geo-strategy was the main theme of the geopoliticians and that geopolitics paved the way for modern concepts of total war.

Other branches of geopolitics were geo-medicine, geo-psychology, geo-jurisprudence and geo-economics. None of them was fully formed, as in fact would have been impossible, for the spatial emphasis was not sufficient to create new disciplines. Geo-medicine was concerned chiefly with diseases associated with different natural environments. Such study has long been a part of geography in all countries. Germany incorporated it into plans for conquering foreign areas and included it in the training of soldiers and other agents of the state who might be sent to remote parts of the earth. Geo-psychology appears to have been an attempt to bring mankind's habit of individual thought and action into line with the dominant environmental determinism of geopolitics. Geo-jurisprudence similarly essayed to harmonize law and environmental determinism. Geo-economics covered the fact-finding and planning of agencies set up to guide the government in ordering the destinies of German economic life.

Educational and Operational Centres.—To implement their program, the geopoliticians used established centres of higher education. At the University of Munich, Haushofer organized his Institute of Geopolitics (Institut fur Geopolitik), the best known, outside Germany, of all the geopoliticians' instruments. It came to be staffed by several score full-time specialists in geography and cognate fields who 'gathered, compiled and classified detailed information about all parts of the earth—its climate. surface features. natural resources, communication systems, economic production and social and political organization.

The work of the institute included both research and planning. Its activities were adopted officially in 1935 by Nazi government agencies which stressed planning. Two revealing names were given to institutions in this field set up under executive ministries: the National Bureau for Space Planning and Space Research (Reichstelle fiir Raumordnung und Raumforschung) and the House of National Planning (Haus der Reichsplanung).

The University of Heidelberg became the seat of the Association of Workers in Geopolitics (Arbeitsgemeinschaft fiir Geopolitik), an organization of all German university instructors concerned with geopolitics. Haushofer was for some time its president. This association directed the study of geopolitics at the university level. Its members monopolized German publication on their subject. The integration of Haushofer's projects, educational and operational. was signalized by creating under the *Reich* ministry of propaganda the National Socialist Teachers' association (Nationalsozialistischer Lehrer-Bund). It included two study groups. one to prepare teachers in the middle schools to present the homeland in geopolitician's terms, the other to prepare teachers in the upper schools to instruct on foreign countries.

In the Advanced School of Politics (Hochschule fur Politik) in Berlin. Haushofer's son Xlbrecht was made professor of geopolitics. From 1941 to 1943 he wrote the first volume of a text in political geography and geopolitics (published posthumously in 1951). Albrecht Haushofer, an active member of the German underground opposition. was executed by the Gestapo in April 1945. With Karl Haushofer's suicide in 1946, the human tragedy of the Haushoier dynasty came to an end.

Consequences for Germany.—One measure of the influence of geopolitics on Germany is the evidence of official support it received. There was none in the Weimar republic to speak of, inasmuch as the nationalistic philosophy and aims of geopolitics were alien to the liberal principles for which the short-lived German democracy stood. When the Nazi party took over in 1933, it gave geopolitics official sanction. Almost immediately German geography succumbed to the pressure and lost itself in geopolitics. Members of the profession who would not follow the new leader either withdrew to physical geography, a safe corner removed from political controversy, or were silenced by being refused permission to publish or lecture. Most of those who took their places bore names hitherto unknown to students of geography.

Only geopoliticians remained free to publish on aspects of geography that treat of mankind, and they took their cue from Haushofer. Through them, and the political connections he exploited and the organizations he sponsored. Haushofer completely dominated this new and exclusive brand of German geography. Taking colour from its authors. what was left of the onetime science of geography became propagandist in tone, intemperate in manner and unreliable as to facts.

The downfall of Nazi Germany erased German geopolitics from the ideological map of the new Germany; the extinction of the monstrous philosophy of Naziism included that of its byproduct. In spite of the feeble revival. in 1951, of the *Zeitschrift für Geopolitik,* geopolitics remained buried in the new Germany. Neither geographers nor political scientists attempted to let a new phoenix of a geopolitics cleansed of National Socialist ideas arise from the ashes. In fact. the bankruptcy of German geopolitics discredited legitimate studies in political geography in Germany following World War II. Far from attempting to revise geopolitics, a disillusioned science of geography in Germany failed to match the progress made especially in the Cnited States and Britain in the development of political geography.

Sound geography could have placed in correct perspective the relative strength of the nations as to strategic position, natural resources and productive capacity, and it would have warned that the natural environment neither fully measures human capacity nor determines the course of collective human action. The geopoliticians falsely assumed political power to rest wholly on material wealth, statistically computed. They added up the total natural resources of a country and multiplied by the intensity of utilization. Similarly they were content merely to count populations. From these facts they estimated the political and military strength of the nations. So engrossed, they failed to take account of the intangible forces generated in any people by living together as a nation. Besides, the myth of German racial superiority blinded them to the latent strength of non-Germans, both as peoples and as individuals.

The martial aims of the geopoliticians became increasingly apparent. They planned to have the revived German nation stride to world supremacy in a single war of conquest. In the slogan *"Blut und Boden"* (race and the land) Germans were taught by the Nazi leaders to vaunt their faith in their racial superiority to all other peoples, and their expectation of territorial supremacy—to be won by one more attack in a centuries-old succession of wars of conquest. While Hitler exploited chiefly the racial aspect of the shibboleth. Haushofer, who was, and remained. married to a woman of Jewish extraction. stressed its territorial aspect. He subscribed to racism only perfunctorily, although he permitted publication of "geographic" articles that embodied the racial "philosophy" of the third Reich.

Within its legitimate field geopolitics made itself little more than a formula for justifying Germany in wars of territorial conquest. From Kjellén it borrowed "autarky," the concept of national self-sufficiency. In the contemporary interdependent world, only the very largest and best-endowed nations could hope to approach permanent self-sufficiency. Others might build up stockpiles for or against an anticipated war of aggression. From Ratzel, geopolitics borrowed concepts about space, focusing them in the term *Lebensraum.* This they defined as the *right* of the German state "organism" to expand to the limit of its desires. More important than these loans: it borrowed from a truly outstanding student of political geography, Britain's Sir Halford Mackinder, the concept of "the heartland," a view of the earth as potentially arrayed in two camps—the land power of inner Eurasia and the sea power of the maritime lands peripheral to the heartland, including all the other continents. Germany, the geopoliticians reasoned, by attaching the heartland could make itself the master of the world.

From the Pan-German movement (*q.v.*) of the turn of the 19th century, geopolitics borrowed pan-regions, beginning with a German-dominated "Middle Europe" and "Eurafrica" as successive steps toward world conquest. From German political history and Ratzel, Haushofer himself worked out the doctrine that a political boundary marks merely the temporary halt of the nation-in-arms in its march toward unlimited territorial expansion.

The contributions of geopolitics to the war that broke out in 1939 were direct and large. The geopoliticians advanced a program for world domination, but it was incomplete because they paid no attention to the problem of assimilating the peoples they might conquer. Their preoccupation with war led them to assume that conquest itself would solve the whole problem.

The propaganda of geopolitics is generally admitted to have carried most weight with the very classes of German society that were least taken in by Hitler's demagogy. Thereby they were conditioned to fight a war of aggression, and their influence upon less-informed folk reinforced the exhortations of the Nazi leaders.

Instruction in geopolitics permeated the school system, and formed part of the training in national fanaticism given to the generation that was destined to bear the brunt of the fighting. The propaganda justified military aggression as "natural," and by implication scientific and inevitable. 'Geopolitics helped to delude all ages and classes of Germans into accepting an overvaluation of their power as a nation. By the same means it persuaded sympathetic or terrified cliques of collaborators in several neighbouring countries to pave the way for the conquests scheduled by the army general staff.

The information collected by the agencies of geopolitics directly aided German war plans. The military successes which stupefied the world in 1940 consummated projects published by geopoliticians well beforehand. The program of conquest was so audacious that it appeared to most non-Germans the dream of crackpots. Hence it was disregarded in the countries that had the power to block German military aggression, until steps taken to bring it to pass plunged the world into conflict. Actually the geopoliticians' estimates of relative military preparedness of the nations and the material resources on which each could rely proved accurate in two years of conquest.

Germany's first crucial military reverse was also forecast by geopolitics. The failure to conquer the Soviet Union was a demonstration of theories of space stressed by all the geo-strategists. Haushofer feared Russia A persistent disciple of Mackinder's teachings as far as the relationship of Russia and Germany was concerned. he emphasized time and again the necessity for Germany to join forces with its huge neighbour, and he rejoiced in the treaty of Aug. 1939 as the achievement of a lifelong ambition. Germany's attack on the Soviet Union in 1941 silenced him. Its unsuccessful outcome confirmed his contentions.

Influence Outside Germany. — Beyond the German-speaking world. the dogma of geopolitics was adopted with equal intensity by only one nation — Japan. Japan, like Germany, grew up on a long history of military conquests. Its militaristic tradition was reset in a frame of continental or world conquest by the Japanese program of "westernization" after 1868.

The objectives of geopolitics were therefore congenial to the Japanese mind. even though Japan and Germany were bound to clash if both persisted successfully in their separate and overlapping plans for conquest.

In addition, Haushofer's early enthusiasm for Japan gave his work a very favourable hearing there. He repeatedly stated his conviction that the Japanese nation was the most complete exemplification of the doctrines of geopolitics, although he pointed out weaknesses in Japan's environment and errors in its governmental policy. Between 1913 and 1938 he wrote six books on Japan alone, besides works covering the orient more broadly and lengthy commentaries in every issue of the *Zeitschrift*. Some of his work was translated into Japanese, and geopolitics was acclaimed and practised by a vigorous group of disciples drawn from Japanese geographers and political scientists.

Fascist Italy identified its territorial program with geopolitics as far as possible, notably in its claim to the Mediterranean sea as exclusively Italian — "mare nostro" ("our sea"). But the German geopoliticians did not hesitate to point out serious inherent weaknesses of Italy as a great power, and also the fact that it lay in the immediate path of German expansion. Presumably geopolitics never seized the imagination of any large section of the Italian people.

In France, the uritings of Ratzel exerted considerable influence on such outstanding students of human geography as P. Vidal de la Blache, J. Brunhes and C. Valloux. who incorporated many of Ratzel's ideas in their system of social geography (*géographie* sociale) but refused to follow German geopolitics along the dangerous road of environmental determinism. Repudiation of the pseudo science of geopolitics was convincingly expressed by A. Demangeon and J. Ancel.

Marxist and Leninist theory is bitterly opposed to the recognition of any influence on the life of states and societies by their natural environment, and geographical determinism has no place in its system. It is not surprising to note that Soviet geographers such as J. W. Semjonow in their contemptuous attacks against "Fascist Geopolitics" went far beyond the realm of German geopolitics and included. as alleged representatives of U.S. and British imperialism and colonialism, practically every writer of reputation in these countries who had written on the subject of political geography, from Ellen Churchill Semple and Alfred T. Mahan to Ellsnorth Huntington, Isaiah Bowman and Nicholas J. Spykman; in Britain from Mackinder to William G. East.

British and U.S. scholars at first dismissed geopolitics without analysis as unscientific and unworthy of study. German geopoliticians had been labouring 20 years when war brought both geopolitics and Haushofer first into full view of the English-speaking public. Beginning in 1940, numerous articles and uncounted comments and editorials made their appearance. In 1942 no fewer than five books traced the origin or analyzed the character of German geopolitics. Under the brilliant, if not always entirely objective, leadership of Nicholas J. Spykman (America's Strategy in *World* Politics, 1942) a new brand of American geopolitics became fashionable.

Once geopolitics had been appraised and applied, the spate of commentaries in English abated. But the subject remained very much alive, as was evinced by the continued and frequent appearance of the term in print without explanation or apology. The sudden rise to prominence of the term and its immediate acceptance by all sections of the English-reading public marked it as useful for expressing a concept more universal than the German movement that publicized the name.

Enduring Effects of Geopolitics. — No aspect of geopolitics is wholly acceptable to the world at large, but several of its ideas have been taken over, generally in modified form.

Useful devices embodied in the geopoliticians' maps have been adopted wherever maps are published. They may be seen in newspapers and pictorial and news magazines. Textbooks and atlases published in the United States and Great Britain after 1943 used a number of map devices that the geopoliticians publicized: among them simplicity. emphasis by means of broad lines or heavy shading, the projection of direction or movement by arrows, and pictorial representation.

The map became a powerful political weapon. Maps, intended to show the interrelations of the entire earth or its larger parts, were frequently drawn on unfamiliar grids. They stood as expressions of "global thinking." which Haushofer stressed from the beginning as a necessary preliminary to successful world domination by Germany. Twentieth-century events made global thinking, as a basis for understanding the world, essential to everybody. That use of the term is, however, very unlike the meaning in geopolitics that gave it currency.

Geopolitics implies a systematic and detailed knowledge of the earth prepared for use by governments. This was the contribution of Haushofer's Institute of Geopolitics at Munich. Similar agencies were set up as a wartime expedient by nations plunged into conflict with Germany, only to find themselves at a dangerous disadvantage through the lack of information that a geographic survey provides.

In peace. no less than in war, nations, drawing their wealth from all parts of the earth, can profit from knowing how the sources of wealth are distributed. Governments are exerting increasing control over natural resources found within their borders. Continued growth of population and speedier transportation promise to intensify the enduring need for accurate and up-to-date knowledge about the earth. The geographic survey. carried on by an agency of government, has permanent and universal utility.

Geopolitics was devised as an adjunct to warfare. It extended the horizon of military procedure in two ways: by adding political strategy to military strategy; by preconditioning the fighting man for each separate natural environment likely to become a theatre of war

Few people think of geopolitics in connection with any of the outgrowths thus far noted. When the word appears in English it is likely to refer loosely to the mutual power position (the power pattern) of the world's political units. Obviously the share of the earth controlled by each nation is a matter involving geography as well as government. Kjellén recognized this in describing the power position of the eight strongest states on the threshold of war in 1914 *(Die Grossmachte der Gegenwart,* 1914). Haushofer underlined it in the three volumes of his postwar revision and supplement. (See *Bibliography.)* If the apportionment of the earth's territory and resources among the nations can be measured in advance of war, each will have a true picture of the material foundation of its own power and that of its potential antagonists. So long as the analysis is objective, reliable as to facts, and unbiased by dogma. it can be argued that the study is as likely to lead a nation to shy away from war as to leap into it. Such an assessment of power promises to be of value only in a world of power politics. Those who use "geopolitics" in this sense contend that the seeds of power politics are so n broadcast by every war, and that until the entire earth is politically unified, sovereign nations may find themselves mustered on the battlefield. Geopolitics is calculated to aid governments in planning their foreign policy.

Planning was conspicuous in German geopolitics. Both Germany and Japan based decisions to launch wars of conquest on geopolitical estimates of the relative power potential of the Axis nations and their adversaries. These decisions were made possible by the choice that the natural environment affords to any state as to how it will use its area, strategical situation, population and natural endowment. Bent on war, the Axis powers prepared themselves to outfight selected opponents who were using equal or richer resources for ends only in small part military. The geopoliticians of both Germany and Japan overlooked the element of choice within the broad frame of natural environment. They assumed that the militaristic way of life followed by both nations was mystically determined by the natural environment, instead of having grown up as a result of frequent decisions to fight, spread over a period of several centuries, in an environment that gave ample scope to military prowess.

Their planning was based on a prejudiced estimate of power—overvaluation of their own and undervaluation of their rivals'. Their success in arms lasted only until latent opposition forces could be marshaled.

Planning is a leading objective of those who advocate geopolitics for the world at large. They use the word to mean that a nation should formulate its national policy only after duly appraising the natural environment as an inescapable condition of its power position. They differ from the German geopoliticians in avoiding ambiguous phrasing and in rejecting deliberate falsification.

In these stands they take safe ground. Some of them, particularly those who have not been trained in geography, drop into the pitfall of metaphysical philosophy; a still larger number believe the natural environment to be deterministic. Imbued with these ideas, they jeopardize the soundness of their planning and expose their program to risks that proved disastrous to the German and Japanese geopoliticians.

Much of the lumber of geopolitics bids fair to be forgotten. It was used as scaffolding to construct a faulty intellectual edifice. The befuddling phrase-making was no more than a device for hoodwinking people into accepting as "science" much that is unsound. Its exclusive orientation toward wars of conquest had values only to nations hoping to start such wars. The untenable hypotheses, such as the assumptions that the state is an organism and has a natural right to *Lebensraum,* helped bring on war, but did not show how to win it.

The name "geopolitics" has acquired such odium that many believe it to be unfitted to associate with respectable scientific terms. It is the only name available to designate the German pseudo science, and it has been urged that *"Geopolitik"* be reserved for that movement. It fits, more exactly than any other title, most of the writing that attempts to apply political geography to the problems of this or that nation. The term "applied political geography" is more aptly reserved for studies of the broad values and applications of geography to political life in general, viewed without national bias. Whatever the settled usage turns out to be, the entire world has been made aware of geography's value to government, through the popular interest in geopolitics. *(See* also GEOGRAPHY.)

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GEOPONICI, or *Scriptores rei rusticae,* the Greek and Roman writers on agriculture. The Greeks paid less attention than the Romans to the scientific study of this subject, which in classical times they regarded as a branch of economics. Thus Xenophon's *Oeconomicus* contains a eulogy on agriculture and its beneficial ethical effects. The writings of Aristotle and his pupil Theophrastus also contain much agricuttural information.

About the 2nd century B.C., Bolus ("Democritus") of Mendes, Egypt, wrote a treatise *Peri Georgias,* frequently quoted by later compilers of *Geoponica* (agricultural treatises). To judge from the numerous writers cited by Varro and Columella, the Alexandrian period gave more attention to the subject. About 88 B.C. Cassius Dionysius of Utica translated into Greek and abridged the great work of the Carthaginian Mago, which was still further condensed by Diophanes of Nicaea in Bithynia for King Deiotarus. Vindonius Anatolius of Beirut and Didymus of Alexandria compiled agricultural treatises that were the bases for the *Geoponica* of Cassianus Bassus. His work in turn was the main source for the Byzantine *Peri georgias eclogai* or *Geoponica* (c. 950) once wrongly ascribed to Constantine VII.

The Romans, aware of the necessity of maintaining a numerous and thriving order of agriculturists, from very early times endeavoured to instill into their countrymen both a theoretical and a practical knowledge of the subject. The occupation of the farmer was regarded as next in importance to that of the soldier, and distinguished Romans did not disdain to practise it. In furtherance of this object, Mago's work was translated into Latin by order of the senate and the elder Cato wrote his *De agri cultura* (extant in a very corrupt state), a simple record in homely language of the rules observed by the old Roman landed proprietors rather than a theoretical treatise. He was followed by the two Sasernae (father and son) and Gnaeus Tremellius Scrofa, whose works are lost. The learned Varro (*q.v.*), when 80 years of age, composed his *Res rusticae,* dealing with agriculture, the rearing of cattle and the breeding of fishes. He was the first to systematize what had been written on the subject, and supplemented the labours of others by experience gained during his travels. In the Augustan age (to make no mention of Virgil's *Georgics)* Julius Hyginus wrote on farming and beekeeping, Sabinus Tiro on horticulture, and during the early empire Julius Graecinus and Julius Atticus on the culture of vines, and Cornelius Celsus (best known for his *De medicina)* on farming. The chief work of the kind, however, is the *De re rustica* of Columella (*q.v.*), which covers all aspects of farming. About the middle of the second century the two Quintilii, natives of Troia, wrote on the subject in Greek. It is remarkable that Columella's work exercised less influence in Rome and Italy than in southern Gaul and Spain, where agriculture became one of the principal subjects of instruction in the superior educational establishments that were springing up in those countries. One result of this was the preparation of manuals of a popular kind for use in the schools. In the third century Gargilius Martialis of Mauretania compiled a *Geoponica* in which medical botany and the veterinary art were included.

The *De re rustica* of Palladius (4th century), in 14 books, which is almost entirely borroued from Columella. is inferior in style and knowledge of the subject. It is a kind of farmer's calendar. in which the different rural occupations are arranged in order of the months. The 14th book (on iorestry) is written in elegiacs. The whole of Palladius and considerable fragments of Martialis are extant.

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GEOPOTENTIAL. The geopotential is the potential energy of a unit mass aith reference to sea level. Surfaces of constant geopotential or level surfaces are fixed in space and may therefore be used as a scale to measure height. Height measured with reference to the geopotential surfaces is called geodynamic height and the common unit is the dynamic metre. For an average value of the gravitational constant the dynamic metre is equal to about 1.02 metric metres.

See ATMOSPHERE; METEOROLOGY; THERMODYNAMICS; UPPER AIR SOUNDINGS. (H. G. HN.)

GEORGE, SAINT, patron saint of England, was an early martyr in the east, perhaps at Lydda in Palestine where his alleged tomb is still shown. Nothing is known of his life. There is no reason to suppose that he is referred to, unnamed, in Eusebius' ecclesiastical history (viii, 5), and Gibbon's identification of him with George of Cappadocia. Athanasius' opponent, has been discredited. From the 6th century, legends about him as a warrior saint became very popular and increasingly extravagant. The story of his rescuing a maiden from a dragon. which first appears in the late 12th century and was popularized by the 13th-century *Golden Legend,* may owe something to the fact that the classical legend of Perseus and Andromeda was localized at Jaffa or Arsuf, not far from Lydda. This story is often represented in art, and St. George is frequently depicted as a youth wearing knight's armour aith a scarlet cross.

St. George has been known in England at least since the 8th century, but how he came to be looked on as its patron saint is not clear. No doubt returning crusaders popularized his cult (he uas said to have been seen in vision helping the crusaders at the siege of Antioch in 1098); but it is probable that he was not recognized as England's patron saint until King Edward III put the newly founded order of the Garter under his protection. He is one of the 14 auxiliary saints, and his feast day in both the eastern and western churches is April 23.

See H. Delehaye, *Les ltgendes grecques des saints militaires,* pp. 45–76 (1909). (D. AR.)

GEORGE I. (George Louis) (1660–1727), king of Great Britain and Ireland, born in 1660, was heir through his father, Ernest Augustus, to the hereditary lay bishopric of Osnabriick, and to the duchy of Calenberg, which formed one portion of the Hanoverian possessions of the house of Brunswick, while he secured the reversion of the other portion, the duchy of Celle or Zell, by his marriage (1682) with the heiress, his cousin Sophia Dorothea. The marriage was not a happy one. George Louis was a bad husband. Count Konigsmark—a handsome adventurer—seized the opportunity of paying court to the deserted wife. Conjugal infidelity was held at Hanover to be a privilege of the male sex. Count Konigsmark was assassinated. Sophia Dorothea was divorced in 1694, and remained in seclusion till her death in 1726. The prince's mother was Sophia, the youngest daughter of Elizabeth (*q.v.*) the daughter of James I. of England. Sophia found herself, upon the death of the duke of Gloucester, the next Protestant heir after Anne. The Act of Settlement in 1701 secured the inheritance to herself and her descendants. Being old and unambitious she rather permitted herself to be burdened with the honour than thrust herself forward to meet it. Her son George took a deeper interest in the matter. In his youth he had fought with determined courage in the wars of William III. Succeeding to the electorate on his father's death in 1698, he had sent a welcome reinforcement of Hanoverians to fight under Marlborough at Blenheim. With prudent persistence he attached himself closely to the Whigs and to Marlborough, refusing Tory offers of an independent command, and receiving in return for his fidelity a guarantee by the Dutch of his succession to England in the Barrier treaty of 1709.

In 1714 when Anne was growing old, and Bolingbroke and the more reckless Tories were coquetting with the son of James II., the Whigs invited George's only son, who was duke of Cambridge, to visit England in order to be on the spot in case of need. Neither the elector nor his mother approved of a step which was likely to alienate the queen, and which was specially distasteful to himself, as he was on very bad terms with his son. Yet they did not set themselves against the strong wish of the party to which they looked for support, and it is possible that troubles would have arisen from any attempt to carry out the plan, if the deaths, first of the electress (June 8) and then of the queen (Aug. 1, 1714), had not laid open George's way to the succession without further effort of his own.

George I. arrived in England when a great military struggle had come to an end. He had therefore no reason to call upon the nation to make great sacrifices. All that he wanted was to secure for himself and his family a high position which he hardly knew how to occupy, to fill the pockets of his German attendants and his German mistresses, to get away as often as possible from the uncongenial islanders whose language he could not speak, and to use the strength of England to obtain petty advantages for his German principality. He attached himself entirely to the Whig party, though he refused to place himself at the disposal of its leaders. He gave his confidence, not to Somers and Wharton and Marlborough, but to Stanhope and Townshend, the statesmen of the second rank. At first he seemed to be playing a dangerous game. The Tories, whom he rejected, were numerically superior to their adversaries, and were strong in the support of the country gentlemen and the country clergy. The strength of the Whigs lay in the towns and in the higher aristocracy. In 1715 a Jacobite insurrection in the north, supported by the appearance of the Pretender, the son of James II., in Scotland, was suppressed, and its suppression not only gave to the Government a character of stability, but displayed its adversaries in an unfavourable light as the disturbers of the peace.

The policy of George I.'s reign is the policy of his ministers. Stanhope and Townshend from 1714 to 1717 were mainly occupied with the defence of the Hanoverian settlement. After the dismissal of the latter in 1717, Stanhope in conjunction with Sunderland took up a more decided Whig policy. The Occasional Conformity Act and the Schism Act were repealed in 1719. But the wish of the liberal Whigs to modify if not to repeal the Test Act remained unsatisfied. In the following year the bursting of the South Sea bubble, and the subsequent deaths of Stanhope in 1721 and of Sunderland in 1722, cleared the way for the accession to power of Sir Robert Walpole, to whom and not to the king was due the conciliatory policy which quieted Tory opposition by abstaining from pushing Whig principles to their legitimate consequences.

Nevertheless something of the honour due to Walpole must be reckoned to the king's credit. It is evident that at his accession his decisions were by no means unimportant. The royal authority was still able within certain limits to make its own terms. This support was so necessary to the Whigs that they made no resistance when he threw aside their leaders on his arrival in England. When by his personal intervention he dismissed Townshend and appointed Sunderland, he had no such social and parliamentary combination to fear as that which almost mastered his great-grandson in his struggle for power. If such a combination arose before the end of his reign it was owing more to his omitting to fulfil the duties of his station than from the necessity of the case. As he could talk no English, and his ministers could talk no German, he absented himself from the meetings of the cabinet, and his frequent absences from England and his want of interest in English politics strengthened the cabinet in its tendency to assert an independent position.

Walpole at last by his skill in the management of parliament rose as a subject into the almost royal position denoted by the name of prime minister. In connexion with Walpole the force of wealth and station established the Whig aristocracy in a point of vantage from which it was afterwards difficult to dislodge them. Yet, though George had allowed the power which had been exercised by William and Anne to slip through his hands, it was understood to the last that if he chose to exert himself he might cease to be a mere cipher in the conduct of affairs. As late as 1727 Bolingbroke gained over one of the king's mistresses, the duchess of Kendal; and though her support of the fallen Jacobite took no effect, Walpole was not without fear that her reiterated entreaties would lead to his dismissal. The king's death in a carriage on his way to Hanover, in the night of June 10–11 in the same year, put an end to these apprehensions.

His only children were his successor George II. and Sophia Dorothea (1687–1757), who married in 1706 Frederick William, crown prince (afterwards king) of Prussia. She was the mother of Frederick the Great. (S. R. G.; X.)

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GEORGE II. (George Augustus) (1683–1760), king of Great Britain and Ireland, the only son of George I., was born in 1683. In 1705 he married Wilhelmina Caroline of Anspach. In 1706 he was created earl of Cambridge. In 1708 he fought at Oudenarde. It was most unwillingly that, on his first journey to Hanover in 1716, George I., who was on bad terms with his son, appointed the prince of Wales guardian of the realm during his absence. In 1717 the existing ill-feeling ripened into an open breach. At the baptism of one of his children, the prince selected one godfather whilst the king persisted in selecting another. The young man spoke angrily, was ordered into arrest, and was subsequently commanded to leave St. James's and to be excluded from all court ceremonies. The prince took up his residence at Leicester House, and did everything in his power to support the opposition against his father's ministers.

When therefore George I. died in 1727, it was generally supposed that Walpole would be at once dismissed. The first direction of the new king was that Sir Spencer Compton would draw up the speech in which he was to announce to the privy council his accession. Compton, not knowing how to set about his task, applied to Walpole for aid. Queen Caroline took advantage of this evidence of incapacity, advocated Walpole's cause with her husband and procured his continuance in office. This curious scene was indicative of the course likely to be taken by the new sovereign. His own mind was incapable of rising above the merest details of business. He made war in the spirit of a drill-sergeant, and he economized his income with the minute regularity of a clerk. A blunder of a master of the ceremonies in marshalling the attendants on a levee put him out of temper. He took the greatest pleasure in counting his money piece by piece, and he never forgot a date. He was above all things methodical and regular. "He seems," said one who knew him well. "to think his having done a thing to-day an unanswerable reason for his doing it to-morrow."

Most men so utterly immersed in details would be very impracticable to deal with. George II. was exempt from this failing. He seemed to have an instinctive understanding that such and such persons were either wiser or even stronger than himself; and when he had once discovered that, he gave way with scarcely a struggle. Though in his domestic relations he was as loose a liver as his father, he was guided by the wise, unobtrusive counsels of his wife until her death in 1737, and when once he had recognized Walpole's superiority he was guided by the political sagacity of the great minister. It is difficult to exaggerate the importance of such a temper upon the development of the constitution. The apathy of the nation in all but the most exciting political questions, fostered by the calculated conservatism of Walpole, had thrown power into the hands of the great landowners. They maintained their authority by supporting a minister who was ready to make use of corruption, wherever corruption was likely to be useful, and who could veil over the baseness of the means which he employed by his talents in debate and in finance. To shake off a combination so strong would not have been easy. George II. submitted to it without a struggle.

So strong indeed had the Whig aristocracy grown that it began to lose its cohesion. Walpole dismissed all who opposed him. An opposition formidable in talents was gradually formed. In its composite ranks were Tories and discontented Whigs, discarded official hacks hungry for the emoluments of office, and youthful purists who fancied that if Walpole were removed corruption would cease. Behind them was Bolingbroke, excluded from parliament but suggesting every party move. In 1737 the opposition acquired the support of Frederick, prince of Wales. His marriage in 1736 to Augusta of Saxony brought on a quarrel with his father. In 1737, just as the princess of Wales was about to give birth to her first child, she was hurried away by her husband from Hampton court to St. James's palace at the imminent risk of her life, simply in order that the prince might show his spite to his father who had provided all necessary attendance at the former place. George ordered his son to quit St. James's, and to absent himself from court. Frederick in disgrace gave the support of his name, and he had nothing else to give, to the opposition. Later in the year 1737, on Nov. 20, Queen Caroline died. In 1742 Walpole, weighed down by the unpopularity both of his reluctance to engage in a war with Spain and of his supposed remissness in conducting the operations of that war, was driven from office. His successors formed a composite ministry in which Walpole's old colleagues and opponents were alike to be found.

War of the Austrian Succession.—The years which followed settled conclusively, at least for this reign, the constitutional question of the power of appointing ministers. The war between Spain and England had broken out in 1739. In 1741 the death of the emperor Charles VI. brought on the War of the Austrian Succession. The position of George II. as a Hanoverian prince drew him to the side of Maria Theresa through jealousy of the rising Prussian monarchy. Jealousy of France led England in the same direction, and in 1741 a subsidy of £300,000 was voted to Maria Theresa. The king himself went to Germany, and attempted to carry on the war according to his own notions. Those notions led him to regard the safety of Hanover as of far more importance than the wishes of England. Finding that a French army was about to march upon his German States, he concluded with France a treaty of neutrality for a year without consulting a single English minister. In England the news was received with feelings of disgust. The expenditure of English money and troops was to be thrown uselessly away as soon as it appeared that Hanover was in the slightest danger. In 1742 Walpole was no longer in office. Lord Wilmington, the nominal head of the ministry, was a mere cipher. The ablest and most energetic of his colleagues, Lord Carteret (afterwards Granville), attached himself specially to the king, and sought to maintain himself in power by his special favour and by brilliant achievements in diplomacy.

In part at least by Carteret's mediation the peace of Breslau was signed, by which Maria Theresa ceded Silesia to Frederick (July 28, 1742). Thus relieved on her northern frontier, she struck out towards the west. Bavaria was overrun by her troops. In the beginning of 1743 one French army was driven across the Rhine. On June 27th another French army was defeated by George II. at Dettingen. Victory brought elation to Maria Theresa. Her war of defence was turned into a war of vengeance. Bavaria was to be annexed. The French frontier was to be driven back. George II. and Carteret after some hesitation placed themselves on her side. Of the public opinion of the political classes in England they took no thought. Hanoverian troops were indeed to be employed in the war, but they were to be taken into British pay. Collisions between British and Hanoverian officers were frequent. A storm arose against the preference shown to Hanoverian interests. After a brief struggle Carteret, now Lord Granville, was driven from office in 1744.

Henry Pelham, who had become prime minister the year before, thus saw himself established in power. By the acceptance of this ministry, the king acknowledged that the function of choosing a ministry and directing a policy had passed from his hands. In 1745 indeed he recalled Granville, but a few days were sufficient to convince him of the futility of his attempt, and the effort to exclude Pitt at a later time proved equally fruitless.

Opposition to **Pitt.**—Important as were the events of the remainder of the reign, therefore, they can hardly be grouped round the name of George II. The resistance to the invasion of the Young Pretender in 1745, the peace of Aix-la-Chapelle in 1748, the great war ministry of Pitt at the close of the reign, did not receive their impulse from him. He had indeed done his best to exclude Pitt from office. He disliked him on account of his opposition in former years to the sacrifices demanded by the Hanoverian connection. When in 1756 Pitt became secretary of State in the Devonshire administration, the king bore the yoke with difficulty. Early in the next year he complained of Pitt's long speeches as being above his comprehension, and on April 5, 1757, he dismissed him, only to take him back shortly after, when Pitt, coalescing with Newcastle, became master of the situation.

Before Pitt's dismissal George II. had for once an opportunity of placing himself on the popular side, though, as was the case of his grandson during the American war, it was when the popular side happened to be in the wrong. In the true spirit of a martinet, he wished to see Admiral Byng executed. Pitt urged the wish of the House of Commons to have him pardoned. "Sir," replied the king, "you have taught me to look for the sense of my subjects in another place than in the House of Commons." When George II. died in 1760, he left behind him a settled understanding that the monarchy was one of the least of the forces by which the policy of the country was directed. To this end he had contributed much by his disregard of English opinion in 1743; but it may fairly be added that, but for his readiness to give way to irresistible adversaries, the struggle might have been far more bitter and severe than it was.

Of the connection between Hanover and England in this reign two memorials remain more pleasant to contemplate than the records of parliamentary and ministerial intrigues. With the support of George II., amidst the derision of the English fashionable world, the Hanoverian Handel produced in England those masterpieces which have given delight to millions, whilst the foundation of the University of Göttingen by the same king opened a door through which English political ideas afterwards penetrated into Germany.

George II. had three sons, Frederick Louis (1707–51); George William (1717–18); and William Augustus, duke of Cumberland (1721–65); and five daughters, Anne (1709–59), married to William, prince of Orange, 1734; Amelia Sophia Eleonora (1711–1786); Elizabeth Caroline (1713–1757); Mary (1723–72), married to Frederick, landgrave of Hesse-Cassel, 1740; Louisa (1724–1751), married to Frederick V., king of Denmark, *1743*.

(S. R. G)

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GEORGE III. (George William Frederick), king of Great Britain and Ireland, was born June 4 (New Style), 1738, the son of George II.'s eldest son Frederick, Prince of Wales, and of Augusta, a princess of Saxe-Gotha. Almost from birth he was introduced to the ungainly squabbles that divided his father and grandfather; and Dr. Ayscough, the tutor assigned to him at the age of six, was chiefly remarkable as an adherent of the opposition. When George was thirteen his absurd father died; Ayscough was dismissed, and the unfortunate boy's education became a matter of acute political controversy, with the result that he had barely time to become accustomed to one set of instructors before they were changtd for another. In later life the old king's recollection of his two successive governors was that Harcourt, though well-intentioned, was wholly unfit for his job, while Waldegrave was a "depraved, worthless man"; and though he had a kindly remembrance of his second episcopal preceptor, Thomas of Peterborough, and of his sub-preceptor, Scott, he called Thomas's predecessor, Hayter of Norwich, an "intriguing, unworthy man, more fitted to be a Jesuit than an English bishop." Though his mother was devoted to him, she was a foolish, ignorant woman, who once remarked that logic was "an odd study" for children of her son's condition. Unfortunately, too, she kept him almost isolated from the world except for the remnants of the little Leicester House clique, such as Egmont and Bubb Dodington and the Earl of Bute, who used to encourage Frederick in his futile intrigues against George II. and his ministers. George is described in his youth as lethargic, an epithet which certainly cannot be applied to him when he became king; but a certain "vanity and obstinacy" and a tendency to let "his anger be turned into sulkiness" and to "behave like a child," which Lady Sarah Lennox noted as traits in his character, remained and are confirmed by his own admission to George Rose in *1804* that "his memory being a good one . . . what he did not *forget* he could not *forgive*," a point he illustrated by his grim declaration that he would not admit Fox to his councils, "even at the hazard of civil war." This reserved and authoritative disposition was much encouraged by the training he received at his mother's court, where Bolingbroke's "Patriot King" was laid down as the guide for his conception of royal duties; while the constantly whispered injunction of his mother, "George, be a king," in contrast to his grandfather's dependence on a Whig oligarchy, was allowed to sink into his mind.

His first actions on being called to the throne on the death of George II. (Oct. 25, 1760) showed his determination to "be a king." Dismissing Pitt, who had come to announce his accession, to await his pleasure, he consulted none of his ministers on the speech he addressed to the Council, but only Bute. Pitt had then been gloriously conducting the Seven Years' War since 1756, but there was as yet no prospect of peace. George III., however, had realized that, as long as Pitt, supported by the Whig oligarchy, was directing a successful war, it would be impossible for the king to obtain control over the machinery of government; accordingly from the outset he proclaimed his intention to bring to an end what he termed a "bloody and expensive war." On Pitt's vehement expostulations this phrase was toned down in the printed version to "expensive, but just and necessary war," and a promise made to consider the interests of the allies, notably Frederick the Great; but the king's resolution was not thereby shaken. Bute was very soon substituted for Holderness, Pitt's docile fellow-secretary, and encouraged those members of the cabinet who were outraged by Pitt's supercilious method of treating them as nonentities but who till then had been too timid to combine against him. Thus the great minister's resignation was brought about when he failed to persuade his colleagues to declare war on Spain in *1761*.

But the king's greatest stroke was in forcing Newcastle to resign a few months later; for Newcastle was the arch-schemer of Whig majorities, powerful from his control over elections and over all the patronage necessary to keep electors and members of parliament contented. With the fall of Newcastle the king took into his own hands all the Treasury patronage, and showed that he meant to be master by turning out some of the greatest Whig lords from their offices in the household or from their lord-lieutenancies in the counties. Negotiations for peace were energetically pushed on by Bute, who succeeded Newcastle at the Treasury, and when the Preliminaries of Paris were ready for submission to parliament, a favourable majority was ensured by the ruthless determination of the king's agent, Henry Fox, who not only bribed existing members profusely, but secured future majorities in the constituencies by a further holocaust of great Whig office holders and by turning out the humblest official voters, such as tide-waiters and other Treasury satellites. At the end of December 1762 the king's victory was made patent to all by a majority of 319 for the Preliminaries, and the Princess of Wales was able to exclaim, "Now my son is king of England!" For the next twenty years of his reign he could summon or dismiss his ministries almost at pleasure.

But though George III. had thus early in his reign obtained control over the government, he had by no means succeeded in obtaining the affection of his people. In his first speech to parliament he had made a bid for this affection by his boast, "Born and bred in this country, I glory in the name of Briton," in pointed allusion to the German upbringing of his two predecessors; but unfortunately the appeal fell flat, largely owing to the use of the word *Briton* instead of *English,* at the presumed suggestion of Bute, whose unpopularity was enhanced by his Scottish nationality. Nor was his marriage in 1761 of a nature to awaken any romantic enthusiasm. In the early days of his reign he had been much attracted by the beauty and unconventional charm of Fox's niece, Lady Sarah Lennox, and had even made a clumsy attempt at a proposal of marriage to her; but the influence of his surroundings, aghast at the prospect of his marriage with a subject, allied too to a powerful Whig clique, overcame his incipient passion, and he chose as his wife Charlotte of Mecklenburg, consoling Lady Sarah by assigning to her the post of bridesmaid. Queen Charlotte, though a lady of no special beauty or charm, made an excellent wife for the king, for both shared a taste for homely domesticity, which, though a subject of derision in court circles, eventually proved one of the chief sources of their people's affections. But for the time being any natural inclination to rejoice at the marriage was overshadowed by the king's partiality to the unpopular Scotsman, Bute, and by the dismissal of the national hero, Pitt, who, it was noted, was shortly afterwards greeted with frenzied enthusiasm in the City, while the king was received with marked coldness. This unpopularity was expressed with cold, almost malignant insolence by Wilkes in his famous No. 45 of the ***North Briton*** (April 23, 1763). The king felt himself insulted by comments on his speech to parliament, which, Wilkes maintained as we should now, were constitutionally applicable only to ministers; and for the next seven years devoted himself with remarkable pertinacity to securing Wilkes's exclusion from parliament, browbeating ministers and influencing private members to carry out the vendetta against him.

By 1763 King George III. had recovered for the throne a good deal of the power and influence which had nominally been left to it by the Revolution, but which had largely lapsed during the reigns of the first two Georges. Constitutionally the king could choose and direct his own ministers, subject of course to the power left to parliament to force their dismissal if they failed to obtain the support of the majority to the king's policy. But now that the king had wrested from the Whigs the means of influencing electors and members of the unrepresentative House of Commons, he was comparatively untrammelled by parliament. It is true that the old parliamentary groups, from which he had to make his choice of ministers, remained: but by his power of patronage he was able in every group to secure a section of personal adherents, always ready to vote for the king's measures even against their own party and hence soon known collectively as "king's friends." But even so there was always a danger that a minister of determination and pronounced views might run counter to the king's wishes; so George III. took the additional precaution of having always a familiar, changed from time to time, either in the cabinet or on its outer fringes, who should report confidentially on the attitude of his colleagues and generally act as the king's spy. Egmont is perhaps the first who emerged in this character; and for short periods Hertford and Rochford seem to have played a similar part. But Northington was the most efficient of these adjuncts, especially in breaking up the first Rockingham administration; until finally the king found the ideal man in North, the prime minister himself. Such, in short, was the system by which the king tried to establish his personal rule as the Patriot King, on whom, as Bolingbroke lyrically exclaimed, "the eyes of a whole people are fixed, filled with admiration and glowing with affection." He was to decide on all measures, his ministers were to be chosen, not from one party, but each according to his fitness for the post he occupied, in the duties of which he was to be responsible to the king alone: in fact, when the system was at its zenith during North's ministry, the cabinet met as a body only when the king summoned it to consider some report of one of his ministers on which he desired further advice.

But the system was not perfected in a day. In spite of all precautions the right ministers to carry it out were not easy to find. Bute, whom the king afterwards described as "deficient in political firmness," resigned immediately after the Treaty of Paris (1763), and George Grenville was tried. But he and his allies, the Bedfords, had not learned the lesson and still attempted to lecture and browbeat the king, as if they were the masters, as in the old days of the Whig supremacy. So Grenville had to go (1765)—not, however, before he had passed the Stamp Act with the king's full approbation—and was succeeded by Rockingham and his party of remnants from the glorious days of Newcastle. Such a ministry was obviously not what the king wanted, was only tolerable for the moment as a means of escape from Grenville, and was intrigued against by the king almost from the start.

When the Rockingham ministry had been sufficiently sapped by Northington, George was able to turn to the one man whom he expected to share his views about a non-party ministry. Pitt indeed had always declared for "measures, not men," and was supremely indifferent to the claims of party when it was a question of national policy, so that superficially there appeared to be the elements of agreement between the two, especially when Pitt formed his ministry (1766) from men of all parties without distinction. No doubt had Chatham, as he had become, retained his faculties and been able to guide the ministry, he, not the king, would have settled its policy, for he was not apt to take his orders from anyone. But, after his virtual retirement within a few months, the ministry he had formed to carry out his own policy proved to be exactly the one best suited to carry out the king's system of government. When by 1770 Chatham, Shelburne, Grafton and Camden had all resigned and Lord North was promoted to the Treasury, the king at last had a ministry in which all the members, and above all their chief North, took their orders directly from him. Not only the general policy but the minutest details of administration were conveyed in the king's daily letters to North and other ministers. For the succeeding twelve years, therefore, the policy of the country was essentially that of the king.

Not only was the king the director of the national policy during the war with America (1776–83), but there is little doubt that he had the country on his side in that policy. George III. stood for the principle that Parliament, under his guidance, had the right to legislate for the colonies, and though Chatham might quite fairly insist on the distinction between general legislation applicable to the whole empire as within the purview of the imperial parliament and legislation affecting only the colonies, on which they had a clear right to decide through their own representatives, and Burke point to the calamitous consequences of alienating America, such distinctions or appeals left cold the bulk of the population of England, who felt that the colonies were ungrateful children, ready to profit from the security our arms had gained for them, but unwilling to pay the price. It was not indeed the merits of the war in which the king was the prime mover that finally disgusted the country, but the series of calamities which marked its progress. For these the king's system of government was chiefly responsible. He himself did all that such a man could do. He supervised the general policy and even more meticulously the details of administration. As is made abundantly clear in his published correspondence[1], the king delighted in taking responsibility upon his own shoulders. He practically assumes the duty of leader of the House by his constant and detailed directions to North as to the conduct of business, he thinks no labour too great in inspecting troops or dockyards, in settling how regiments are to be raised, foreign mercenaries to be hired or naval expeditions to be equipped and, incidentally, devotes quite as much care to deciding how, on a journey to Portsmouth, his equerries and other attendants are to travel and what horses and carriages are to be taken from the royal stables. He certainly did not want courage, either physical or moral, as he showed throughout his life. "Let not this check dismay You," he wrote to Grafton, "in this World these things will happen, therefore rest assured that it will if possible stimulate me to act with greater vigour": as is well known, during the Gordon riots he and his old enemy Wilkes seem to have been the only people who did not lose their heads: when poor North moaned to him about the expense of the war he rebukes him for "weighing such events in the Scale of a Tradesman behind his Counter": he tells Sandwich that "the English Lion when roused has not only his wonted resolution but has added the swiftness of the Race Horse": and when there is some difficulty about Howe accepting the American command he writes to poor North, "Before I get to dinner I just take up my pen to acquaint You that things are very far from desperate, that if no one will interfere I do not despair of bringing things to rights . . . therefore rest satisfied till You hear more from Me."

But the trouble was that, though in some respects a shrewd judge of men when he was not crossed, George III. had not the eagle eye of a Chatham in planning and supervising a campaign, and still less the ability to make lesser men carry out his bidding. And owing to his calculated aversion to really able men who would undertake responsibility, he had to rely on ministers like Lord George Germain, incompetent and quarrelsome, odious too for his behaviour at Minden, North, a timorous soul, Sandwich, an evil liver, as the king himself admitted. Scandals in his own family, which led to the Royal Marriages Act of 1770, and his patent inability to control the excesses of his graceless heir did not add to the king's popularity, and cast doubts on his competence. Above all, his extravagant methods of securing a complacent parliament by the distribution of sinecures and even direct money bribes were at last beginning to awaken alarm Debts amounting to over £1,000,000 on his ample civil List, which had to be paid by the nation while engaged in this "bloody and expensive" war, and the wasteful extravagance of the royal household under a king notoriously parsimonious were rightly attributed to the unavowed exercise of "influence," and tended to unite opposition in the country and even in the House, in a way that Wilkes, the American war and Junius's gross attack on the king had all failed to do. Finally in 1780 the hitherto docile House of Commons accepted Dunning's motion that "the power of the Crown has increased, is increasing and ought to be diminished": a resolution that George III. attributed merely to a few "factious Leaders and ruined men," who wished to overturn "this excellent Constitution . . . the most beautiful Combination that ever was framed."

But two years later, when England, with almost all Europe against her, was forced, after Yorktown, to give up the struggle in America, George at last realized that his attempt to govern on the lines of the "Patriot King" had finally failed. So fully was he aware of this that on two separate occasions he seriously contemplated abdication; and on both occasions drew up messages to announce his decision to Parliament. The first occasion was in 1782, when he was forced to take a Rockingham ministry after North's fall, the second when, on the defeat of Shelburne (1783), he saw no alternative to the hated Fox-North coalition. These draft messages are drawn up with a dignity of language all the more striking as they are a complete admission of failure. He emphasizes his scrupulous respect for the "Rights of Parliament," a perfectly true claim, since in normal times its composition gave him complete control over it. His more detailed reasons set forth in the drafts of 1783 give the best exposition of his principles of government and incidentally suggest the reasons for their ultimate failure. His "pleasing hope," he declares to have been that, "He might have proved the happy Instrument of conciliating all Parties, and thus collecting to the Service of the State, the most able Persons this Nation produced. . . . This Patriotic Endeavour has proved unsuccessful, by the Obstinacy of a Powerful Combination that has long manifested a resolution of not entering into Public Service, unless the whole Executive management of affairs is thrown entirely into their hands." In other words George III. was beaten by the demand for full responsibility of the people's representatives for the executive as well as the legislative functions of government.

The year 1783, therefore, marks a clear epoch, not only in the reign of George III., but also in our constitutional history. It is perfectly true that the king did not in a day give up his ingrained ambition "to be a king," and that there are many instances after the date of his draft abdication in 1783 of successful attempts by him to influence the government. He took an active part in securing the rejection of Fox's India Bill in 1783 and in dismissing the Coalition; and the *Parliamentary Papers* of *John Robinson* (Camden Series, 1922) afford conclusive evidence that Pitt's victory at the polls in 1784 was largely due to the active interference of the king in the elections. Pitt's resignation in March 1801 was entirely due to the king's refusal to agree to his minister's policy of conciliation to the Catholics; his refusal to admit Fox into Pitt's reconstituted ministry of 1804 was decisive. Although he admitted Fox into the ministry of All the Talents in 1806 and even went so far as to tell him that "I have no desire to look back upon old grievances, and you may rest assured that I never shall remind you of them," yet when, after Fox's death, the ministry wished to allow Roman Catholics to join the army, he not only flatly refused, but forced their resignation by demanding a written assurance that they would never again bring up the Catholic question in any form. All this is true, just as it is true that George IV. and William IV. and even Victoria and Edward VII. still could exercise a certain amount of personal influence in the composition of a ministry or on the execution of its measures. But largely owing to the long ministry of Pitt, who, no more than his father, was one to take directions from a king or anyone else as to the policy he thought good, the growth of the cabinet's and still more of a strong prime minister's independence became an established understanding of the constitution. It is to be remembered too that the unwillingness of Pitt and other ministers to oppose a strong prejudice of the king, such as that against the Catholic claims or against Fox, was almost entirely due to the fear of inducing another bout of insanity in their master and not to any concession to the king's view of his own powers.

As early as 1765 there appeared symptoms of insanity in the king during a comparatively trivial illness, but they soon passed off. In October 1788, however, his madness was unmistakable. He became violent and a danger even to those who loved him best, and had to be put under restraint. Unfortunately he was at first put under the care of ignorant doctors, whose only idea of treating madness was by means of a strait waistcoat and even more brutal measures. At last he came under the charge of Dr. Willis, who had introduced a new method of soothing and persuasive treatment. Even more pathetic were the political squabbles that ensued over the Regency Bill. The obvious regent was the Prince of Wales, but, as he was a bitter opponent of the king and consequently an ally of Fox and all the disappointed Whigs, Pitt naturally thought that his powers during the king's temporary illness should be limited. Feeling grew very bitter on the subject, the doctors were dragged into the dispute, and the Prince's ribaldry about his unfortunate father became a public scandal. Fortunately under Willis's treatment the king recovered by March 1789, and the contentious Regency Bill was dropped. Again in the first half of 1801 he had bouts of madness under the excitement of the Catholic question and again in 1804 and 1810; in 1811 after the

[1] *Correspondence of George III. from 1760 to 1783* edited by Hon. Sir John Fortescue, 6 vols., 1927–28.

death of his favourite daughter, Amelia, his insanity became permanent, a Regency Bill was passed, and the old king remained in seclusion, blind as well as mad, till his death on Jan. 29, 1820.

During the first twenty-three years of his reign, when he was attempting to revive personal government, George III. enjoyed little of his people's affection. The dynasty had never yet achieved popularity, and George III., in spite of the bright hopes with which he ascended the throne, had done very little to win it for himself. At first he was overshadowed by the popular hero, Pitt, and his predilection for the Scotsman Bute did not help him. Few stories likely to endear him with the people radiated from the court, for he hardly saw any even of his ministers except on business or at formal levees, and for choice lived frugally in the dull seclusion of his domestic circle. His devotion to public business took no romantic turn, for he rarely captivated his people by such appeals as Pitt's in the Seven Years' War, and his industry was rather that of a clerk than of a great statesman. So immersed was he in the routine duties of his office that until 1788, when he went to drink the waters at Cheltenham, he had never, according to Wraxall, stirred further from London than the Nore, Coxe Heath, Oxford and Portsmouth. But, paradoxically, when he was no longer the real master in the state his popularity increased enormously. The first strong demonstration of this new popularity was on his recovery from his illness in 1789, partly no doubt from sympathy with his affliction, partly in indignation at his son's and his friends' hardly concealed hope that he would not recover. After that his popularity never waned. His sturdy conservatism—"I will have no innovations in my time," as he said to Eldon—and even his narrow obstinacy in the American War and in resisting Catholic claims; still more his determination to fight on against the French regardless of defeats and desertions by allies, struck a sympathetic chord in the hearts of his subjects. And as he became better known, with his little trick of repetition and his "What? What?" at the end of every sentence, especially during his visits to Weymouth, where he talked unceasingly and shrewdly, if not always cleverly, with all and sundry about their homely concerns, their apple-dumplings and so on, he won the love of his countrymen as "farmer George," one of themselves, with the same tastes, though a king, as the country folk with whom he loved to gossip; in fact, as Wraxall observed, by the end of his reign "his virtues had obtained for him a higher place in our esteem than any prince has occupied since the conquest."

Viewing him from a greater distance of time, we can say of him that few kings have shown greater courage, both moral and physical, in accepting responsibility or affronting actual danger—"he could not bear," he once said, "that any of his family should want courage." With little appreciation of beauty he preferred West to Reynolds, thought little of Shakespeare's "sad stuff," and had "no taste for what was called the fine, wild, beauties of nature; he did not like mountains and other romantic scenes, of which he sometimes heard much"; still he had a good taste in music and was a generous and interested patron of science and learning—for is it not to him that we owe the nucleus of the British Museum Library? Though almost malignant in his vendettas against greater men such as Chatham who had crossed his purposes, yet when he had accepted defeat he could be a generous loser, as in his remark to Fox already quoted and in his speech to Adams, the first envoy to St. James's from the United States:—"I will be very frank with you. I was the last to consent to the separation: but the separation having been made and having become inevitable, I have always said, as I say now, that I would be the first to meet the friendship of the United States as an independent power." Lastly, not the least service he rendered the country was the homely domesticity, even the dullness of his life. Thereby he set a standard of faithful troth in the relations of private life, which was new at any rate in the court circles of England and which has survived even the Regency to become almost a commonplace of modern English life. *(See* genealogical table in article ENGLISH HISTORY.)

BIBLIOGRAPHY.—Correspondence of George III. from 1760 to 1783 (ed. Fortescue) 6 vols., 1927–28; this contains, *inter alia,* the king's letters in *Corr. of Geo. III. with Lord North* (ed. Donne) 2 vols. 1867, but the latter book has useful notes. Geo. Rose, *Diaries & Corr.* 2 vols. 1860, has some illuminating talks with the king. Most of the Memoirs and Correspondence of the latter half of the 18th century have information about Geo. III. The *Histories* of England by J. Adolphus (1803, etc.) & W. N. Massey (4 vols., 1855–63) have first hand stories. J. H. Jesse, *Memoirs of Life & Reign of Geo. III.,* 3 vols., 1867, may also be consulted. L. Melville, *Farmer George,* 2 vols., 1907, and B. Willson, *Geo. III. as man, monarch and statbsman,* 1907, are more recent compilations about him. (B. Wi.)

GEORGE IV. [George Augustus Frederick] (1762–1830), king of Great Britain and Ireland, eldest son of George III., was born at St. James's Palace, London, on Aug. 12, 1762. He was naturally gifted, was well taught in the classics, learnt to speak French, Italian and German fluently, and had considerable taste for music and the arts; and in person he was remarkably handsome. His tutor, Bishop Richard Hurd, said of him when 15 years old that he would be "either the most polished gentleman or the most accomplished blackguard in Europe—possibly both." Reaction from the strict and parsimonious style of his parents' domestic life had its natural effect in plunging the young prince of Wales, flattered and courted as he was, into a whirl of pleasure-seeking. At the outset his disposition was brilliant and generous, but it was essentially unstable, and he started even before he came of age on a career of dissipation which in later years became wholly profligate. He had an early amour with the actress Mary ("Perdita") Robinson, and in the selection of his friends he opposed and annoyed the king, with whom he soon became (and always remained) on the worst of terms, by associating himself with Fox and Sheridan and the Whig party, When in 1783 he came of age, a compromise between the coalition ministry and the king secured him an income of £50,000 from the Civil List, and £60,000 was voted by parliament to pay his debts and start his separate establishment at Carlton House. There, under the auspices of Fox and Georgiana, auchess of Devonshire, he posed as a patron of Whig politics and a leader in all the licence and luxury of gay society—the "First gentleman of Europe," as his flatterers described him as years went on. And at this early age he fell seriously in love with Mrs. Fitzherbert.

His connection with this lady was for some time the one redeeming and restraining factor in his life. Mary Anne (or as she always called herself, Maria) Fitzherbert (1756–1837) was the granddaughter of Sir John Smythe, Bart., of Acton Burnell Park, Shropshire, and came of an old Roman Catholic family. Her second husband, Thomas Fitzherbert, died in 1781, leaving his widow with a comfortable fortune. She became a prominent figure in London society, and the young prince wooed her with all the ardour of a violent passion. The Act of Settlement (1689) entailed his forfeiture of the succession if he married a Roman Catholic, apart from the fact that the Royal Marriage Act of 1772 made any marriage illegal without the king's consent. which was out of the question. They were secretly married by the Rev. R. Burt, a clergyman of the Church of England, on Dec. 15, 1785. There is no doubt as to Mrs. Fitzherbert's belief, supported by ecclesiastical considerations, in her correct and binding, though admittedly illegal, relationship to the prince as his canonical wife; and their relationship was treated by their intimates on the footing of a morganatic marriage. The position nevertheless was inevitably a false one; Mrs. Fitzherbert had promised not to publish the evidence of the marriage (which, according to a strict interpretation of the Act of Settlement might have barred succession to the crown), and the rumours which soon got about led the prince to allow it to be disavowed by his political friends. He became heavily involved in debt, and as the king would not assist him, shut up Carlton House, and went to live with Mrs. Fitzherbert at Brighton. In 1787 a proposal was brought before the House of Commons by Alderman Newnham for a grant in relief of his embarrassments. It was on this occasion that Fox publicly declared in the House of Commons, as on the prince's own authority, in answer to allusions to the marriage. that the story was a malicious falsehood. A little later Sheridan, in deference to Mrs. Fitzherbert's pressure and to the prince's own compunction, made a speech guardedly modifying Fox's statement; but though in private the denial was understood, it effected its object, the House voting a grant of £221,000 to the prince and the king adding £10,000 to his income; and Mrs. Fitzherbert. who at first thought of severing her connection with the prince, forgave him. Their union—there was no child of the marriage—was brutally broken off in June 1794 by the prince, when further pressure of debts (and the influence of a new Egeria in Lady Jersey) made him contemplate his official marriage with princess Caroline; in 1800, however, it was renewed, after urgent pleading on the prince's part, and after Mrs. Fitzherbert had obtained a formal decision from the pope pronouncing her to be his wife, and sanctioning her taking him back; her influence over him continued till shortly before the prince became regent, when his relations with Lady Hertford brought about a final separation. For the best years of his life he had at least had in Mrs. Fitzherbert the nearest approach to a real wife, and this was fully recognized by the royal family[1]. But his dissolute nature was entirely selfish, and his various liaisons ended in the dominance of Lady Conyngham, the "Lady Steward" of his household, from 1821 till his death.

In 1788 his father's first attack of insanity made the prince's position in the State one of peculiar importance. Fox maintained and Pitt denied that the prince of Wales, as the heir-apparent, had a right to assume the regency independently of any parliamentary vote. Pitt, with the support of both Houses, proposed to confer upon him the regency with certain restrictions. The recovery of the king in Feb. 1789 put an end, however, to the prince's hopes. In 1794 the prince consented to a marriage with a German Protestant princess, because his father would not pay his debts on any other terms, and his cousin, Princess Caroline of Brunswick, was brought over from Germany and married to him in 1795. Her behaviour was light and flippant, and he was brutal and unloving. The ill-assorted pair soon parted, and soon after the birth of their only child, the princess Charlotte, they were formally separated. With great unwillingness the House of Commons voted fresh sums of money to pay the prince's debts.

In 1811 he at last became prince regent in consequence of his father's definite insanity. He had always lived in close connection with the Whig opposition, and he now empowered Lord Grenville to form a ministry. There soon arose differences of opinion betaeen them on the answer to be returned to the address of the Houses, and the prince regent then informed the prime minister, Mr Perceval, that he should continue the existing ministry in office. The ground alleged by him for this desertion of his friends was the fear lest his father's recovery might be rendered impossible if he should come to hear of the advent of the opposition to power. Lord Wellesley's resignation in Feb. 1812 made the reconstruction of the ministry inevitable. As there was no longer any hope of the king's recovery, the former objection to a Whig administration no longer existed. Instead of taking the course of inviting the Whigs to take office, he asked them to join the existing administration. The Whig leaders, however, refused to join, on the ground that the question of the Catholic disabilities was too important to be shelved, and that their difference of opinion with Mr. Perceval was too glaring to be ignored. The prince regent was excessively angry, and continued Perceval in office till that minister's assassination on May 11, when he was succeeded by Lord Liverpool, after a negotiation in which the proposition of entering the cabinet was again made to the Whigs and rejected by them. In the military glories of the following years the prince regent had no share. When the allied sovereigns visited England in 1814, he played the part of host to perfection. So great was his unpopularity at home that hisses were heard in the streets as he accompanied his guests into the city. In 1817 the windows of the prince regent's carriage were broken as he was on his way to open parliament.

The death of George III. on Jan. 29, 1820, gave to his son the title of king without altering the position which he had now held for nine years. The relations between the new king and his wife unavoidably became the subject of public discussion. In 1806 a charge against the princess of having given birth to an illegitimate child had been conclusively disproved, and the old king had consequently refused to withdraw her daughter, the princess Charlotte, from her custody. In the regency the prince was able to interfere, and prohibited his wife from seeing her daughter more than once a fortnight. On this, in 1813, the princess addressed to her husband a letter setting forth her complaints, and receiving no answer published it in the *Morning Chronicle*. The prince regent then referred the letter, together with all papers relating to the inquiry of 1806, to a body of 23 privy councillors for an opinion whether it was fit that the restrictions on the intercourse between the princess Charlotte and her mother should continue in force. All except two answered as the regent wished them to answer. But the general public leaned towards the wife of a notorious profligate. Addresses of sympathy were sent up to the princess from the city of London and other public bodies.

The discord again broke out in 1814 in consequence of the exclusion of the princess from court during the visit of the allied sovereigns. In August in that year she left England, and after a little time took up her abode in Italy. The accession of George IV. brought matters to a crisis. He ordered that no prayer for his wife as queen should be admitted into the Prayer Book. On June 7 she arrived in London. Before she left the continent she had been informed that proceedings would be taken against her for adultery if she landed in England. Two years before, in 1818, commissioners had been sent to Milan to investigate charges against her, and their report, laid before the cabinet, in 1819, was made the basis of the prosecution. On the day on which she arrived in London a message was laid before both Houses recommending the criminating evidence to parliament. A secret committee in the House of Lords after considering this evidence brought in a report on which the prime minister founded a Bill of Pains and Penalties to divorce the queen and to deprive her of her royal title. The bill passed the three readings with diminished majorities, and when on the third reading it obtained only a majority of nine, it was abandoned by the Government. The king's unpopularity, great as it had been before, was now greater than ever. In the following year (1821) Caroline attempted to force her way into Westminster Abbey to take her place at the coronation. On this occasion popular support failed her; and her death in August relieved the king from further annoyance.

Immediately after the death of the queen, the king set out for Ireland. His good reception in Dublin encouraged him to attempt a visit to Edinburgh in the following year (Aug. 1822). Since Charles II. had come to play the sorry part of a covenanting king in 1650 no sovereign of the country had set foot on Scottish soil. Sir Walter Scott took the leading part in organizing his reception, which was enthusiastic. He returned from Edinburgh to face the question of the appointment of a secretary of state which had been raised by the death of Lord Londonderry (Castlereagh). It was upon the question of the appointment of ministers that the battle between the Whigs and the king had been fought in the reign of George III. George IV. had neither the firmness nor the moral weight to hold the reins which his father had grasped. He disliked Canning for having taken his wife's side very much as his father had disliked Fox for taking his own. But, Lord Liverpool insisted on Canning's admission to office, and the king gave way. Tacitly and without a struggle the constitutional victory of the last reign was surrendered. But it was not surrendered to the same foe as that from which it had been won. The coalition ministry in 1784 rested on the great landowners and the proprietors of rotten boroughs. Lord Liverpool's ministry had hitherto not been very enlightened, and it supported itself to a great extent upon a narrow constituency. But it did appeal to public

[1]Mrs. Fitzherbert herself, after her final separation from the prince, with an annuity of £6,000 a year, lived an honoured and more or less retired life mainly at Brighton. There she died in 1837. William IV. on his accession offered to create her a duchess, but she declined; she accepted, however, his permission to put her servants in royal livery. The actual existence of a marriage tie and the documentary evidence of her rights were not definitely established for many years; but in 1905 a sealed packet, deposited at Coutts's bank in 1833, was at length opened by royal permission and the marriage certificate and other conclusive proofs therein contained were published in W. H. Wilkins's *Mrs. Fitzherbert* and *George IV*. In 1796 the prince had made a remarkable will in Mrs. Fitzherbert's favour, which he gave her in 1799, and it is included among these documents (now in the private archives at Windsor). In this he speaks of her emphatically throughout as "my wife." It also contained directions that at his death a locket with her miniature, which he always wore, should be interred with him; and Mrs. Fitzherbert was privately assured, on the duke of Wellington's authority, that when the king was buried at Windsor the miniature was on his breast.

opinion in a way that the coalition did not, and what it wanted itself in popular support would be supplied by its successors. What one king had gained from a clique another gave up to the nation.

Once more, on Lord Liverpool's death in 1827, the same question was tried with the same result. The king not only disliked Canning personally, but he was opposed to Canning's policy. Yet after some hesitation he accepted Canning as prime minister; and when, after Canning's death and the short ministry of Lord Goderich, the king in 1828 authorized the duke of Wellington to form a ministry, he was content to lay down the principle that the members of it were not expected to be unanimous on the Catholic question. When in 1829 the Wellington ministry unexpectedly proposed to introduce a Bill to remove the disabilities of the Catholics, he feebly strove against the proposal and quickly withdrew his opposition. The worn-out debauchee had neither the merit of acquiescing in the change nor the courage to resist it.

George IV. died on June 26, 1830, and was succeeded by his brother, the duke of Clarence, as William IV. His only child by Queen Caroline, the princess Charlotte Augusta, was married in 1816 to Leopold of Saxe-Coburg, afterwards king of the Belgians, and died in childbirth on Nov. 6, 1817.

George IV. was a bad king, and his reign did much to disgust the country with the Georgian type of monarchy; but libertine and profligate as he became, the abuse which has been lavished on his personal character has hardly taken into sufficient consideration the loose morals of contemporary society, the political position of the Whig party, and his own ebullient temperament. Thackeray, in his *Four Georges*, is frequently unfair in this respect. The just condemnation of the moralist and satirist requires some qualification in the light of the picture of the period handed down in the memoirs and diaries of the time, such as Greville's, Croker's, Creevey's, Lord Holland's, Lord Malmesbury's, etc.

(S. R. G.; H. C.)

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GEORGE V. (1865–1936) King of Great Britain and Emperor of India was born at Marlborough House, London on June 3, 1865. He was a grandson of Queen Victoria and the second son of Albert Edward, the Prince of Wales, afterwards Edward VII. and of Alexandra, a Princess of Denmark and sister of the Empress Marie of Russia. King George was thus first cousin of the illfated Czar Nicholas II. whom he resembled in face and form especially in early life. Also he was first cousin of the Emperor William II. of Germany, Queen Victoria of Spain, Queen Marie of Rumania, King Constantine and Queen Sophie of Greece.

When 6½ years old, he and his elder brother, Prince Albert Victor, two years his senior, were placed under the tutorship of John Neale Dalton, then curate of Sandringham. In 1877 the two princes became naval cadets on the "Britannia" at Spithead, where they passed through the ordinary curriculum, and in 1879 they joined H.M.S. "Bacchante" under the command of Captain Lord Charles Scott, making a voyage to the West Indies, in the course of which they were rated midshipmen. After a month at home in 1880 they visited South America, South Africa, Australia, the Fiji Islands, Japan, Ceylon, Egypt, Palestine and Greece. A narrative of this voyage, *The Cruise* of *H.M.S. "Bacchante,"* compiled from the letters, diaries and notebooks of the princes, was published in 1886. At the close of this tour in 1882 the brothers separated. Prince George, who remained in the naval service, was appointed to H.M.S. "Canada," on the North American and West Indian station, and was promoted sub-lieutenant. He passed through the Royal Naval college at Greenwich and the gunnery and torpedo schools, being promoted lieutenant in 1885. He served successively in H.M.S. "Thunderer," "Dreadnought" and "Alexandra" of the Mediterranean squadron and H.M.S. "Northumberland" of the Channel Squadron. In 1890 he commanded the gunboat "Thrush" on the North American and West Indian Station, and in 1891, promoted commander, he commissioned the "Melampus." He was promoted captain in 1893, rear-admiral in 1901 and vice-admiral in 1903 nor was there any doubt as to his aptitude for seamanship. Throughout his life, he was a familiar figure at Cowes where his yacht, the "Britannia'—,a winner, it is stated, of 360 prizes in all—was frequently sailed by him in person. Among his friends was John Masefield, the seaman who became poet laureate. George's punctuality, sense of order, vigorous vocabulary—even his famous parrot—suggested the sailor. His collection of stamps is the most complete in existence and, in later years, he was devoted to the radio and motion picture.

In January 1892, his elder brother the duke of Clarence died and as heir to the throne, George had to relinquish his active career in the navy. He was created duke of York, earl of Inverness and Baron Killarney in 1892, and on July 6, 1893 he married Princess Victoria Mary (1867–1953), daughter of Francis, duke of Teck, and Princess Mary Adelaide, duchess of Teck, daughter of Adolphus Frederick, duke of Cambridge. Popularly she was beloved as the Princess Mary. Their eldest son, Prince Edward Albert, was born at White Lodge, Richmond, on June 23, 1894; Prince Albert Frederick George, duke of York, was born at Sandringham on December 14, 1895; Princess Victoria Alexandra Alice Mary on April 25, 1897; Prince Henry William Frederick Albert, duke of Gloucester, on March 31, 1900; Prince George Edward Alexander Edmund, duke of Kent, on December 20, 1902; and Prince John Charles Francis on July 12, 1905 (died January 18, 1919). For eighteen years, George and Mary, spending much of their time at York Cottage, near Sandringham, were overshadowed by the prestige of Queen Victoria and by the magnificent urbanity of King Edward VII. They visited Ireland in 1899 and it had been arranged before the death of Queen Victoria that they should make a tour in the colonies. On the accession of King Edward VII. (1901) this plan was confirmed. They sailed in the "Ophir" on March 16, 1901, travelling by the ordinary route, and landed at Melbourne in May, when they opened the first parliament of the Commonwealth. They then proceeded to New Zealand, returning by way of South Africa and Canada. In November 1901 the duke was created prince of Wales.

On May 6, 1910, King Edward VII. died. Since the new Prince of Wales was under 16, Queen Mary was nominated regent in the event of the demise of the Crown while the heir to the throne was under age. Parliament granted a civil list of £470,000 a year.

The domestic tastes of the King were a contrast to the social brilliance of his father and from the first, he appealed to the quiet solidities of the nation. The bitter quarrel between Edward and the Kaiser had no place in George's conception of duty. His only policy was conciliation and he began with the accession declaration which had contained words that were needlessly offensive to Roman Catholics. Acting under George's insistence, Parliament substituted the formula:

> I do solemnly and sincerely in the presence of God, profess, testify and declare, that I am a faithful Protestant, and that I will according to the true intent of the enactments which secure the Protestant succession to the Throne of my Realm, uphold and maintain the said enactments to the best of my power according to law.

A constitutional crisis was raging. The House of Lords rejected a budget passed by the House of Commons and the Commons replied by carrying a Parliament Bill that limited the powers of the Lords. After two elections had been won by the Liberal government in power, George—following the precedent of the Reform Bill of 1832—agreed to create peers in order to secure the passage of the measure which indication of the prerogative was sufficient for the purpose. Over Home Rule for Ireland, the crisis continued and the arming of Ulster, with a mutiny of British troops at the Curragh near Dublin, led the King to invite leaders of all parties—in 1914—to a conference at Buckingham Palace where, however, no settlement was reached.

It was soon apparent that King George—however simple his private life—intended to continue and even to outshine the ceremonial splendors of the Edwardian era. The coronation at Westminster Abbey, on June 22, 1911, was attended by representatives from all parts of the Empire and other countries and, in order to complete the public assumption of royal authority throughout the United Kingdom, the King and Queen, with the prince of Wales and Princess Mary, made State visits to Ireland, Wales and Scotland during July. At the opening of Parliament, the King wore his crown and, amid some misgivings on the part of his advisers, he proceeded with Queen Mary to India, where a coronation durbar was held at Delhi (December 12, 1911). The constitutional functions of the King in Great Britain were entrusted to a Council of State.

King George exerted little influence over events in Europe that led up to World War I. During that prolonged ordeal, he appeared in uniform when opening Parliament and on other public occasions. The Court, like the nation, was mobilized for active service. Royal visits were paid to important factories and workshops at the munition centres throughout Great Britain, as well as to shipbuilding yards, hospitals and other institutions engaged in war-work. Periodical visits were made by him to the Grand Fleet. In 1917 Queen Mary accompanied the King to France. The King made frequent visits to the French and Belgian fronts. Finally, after the Armistice, the King made another visit to Paris and to the battle-fields, Nov. 27–Dec. 10, 1918, and had an enthusiastic reception in the French capital (Nov. 28-30).

The long record of royal attendances at notable ceremonies included the funeral services at St. Paul's for Lord Roberts (Nov. 19, 1914) and Lord Kitchener (June 13, 1916); the commemoration service there on the entry of the United States into the war (April 20, 1917); the Albert Hall commemoration of the first Seven Divisions (Dec. 15, 1917); the thanksgiving at St. Paul's on Their Majesties' silver wedding (July 6, 1918); the presentation to the King at Buckingham Palace by the special Japanese mission of the sword and badge of a Japanese field-marshal (Oct. 29, 1918); and other events. On the occasion of Their Majesties' silver wedding, the King and Queen were received at the Guildhall (July 6, 1918) and were presented with a cheque for £53,000, subscribed by the citizens of London, to be devoted to charities according to Their Majesties' wish, together with a silver tankard once owned by Charles II.

On July 17, 1917 it was announced that King George had abandoned all German titles for himself and his family. At the same time a proclamation was issued to the effectthat henceforth the royal house of Great Britain and Ireland would be known, not as the house of Saxe-Coburg-Gotha, or popularly as the house of Hanover or Brunswick, but as the house of Windsor. It had previously been announced (June 20, 1917) that the King had decided that those princes of his family who were British subjects but bore German titles should relinquish those titles in favour of British names.

After the war, the world was faced by a dramatic paradox. The great autocracies of Russia, Germany and Austria-Hungary had collapsed in revolution. The British throne was unshaken. Immediately after the Armistice in 1918, the King and Queen on successive days made popular progresses through London and received general ovations. There were carriage drives through the city (Nov. 11) to a special thanksgiving at St. Paul's (Nov. 12), through the East End (Nov. 13), the south (Nov. 14), the north (Nov. 1j), the north-west (Nov. 18) and the south-west (Nov. 22). On Dec. 27 a banquet was given in honour of President Wilson at Buckingham Palace, where he and Mrs. Wilson were staying with the King and Queen.

On June 21–22, 1921, the King and Queen visited Belfast, where His Majesty inaugurated the new parliament of Northern Ireland. The King made an appeal to all Irishmen to pause and stretch out the hand of forbearance, to forgive and forget and to make for the land they loved a new era of peace, contentment and good-will. When, in the following December, an agreement was at last reached with the Irish Free State, the King in his telegram of congratulation to Mr. Lloyd George, ventured to hope thar his own speech at Belfast might have contributed to bring it about.

The policy of cultivating pageantry was developed further when, on February 28, 1922, the King's only daughter, Princess Mary, was married to Viscount Lascelles not in the comparative seclusion of a royal chapel but in Westminster Abbey. An astonishing response by the people encouraged the King to arrange that the Abbey should be the scene of other weddings in his family—the duke of York to Lady Elizabeth Bowes-Lyon on April 26, 1923, and the duke of Kent to Princess Marina of Greece and Denmark on November 29. 1934, which was broadcast throughout the world. Because of the death of the bride's father, the duke of Ruccleuch, the duke of Gloucester was married quietly on Nov. 6, 1935, to Lady Alice Montagu Douglas Scott.

In 1922, the King and Queen paid a state visit to Belgium and in 1923 they visited Italy. They were guests of King Vittoria Emanuele III. but it was arranged that, on May 9, they should be received by the Pope. The appearance of the King and Queen at great functions—the British Empire Exhibition at Wembley in 1924, the dedication of Liverpool Cathedral and the opening of the Mersey Tunnel are typical of these occasions—demonstrated the evergrowing affection which surrounded them on every side. Occasionally, a Socialist would raise his voice in not very convincing dissent. But the failure of the General Strike of 1926 proved that Great Britain, however hard hit, wanted no Communism. In 1928, the grave illness of the King aroused sympathy throughout the world and during the concluding years of an amazing reign, his prestige could hardly have been greater. His Christmas broadcasts, relayed from continent to continent, were irresistible in their dignified and intimate goodwill.

In May 1935, 25 years after accession, King George celebrated a Silver Jubilee which was marked by unforgettably enthusiastic expressions of affectionate loyalty of his subjects. Despite medical advice, King George insisted on wintering in England and on January 20, 1936, he succumbed at Sandringham to a chill. He was buried with his parents in St. George's Chapel, Windsor, and six kings attended the obsequies—Great Britain, Rumania, Denmark, Norway, Bulgaria and Belgium. His coffin was made by the village carpenter at Sandringham. At his funeral, the crowds were greater than any that ever gathered in the streets of London.

GEORGE VI (1895–1952), king of Great Britain, Ireland and the British Dominions beyond the Seas, second son of King George V and Queen Mary, was born at York Cottage, Sandringham, Dec. 14, 1895. He passed through Osborne and the Royal Naval college, Dartmouth, and in World War I served as a sub-lieutenant at Jutland. He was then attached to the naval branch of the R.A.F. and in Oct. 1918 was on the western front. After the war he spent several terms at Trinity college, Cambridge.

In June 1920, he was created duke of York and on April 26, 1923, he married Lady Elizabeth Bowes-Lyon. Princess Elizabeth, who succeeded her father as Elizabeth II in 1952, was born on April 21, 1926, and Princess Margaret on Aug. 21, 1930.

In Dec. 1924 the duke and duchess paid an unofficial visit to East Africa, during which the duke gained knowledge of conditions in East Africa. Less widely travelled than were his father and elder brother, he had seen something of the empire during his naval service and with the duchess carried out an important visit to Australia to open parliament at Canberra in 1927.

On the accession of his brother, Edward VIII (*q.v.*), the duke became heir presumptive, and on Edward VIII's abdication on Dec. 11, 1936, he succeeded as George VI. Their majesties were crowned on May 12, 1937.

In July 1937 they visited Ulster and the following July paid a state visit to France. In May and June 1939 they toured Canada and also visited the U S.

World War II imposed heavy burdens on the king and queen, who were indefatigable in their encouragement to their people. The king paid frequent visits to units of all the fighting services, both British and dominion, stationed in Britain, and to munitions factories, dockyards and other areas engaged in the war effort. He also visited the land fronts in North Africa (1943) and Italy (1944). The king and queen made many tours of the badly bombed areas of London and the provinces. On the first and successive wartime Christmas days, the king revived his father's practice of broadcasting a message to the empire.

His career and reign had close parallels with his father's. Each was educated without expectation of succeeding to the throne, and each entered the navy, so far as might be. "professionally." Again, each succeeded to the throne little known to the public men of his day and in times of abnormal difficulty. In each case, too, there was the same impartiality in dealing with their governments. He died at Sandringham Feb. 6, 1952. (C. M. CL.; X.)

GEORGE I. (1845–1913), king of the Hellenes, was the second son of Christian IX. of Denmark, and brother of Queen Alexandra of England. He was nominated for the Greek, throne by the British Government, at the request of the Greek national assembly. on the expulsion of King Otto I. in 1862, his election being recognized by the Powers on June 5, 1863. He was assassinated at Salonica on March 18, 1913, by a Greek named Schinas. For the events of his reign, *see* GREECE: *Modern History*.

GEORGE II (1890–1947), King of the Hellenes, eldest son of King Constantine, was born on July 20, 1890, at Tatoi, the royal villa near Athens. On account of his supposed Germanophile tendencies during World War I, he was excluded from the succession by the Allies in favour of his younger brother, Alexander, upon the deposition of his father by the ultimatum of June 11, 1917. After his father's restoration to the throne in 1920, he married on Feb. 27, 1921, Princess Elizabeth, elder daughter of King Ferdinand and Queen Marie of Rumania. Upon the second deposition of his father by the revolution of General Plasteras, his younger brother Alexander I having died in 1920 he succeeded to the throne on Sept. 27, 1922. After the unsuccessful counter-revolution of Oct. 1923, his position became more difficult. although there was no proof that he had been a party to that rising. Republican feeling grew under the leadership of Papanastasiou and others, and a number of military and naval officers demanded the deposition of the Gliicksburg dynasty. On Dec. 19, 1923, the king and queen left Greece. Next day. Admiral Condouriotes, for the second time: became regent. On March 25, 1924, the assembly deposed the dynasty and forbade its members to reside in Greece; and the plebiscite of April 13 confirmed the vote of the assembly.

On Oct. 10, 193j. the assembly declared for the restoration of the monarchy, and after a plebiscite in November showed this was the popular desire, George II returned as king. The nazi invasion of 1941 again caused him to leave the country. A plebiscite brought him back on Sept. 27, 1946, for a brief period before his death on April 1, 1947, in Athens. *(See* GREECE.)

GEORGE OF LAODICEA in Syria, often called "the Cappadocian," from 3j6 to 361 Arian archbishop of Alexandria, was born probably at Epiphania, in Cilicia. After many wanderings, in which he amassed a fortune: first as an army contractor and then as a receiver of taxes, he reached Alexandria, where in 356 he was promoted by the prevalent Arian faction to the vacant see. A semi-Arian or Homsiousian, George instigated the second Sirmian formula (promulgated by the third council of Sirmium 357). which was conciliatory toward strict Arianism, was opposed at the council of Ancyra in 358. His persecutions of the orthodox raised a rebellion which compelled him to flee for his life; but his authority was restored by a military demonstration. On the accession of Julian, he was killed by the people on Dec. 24, 361.

Though brutal in character, George possessed a cultivated literary taste and collected a splendid library, which Julian ordered to be conveyed to Antioch for his own use. An anonymous work against the Manicheans discovered by Lagarde in 1859 in a manuscript of Titus of Bostra has been attributed to him.

The sources for the life of George of Laodicea are Ammianus, Gregory Nazianzen, Epiphanius and Athanasius. Gibbon's theory of his identification with the patron saint of England is now rejected *(see* GEORGE, SAINT).

See J. H. Newman, *The Arians of the 4th Century* (1871); C. S. Hulst, *St. George of Cappadocia in Legend and History* (1910).

GEORGE THE **MONK** (also called HAMARTOLOS, "sinner") (fl. 9th century), Byzantine chronicler, lived during the reign of Michael III (842–867), but nothing seems to be known of his life. His *Chronicon Syntomon* ("Chronicle") in four books covers the period from the Creation to the death (in 842) of the emperor Theophilus, whose widow Theodora restored the use of icons (843). His main attention is focused on religious matters; the iconoclasts are fiercely attacked, and the work is full of theological discussions. It is an important contemporary authority for the years 813 to 842; but the early parts are a compilation based mainly on Malalas, Theophanes and various ecclesiastical works. In the introduction the author declares that his only object is to relate with strict truth such things as are "useful and necessary."

A continuation of this chronicle up to 948 is known as GEORGIUS CONTINUATUS. As the continuator is called "a Logothete" in some manuscripts he may have been Simeon Magister. In this continuation more attention is devoted to political history, and the author is clearly biased against Constantine VII and the Macedonian dynasty. This work was frequently used by other historians and the fact that it was subsequently reissued with alterations and interpolations makes it very difficult to arrive at the original text.

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GEORGE, HENRY (1839–1897), U.S. economist and land reformer, popularizer of the "single tax" idea, was born in Philadelphia, Pa.. Sept. 2, 1839, of a religious, middle-class family. When not quite 14 years of age he left school. After two years as a clerk in the importing house of Asbury and Company, he became a seaman on the "Hindoo" for a voyage to Australia and India. On his return to Philadelphia in 1856 he learned typesetting, and in the following year signed up as steward on the United States lighthouse tender "Shubruck," bound for the Pacific coast service. He quit the ship in San Francisco and joined the gold rush to the Frazier river in Canada, but arrived too late. George spent the next two decades (1858–80) in California in newspaper work and Democratic party politics, developing in the process his gifts for writing and oratory but achieving little worldly success. After eight years of intermittent employment as a typesetter and five years as an editor for several newspapers, including the *San Francisco Chronicle,* he, along with two partners, started in 1871 the *San Francisco Daily Evening Post;* four years later, however, a policy of expansion strained the firm's credit and ended the enterprise.

George had failed at several attempts to gain elective office, but in 1876 a Democratic governor appointed him state inspector of gas meters. a job that ended with Republican victory in 1879. It had enabled him, however, to prepare his most important work, *Progress and Poverty* (1879). This book caught the spirit of discontent that continued to sweep a world just emerging from the great depression of 1873–78. He took as a basis the intricate orthodox. or "Ricardian." doctrine of rent, and in clarifying it for the ordinary reader gave it new meaning. Extending the law of diminishing returns and of a "margin of productivity," but still applying it to land alone, he held that since economic progress entailed a growing scarcity of land, the idle landowner reaps ever greater returns at the expense of the productive factors of labour and capital. The proposal, for which George became famous, was that the state tax away all economic rent and abolish all other taxes.

He optimistically envisaged that the government's annual income from this "single tax" would be so large that there would be a surplus for expansion of public works, from roads to universities. The economic argument was re-enforced and dominated by a humanitarian and religious appeal. The book had an enormous sale and was translated into many languages. Its vogue was enhanced by his pamphlets, voluminous contributions to the leading popular magazines and his lecture tours both in the United States and the British Isles. George moved to New York in 1880. Such was his reputation that in 1885 he became the mayoralty candidate of the reform forces in a spectacular contest, which he barely lost to the Democratic candidate, Abram Hewitt, running substantially ahead of the Republican candidate, Theodore Roosevelt. He died in New York on Oct. 29, 1897.

George's specific remedy had no significant practical result, and economists of reputation who supported it were rare. His economic analysis, though more sophisticated than that of most of his contemporaries, is crude by modern standards. His forceful emphasis, however, on "privilege" and the demand for equality of opportunity, coupled with a systematic economic analysis, proved a stimulus to orderly reform.

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GEORGE, STEFAN (1863–1933), German lyric poet who was chiefly responsible for the revival of German poetry at the turn of the 19th century, was born at Biidesheim, near Bingen, July 12, 1868. He studied philosophy and the history of art in Paris, Munich and Berlin, and traveled widely, becoming associated with Mallarmé and the Symbolists in Paris and with the Pre-Raphaelites in London. Returning to Germany, where he divided his time between Berlin, Munich and Heidelberg, he founded a literary school of his own, the *George-Kreis,* held together by the force of his authoritarian personality. Many famous writers—including Hofmannsthal, briefly, Karl Wolfskehl, Friedrich Gundolf and Norbert von Hellingrath—belonged to it, or contributed to its journal, *Blätter* fur *die Kunst,* founded in 1892.

George aimed to impose a new classicism on German poetry, avoiding impure rhymes and metrical irregularities. Vowels and consonants were arranged with precision to achieve harmony. The resulting symbolic poem was intended to evoke a sense of intoxication. These poetic ideals were a protest not only against the debasement of the language but also against materialism and naturalism, to which George opposed an austerity of life and a standard of poetic excellence, preaching a humanism inspired by Greece, which he hoped would be realized in a new society. His ideas, and the affectations into which they led some of his disciples, his claim of superiority and his obsession with power, were ridiculed, attacked and misused by those who misunderstood them; it is necessary to remember that George himself was strongly opposed to the political developments which his ideas are sometimes thought to reflect. Indeed, one of his disciples, Count Claus von Stauffenberg, attempted to assassinate Hitler on July 20, 1944.

George died at Minusio, near Locarno, Dec. 4, 1933.

George's collected works fill 18 volumes *(Gesamtausgabe,* 1927–34), including five of translations and one of prose slretches. His collections of poetry, of which *Hymnen* (1890), *Pilgerfahrten* (1891), *Algabal* (1892), *Das Jahr der Seele* (1897), *Der Teppich des Lebens und die Lieder von Traum und Tod* (1899), *Der siebente Ring* (1907), *Der Stern des Bundes* (1914) and *Das neue Reich* (1928) are the most important, show his poetic and spiritual development from early doubts and searching self-examination to complete assurance of his role as a seer and as leader of the coming new society. Personally, and spiritually, he found the fulfillment of his striving for significance in "Maximin" (Maximilian Kronberger; 1888–1904) a beautiful and gifted youth whom he met in Munich in 1902. After his death George claimed that he had been a god, glorifying him in his later poetry and explaining his attitude to him in *Maximin, ein Gedenkbuch* (privately published, 1906).

Selections of George's poetry have been translated into English by C. M. Scott (1910) and C. N. Valhope and E. Morwitz (1943).

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GEORGE, LAKE, a long, narrow lake in the eastern part of New York state in the foothills of the Adirondack mountains, which rise more than 2,000 ft. above the lake. Prospect mountain, rising 1,705 ft. above sea level, and Black mountain, 2,732 ft. in height, are the most prominent. Lake George has a maximum depth of about 400 ft., is 317 ft. above sea level and 224 ft. above Lake Champlain, into which it has an outlet to the north through a narrow channel containing many rapids and falls. The lake is about 33 mi. long and varies in width from $\frac{3}{4}$ mi. to 3 mi.

It has clear water, coming from mountain brooks and submerged springs, a clean, sandy bottom and beautiful tints of green and blue. It is noted for its beautiful mountain scenery, and its islands and is a favourite summer resort. Geologists are of the opinion that Lake George is of glacial origin.

Before the advent of the white man the lake was a part of the natural trail over which the Iroquois Indians frequently made their way northward to attack the Algonkins and the Hurons. During the struggle between the English and the French for supremacy in North America, and during the American Revolution, this natural pathway was still the best route of communication between New York and Canada and was of great strategic importance. Samuel de Champlain explored Lake Champlain in 1609, and at that time heard from the Indians of the beautiful lake, called by them *Andiatarocte* ("place where the lake contracts"); but no records show that Champlain ever visited Lake George. The first white man to see the lake (Aug. 18, 1642) appears to have been Father Isaac Jogues, a Jesuit missionary, who in company with René Goupil and Guillaume Conture was being taken by his Mohawk Indian captors from the St. Lawrence to the town of the Mohawks. In the spring of 1646 Father Jogues, while on a half-religious, half-political mission to the Mohawks, again visited the lake on the eve of the feast of Corpus Christi. He gave it the name "Lac du St. Sacrement." In 1755, Gen. Sir William Johnson renamed it Lake George in honour of George II of England. James Fenimore Cooper refers to it in his novels as Lake Horicon.

Lake George was the scene of many engagements during the French and Indian War and during the Revolution. On Sept. 8, 1755, at the head of the lake, Gen. William Johnson defeated a force of about 1,400 French, Canadians and Indians under Baron Ludwig August Dieskau, who left Canada with the intention of attacking Ft. Lyman (later Ft. Edward). The engagement is known as the battle of Lake George; a monument commemorating the battle was-erected in 1903. Following the battle, Gen. Johnson built a fort of logs and earth on the shores of Lake George near the battlefield which he called Ft. William Henry in honour of William Henry, duke of Gloucester. In the meantime the French entrenched themselves at Ticonderoga. Two years later, in March 1757, the governor of Canada sent an expedition of about 1,600 men to capture the fort, but the expedition failed. In August of the same year the garrison, in desperate straits because of loss of ammunition and supplies, surrendered to the marquis de Montcalm. While under escort to Ft. Edward, the Indian allies of Gen. Montcalm massacred or took prisoner a large part of the force. Ft. William Henry was destroyed. Gen. James Abercrombie's large army marched from the lake to its defeat at Ticonderoga in July 1758. Lord Amherst advanced along the lake en route to Ft. Ticonderoga, which he captured in July 1759. Near the site of Ft. William Henry, Gen. Amherst later built a new fort known as Ft. George. Its ruins remain.

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GEORGE THE PISIDIAN (GEORGIUS PISIDA or GEORGIOS PISIDES) (fl. 7th century A.D), Byzantine poet, was a valuable chronicler of contemporary events. Born in Pisidia, he became a deacon and keeper of the records of the church of St. Sophia in Constantinople. His works include a poem of 1,088 iambic lines on the campaign of the emperor Heraclius (610–641) against the Persians, apparently the work of an eyewitness; the *Avarica*, an account of the abortive attack on Constantinople by the Avars (626) ; the Heraclias, a survey of the exploits of Heraclius down to the overthrow of the Persian King Khosrau II (628); a didactic poem *Hexaemeron* or Cosmourgia, on the creation; a treatise on the vanity of life after the manner of Ecclesiastes; a controversial composition against Severus. bishop of Antioch; and a poem on the resurrection of Christ. In his hands the Byzantine 12-syllable iambic verse begins to take shape. This became the principal verse in subsequent learned medieval Greek poetry. Pisides, while adhering faithfully to the rules of ancient metre (which from *c.* A.D. zoo was no longer distinguishable by ear) normally accentuates the 11th syllable of his iambic verse, and rigorously observes the caesura after the fifth or the seventh syllable. He also avoids an accent on the seventh syllable if a caesura follows, and is careful to avoid enjambment. By this means he combined the laws of ancient metre (based on quantity) with the new Byzantine metrical system (based on numbers of syllables and place of accents in a line), a real tour de force. Subsequent Byzantine poets as late as the 14th century followed him, and even developed this system further when writing iambic trimeters. Although later Byzantines admired his work, and although it has undoubted historical value, modern criticism rightly pronounces it dull.

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GEORGE THE SYNCELLUS (GEORGIOS SYNKELLOS), of Constantinople. Byzantine chronicler and ecclesiastic, lived at the end of the 8th and the beginning of the 9th century A.D. He was the *syncellus* (cell mate, the confidential companion assigned to the patriarchs. in reality sometimes little more than a spy) of Tara(u)sius, patriarch of Constantinople (784–806), after whose death he retired to a convent and wrote his *Chronicle* of events from Adam to Diocletian (285). At his request, the work was continued after his death by his friend Theophanes Confessor. The Chronicle, which is rather a chronological table (with notes) than a history, is valuable. in spite of its religious bias and dry and uninteresting character, for the fragments of ancient writers and apocryphal books preserved in it (*e.g.,* considerable portions of the *Chronicle* of Eusebius).

GEORGETOWN, the capital of British Guiana, the only British possession in South America (see GUIANA), and seat of the colonial government, is situated on the right bank of the Demerara river at its mouth. Pop. (1946) 73.509; (1956 est.) 92.808. Area 2.5 sq.mi. Known during the Dutch occupation as Stabroek ("standing pool"). it was established as the seat of government of the combined colonies of Essequibo and Demerara (now with Berbice forming the three counties of British Guiana) in 1784, its name being changed to Georgetown in 1812. The streets are wide and straight, intersecting each other at right angles, several having double roadways. The city has about 30 mi. of macadamized roads. In Main street, the finest street in Georgetown, the canal which formerly existed in the middle of its dual carriageway has been filled in to form a broad walk with seats beneath its large. overhanging trees, and with gay, tropical flowers in sunken concrete troughs on its parapets. The principal residences, standing in their own gardens, are scattered over the town. Most of the houses and public buildings are constructed of wood. the former generally raised on brick pillars 4–10 ft. from the ground, the bright colouring of the wooden walls. jalousies and roofs adding to the beauty of the streets. As a consequence of two major conflagrations in 1945 and 1951, the majority of buildings in the business section have been rebuilt in ferroconcrete.

The public buildings in the centre of the city containing the offices of the government and the hall of the legislature, formerly called the court of policy, were erected between 1829 and 1834. They form a handsome E-shaped, brick-plastered bldck with deep porticoes and marble-paved galleries carried on castiron columns. The law courts, built in the 1880s, have a ground floor of concrete and iron. the upper story being of hardwood. Among other public buildings are the town hall, which was designed by a Jesuit priest and built between 1887 and 1889. and the Anglican (a great wooden building) and Roman Catholic (rebuilt in ferroconcrete after a fire in 1913) cathedrals. One of the two hospitals is government owned and the other is run by the Roman Catholic community. There are two government-owned secondary schools—the Queen's college for boys with accommodation for about 750 pupils. and the Bishops' high school for girls with accommodation for about 600 students. There is also a government technical institute which provides basic technical education. The Royal Agricultural and Commercial society has a large reading room and lending library. Its museum is chiefly devoted to the fauna of British Guiana but also contains collections of local economic, mineral and botanical exhibits, foreign birds and mammals.

The extensive botanical gardens to the east of the city are admirably laid out, and there is a small zoo containing local birds, animals and reptiles. The nurseries are devoted chiefly to the raising of plants of economic importance and the collections of ferns and orchids are very fine. In the gardens are the fields of the board of agriculture, where experimental work in the growth of sugar cane, rice, cotton. etc., is carried on. Other popular resorts are the sea wall and the promenade gardens in the centre of the city. There are facilities for outdoor sport and recreation including cricket. football and horse racing and there is also a privately owned rowing club. The city. once malarial, has been free from the disease since 1945. Water for public and domestic use is taken from the Lamaha conservancy (reservoir) on the east coast of Demerara.

Water street, the main business centre. runs parallel to the river for about $2\frac{1}{2}$ mi. and contains the stores of the wholesale and retail merchants, their wharves running out into the river to allow steamers to come alongside. British Guiana is in direct communication with the United Kingdom. France, the Cnited States. Canada and other countries, and steamships of various companies call frequently at Port Georgetown. There are public and private tidal berthage facilities with warehouse accommodation. The nine principal wharves, all privately owned, are situated along the river frontage and vary in length from 210 ft. to 575 ft. (E. A. As.)

GEORGETOWN, formerly a city of the District of Columbia. U.S.. now part of the city of Washington, D.C., is at the confluence of the Potomac river and Rock creek, about $2\frac{1}{2}$ mi. W.N.W. of the national Capitol. The streets are old-fashioned, narrow and well shaded. On the "Heights" are many fine residences with beautiful gardens: the Georgetown Visitation Junior college, a Roman Catholic college for women. founded in 1799; and the college and the astronomical observatory (1842) of Georgetown university.

Georgetown was settled late in the 17th century. It was laid out as a town in 1751, chartered as a city in 1789. merged in the District of Columbia in 1871, and annexed to the city of Washington in 1878. In the early days of Washington it was a social centre of some importance. The studio. for two years, of Gilbert Stuart. and "Kalorama." the residence of Joel Barlom were there. Legislation was passed by the 81st congress in 1950 to preserve the character of this section, to be known as Old Georgetown, by regulating the height. exterior design and construction of private and semipublic buildings in the area. See also WASHINGTON, D.C.

GEORGIA (Georgian *Sakartvelo*, Russian *Gruzia*, Turkish *Gürcistan,* Arabic *Jorzan,* Armenian *Vrastan*). a soviet republic of Transcaucasia, bounded on the north by the Russian Soviet Federated Socialist republic. on the east by Azerbaijan, on the south by Armenia and Turkey and on the west by the Black sea.

The surface of Georgia is characterized by a great variety of land forms. To the north lies the Caucasus with its lofty peaks (Elbrus. 18.481 ft.; Dykhtau. 17.054 ft.: Shkhara. 17.063 ft.; and Kazbek or Mkinvari. 16.558 ft.), the highest in Europe. The

Caucasus is a natural frontier: but there are three main passes through it, connecting Georgia with the great steppe to the north: Krestovy pass (7.835 ft.) south of the Darial gorge, Mamison pass (9,281 ft.) and Klukhor pass (9,239 ft.). To the south lies the Armenian plateau or lesser Caucasus. The Surami or Likhi range. a spur from the Caucasus to the Armenian plateau forms a watershed between the Black and the Caspian seas. The coastal lowlands along the Black sea and the Rion valley enjoy a Mediterranean and even subtropical climate. In eastern Georgia. between the Alazan and the Kura (Mtkvari) rivers, is bare steppe. cultivable only if irrigated. Round the Alazan, however. with its numerous left-bank mountain tributaries, is the fertile vine-growing Kakhetia. (For flora and fauna see CAUCASUS.)

The Georgians seem to be the result of the fusion of many tribes. the majority of which originated in Asia Minor and began to migrate thence to the western part of Transcaucasia in the 12th century B.C. They can therefore be described as an ancient Mediterranean race: their skin is white and sometimes slightly olive: their eyes are brown to black; their stature is medium to tall; and the head is oval. with a long face, pronounced cheek bones and an aquiline nose.

Their language stands apart from any other known speech. The peculiar Georgian alphabet is very ancient and adequate for expressing the wealth of varied sounds of the language. (See GEORGIAN LITERATURE.)

History. — According to Georgian annals, the peoples of the Caucasus derive from Targamos. a descendant of Japhet, who came from Babylon. Kartlos, one of the sons of Targamos, is the ancestor of the Kartlians (the eastern branch of the Georgians). and his brother Egros of the Mingrelians (the western branch). The Kartlians inhabited the upper Mtkvari valley and the Egrissi colonized the Rion valley west of the Likhi watershed. In the 4th century B.C., when Alexander of Macedon destroyed the Achaemenid Persian empire. the figure of a half-legendary Georgian dynast. the mepe or king Farnavazi of Parnabazus of Iberia (the country of the Kartlians), emerges with his capital at Mtskhet. He liberated the Iberians from the rule of a Macedonian governor and was suzerain over Kudzhi, the ruler of Egrissi or Colchis. He appointed eight provincial governors (*eristavni*), who represented the power of central authority over the local family heads (*mamasakhlisni*). Colchis was subjugated by Mithradates VI of Pontus. in the first decade of the last century B.C.; Roman "friendship" was imposed in 6j B.C. after Pompey's victory over Mithradates.

Mediaeval Georgia. — In the 4th century A.D., during the reign of the Iberian king Miriani (300–362), the Georgians embraced Christianity: their illuminatrix was Saint Nino (crucified in 330). During the next three centuries Georgia was involved in the conflict between the Byzantine and Persian empires. Colchis. now called Lazica. became more closely bound to Byzantium. Iberia passed under Persian control, then regained its independence under Vakhtang I Gurgaslani ("the Lion of Georgia;" 450–503) became a Persian province again in 533 and was finally restored by the Byzantines in 562 as a kingdom for Guaram. a descendant of Vakhtang through his mother, who made his capital at Tiflis (or Tbilisi, from tbili, "warm").

In the 7th century the caliphate succeeded the Sassanids in the suzerainty of Georgia and in the 8th century an Arab emirate was established in Tiflis. Meanwhile the house of Bagrationi was gaining in influence both in Armenia (*q.v.*) and in Georgia. For a few generations there were obscure princely rivalries and local wars until Bagrat III (1008–14) succeeded in uniting Georgia. During the reign of Bagrat IV (1027–72) the Seljuk Turks invaded Georgia for the first time. The country was saved by the crusades which forced the Turks to turn their attention to the Levant.

Ring David II Aghmashenebeli (*i.e.*, the Restorer; 1089–1125) reconquered Tiflis in 1122; thenceforth it was the capital of the united kingdom. When David died. Georgia extended from the Black sea to the Caspian. His successors failed to maintain political predominance and lost some territory, but Queen Tamara (1184–1212), extended the royal dominions into Armenia and to the Caspian sea again. The appearance of Jenghiz Khan's armies in 1220 rang the knell of Georgia's golden age.

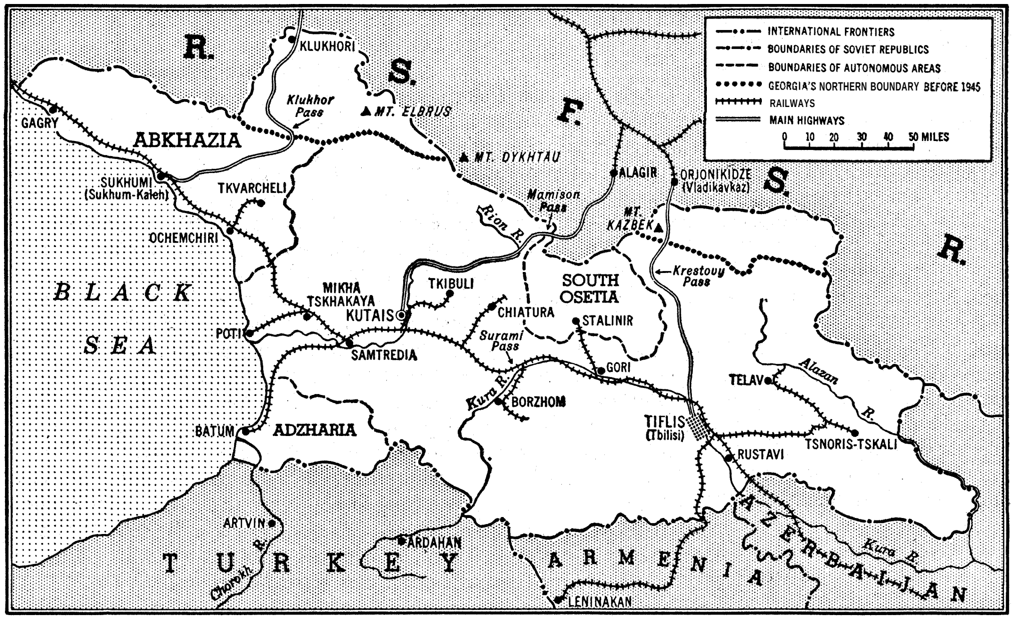
By 1236 the country east of the Likhi mountains was brought under Mongol overlordship, while its western part, which had become known as Imeretia, retained its independence. The collapse of Mongol rule in Persia during the first quarter of the 14th century favoured a temporary restoration of Georgian unity under Giorgi V Brtskinvale (*i.e.*, the Brilliant; 1314–1346) and his two successors, but in 1386 a more serious blow was dealt the country by Timur who took Tiflis and made prisoner King Bagrat V (1360–93). The devastations of Timur continued until 1404. but under Alexander (1413–43) another era of rebirth mas reached. Alexander, however. was the last member of the house of Bagrationi to be a king of all Georgia. Under his successors the various branches of the royal houses divided the country among themselves.

Turkish and Persian Rivalries. — While Georgia was weak and divided, Persia emerged again as a dangerous neighbour. Turkey, having conquered Constantinople, became a great power. Nevertheless. Christian Georgia survived because the two Moslem powers were never both strong at the same time and because their policies were always opposed. The 16th and 17th centuries witnessed a cultural renaissance in Georgia, but the country's political history during that period was one of civil strife. From 1636 Kartlia and Kakhetia were Persian dependencies. while the kingdom of Imeretia and the principalities of Samtskhe. Guria. Mingrelia, Abkhazia and Svanetia were within the Turkish sphere of influence. At the beginning of the 18th century Persia again slipped into anarchy, Turkish power was declining, and Russian imperialism appeared in Transcaucasia in 1722.

Annexation by Russia. — Taymurazi II. of the Kakhian line of the Bagratids, used this situation with skill and in 1744 was crowned in Tiflis as king of Kartlia. while his son Irakli became king of Kakhetia. When Taymurazi died in 1762. Irakli II pursued his father's policy of erecting a Caucasian multinational state based on Georgia. He partly succeeded, for his kingdom stretched from the Darial gorge to Nakhichevan and from Likhi range to Gandzha (Kirovabad); but all western Georgia remained in Turkish hands. He concluded with Russia a treaty of alliance (Georgiyevsk. July 24, 1783). whereby Russia guaranteed Georgia's independence while Irakli acknowledged Russian suzerainty. Russia, however, was unable to come to the aid of its ally when in 179j Agha Mohammed of Persia invaded Georgia and left Tiflis in ruins. Irakli died on Jan. 11, 1798. and his weak successor. Giorgi XII. offered little resistance to the increasing Russian control over Georgia. He died on Dec. 28, 1800. and on Feb. 16, 1801. the kingdoms of Kartlia and Kakhetia were incorporated in the Russian empire. The kingdom of Imeretia was annexed in 1810, while Guria. Mingrelia. Svanetia and Abkhazia were definitively annexed to Russia in 1830. 1857, 1864 and 1867 respectively; Samtskhe. under Turkish domination from 1625. was annexed by Russia in 1878.

Nationalism and the Independent *Republic*.—Under Russian domination no legal political activities were tolerated until the Russian Revolution of 1905. But from the second half of the 19th century there existed two so-called literary groups. one led by Ilia Chavchavadze (1837–1907), one of the greatest Georgian writers, the other by Giorgi Tsereteli (1842–1900), which were actually national political movements; and in 1893 the Third Group was born, an illegal Social Democratic party led by Noah Zhordania (1868–1953), Karlo Chkheidze and others. After 1905 a National Democratic party was established. There was also a small Bolshevik wing in the Georgian Social Democratic party, of which Ioseb Dzhugashvili (Stalin) was a member.

After the Russian Revolution of March 1917 the three Transcaucasian nationalities. Georgians, Armenians and Azerbaijanis, formed on Sept. 20. 1917, a Transcaucasian federal republic, which, however, broke down on May 26. 1918. Georgia then became independent, but the Turks had occupied Batum on April 15, and. the new Soviet Russian regime's professions of amity were not trusted. In this situation Akaki Chkhenkeli. the Social Democratic premier, signed with Gen. Otto von Lossow a Germano-Georgian treaty of friendship at Poti, on May 28, 1918.



GEORGIA AND SURROUNDING AREAS, INCLUDING PRINCIPAL RAIL AND HIGHWAY SYSTEMS

and a small German force of 3,000 was landed there. On June 4, a Turko-Georgian peace treaty was signed at Batum, ceding this port. Artvin and Ardahan (the old Samtskhej to Turkey.

The collapse of the Central Powers created a new situation. Germans and Turks left Georgia and a British force landed at Batum on Dec. 27, 1918 (they withdrew on June 4, 1920). A constituent assembly, chosen by a tree election in Feb. 1919. formed a new government headed by Zhordania. A delegation headed by Evgheni Gheghechkori, the Social Democratic foreign minister, was sent to Paris to seek recognition of Georgia's independence. Only on Jan. 1j, 1920, was a *de facto* recognition granted by the Allied Powers.

Georgia in the U.S.S.R.—On May 7, 1920, Soviet Russia concluded a peace treaty with Georgia, recognizing its independence: but this was a manoeuvre to gain time so as to undermine the new state from within. Such was the task of S. M. Kirov, who was sent to Tiflis as Soviet envoy. Georgia was recognized by the Allies *de jure* on Jan. 27, 1921, but on Feb. 11 Russian armies invaded the country. On Feb. 22 Turkey presented an ultimatum demanding the cession of Artvin and Ardahan. On Feb. 25 a Soviet republic was proclaimed in Tiflis. The Georgian government left the country on March 18 and established itself in Paris. while on March 16, 1921. a Russo-Turkish treaty was signed in Moscow. Turkey agreed to cede Batum to the Soviet republic of Georgia, but retained Artvin and Ardahan.

Stalin, who had an insignificant following in independent Georgia, was now its master as a member of the Kremlin Politburo and people's commissar for nationalities in the Soviet government. Fearing that even the Georgian Communists would be inclined to favour separatist feelings, on March 12, 1922, he included Georgia in a Transcaucasian Soviet Federated Socialist republic. A rising organized by Kaikhosro Cholokashvili broke out in Georgia on Aug. 27, 1924, but was put down by the Red army. On Dec. 5, 1936. the T.S.F.S.R. was dissolved and Georgia became a direct member of the U.S.S.R.

Population.— According to the census of 1939 the total population of Georgia was 3,542,289; in 1959 it was 4,049,000. Between 1939 and 1959 the urban population of the republic increased by about 63%, the rural population decreased by 9%. Tiflis, the capital, had 693,000 inhabitants in 1959; Kutaisi 128,000 and Batumi 82.000.

Before World War II the total area of the Georgian republic was 26.834 sq.mi., including the Abkhazian autonomous republic (3,320 sq.mi., with a population of 201,016 in 1926. about half of them Moslem), the Adzharian autonomous republic (1,080 sq.mi., with a population of 131,957 in 1926, mainly Moslem Georgians). and the South Ossetian autonomous province (1,430 sq.mi., with a population of 87,375 in 1926. mainly Moslems of Iranian origin). After World War II, when the Karachaev autonomous province and the Chechen-Ingush autonomous republic were suppressed and their populations deported to Siberia, the southern parts of both territories were given to Georgia. By this process Georgia increased its area to 26,911 sq.mi.

Economy. — Land under crops increased beween 1913 and 1950 from 741,200 ha. to 913.600 ha. The latter figure included 760,100 ha. under grain, 42,700 ha. under technical crops, 43,300 ha. of orchards (of which 22,500 ha. were of citrus fruit) and tea plantations covering 52,000 ha. and yielding about 31,000 metric tons of tea. In 1931 there were 2,114 collective farms, 82 state farms and 84 machine and tractor stations. Livestock in 1946 amounted to 1,490,000 head of cattle: 460,000 pigs and 2,069,000 sheep and goats.

Between 1913 and 1946 the number of workers employed in heavy industry increased from 10,900 to 80.600. The manganese ore deposits at Chiatura are among the richest in the world; their metal content is 57%, and the extraction amounted to 1,650,400 tons in 1937. Coal output at Tkibuli and Tkvarcheli increased between 1913 and 19jo from 70,000 tons to 1,323,000 tons. By 1946 the installed generating capacity amounted to 222,000 kw. as compared with 26,300 kw. in 1928. Production of electric power had amounted in 1946 to 816,000,000 kw.hr.; but as new hydroelectric power stations were built subsequently. it was estimated that twice as much was being generated by 1954. After World War II an iron and steel plant started production at Rustavi.

By 1946 there were in the republic 473 mi. of railways as compared with 276 mi. in 1913. The Poti-Tiflis line, built in 1867, was extended to Baku in 1883. The line linking Georgia along the Black sea coast with Rostov via Tuapse was opened in 1946.

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GEORGIA is a southern state of the U.S. and youngest of the original 13 states, having been chartered as a colony in 1732 by George II of Great Britain. from whom it derived its name. With a total area of 58.876 sq.mi., it is the largest state east of the Mississippi river and 21st in size of all the states. Until early in the 19th century it comprised nearly all the present area of Alabama and Mississippi. Its size and its agricultural and industrial prominence earned for it before 1860 the popular title of "empire state of the south." The capital has been Atlanta since 1878. The official flower is the Cherokee rose. The state bird is the brown thrasher. Georgia is bounded on the north by Tennessee and North Carolina at the 35° parallel (north latitude) and on the south by Florida at the 30° 42' 42" parallel. It is bounded on the east by South Carolina and the Atlantic ocean and on the west by Alabama. It lies between the meridians 80° 53' 15″ and 85° 36' west longitude.

PHYSICAL GEOGRAPHY

Physical Features. — The surface of Georgia is divided into five physical zones. The most prominent of these is the coastal plain of 35,000 sq.mi. It extends from the Atlantic seacoast. which is skirted by numerous fertile semitropical islands of the Sea Islands group. northward to the fall line. which extends from Augusta through Milledgeville and Macon to Columbus. North of this line is the Piedmont plateau of rolling foothills that rise gradually in height from 500 ft.. until they reach the mountains about 50 mi. N. of Atlanta, to somewhat less than 2,000 ft. Above this plateau lie three small regions, the largest of which is the Blue Ridge in the northeast (part of the Appalachian mountain system), extending south and west into Georgia to a distance of 48 and 92 mi., respectively. In the extreme northwestern corner of the state is the Cumberland plateau (part of the Allegheny system), represented by Lookout and Sand mountains, having an elevation of about 2.000 feet. Between the two regions mentioned lies the Great valley, extending southward to Cedartown. The Georgia mountains are part of a mountain system running from Canada to central Alabama, appearing from Virginia to Georgia in the two separate prongs mentioned above, nith a wide valley between. The highest point in the state is Brasstown Bald (4.784 ft.), in the Blue Ridge region. The approximate mean elevation of the state is 600 ft. Near Atlanta, in the upper Piedmont plateau, is Stone mountain, probably the largest piece of exposed granite in the world.

On the Blue Ridge mountains in the northeast corner of the state begins a water parting line, the fall line, extending southwest to Atlanta, southeast of which the waters flow into the Atlantic ocean and above which they find their way to the Gulf of Mexico. The Great valley region and most of the western portion of the Blue Ridge mountains are drained by the Etowah and the Oostanaula rivers and their tributaries, forming at Rome the Coosa, mhich empties into Mobile bay. The Cumberland plateau and the northwestern part of the Blue Ridge mountains constitute a part of the Tennessee basin. The principal rivers of the state are the Savannah, forming the boundary with South Carolina; the Oconee and the Ocmulgee, nhich unite in the south-central part of the state to form the Xltamaha; the Satilla in the southeast; and the Flint and the Chattahoochee, which unite in the southwest corner to form the Apalachicola in Florida. All except the Satilla rise in the upper Piedmont and are navigable only south of the fall line. In the southeastern part of the state is the Okefenokee swamp, covering an area of 660 sq.mi., a national wildlife sanctuary, most of which lies in Georgia. Much of the area in this region of the state is unsuitable for cultivation because of numerous marshes and swamps.

Climate.--The climate of Georgia is mild. Mean annual temperatures range from about 57° to 68° F. January averages are about 40° in the mountains and 54° on the south coast; July averages range from about 74° to 82°. Mean annual rainfall is almost 50 in. a year. Snowfall averages seven to ten inches a year in the mountains, about three in Atlanta and becomes negligible on the coastal plain.

Soil.—Georgia is notable for the variety of its soils, by far the greatest number being found in the upper coastal plain. The dominant pattern is in northern Georgia, loam and clay rich in decomposed limestone and calcareous shales; in the Piedmont. clays and loams. mostly of dark red colour, derived from decomposed hornblende; and in the coastal plain. gray sands and sandy loams.

Vegetation.- here are 250 species of trees native to the state, more than 90% of which are of commercial importance. The mountains are covered with oak and hickory varieties, with shortleaf pine as a secondary type. Other hardwoods are hemlock, maple and chestnut. Loblolly pine grows abundantly in the Piedmont, while longleaf pine is found in the western and southern portions of the state. White and red oak, yellow poplar, cherry and ash' are important hardwoods throughout most of the state. The coastal area is noted for live oaks, cypresses and palmettos. Important flowering trees are magnolia, mimosa, dogwood, redbud, tulip and crepe myrtle, the last being nonindigenous. There are more species of shrubs than of trees. The most common flowering shrubs are yellow jasmine, flowering quince and arbutus, with rhododendron and laurel predominating in the mountains. The Cherokee rose bears a small white blossom with yellow centre. Spanish moss is abundant on the coast and around the streams and swamps of the entire coastal plain.

Animal Life.—There are 79 species of reptiles. Of these 40 are snakes, 23 are turtles, 13 are lizards and 3 are crocodilians. Poisonous snakes are the rattlesnake. of which the eastern diamondback is the most noted, copperhead and cottonmouth moccasin, the last being aquatic and found largely in the coastal plain. The coral snake is rare. Of the 63 species of amphibians 35 are salamanders and 28 are frogs and toads.

There are 160 species of birds that breed in Georgia and a greater number of migratory fowl. The largest family is the sparrow, of which 67 varieties have been identified. The bobwhite, or Virginia quail, is widely distributed and is the most popular game bird. Second in popularity and distribution is the dove. Marsh hens are abundant on the coast, and wild turkeys are found in the mountains and on the coast. Migrating geese and ducks are found on inland lakes, as well as on the coast The Okefenokee swamp has many interesting and rare waterfowl. including the water turkey. Virginia deer are found in 50 counties, but the coastal counties have the largest number. The black bear is found in 13 counties being most abundant in Ware and Charlton. Other prominent wildlife include the rabbit. squirrel, opossum, fox, raccoon, muskrat, mink, otter and weasel. Less prominent are the beaver, badger, wildcat. civet cat, mole, panther and skunk. The most popular fresh-water game fish are trout. bass. bream shad and catfish; all except the last are produced in state hatcheries for restocking. Off the coast are dolphins, porpoises, edible shrimps, blue crabs and tidewater oysters.

Parks and Monuments.—The 27 state parks range in area from the Jefferson Davis Memorial park (less than 5 ac.. near Irwinville) to Jekyll Island (an 11.000-ac. sea island, near Brunswick). The total acreage is in excess of 36,000. The parks are distributed throughout the state but are more numerous in the mountain area, where Vogel State park ranks high in tourist popularity. Nearly all state parks contain lakes or are adjacent to large bodies of impounded water. The Georgia Veterans Memorial park in Crisp county borders on the 13.000-ac. Lake Blackshear. The federal government administers six areas in Georgia. the largest being the Chattahooche National forest in north Georgia (nith headquarters at Gainesville), comprising 668,271 ac. Others of unusual interest are the Kennesaw Mountain National Battlefield park near Marietta, the Chickamauga and Chattanooga National Military park in Walker and Catoosa counties, and the Ocmulgee National monument (Indian) at Macon. The most important cemetery park is at Andersonville in Sumter county, where about 13,000 Union prisoners died in 1864.

HISTORY

Colonial.—Georgia's formation was the result of a desire of the British government to protect South Carolina from invasion by the Spaniards from Florida, and by the French from Louisiana. as well as of the desire of James Edward Oglethorpe (*q.v.*) to found a refuge for the persecuted Protestant sects and for the unfortunate but worthy indigent classes of England. The charter was granted to "the trustees for establishing the colony of Georgia in America," giving the colony a unique type of control. yet someuhat like the proprietary form. Parliament gave F10.000 to the enterprise, and the trustees encouraged the settlers to grow silk, grapes, hemp, olives and medicinal plants, for which England was dependent upon foreign countries. The sale of rum and the introduction of Negro slaves were forbidden. and severe limitations were placed on land tenure. Oglethorpe, as resident trustee, accompanied the first colonists, uho settled at Savannah in 1733. The early settlers were English, German Lutherans (Salzburgers), Scottish Highlanders, Portuguese Jews, Piedmontese, Swiss and others; but the main tide of immigration came from Virginia and the Carolinas after 1750.

As a bulwark against the Spanish and French the colony was successful, but as an economic and philanthropic experiment it was a failure. The industries planned for the colony did not thrive, and because sufficient labour could not be obtained, the importation of slaves was permitted, under certain conditions, in 1749. About the same time, parliament directed the trustees to end the prohibition on the sale of rum, and the restrictions on landholding were gradually removed. In 1753 the charter of the trustees expired and Georgia became a royal province, its character rapidly changing to resemble that of other southern colonies.

Under the new regime the colony was so prosperous that Sir James Wright (1716–85), the last of the royal governors, declared Georgia to be "the most flourishing colony on the continent." The people mere led to revolt against the mother country through sympathy with the other colonies rather than through any grievance of their own. The centre of revolutionary ideas was St. John's parish on the coast (settled by New Englanders, chiefly from Dorchester, Mass.) and the area north of Augusta (settled by Carolinians and Virginians). Loyalist sentiment was so strong that only 5 of the 12 parishes sent representatives to the first provincial congress, which met on Jan. 18, 1775, and its delegates to the Continental Congress therefore did not claim seats in that assembly. Six months later all the parishes sent representatives to another provincial congress that met on July 4, 1775.

The war that followed was a severe civil conflict, with the Loyalist and Revolutionary parties being almost equal in numbers; a large number of moderates preferred a neutral course. In 1778 the British seized Savannah, which they held until 1782, meanwhile reviving the British civil administration. and in 1779 they captured Augusta and Sunbury; but after 1780 the revolutionary forces were generally successful against Tories in the upcountry in bloody guerrilla fighting. Civil affairs also fell into confusion, partly because of a schism among the revolutionists. While a state constitution was adopted in 1777, harmony did not prevail until 1781.

Early Statehood.—In the Constitutional Convention of 1787 Georgia's delegates almost invariably gave their support to measures designed to strengthen the central government. Georgia became the fourth state to ratify the federal constitution (Jan. 2, 1788), and one of the three that ratified unanimously. Afterward a series of conflicts between federal and state authority caused the growth of states' rights theories. Because of these conflicts a majority of Georgians adopted the principles of the Democratic-Republican party, and early in the 19th century the people were virtually unanimous in their support of Jeffersonian ideas. The position of congress and of the supreme court with regard to Georgia's policy in the Yazoo frauds aroused distrust of the federal government. In 1795 the legislature granted, for $500,000, the territory extending from the Alabama and Coosa rivers to the Mississippi river, and between 35° and 31° N. lat. (almost all the present state of Mississippi and more than half of the present state of Alabama), to four land companies, but in the following year a new legislature rescinded the contracts, on the ground that they had been fraudulently and corruptly made. In the meantime the U.S. senate had appointed a committee to inquire into Georgia's claim to the land in question, and as this committee pronounced that claim invalid, congress. in 1800, established a territorial government over the region. The legislature of Georgia remonstrated but expressed a willingness to cede the land to the United States. In 1802 the cession was ratified, it being stipulated, among other things, that the United States should pay to the state $1,250,000, and should extinguish "at their own expense, for the use of Georgia, as soon as the same can be peaceably obtained on reasonable terms," the Indian title to all lands within the revised limits of Georgia. In 1824 the state remonstrated in vigorous terms against the dilatory manner in which the national government was discharging its obligation, with the result that in 1825 a treaty was negotiated at Indian Springs by which a small and unrepresentative group of friendly (Lower) Creeks agreed to exchange their remaining lands in Georgia for $5,000,000 and equal territory beyond the Mississippi. But Pres. John Quincy Adams, convinced that this treaty was accompanied by bribery and learning that it was not confirmed by the entire Creek nation, authorized a new one, signed at Washington in 1826, by which the Creeks kept a small tract within the recognized limits of Georgia. Gov. George M. Troup (1780–1856) proceeded to execute the first treaty, and the Georgia legislature declared the second treaty illegal and unconstitutional. In reply to a communication of President hdams, early in 1827, that the United States would take strong measures to enforce its policy, Governor Troup asked his legislature to prepare to resist to the utmost any military attack that the U.S. government should think proper to make. A final treaty, in 1827, ended the Creek controversy.

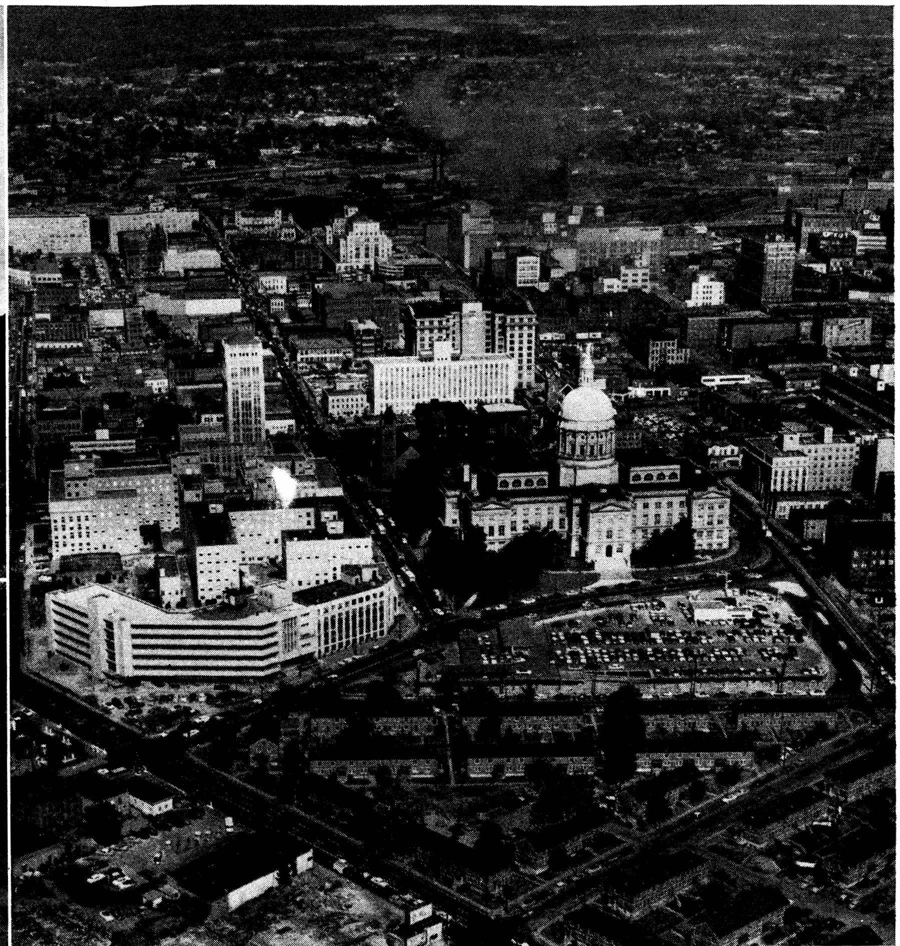
The controversy with federal authorities over Indian removal then focused on the Cherokees. In 1828 the legislature extended the jurisdiction of Georgia law to the Cherokee lands lying in the northern part of the chartered limits of Georgia. Andrew Jackson, then president, sided with Georgia, informing the Cherokees that their only alternative to submission to Georgia was emigration. Thereupon the chiefs resorted to the U.S. supreme court, which in 1832 declared that the Cherokees formed a distinct community "in which the laws of Georgia have no force" and annulled the decision of a Georgia court that had extended its jurisdiction into the Cherokee country (Worcester v. Georgia). But the governor of Georgia declared that the decision was an attempt at usurpation that would meet with determined resistance. and President Jackson refused to enforce the decree. He did, however, work for the removal of the Indians, which was effected in 1838.

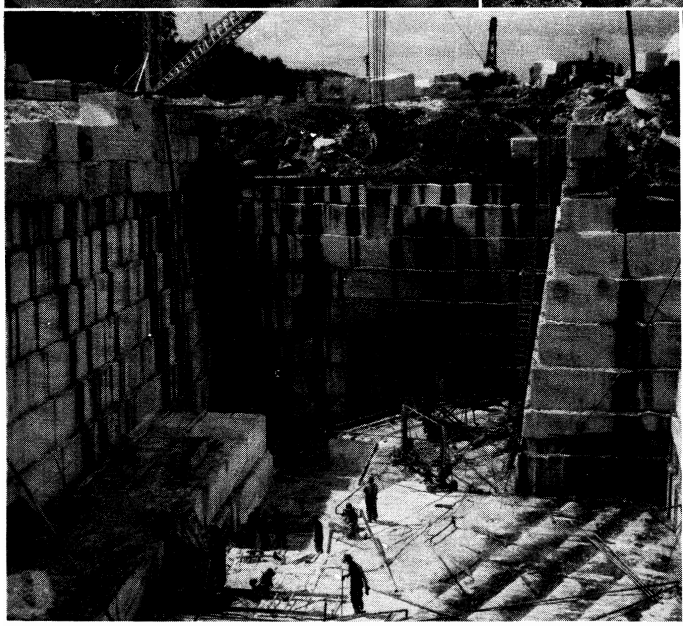
Politics and Slavery.—Despite early national political unity, local partisanship had been represented by two factions. One, led successively by William H. Crawford and George M. Troup, represented the interests of the coastal element and the upcountry slaveholding communities; the other, formed by John Clark (1766–1832) and his father Elijah, found principal support among the nonslaveholders and the frontiersmen. At the same time there was a sectional cleavage between the older communities along the coast and the newer upcountry communities, in which the latter early gained a dominant position, as a result of which the capital was removed to the upcountry, where it became fixed at Milledgeville in 1807, and in the creation of numerous counties throughout the rapidly expanding cotton belt of middle Georgia. (Up to 1924 a total of 161 counties had been created; in 1932 the number was reduced to 159.)

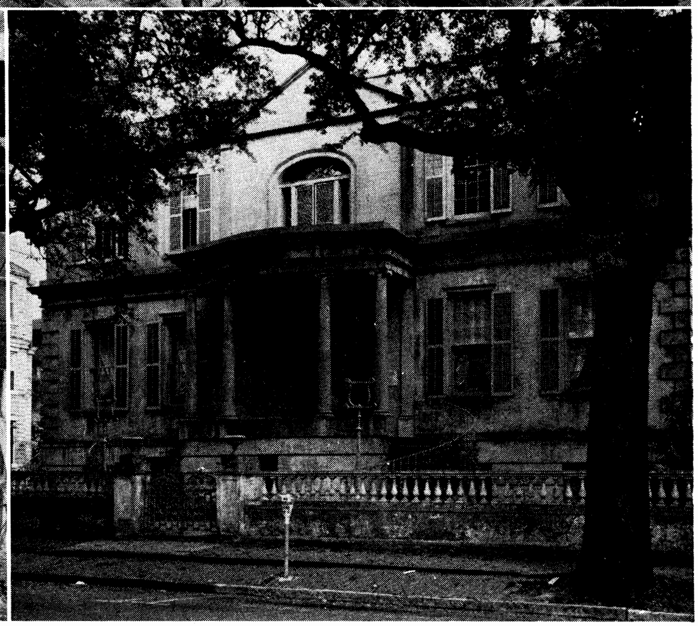
The Troup faction. under the name of the States' Rights party, after 1832 endorsed the nullification policy of South Carolina against federal tariff laws. The Clark faction, calling itself the Union party, opposed South Carolina's conduct, but on the grounds of expediency rather than of principle. Because of its opposition to President Jackson's stand on nullification, the Troup party affiliated with the new Whig party, while the Clark party was merged into the Democratic party led by Jackson. The antislavery and nationalistic views of the Whig party during the 1850s caused its members in Georgia to shift to the Democratic party.

The activity of Georgia in the slavery controversy was important. Popular opinion at first opposed the Compromise of 1850 (see COMPROMISE MEASURES OF 1850), and some politicians demanded immediate secession from the Union. Others contended that the compromise was a great victory for the South and in a campaign on this issue secured the election of such delegates to the state convention (at Milledgeville) of 1850 that that body adopted, on Dec. 10, by a vote of 237 to 19, a series of conciliatory resolutions, since known as the Georgia platform. The approval in other states of the Georgia platform in preference to the Alabama platform (see ALABAMA) caused a reaction in the South against secession, which was followed for a short period by a return to approximately the former party alignment. But in 1854 the rank and file of the Whigs joined the American or Know-Nothing party (*q.v.*), which evaded the slavery issue, while most of the Whig leaders went over to the Democrats. The Know-Nothing party was nearly destroyed by its crushing defeat in 1856, and in the next year the Democrats, by a large majority, elected as governor Joseph Emerson Brown (1821–94), who, by three successive re-elections, was continued in that office until the close of the American Civil War.

Secession and the Civil War.—The Kansas question and the attitude of the North toward the decision in the Dred Scott case were arousing the South when Brown was inaugurated the first time. In his inaugural address he clearly indicated that he would favour secession in the event of any further encroachment on the part of the North. On Nov. 7, following the election of Pres. Abraham Lincoln, the governor, in a special message to the legislature, recommended the calling of a convention to decide the







BY COURTESY OF (TOP LEFT) GEORGIA POWER CO., (TOP RIGHT) GEORGIA DEPARTMENT OF COMMERCE. (CENTRE LEFT, BOTTOM RIGHT) SAVANNAH CHAMBER OF COMMERCE; PHOTOGRAPH, (BOTTOM LEFT) EWING GALLOWAY

VIEWS OF GEORGIA

Top left: Cloudland Canyon State park in the Cumberland range, northwest section of the state

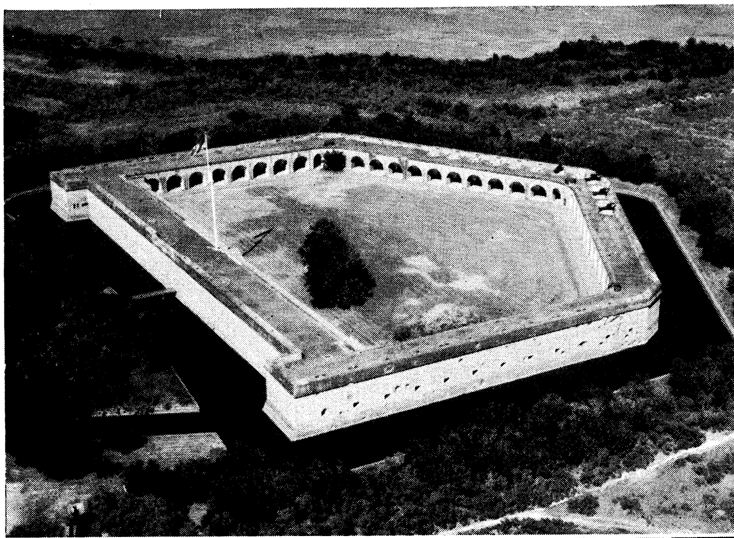
Top right: Atlanta, showing the state capitol building in the foreground. It was built in 1885-89 and patterned after the national capitol

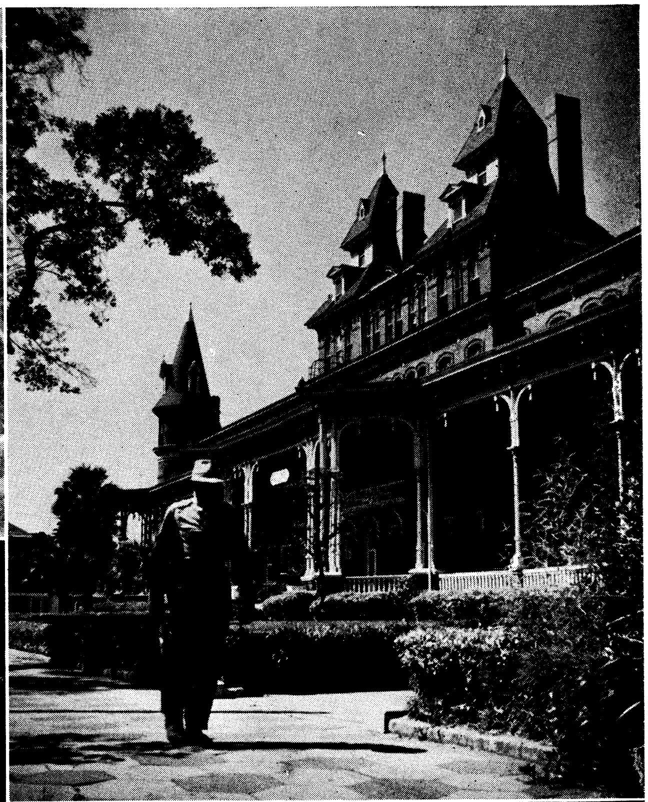
Centre left: Marble bench at Savannah marking the first camp site, in 1733, of James E. Oglethorpe (1696–1785), founder of the Georgia colony

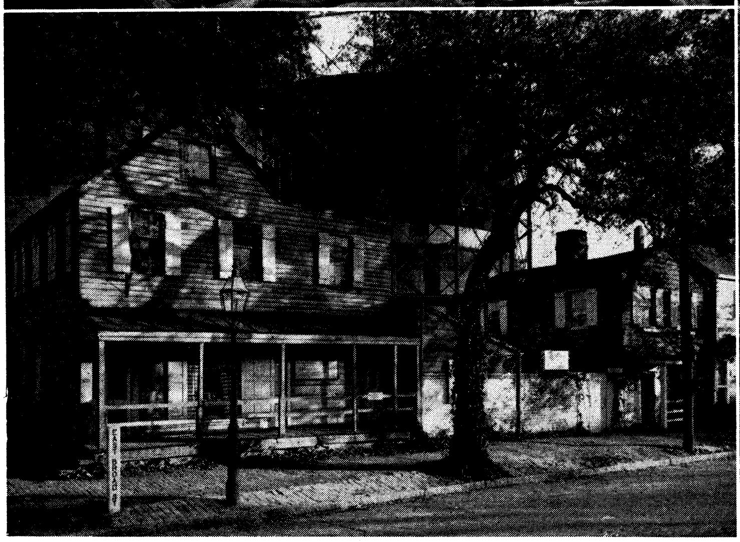
Bottom left: Marble cutting near Tate in northern Georgia. This quarry was first worked in 1884

Bottom right: Owens-Thomas house at Savannah, built in 1816-19. It is considered one of the finest U.S. examples of the regency period of architecture

GEORGIA







BY COURTESY OF (TOP LEFT) GEORGIA DEPARTMENT OF COMMERCE, (TOP RIGHT) "HOLIDAY," (BOTTOM LEFT, BOTTOM RIGHT) SAVANNAH CHAMBER OF COMMERCE; PHOTOGRAPH, (CENTRE LEFT) CAROLYN CARTER

SCENES IN GEORGIA

Top left: Fort Pulaski National monument on Cockspur Island at the entrance to the Savannah river. Its capture by Federal troops in 1862 successfully demonstrated for the first time the effectiveness of cannon fire on masonry walls

Top right: Oglethorpe hotel, Brunswick, designed by Stanford White (1853–1906)

Centre left: Glade shoals near Gainesville in the foothills of the Blue Ridge range, northeastern Georgia

Bottom left: Pirates' house near the Savannah waterfront. In the 18th century seamen were shanghaied from there for sailing ships through an underground tunnel connecting the house with the waterfront

Bottom right: Old harbour light (1852) at the foot of Emmett park in Savannah, near the Savannah river question of secession. Alexander H. Stepliens and Herschel V. Johnson contended that Lincoln's election was insufficient ground for such action. On Nov. 17 the legislature passed an act directing the governor to order an election of delegates on Jan. 2, 1861, and their meeting in a convention on Jan. 16. On Jan. 19 this body passed an ordinance of secession by a vote of 208 to 89. Already the 1st regiment of Georgia volunteers! under Col. Alexander Lawton (1818–96), had seized Ft. Pulaski at the mouth of the Savannah river, and Governor Brown proceeded to Augusta and seized the Federal arsenal there. Toward the close of 1861, however, Federal warships blockaded Georgia's ports, and early in 1862 Federal forces captured Tybee Island, Ft. Pulaski, St. Marys, Brunswick and St. Simons Island. Georgians responded freely to the call for volunteers: but when the Confederate congress. in April 1862, passed the conscript law, Governor Brown, in a correspondence with Pres. Jefferson Davis, offered serious objections. Brown also quarreled with Davis on other Confederate policies that he considered as infringements on the rights of a sovereign state.

In 1863 northwest Georgia was involved in the Chattanooga campaign. In the following spring Georgia was invaded from Tennessee by a Federal army under Gen. William T. Sherman. The resistance of Gen. Joseph E. Johnston and Gen. J. B. Hood proved ineffectual, and on Sept. 2 Atlanta was taken. On Nov. 15 Sherman burned Atlanta and began his famous March to the Sea, taking Savannah late in December. In the spring of 1865, Gen. J. H. Wilson, with a body of cavalry, entered the state from Alabama, seized Columbus and West Point on April 16, and on May 10 captured Jefferson Davis, president of the Confederacy, near Irwinville.

Reconstruction. — In accord with Pres. Andrew Johnson's plan for reorganizing the southern states! a provisional governor, James Johnson, was appointed on June 17, 1865, and a state convention reformed the constitution to meet the new conditions, rescinding the ordinance of secession, abolishing slavery and formally repudiating the state debt incurred in the prosecution of the war. A legislature and other officials were elected in Nov. 1865. The legislature ratified the 13th amendment on Dec. 9, and five days later Charles J. Jenkins was inaugurated governor. But both the convention and legislature incurred the suspicion and ill will of congress. Georgia was placed under military government, as part of the 3rd military district, by the Reconstruction act of March 2, 1867.

Under the auspices of the military authorities, registration of electors for a new state convention was begun, and 95,168 Negroes and 96,333 whites were registered. The acceptance of the proposition to call the convention and the election of many conscientious and intelligent delegates were largely the result of the influence of former Governor Brown, who was strongly convinced that the wisest course was to accept quickly what congress had offered. The convention met in Atlanta on Dec. 9, 1867, and by hfarch 1868 had revised the constitution to meet the requirements of the Reconstruction acts. The constitution was duly adopted by popular vote; and elections were held for the choice of a governor and legislature. Rufus Brown Bullock, Republican, was chosen governor; the senate had a majority of Republicans; and in the house of representatives, by the close vote of 76 to 74, a Republican was elected speaker. On July 21, the 14th amendment was ratified, and, as evidence of the restoration of Georgia to the Union, its congressmen were seated on July 25, 1868.

In Sept. 1868 the Democrats in the state legislature, being assisted by some of the white Republicans, expelled the 27 Negro members and seated their defeated a-hite contestants. In retaliation congress excluded the state's representatives on the technicality that their credentials did not state to which congress they were accredited, and, on the theory that the government of Georgia was a provisional organization, passed an act requiring ratification of the 15th amendment before Georgia's senators and representatives would be seated. The department of war then concluded that the state was still subject to military authority and placed Gen. A. H. Terry in command. With his aid and that of congressional requirements that all members of the legislature must take the test oath of nonsupport to any pretended government, *i.e.*, the Confederacy, and that none be excluded on account of colour, a Republican majority nas secured for both houses, and the 15th amendment was ratified. On July 15, 1870, Georgia was finally readmitted to the Union.

Reconstruction in Georgia was comparatively moderate, largely because a number of conservatives under the leadership of former Governor Brown supported the Reconstruction policy of congress. The election of 1870 gave the Democrats a majority in the legislature; Gov. Rufus B. Bullock, fearing impeachment, resigned, and at a special election James M. Smith was chosen to fill the unexpired term. After that the control of the Democrats was complete. Georgia, however, did not frame her home-rule constitution until 1877, when the threat of further military intervention had ended.

Post-Reconstruction. — The history of Georgia since Reconstruction has been one of nominal social and economic progress, nith the state standing firmly Democratic in politics. The 18-year inter\-a1 following 1872 was dominated by the Bourbon triumvirate of Joseph E. Brown, Alfred H. Colquitt and John B. Gordon, nho stood for low taxes and limited public services and who maintained a close liaison between business and political interests. The leasing of convicts to private concerns was the most criticized of their policies. The Independent movement, later backed by the Farmers alliance, challenged Bourbon control throughout most of the period, but by 1892 the Populist threat, with its greater appeal to rural voters, became more serious. All factions sought the Negro vote, and political corruption was widespread. The waning of Populism at the beginning of the 20th century was accompanied by the adoption of several new measures. Virtual disfranchisement of the Negro was effected by registration requirements in 1908 ("grandfather" laws, which placed restrictions on Negroes by requiring that a registrant be "a veteran of any war" or "the descendant of a veteran"), and the convict-lease system was abolished. A state-nide prohibition law of 1907 proved unpopular, and this issue remained prominent until adoption of the 19th amendment to the U.S. constitution in 1919 brought national prohibition. Laws seeking to protect labour in the state's growing industries and reforms in educational policy, with additional appropriations for public schools, were other notable measures adopted in the first quarter of the 20th century.

The Neill act of 1917 placed primary elections under legal control, establishing the county unit system for determining winners in such elections. In 1920 a constitutional amendment fixed the number of first-class counties at 8 and the number in the second classification at 30, while those remaining were in the third class. First-class counties were the most populous, and each had three representatives in the legislature and cast six unit votes. The second group of 30 counties had two representatives each and was entitled to four unit votes. The remaining 122 counties were the least populous. and each had one representative and cast two unit votes. Thus first-class counties had a total of 48 votes; second class. 120 votes; and third class. 244 votes, the total of all votes being 412 Subsequently the number of counties was reduced to 159 and the total of county unit votes to 410. Since nomination in the Democratic primary in Georgia was tantamount to election, county unit voting, together with the three-class system of representation, placed political control in the hands of the smaller counties dominated by rural voters.

In 1930 Richard B. Russell was elected governor on a platform of revamping governmental machinery to effect economy and efficiency. The Reorganization act of 1931 reduced 102 administrative units to 18 and established a board of regents to administer the public colleges and the university. Russell was succeeded in 1933 by Eugene Talmadge, who for four years opposed most aspects of the national administration. The Roosevelt administration nas popular in Georgia, honever, and Eurith D. Rivers after 1937 brought the state into the orbit of the New Deal, although his failure to finance expanded state services brought Talmadge hack to poner four years later on a platform of economy. He now attacked the more subtle effects of the New Deal, and the promotion of social equality for all races, and launched a white supremacy offensive. He caused the dismissal of several university-system officials thought to be advocating mixing of the races in public colleges and schools, the dismissals in turn causing the colleges to lose accreditation. Ellis Gibbs Arnall defeated him in 1942 and introduced a program of reform, restored college accreditation, lowered the voting age to 18, abolished the poll tax and promoted the adoption of a new constitution in 1945, embracing approximately 50 changes.

In the Democratic primary of July 1946, Eugene Talmadge, backed by rural voters and supported by some industrialists, again received the nomination for governor under the county unit system, although losing the popular vote to James V. Carmichael. In the following November he was formally elected governor without opposition, but he died before his inauguration. The general assembly convened in January and according to lam canvassed the election returns to find that about 700 write-in votes had been cast for the governor-elect's son, Herman E. Talmadge, whom they then declared governor. Because the constitution of 1945 was not clear on the question of succession in such a case, confusion followed. Arnall and the lieutenant governor-elect, Melvin E. Thompson, each claimed the succession on different legal grounds. Arnall was forcibly ejected from the governor's mansion by Talmadge partisans, who held the capitol for 67 days. On March 16 the state supreme court ruled in favour of Thompson, but in the special primary of 1948 young Talmadge won over Thompson in a county unit vote of 312 to 98, the popular vote being Talmadge, 357,865; Thompson, 312.035.

A federal court decision in 1945 ordered the Democratic (white) primary in Georgia open to Negro voters, causing the registration of Negroes to increase more than 700% by the end of the following year and providing new impetus to the white supremacy issue. A reregistration act in 1949, containing literacy, character and citizenship tests, and aimed at minimizing the Negro vote, proved unsatisfactory and was repealed after one year. In 1950 (and again in 1952) a proposed amendment extending the county unit system to general elections was defeated by the people. In the meantime a sweeping 3% sales tax levy enacted by the Herman Talmadge administration, most of which went largely for educational purposes, resulted in a rapid upgrading of Negro schools. What promised to prove the most serious issue since Reconstruction was provided in May 1954, when the U.S. supreme court announced its decision that segregation in public schools was unconstitutional. In November an amendment was ratified enabling the state to abolish public education but granting subsidies to private schools. Marvin Griffin in the meantime campaigned for governor on the Talmadge position of continued segregation and was elected. Accordingly, in 1955, the legislature passed a standby private-school law to go into effect if the court ordered a specific school to desegregate.

GOVERNMENT

Constitutions.— Georgia has had a total of eight constitutions, that of 1877 having the longest continuous history although amended 301 times. In 1945 a new constitution was adopted, about 90% of which was taken from the preceding document. Revision mas largely confined to form and organization although important changes were made. The amendment of 1941 increasing the governor's term from two to four years was continued in the new constitution, as was the teen-age qualification for voting (1943). The governor was made ineligible to succeed himself until four years from the date of leaving office. The membership of the state senate was increased from 52 to 54, bringing the total membership of the legislature to 259. The office of lieutenant governor was added along with several new boards, all being constitutional offices. The number of justices of the supreme court was increased from six to seven. Salaries of state officials in general were raised, the per diem pay of legislators being fixed at $15.

During his administration Gov. Eugene Talmadge had obtained legislative endorsement of his plans to give the governor, functioning along with the state auditor as the budget committee, power to transfer funds from one purpose to another. This executive subsequently exercised such power over the purse as to give him unusual control over every aspect of state government and to open the way for administrative abuses, which in turn crystallized a movement led by Governor Arnall to weaken the powers of the governor and to improve administrative efficiency. Arnall's proposals to make the board of regents, board of education, board of pardons and paroles, game and fish commission, and public service commission constitutional agencies mere ratified by the people in 1943. The constitution of 1945 continued this trend toward cutting down the powers of the governor and effecting decentralization in administration.

The 1877 constitution placed severe limitations on finance, taxation and debt, although amended many times to meet requirements of changing circumstances. In June 1937, 26 constitutional amendments were ratified, liberalizing the powers of the legislature, particularly with respect to the state's co-operating in the social program of the New Deal. A clause limiting the debt of a minor civil division to 7% of the assessed valuation of its property was amended 135 times before 1945. The new constitution raised the limit to 10%, but the additional debt had to be approved by a majority vote, as against a two-thirds vote in the old constitution, and had to be paid in five years. A significant new provision required that all tax moneys for state purposes be paid into the state treasury and that appropriations be made by the legislature to departments and agencies in specific sums. The new provision removed the old principle of allocating certain revenue to specific objectives, a practice which at one time removed as much as 60% of all state funds from legislative control. A determined effort by highway interests to amend the nen constitution so that most of the gasoline taxes and license-tag fees would be earmarked for construction and maintenance of roads succeeded in 1952.

Finances.— In the second half of the 20th century, Georgia's total annual income exceeded $300,000,000, more than 80% of it being derived from taxes that were nonexistent at the beginning of the century. The 3% general sales tax, begun in 1951, accounted for nearly 40% of the total. Motor-vehicle license taxes and gasoline taxes, begun in 1910 and 1921, respectively, provided 28%; while the income tax, introduced in 1929, accounted for slightly more than 15%. State taxes on land and real estate, once an important source of state revenue, mere reduced to one-fourth of a mill in 1951 and thereafter contributed only a negligible part of the state's income but remained the most important source of revenue for local government. Of the state's total income more than one-half was being spent for education; about one-quarter for highways; less than one-tenth for public health and public welfare; and less than one-tenth for all other departments. By 1950 Georgia's fixed debt had been paid off. and the state's financial position was better than at any time since 1860.

POPULATION

In 1760 Georgia's population was less than 10,000, with Negro slaves forming one-third of the total. By the end of the colonial period the number of settlers had grown to 33,000, of whom 18,000 were slaves. The state continued to grow throughout the American Revolution and by the first census in 1790 had reached 82,548, concentrated in the L-shaped corridor along the Savannah river and thence down the coast to the Altamaha. By 1800 the population had almost doubled, having increased to 162,686, 90% of the increase occurring in the upcountry, where land grants had become available. The population reached 691,392 by 1840, resulting from the freeing of land by removal of Indians, free grants of the state's western lands and rapid expansion of cotton planting. The 1860 population of 1,057,286 was 44% Negro and mas concentrated in the newer middle Georgia counties. In 1900 the population nas 2,216,331, with 46.7% Negro and 15.6% urban. Throughout the 20th century there was a steady decline in the proportion of Negroes and a sharp rise in the percentage of urban inhabitants.

In 1960 the total population was 3,943,116 (an increase of 498.538 over 1950), or 67.0 persons per square mile. The entire urban population, including the urban fringe adjacent to the five larger cities (and six unincorporated places of 2.500 or more elsewhere). was 2,182,117, or 55.3% of the state total. There are five standard metropolitan areas—Atlanta, Augusta, Columbus, Flacon and Savannah. With the exception of the nonwhites (practically all Negro), who comprised about 30% of the total population, Georgia's people were largely of Anglo-Saxon origin. The foreign-born comprised only a small fraction of 1%. South Georgia was heavily populated with Negroes, while a few north Georgia counties had none. All groups were predominantly Protestant in religion. In both the native white and the Negro population, males were outnumbered. the ratios being 98.8 (per 100 females) and 90.6. respectively. in 1950. In the second half oi the 20th century the rura! population was declining more rapidly than in the past because of crop-reduction programs and other changes in the agricultural pattern. Farm tenancy was also declining. 40% of the farmers belonging to that category, as opposed to 55% in 1940. Many Negroes were moving from farms to urban communities outside the state.

*Georgia: Places of 5,000 or More Population (1960 census)**

Place	Population				
	1960	1950	1940	1920	1930
Total state	3,943,116	3,444,578	3,123,723	2,895,832	2,216,331
Albany	55,890	31,155	19,055	11,555	4,606
Americus	13,472	11,389	9,281	9,010	7,674
Athens	31,355	28,180	20,650	16,748	10,245
Atlanta	487,455	331,314	302,288	200,616	89,872
Augusta	70,626	71,508	65,919	52,548	39,441
Bainbridge	12,714	7,562	6,352	4,792	2,641
Brunswick	21,703	17,954	15,035	14,413	9,081
Cairo	7,427	5,577	4,653	1,908	690
Carrollton	10,973	7,753	6,214	4,363	1,998
Cartersville	8,668	7,270	6,141	4,350	3,135
Cedartown	9,340	9,470	9,025	4,053	2,823
Chamblee	6,635	3,445	1,081	253	—
College Park	23,469	14,535	8,213	3,622	517
Columbus	116,779	79,611	53,280	31,125	17,614
Cordele	10,609	9,462	7,929	6,538	3,473
Covington	8,167	5,192	3,900	3,203	2,062
Dalton	17,868	15,968	10,448	5,222	4,315
Dawson	5,062	4,411	3,681	3,504	2,926
Decatur	22,026	21,635	16,561	6,150	1,418
Dock Junction	5,417	4,160	—	—	—
Douglas	8,736	7,428	5,175	3,401	617
Dublin	13,814	10,232	7,814	7,707	2,987
Eastman	5,118	3,597	3,311	2,707	1,235
East Point	35,633	21,080	12,403	5,241	1,315
Elberton	7,107	6,772	6,188	6,475	3,834
Fair Oaks	7,969	3,131	—	—	—
Fitzgerald	8,781	8,130	7,388	6,870	1,817
Forest Park	14,201	2,653	577	308	—
Fort Valley	8,310	6,820	4,953	3,223	2,022
Gainesville	16,523	11,936	10,243	6,272	4,382
Garden City	5,451	1,557	—	—	—
Griffin	21,735	13,982	13,222	8,240	6,857
Hapeville	10,082	8,560	5,059	1,631	430
Jesup	7,304	4,605	2,903	1,94[illegible]	805
La Fayette	5,588	4,884	3,509	2,104	491
La Grange	23,632	25,025	21,983	17,038	4,274
Macon	69,764	70,252	57,865	52,995	23,272
Marietta	25,565	20,687	8,667	6,190	4,446
Midway-Hardwick	16,909	14,774	—	—	—
Milledgeville	11,117	8,835	6,778	4,619	4,219
Monroe	6,826	4,542	4,168	3,211	1,846
Moultrie	15,764	11,639	10,147	6,789	2,221
Newnan	12,169	8,218	7,182	7,037	3,654
North Atlanta	12,661	5,930	1,365	—	—
Perry	6,032	3,849	1,542	678	650
Quitman	5,071	4,769	4,450	4,393	2,281
Rome	32,226	29,615	26,282	13,252	7,291
Sandersville	5,425	4,480	3,566	2,695	2,023
Savannah	149,245	119,638	95,996	83,252	54,244
Smyrna	12,038	2,005	1,440	791	238
Statesboro	8,356	6,097	5,028	3,807	1,197
Swainsboro	5,943	4,300	3,575	1,578	895
Thomaston	9,336	6,580	6,396	2,502	1,714
Thomasville	18,246	14,424	12,683	8,196	5,322
Tifton	9,903	6,831	5,228	3,005	1,384
Toccoa	7,303	6,781	5,494	3,567	2,176
Valdosta	30,652	20,046	15,595	10,783	5,613
Vidalia	7,569	5,819	4,109	2,860	503
Warner Robins	18,633	7,986	—	—	—
Waycross	20,944	18,899	16,763	18,068	5,919
Waynesboro	5,359	4,461	3,793	3,311	2,030
Winder	5,555	4,604	3,974	3,335	1,145

*Populations are reported as constituted at date of each census.
Note: Dash indicates place did not exist during the reported census, or data were not available.

EDUCATION

State School **System.**—As early as 1742 the Georgia trustees provided free tuition for children of poor families to attend a school at Savannah, and various forms of educational subsidy have continued throughout the state's history. After the American Revolution. academies were established in several counties with funds from confiscated Loyalist estates and by gifts of public land. By 1860 over 500 academies had been chartered, many by private, civic and religious groups. The acadetny system, essentially aristocratic. remained the general pattern of education throughout the pre-American Civil War period. Tuition was not free until 1817 and then only for children of indigent parents.

The constitution of 1868 authorized free public education on the elementary level for all children, and a school law was enacted in 1870. Appropriations reached S1.000.000 in 1893. Supplementary local tases for elementary schools were permitted by a constitutional amendment in 1904, but counties were not required to levy such a tax until 1919. In 1911 the state board of education became a professional one, and uniform schoolbooks were adopted; in the following year high schools became a part of the public-school system. In 1937 a seven-months elementary-school term was guaranteed by the legislature. The compulsory school law as amended in 1919 required attendance between the ages of 8 and 14 at least through the seventh grade.

School consolidation on a local experimental basis was begun in 1903. but not until 1919 did the legislature appropriate funds to encourage this movement. Simultaneously an adult illiteracy commission was established, followed by local taxation for adult schools, resulting in noteworthy progress in the eradication of illiteracy, the percentage dropping from 18.4% in 1920 to 9.4% in 1930.

In 19\33 the budget for elementary and secondary education was approximately $16.000.000 and by the second half of the 20th century had increased to more than $140.000.000. Free textbooks, a minimum teacher salary schedule of $3.000. a retirement system and a twelfth grade had been added. Vocational education was expanded and library services added. including one of the largest film libraries in the U.S. Enrollment in the public schools in 1933 was 750.054. as compared with more than Y60.000 in the second half of the 20th century. The number of public-school teachers increased from less than 20.000 to more than 30.000. The average salary of teachers rose from $655.15 to nearly $3.500.

Colleges and Universities.—The University of Georgia. at Athens. the oldest institution of higher learning in the state, was chartered in 1785 but did not open until 1801. In 1828 a medicai college was established at Augusta. During the latter half of the 19th century the state established many other colleges. including the Georgia Military institute st Marietta (destroyed by federal military forces in 1864), the Georgia Institute of Technology at Atlanta, a college for women at Milledgeville, a teacher's college and a college of agriculture at Athens. an agricultural college at Dahlonega and a number of small branch colleges in southern Georgia. In the first half of the 20th century five senior colleges and eight junior colleges (including a technical school) were established, all for white students only. In addition three public Negro colleges were provided. all located in the southern part of the state. at Albany, Fort Valley and Savannah.

Before 1931 the public colleges each had its own board of trustees and operated independentiy under separate fiscal systems. The creation of the university system of Georgia brought them and three agricultural experiment stations under one board of regents. the chief administrative officer being the chancellor. with his office in Atlanta. Seven of the existing institutions were immediate!~discontinued. and one new college was established in western Georgia. a populous area where four institutions were abolished. The regents controlled all the institutions as one fiscal unit, apportioning funds received from the legislature according to the needs of the individual institutions, The regents set up a councii of the university system. comprising the presidents. deans, other administrative officers arid some members of the teaching staffs of the schools, and some pi-ogress was made in defining the function of various units and integrating them into a more logical system of higher education. The regents, however. did not halt the trend early manifested in Georgia of developing area or regional colleges. In the second half of the 20th century a commuter's college, the Georgia State College of Business Administration. was created for the Atlanta area; and a day junior coilege was each authorized for Savannah. Augusta and Columbus. The university also established off-campus centres in various cities, some of which had local private colleges.

In 1933 the university system received an appropriation of approximately $1,500,000; in the second half of the 20th century the figure had increased nearly 15-fold. Enrollments increased during the same period from 9,000 to 25,000 students. Outside the university system are Agnes Scott college (Decatur, 1889; for women), Berry college (nonsectarian; Mount Berry, 1926), Tift college (Baptist; Forsyth, 1849; for women), Emory university (Methodist; near Atlanta, 1836), La Grange college (Methodist; La Grange, 1831). Mercer university (Baptist; Macon, 1833), Oglethorpe university (nonsectarian; near Atlanta, 1835). Piedmont college (Congregational; Demorest, 1897), Shorter college (Baptist; Rome, 1873), Wesleyan college (Methodist; Macon, 1836; for women), and Brenau college (nonsectarian; Gainesville, 1878; for women), all for white students. Atlanta is the largest centre in the south for the higher education of Negroes, having five undergraduate private colleges: Spelman (Baptist; 1881; for women), Morris Brown (Methodist; 1881), Clark (Methodist; 1877). Morehouse (Baptist; 1867: for men) and Gammon Theological seminary (Methodist; 1883); Atlanta university (nonsectarian; 1867) for undergraduates and graduates; and the Atlanta School of Social Work, affiliated nith Atlanta university in 1938, for graduates. Paine college (Methodist; 1883) in Augusta, is the only other private college for Negroes in Georgia.

Corrections and Welfare. — In 1811 Georgia began construction at Milledgeville of a state penitentiary that had a number of workshops and by 1820 had inaugurated a program of penal and criminal reform unusually progressive for the times. The rapid increase of the prison population following the emancipation of the Negro in 1865, there being no Negro prisoners before emancipation, brought a reversal of the earlier policy, resulting in the bulk of prisoners being leased to private businesses or assigned to county-operated chain gangs. The former practice ended in 1908. The constitution of 1945 established a board of corrections that assumed operation of a large new central penitentiary at Reidsville, and the custom of using convicts on county roads practically disappeared.

The Reorganization act of 1931 brought under a single board of control all state eleemosynary institutions, but in 1940 this board was abolished and the institutions placed under the public welfare department, though subsequently four were transferred to other departments. In 1943 the Georgia Academy for the Blind (Macon) and the Georgia School for the Deaf (Cave Spring) were transferred to the department of education, and later the tuberculosis sanitarium at Alto (later at Rome) was placed under the supervision of the board of health. In 1959 the Milledgeville State hospital, previously operated largely for the custodial care of 10,000 to 12,000 patients, was transferred to the board of health. The six institutions remaining under the department of public welfare were a training school for mental defectives (near Augusta), a training school for white boys (Milledgeville), a training school for Negro boys (Augusta), a training school for white girls (Atlanta), a training school for Negro girls (Macon), and a factory for the blind (Bainbridge).

THE ECONOMY

Agriculture. — Agriculture was the principal occupation of the people of Georgia until after World War II, when acceleration of mechanized farming reduced the farm population and the state underwent rapid industrialization. The most significant trend in Georgia agriculture in the second half of the 20th century was away from cotton, the principal money crop for 150 years, to a wide diversification. The largest cotton crop was in 1911, when 2,768,000 bales were produced on approximately 5,000,000 ac. A marked decline in cotton was noted in the early 1920s as a result of boll weevil infestation, the 1923 crop dropping to 588,000 bales. Diversification began at this point, and, after 1933, federal crop-control programs accelerated the movement. In the second half of the 20th century the soil-bank program had removed 380,000 ac. from production, of which only 10% was cotton; and the value of the state's corn crop in 1957 exceeded that of cotton for the first time since the American Civil War.

Loss of income from cotton was more than replaced by income from such new crops as tobacco, peanuts, poultry, livestock and forestry products. Tobacco, grown in Georgia since colonial times, underwent adaptability for commercial cigarettes during World War I, and by mid-century about 100,000 ac. annually were planted in southern Georgia. The state ranked first in the nation in peanut and in pimiento production, more than 500,000 ac. of peanuts being planted annually and harvested for nuts in addition to 150,000 ac. for hog grazing and other purposes. The pimiento industry began in 1912, when a superior plant was imported from Spain and was found to be adaptable to the cotton belt. The peppers came to be grown under contract to commercial packers.

The most spectacular development in Georgia agriculture was the rapid rise of the poultry industry. While the initial emphasis in the 1920s had been on egg production, the most outstanding results were later achieved in growing broilers, production increasing 126-fold. Tributaries to the broiler industry were processing plants, hatcheries, feed mills and supply houses. Livestock mas in the second half of the 20th century responsible for almost 40% of the state's gross farm income and 333% of its cash income. While ranking lowest among the southern states in the number of animals, Georgia played a leading role in developing herds of improved breeds, the greatest expansion being in the former cotton belt. Free range grazing in southern Georgia did not completely disappear until the second half of the 20th century. Other income from diversified agriculture was in valuable peach and watermelon crops in middle and southern Georgia, respectively; apples in northeast Georgia; and pecans, produced in nearly every county in the state, with large commercial orchards in its middle and southern portions.

Woodlands covered 24,000,000 ac., comprising two-thirds of the state's total area; under fire-protection measures, they were one of the state's greatest natural resources. After 1933 over 360,000 ac. of Georgia land were replanted with more than 1,000,000,000 trees, and the total annual value of ram timber and pulpwood after harvesting rose to $200,000,000. its processed value being $800,000.000. In lumber products Georgia ranked high in the nation and produced over 70% of the nation's naval stores.

Industry. — The total annual value of Georgia's manufactured goods in the second half of the 20th century was more than twice that of agricultural products. More than half of the state's rural population commuted daily to urban jobs; one plant at Marietta drew its workers from 39 counties. The mill village, once common everywhere, had almost disappeared. The largest single product manufactured was textiles. Lumber products ranked second. Wood processing and wood products plants increased more than sixfold after 1935, employees in this industry quadrupling in number. The newest manufacturing enterprise was pulpwood, which began in 1936, much of this going into the production of paper bags. About 40% of Georgia's new manufacturing plants were located in towns of fewer than 5,000 persons and utilized local labour and ram materials, but many large national concerns also located in Georgia near urban centres and were engaged in the manufacture of a wide range of products.

Minerals. — The most important mineral, sedimentary kaolin, found largely in the coastal plain just south of the fall line, is used in making whiteware and as filling and coating for paper. Other products of the region are limestone, fuller's earth, portland cement and bauxite. The crystalline rocks of the Piedmont and mountain region provide granite, marble, talc, feldspar, asbestos, ochre and barite, of which granite is the most important, being used principally for monuments. The granite industry is mainly around Elberton in northeast Georgia. Marble from the Tate quarries is widely noted for its quality and beauty and is second in importance in this region. In the Paleozoic area of northwest Georgia the principal products are portland cement, crushed limestone and ochre. Metal mining is confined to Bartom, with barite, ochre and brown iron ore being the leading products. Small quantities of coal are mined on Lookout and Sand mountains. The Dahlonega district, once famous as a gold-mining region, produces only negligible quantities of this metal.

Transportation. — Atlanta, long an important rail centre for the southeastern U.S., became a major air and motor transportation hub in the second quarter of the 20th century. Georgia in 1954 had 14.394 mi. of surfaced highways, 111 airports. and a motor vehicle registration of 1,239,000. Rail mileage exceeded 6.000. Other means of transportation were navigable rivers below the fall line. and ocean vessels having piers at St. Rlarys, Brunswick, Darien and Savannah.

See also references under "Georgia" in the Index volume.

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Current statistics on production. employment. industry, etc., may be obtained from the pertinent state departments; the principal figures, together with the current history, are summarized annually in the *Britannica Book of the Year*, American edition. (Js. C. B.)

GEORGIA, STRAIT OF. The Strait of Georgia lies between the central east coast of Vancouver Island and the southwestern mainland of the province of British Columbia, Canada. Its length is about 140 mi., and its greatest width about 20 mi. The northern part of the strait is almost closed off by a group of islands lying northeast of the town of Campbell River. The southern end of the strait is blocked by the San Juan Islands of Washington state. Depth of water in mid-channel is about 150 to zoo fathoms, but there are deeper, submerged valleys, and also numerous shoals which indicate the tops of submerged islands. There is a general counterclockwise movement of surface water in Georgia strait, aided by the large outflow of fresh water from the Fraser river. Tidal streams are complicated because tidal currents from Juan de Fuca strait to the southwest, and from Queen Charlotte strait to the northwest, both penetrate into Georgia strait. (J. L. R.)

GEORGIAN ARCHITECTURE, in architecture was the style of the 18th century in England and in the English colonies in America. There are slight differences in usages of the term in the two countries. In England, Georgian refers to the mode in architecture and the allied arts of the reigns of George I, II and III, extending from 1714 to 1820. The last decade of this era is often distinguished as Regency. The English Georgian style was strongly influenced by the work of the Italian Andrea Palladio (1518–1580). Introduced to England during the reign of James I in the 1620s, the Palladian style became even more admired in the 1720s under George I. Classical, formal and elegant, it esteemed "correctness" more than comfort.

In America, Georgian refers to the architectural style of the English colonies from about 1700 to the Revolution. Also formal and aristocratic in spirit, it was at first based on the baroque work of Sir Christopher Wren and his English followers in the late Stuart period, but after 1750 it became more severely Palladian. Typically, houses were of red brick with white-painted wood trim and sliding-sash windows. Interiors had central halls, elaborately turned stair balustrades, paneled walls painted in warm colours, and white plaster ceilings. All of these features were new to the colonies in 1700. Some of the earliest Georgian buildings were at Williamsburg, capital of Virginia from 1699 to 1780; other notable examples are Independence hall, Philadelphia (1745), and King's chapel, Boston (1754). The style was followed after the Revolution by the Federal style. 1780–1820. *See* also BAROQUE AND POST-BAROQUE ARCHITECTURE; GEORGIAN STYLES.

See Hugh Morrison, *Early American Architecture* (1952).

(HH. M.)

GEORGIAN BAY, the northeast section of Lake Huron, lies entirely within the Canadian province of Ontario. The bay is separated from the lake by Manitoulin Island and the Saugeen (or Bruce) peninsula. It is 120 mi. long and 51 mi. wide. Depth of water in the bay is generally between 100 and 300 ft.; the maximum depth is 540 ft. at a point near the main channel leading to Lake Huron. The bay also is connected with the north channel of Lake Huron, which lies north and west of Manitoulin Island. The principal tributary rivers are the French, draining Lake Nipissing on the northeast; the Maganatawan; the Muskoka draining the Muskoka chain of lakes; the Severn draining Lake Simco; and the Nottawasaga, which enters from the south. Small boats may pass from Georgian bay to the Bay of Quinte, on Lake Ontario, by traveling through the Trent valley waterway which includes the Trent canal. built in 1918.

The Georgian Bay national park, at the southeastern corner of the bay, was established in 1930 and it includes 30 of the more than 20,000 small islands of the bay. The region is forested and thousands of tourists visit the shore resorts in summer. The bay was the first part of the Great Lakes seen by white men, who reached it by way of the Ottawa and French rivers in 1615.

For a discussion of origin, geologic setting, history and commerce *see* GREAT LAKES, THE; and HURON, LAKE. (J. L. HH.)

GEORGIAN LANGUAGE. The Georgian language forms, together with Svanian, Mingrelian and Lazian, the southern or Kartvelian group of the Caucasian languages (*q.v.*). For the speakers of Svanian and Mingrelian it serves as the language of literature and of instruction. Among the Caucasian languages, only Georgian has an ancient literary tradition. The oldest inscriptions date from the 5th century, at which time also parts of the Bible were translated from Armenian into Georgian. The language of this period differs in some points from classical Old Georgian of the 10th and 11th centuries still in use in religious services. Old Georgian is somewhat difficult to understand but by no means incomprehensible to the Georgians of today; it was used in liturgy and for theological writings until the end of the 18th century. Old Georgian abounds in loan words from Armenian and especially from Greek; with the help of Greek the foundations were laid for a philosophical terminology. The language of medieval poetry, largely influenced by Persian, stands nearer to the contemporary language. But only in the middle of the 19th century did the literary language become definitively adapted to the living language of the people. The vocabulary of New Georgian is very extensive as compared with that of Old Georgian, every author drawing from his vernacular and even coining new expressive words. The dialects of modern Georgian show but slight differences, the most aberrant being those of the northeastern mountain tribes (Khevsurs, P'shavs).

The phonemic system of Georgian comprises the five cardinal vowels and 28 (Old Georgian, 2 more) consonant phonemes. This system is notably simpler than that of the North Caucasian languages; it shares with them some characteristic traits, *e.g.*, the division of the stops and affricates into three modes of articulation: voiced b, d, *g, dz, j*, voiceless with aspiration *p‘, t‘, k‘, ts, ch* and voiceless glottalized *p, t, k* or q, *ds, tch*. Diphthongs were current in Old Georgian, but have been reduced to single vowels. There is no phonemic vowel length. The first syllable of the word, or in longer words frequently the antepenultimate, is marked by very slight stress.

Georgian has roughly the same parts of speech as the Indo-European languages. The opposition between noun and verb is distinctly marked. The noun has seven cases: nominative, vocative, genitive, dative, ablative-instrumental, terminative-adverbial and a special case called ergative which in some constructions denotes the agent with a transitive verb. Because of fusion with postpositions there arose in New Georgian some secondary local cases. In Old Georgian the plural was formed in the nominative by *-ni,* vocative *-no,* oblique cases *-t'a;* this plural is seldom used in New Georgian, the regular plural being formed with a suffix *-eb-* to which are added the case endings used in the singular. There are no articles and no gender, even in pronouns. The attributive adjective, standing in New Georgian habitually before the noun, agrees with the noun in case but not in number.

It is the verb which shows fundamental differences from Indo-European languages. The Georgian verb is multipersonal: (1) The person of the agent is denoted in the third person by endings, in the first and second persons by prefixes most of which are not connected etymologically with the independent personal pronouns: *me v-dser* "I write," *shen dser* (in oldest Georgian *kh-dser)* "thou writest," *igi dser-s* "he writes." (2) Another set of personal prefixes refers to an object: *m-dser* "thou writest to me," *g-dser-s* "he writes to thee." (3) Relations between agent and objects called "versions" by Georgian grammarians are denoted by vowels inserted between the personal prefixes and the verbal root: *a-dser* (in oldest Georgian *kha-dser)* "thou writest on it," *vi-dser* "I write for me," *vu-dser* "I write for him," *e-dser-ebis* "it is written on it/for him." (4) The tenses of the verb are distributed according to three systems: present, aorist and perfect. In verbs corresponding to those called transitive in the Indo-European languages there is a different construction in each system. In the present the agent is put into the nominative, both direct and indirect objects into the dative: *kats-i dser-s dseril-s* "the/a man is writing the/a letter." In the aorist the object is put into the nominative, the agent into the ergative: *kats-man da-dser-a dseril-i* "the/a man wrote the/a letter." This construction which resembles the passive construction of other languages is characteristic of all Caucasian languages. In the perfect which denotes an action in the past not witnessed by the speaker, the object is put into the nominative, the agent into the dative: *kats-s da-u-dser-ia dseril-i* "it appears (it is said) that the man wrote the letter."

The Georgian alphabet was probably composed by Christian missionaries during the 5th century under the influence of and with some loans from the Greek alphabet. The bulk of the signs might have been derived from a form of the Aramaic script used in inscriptions dating from the 2nd century which have been discovered at Armazi, an ancient capital of Georgia. From the oldest form of the Georgian script arose in the 10th century an angular book script; from this developed the round form called *mkhedruli* on which are based the modern printed characters.

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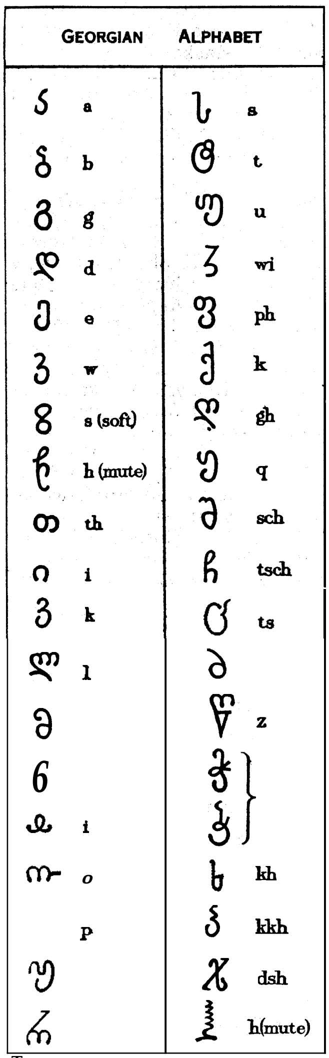
GEORGIAN LITERATURE. The earliest extant Georgian literature dates from soon after the conversion of Georgia by St. Nino, early in the 4th century, and the oldest manuscripts known are biblical. liturgical and hagiological—all of great value. They show a stage of linguistic development, a wealth of words and grammatical forms which prove that the language must already have had an ancient literary history. There were early translators of the Greek classical authors, and one of these says, in a preface, that he has endeavoured to give so exact a rendering of the text that he has converted philosophical terms syllable by syllable, a method which has endowed Georgia, from the 12th century. with a metaphysical terminology of great exactitude.

The folklore *(cf.* vol. i of the Grimm library, London, 1894) is of deep interest for comparative purposes, and its viens of the underworld may thro light on the religions of Egypt and Assyria.

One folk tale. *Et'heriani,* in prose and verse, the theme of which has been used for a successful opera in the 20th century. evidently assumed a literary form before the Christian era, and there is reason to believe that this may also be the case with the cycle of poems about Tariel, the hero of the greatest masterpiece of Georgian literature, attributed to Shot'ha Rust'haveli, an epic of more than 1,500 rhyming quatrains written in the reign of Queen T'hamar (1184–1212). This has been rendered into English prose *(The Man in the Panther's Skin, a Romantic Epic,* Roy. Asiat. Soc., 1911), and it gives Georgia a high place in the literature of the world.



THE GEORGIAN NATIVE ALPHABET
The Georgian, together with the majority of other Caucasian languages, composes a group fundamentally distinct from the Indo-European linguistic family

The T'hamarian age has also left us a large number of odes of great rhythmic variety, full of allusions to Greek and oriental writers. and translations or adaptations of foreign works, such as the *Story of the Loves of Vis and Ramin (Visramiani,* Eng. trans. published by Roy. Asiat. Soc., 1914), a romance of ancient Persia. Persian influence in Georgian literature was strong in the 17th century, and among the poets may be mentioned King T'heimuraz I (lyrics and translations). In the 18th century a revival of nationalism was aided by the founding of a printing press at Tiflis. where, in 1712, King Vakhtang VI published, with an elaborate commentary, the work of Rust'haveli; he also compiled a code of laws in which the ancient customary laws are of special interest.

Of this period also are compilations on the history and geography of Georgia (by Prince Vakhusht), both texts with a vast amount of other matter, published and translated by M. F. Brosset, by far the greatest. as he was the first, of western students of the literature. A great name is that of Prince Sulkhan Orbeliani (1655?–1725?), who in 1714 was Georgian envoy at Versailles. He kept a diary of his travels in Europe (partial French and Latin trans. in *Journ. Asiat.*, Paris, 1832 and 1834). and among his published works are a valuable dictionary of the language (Tiflis, 1884), and a rhymed translation of parts of the Persian Anvar-i-Suhaili. His Book *of Wisdom and Lies* (Eng. trans., 1894) is, after Rust'haveli. the most popular of Georgian books; in the form of interwoven apologues it highly recommends a sporting and Spartan education. In the early part of the 19th century the influence of Europe gre , and in the lyrics of A. Chavchavadze (1786–1846) and N. Barat'hashvili (1816–46) there is a Byronic strain, but G. Erist'havi, the first dramatist and founder of the national theatre. who translated poems of Petrarch. Johann Schiller, Adam Mickiewicz and others, had a steadying effect. The oppression of an alien rule (Russia, after 1801) inspired the patriotic verse of G. Orbeliani (1801–23) and Ilia Chavchavadze (1837–1907), who was the greatest Georgian of his generation in all branches of literature and public life. Acaci Tseret'heli (1840–191j) was the popular lyric poet of the century. I. Machabeli and D. Qiphiani translated Shakespeare into Georgian.

BIBLIOGRAPHY.—A general history of Georgian literature was published in 1895–1901 by A. Khakhanov (in Russian). M. F. Brosset's translation of the Georgian chronicles was published in St. Petersburg

(1849–58).

There is a good Georgian library at the Bodleian in Oxford and another at Harvard. At Oxford there is a fund for the encouragement of the study of Georgian literature.

GEORGIAN STYLES, in architecture and the decorative arts, developed during the 18th century in Great Britain and her colonies. During the reign of the Georges (1740–1830), urbgn aristocrats and merchants preferred the sober models of Andrea Palladio and Inigo Jones to the grandeur of continental baroque, and they built entire city squares of uniform, symmetrical town-houses, the façades of which were characterized by classical pilasters, pedimented doors and windows and graceful moldings. Their interiors—with paneled walls, quiet colours, Roman stucco ornamentation and Chippendale, Hepplewhite or Sheraton furniture—made elegant settings for the works of Reynolds and Gainsborough. Cnder the influence of the Adam brothers, the later style veered toward more authentic neoclassicism.

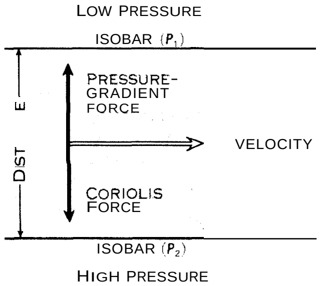
See also BAROQUE ART; GEORGIAN ARCHITECTURE; NEOCLASSICAL ART.

BIBLIOGRAPHY.—John Gloag, *Georgian Grace* (1956); A. E. Richardson, *Georgian England* (1931). (WM. F.)

GEORGIUS CONTINUATUS: see GEORGE THE MONK.

GEOSTROPHIC WIND. When air moves horizontally without friction or acceleration, there is a balance between the deflecting force of the earth's rotation—Coriolis force (see MOTION, LAWS OF)—and the force arising from the horizontal variations of pressure. The wind blowing under this balance of forces is called "geostrophic wind."

The magnitude and direction of geostrophic winds are given by the direction and spacing of isobars (lines of constant pressure) on a horizontal surface. In the figure, two such isobars are drawn. The pressure p_1 along one isobar is less than the pressure p_2 along the other. The pressure gradient force acts at right angles to the isobars and toward lower pressure. The Coriolis force acts at right angles to the wind, to the right in northern hemisphere. In order that these two forces balance, the wind, indicated in the figure by the white arrow, must be parallel to the isobars, with lower pressure to its left. The smaller the distance between isobars, the faster the wind. Geostrophic wind is also proportional to the slope of isobaric surfaces and directed along contours of such surfaces. with high elevations to the right of the geostrophic wind (in the northern hemisphere).



THE BALANCE OF FORCES FOR GEOSTROPHIC AIR FLOW IN THE NORTHERN HEMISPHERE

In the southern hemisphere, the Coriolis force acts to the left of the wind, and therefore the relations between direction of the geostrophic wind and pressure field are opposite to those in the northern hemisphere.

In general, the geostrophic wind represents the actual wind with an error of about 10%, provided the actual winds are averaged over areas of 100 miles or more. But the geostrophic wind is generally a poor approximation close to the surface (see EKMAN SPIRAL), in regions of fast winds and large trajectory curvature and near the equator.

The geostrophic wind relation is useful in the analysis of weather maps because it aids in the constrcction of stream lines in regions of scant wind observations, and in the construction of isobars where pressure data are poor, particularly in the stratosphere (*q.v.*). (H. A. A. P.)

GEPHYREA, an obsolete phylum of small-to-microscopic wormlike animals, which has been broken down into the following groups: Echiurida, Sipunculida, Priapulida and Phoronida (*qq.v.*).

GERA, a town of Germany in the district of the same name, on the banks of the White Elster, 45 mi. S.S.W. of Leipzig. Pop. (1950) 98,576.

Gera (in ancient chronicles Geraha) became a town in the 11th century, and in the 12th century it came into the possession of the lords of Reuss.

The town was sacked by the Bohemians in 1450, was burned down by the Swedes in 1639 and suffered from fires in 1686 and 1780, after which it was mostly rebuilt.

Its educational establishments include a weaving school. Osterstein, the former residence of the princes of Reuss, stands on the site of a 9th-century castle. Gera is noted for its industrial activity. Its industries include wool weaving and spinning, dyeing, iron founding, the manufacture of textiles, machinery. musical instruments, leather and tobacco, and printing (books and maps) and flower gardening.

GERALDTON, a town and seaport in the district of Victoria in Western Australia, 306 mi. by road north-northwest of Perth. Pop. (1954) 8,309. Geraldton is the seat of a Roman Catholic bishop, the centre of extensive crayfishing and market gardening industries and a seaside resort. The town serves a wide agricultural area. The chief exports are wheat, wool, tomatoes, processed crayfish tails and flour.

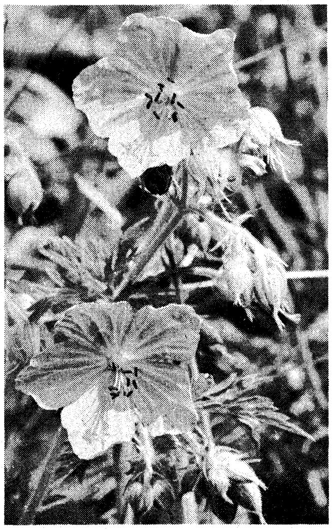
GERANIACEAE, a small but widely distributed family of Dicotyledons belonging to the Archichlamydeae, containing about 700 species in 11 genera. The family is represented in Britain by two genera, Geranium (cranes-bill) and *Erodium* (storks-bill), to which belong nearly two-thirds of the total number of species. The same two genera are the only representatives of the family in North America. The plants are mostly herbs, rarely shrubs, with generally simple glandular hairs on the stem and leaves. The opposite or alternate leaves have a pair of small stipules at the base of the stalk and a palminerved blade. The flowers, generally in a cymose inflorescence, are hermaphrodite, hypogynous and, except in Pelargonium, regular. The parts are arranged in fives. There are five free sepals, overlapping in the bud, and, alternating with these, five free petals. In Pelargonium the flower is zygomorphic with a spurred posterior sepal and the petals differing in size or shape. In Geranium the stamens are obdiplostemonous, *i.e.*, an outer whorl of five opposite the petals alternates with an inner whorl of five opposite the sepals; at the base of each of the antisepalous stamens is a honey gland. In Erodium the members of the outer whorl are reduced to scalelike structures (staminodes), and in Pelargonium from two to seven only are fertile. There is no satisfactory explanation of this break in the regular alternation of successive whorls. There are five, or fewer, carpels, which unite to form an ovary with as many chambers, in each of which are one or two, rarely more, pendulous anatropous ovules, attached to the central column in such a way that the micropyle points outward and the raphe is turned toward the placenta. The long beaklike style divides at the top into a corresponding number of slender stigmas.

The larger-flowered species of Geranium are markedly protandrous, the outer 'stamens, inner stamens and stigmas becoming functional in succession. For instance, in the meadow cranes-bill, G. *pratense,* each whorl of stamens ripens in turn, becoming erect and shedding their pollen; as the anthers wither the filaments bend outward, and when all the anthers have diverged the stigmas become mature and ready for pollination. By this arrangement self-pollination is prevented and cross-pollination ensured by the visits of bees which come for the honey secreted by the glands at the base of the inner stamens.

In species with smaller and less conspicuous flowers, such as *G. molle,* self-pollination is possible, since the divisions of the stigma begin to separate before the outer stamens have shed all their pollen; the nearness of the stigmas to the dehiscing anthers favours self-pollination.

In the ripe fruit the carpels separate into five one-seeded portions (cocci), which break away from the central column, either rolling elastically outward and upward or becoming spirally twisted. In most species of Geranium the cocci split open on the inside and the seeds are shot out by the elastic uptwisting; in Erodium and *Pelargonium* each coccus remains closed, and the long twisted upper portion separates from the central column, forming an awn, the distribution of which is favoured by the presence of bristles or hairs. The embryo generally fills the seed; the cotyledons are rolled or folded.

Geranium is the most widely distributed genus; it has 300 species and is spread over all temperate regions with a few species in the tropics. Three British species — G. *sylvaticum,* G. *pratense* and *G. robertianum* (herb Robert) reach the arctic, while G. *patagonicum* and G. *magellanicum* are found in the antarctic. *Erodium* contains 65 species (two British), most of which are confined to the Mediterranean region and west Asia, though others occur in America, in South Africa and west Australia. *Geranium* is represented in eastern U.S. by 11 species, 7 of which are introduced. In this region *Erodium* is represented only by two species introduced from Europe. In the western U.S. there are five species of *Geranium,* and *Erodium* is represented by one native species which extends throughout the whole region west of the Rocky mountains, where it is known as pin clover and pin grass. *Pelargonium,* with 250 species, has its centre in South Africa; the \\-ell-known garden and greenhouse "geraniums" are species of *Pelargonium* (see GERANIUM).



JOHN MARKHAM

MEADOW CRANES-BILL (GERANIUM PRATENSE)

For a monographic treatment of the family see R. Knuth, Geraniaceae. Pflanzenreich *53* (iv, 129): 1–640, fig. **1-80** (1912).

GERANIUM, the name of a genus of plants, the type of the family Geraniaceae, commonly called cranes bill; but also the common name of the garden geraniums, all of which belong to the South African genus *Pelargonium.* Formerly the genus Geranium comprised most of the family Geraniaceae.

The species of Geranium consist mostly of annual or perennial herbs, dispersed throughout the temperate regions of the world. They number about 250 and bear a considerable family resemblance. The leaves are for the most part palmately lobed, and the flowers are regular, consisting of five sepals, five imbricating petals, alternating with five glandules at their base, ten stamens and a beaked ovary. Fourteen species are natives of the British Isles. G. robertianum is herb Robert, a common plant in hedge banks. *G. sanguineum*, with flowers a deep rose colour, is often grown in borders, as are also the double flowered varieties of G. *pratense*. Many others of exotic origin form handsome border plants in our gardens of hardy perennials.

In North America about 25 species of Geranium are found, inclusive of several naturalized from the old world. Of the native species well-known representatives are the spotted cranes-bill or wild geranium (G. *maculatum*), common in woods from Newfoundland to Manitoba and southward to Georgia and Nebraska, with handsome rose-purple flowers, one to one and one-half inches broad; the Carolina cranes-bill (G. carolinianum), found in barren soil across the continent from Nova Scotia to British Columbia and southward to Florida and Mexico, with pale pink or white flowers about one-half inch broad; and the herb Robert mentioned above, which is native to rocky woods from Nova Scotia to Manitoba and southward to New Jersey and Missouri.

Pelargonium, though agreeing with Geranium in certain points of structure, differs in that the flowers are irregular, the two petals which stand uppermost being different — larger, smaller or differently marked — from the other three, which latter are occasionally wanting. This irregularity the modern florist has done much to annul, for the increased size given to the flowers by high breeding has usually been accompanied by the enlargement of the smaller petals, so that a near approach to regularity has been in some cases attained. Another well-marked difference, however, remains: the back or dorsal sepal in *Pelargonium* has a hollow spur, which is adnate; *i.e.,* joined for its whole length with the flower-stalk; while in Geranium there is no spur. This peculiarity is best seen by cutting through the flower stalk just behind the flower, when in Pelargonium there will be seen the hollow tube of the spur.

The various races of pelargoniums have sprung from the intermixture of some of the species obtained from the Cape of Good Hope. The older show-flowered varieties have been gradually acquired through a long series of years. The fancy varieties, as well as the French spotted varieties and the market type, have been evolved from them. The zonal or bedding race. on the other hand. has been more recently perfected; they are supposed to have arisen from hybrids between Pelargonium inquinans and *P. zonale;* perhaps better considered as belonging to P. *hortorum,* for the hybrid origin of many garden geraniums is obscure.

In all the sections the varieties are of a highly ornamental character, but for general cultivation the market type is preferable for indoor purposes, while the zonals are effective either in the greenhouse or flower garden. Some of the Cape species are still in cultivation — the leaves of many being beautifully subdivided, almost fernlike in character, and some of them are deliciously scented; P. quercifolium is the oak-leaf geranium. The ivy-leaf geranium, derived from P. *peltatum,* has given rise to an important class of both double- and single-flowered forms adapted especially for pot culture, hanging baskets, window boxes and the greenhouse. The common household geranium can be wintered over by hanging, roots up, in a cool, frost-free place.

The best soil for pelargoniums is a mellow fibrous loam with good well-rotted stable manure or leaf mould in about the proportion of one-fifth; when used it should not be sifted, but pulled to pieces by the hand, and as much sand should be added as will allow the water to pass freely through it. All are readily increased by cuttings made from the shoots when the plants are headed down after flowering, or in the spring, when they will root freely in a temperature of 65° to 70° F. They must not be kept too close, and must be very moderately watered.

GERARD (d. 1108), archbishop of York under Henry I, began his career as a chancery clerk in the service of William Rufus. He was one of the two royal envoys who, in 1095, persuaded Urban II to send a legate and Anselm's pallium to England. Gerard was rewarded for his services with the see of Hereford (1096). On the death of Rufus he at once declared for Henry I, by whom he was nominated to the see of York. He made difficulties when required to give Anselm the usual profession of obedience, and took the king's side on the question of investitures. He pleaded Henry's cause at Rome with great ability, and claimed that he had obtained a promise, on the pope's part, to condone the existing practice of lay investiture. But this statement was contradicted by Paschal, and Gerard incurred the suspicion of perjury. About 1103 he wrote or inspired a series of tracts which defended the king's prerogative and freely attacked the ecumenical pretensions of the papacy. In 1105, he became a stanch friend and supporter of Anselm. Gerard was a man of considerable learning and ability; but the chroniclers accuse him of being lax in his morals, an astrologer and a devil worshipper.

(H. W. C. D.)

GERARD (c. 1040–1120), variously surnamed TUM, TUNC, TENQUE or THOM, founder of the order of the Knights of St. John of Jerusalem (*q.v.*), found his way in some capacity to Jerusalem, where a hospice existed for visitors to the holy places. Of this institution Gerard became guardian about 1100, and he organized that religious order of St. John which received papal recognition from Paschal II in 1113, by a bull which was confirmed by Calixtus II shortly before the death of Gerard in 1120.

GERARD OF CREMONA (*c.* 1114–1187), medieval translator of Arabic into Latin, was born at Cremona in Lombardy. Little is known of his life. He went to Toledo to learn Arabic in order to read the Almagest of Ptolemy (not then translated into Latin) and remained there for the rest of his life. About 80 translations from the Arabic have been attributed to him. but it has been suggested that he was in charge of a school of translators which nas responsible for some. Many early printed editions of them omit the name of the translator. His translation of the *Almagest* (printed in 151j) was finished in 1175, it became more popular than that made from the Greek text about 15 years earlier in Sicily. Among other Greek authors translated from Arabic versions traditionally by Gerard are Aristotle, Euclid and Galen.

Translations of original Arabic texts attributed to him include works on medicine (*e.g.,* Avicenna's "Canon"), mathematics, astronomy, astrology and alchemy.

See B. Boncompagni, *Gherardo Cremonese e Gherardo da Sabbionetta* (1851); G. Sarton, *Introduction to the History of Science,* vol. 2, pp. 338–344 (1931).

GÉRARD, FRANÇOIS, BARON (1770–1837), French painter, who executed portraits of the most celebrated men and women of Europe, was born on May 4, 1770, at Rome, where his father occupied a post in the house of the French ambassador. At the age of 12 he obtained admission into the Pension du Roi at Paris, and from there passed to the studio of the sculptor Augustin Pajou; he subsequently studied with the painter Brenet and with David. In 1791, on his return to Paris after a stay in Rome, David availed himself of Gérard's help, and one of that master's most celebrated pictures—"Le Pelletier de St. Fargeau"—may owe much to the hand of Gérard. In 1793, at David's request, he was named a member of the revolutionary tribunal, from the fatal decisions of which, however, he invariably absented himself. In 1794 he obtained the first prize in a competition, the subject of which was "The Tenth of August," and in 1795 produced his famous "Bélisaire." A portrait of his generous friend Isabey the miniaturist (in the Louvre) obtained undisputed success in 1796, and the following year he executed his "Psyché et l'Amour" (also in the Louvre). A portrait of Madame Bonaparte in 1799 established his position as a portrait painter. All the leading figures of the empire and of the restoration sat for Gérard. This extraordinary vogue was due partly to the charm of his manner and conversation; Madame de Staël, Canning, Talleyrand and the duke of Wellington all bore witness to this.

Gérard died on Jan. 11, 1837.

GERARD, JAMES WATSON (1867–1951), U.S. lawyer and diplomat, was born at Geneseo, K.Y., on Aug. 25, 1867. Educated at Columbia university and at the New York law school, he was admitted to the bar in 1852 and began to practise in New York city. In 1908 he became associate justice of the supreme court of New York, resigning in 1913 on being appointed ambassador to Germany. At the outbreak of World War I, he assumed the care of British, Japanese, Rumanian and Serbian interests in Germany. On Feb. 3, 1917, diplomatic relations were broken off by the U.S. and he was recalled. On his return he resumed the practice of law in New York city.

Gerard wrote My *Four Years in Germany* (1917); *Face to Face with Kaiserism* (1518); and My *First Eighty-three Years in America* (1951).

He died in Southampton, N.Y., Sept. 6, 1951.

GÉRARD, JEAN IGNACE ISIDORE: *see* GRANDVILLE.

GERARD, JOHN (1545–1612), English herbalist and surgeon best known for his *Herball,* was born at Nantwich, Cheshire. He was educated at Willaston and, setting up in London, acted as superintendent of the gardens of Lord Burghley, chief secretary of state under Elizabeth I. Gerard's *Herball* (1597) was really an adaptation of the *Stirpium historiae pemptades* (1583) of Rembert Dodoens. Its style makes it the most famous of English herbals, though not the best. Its illustrations are mostly impressions from the wood blocks employed by Johann Teodor Tabernaemontanus in his *Icones plantarum,* published at Frankfurt in 1590. One of the woodcuts in the *Herball* represents the potato, and is thought to be the first figure of the plant published. There is also a figure of the "goose tree."

Gerard died in London in Feb. 1612.

See A. Arber, *Herbals,* 2nd ed. *(1938).*

GERARD, JOHN (1564–1637), English Jesuit missionary in England under Elizabeth I, was born at Etwall hall. Derbyshire, Oct. 4, 1564. After studying at the English college in Rome, where he was ordained priest, he entered the Society of Jesus in 1588, and returned secretly to England. Starting in Norfolk and then working south into Suffolk and Essex, Gerard established several centres with resident Catholic priests in the houses of the gentry. Dressed as a country gentleman he traveled unmolested and made many converts. He was a born leader, a man of commanding stature, great vigour of constitution, fluent in several languages, with a natural courtliness of manner. In July 1594 he was captured and spent three years in prison. He escaped from the Tower of London in 1597, and subsequently worked in Northamptonshire, Oxfordshire and Buckinghamshire. After the Gunpowder plot he managed to leave England in dis uise in 1606. The rest of his life was spent in English colleges on the continent. In 1607 he wrote a history of the Gunpowder plot and his autobiography, a vivid and accurate account (in Latin) of his experiences in England. He was spiritual director of the English college in Rome (1627–37), where he died, July 27, 1637.

See *The Condition of Catholics Under James I (Father Gerard's Narrative of the Gunpowder Plot),* ed. with his life by J. Morris *(1871)* and P. Caraman's trans. of the Autobiography, 2nd ed. *(1956).* (P. CN.)

GERASA, an ancient city of Palestine in the highlands of Gilead, 20 mi. N. of 'Ammān (Philadelphia) and 20 mi. E. of the Jordan (mod. Jerash). The city, now ruined, is pleasantly situated in a valley through which runs a perennial stream, the Chrysorrhoas of the Greeks, to fall into the Zerka (Jabbok) 6 mi. to the south. The site is undulating and strewn with knolls offering excellent positions for public buildings, a circumstance of which the Roman architects took full advantage, as their structures, magnificent even in ruin, testify. After 1878 a colony of Circassians occupied the site, or rather a small portion of it. The building materials for their village on the east bank of the stream have been extracted from the ruins, the bulk of which lie on the west bank.

The delightful orchard gardens of Jerash make it one of the pleasantest towns in all Palestine.

History.—Nothing up to the present, is known of the history of the city in Old Testament times or earlier, although the site was probably occupied. unless it represents Ramoth Gilead as has been suggested. Iamblichus asserts that it was originally colonized by veterans of Alexander the Great. Josephus tells us that it was captured by Alexander Jannaeus (c. 83 B.C.), rebuilt by the Romans (c. A.D. 65), burned by the Jews, and subsequently desolated and burned by Vespasian's captain Annius. From the time of Trajan it belonged to the Roman province of Syria, but about A.D. 160 it was allotted to the province of Arabia and during the peaceful reign of the Antonines (130–180), was adorned with magnificent buildings and rose rapidly in importance and prosperity.

If was the second city of the Decapolis and early in Christian times became the see of a bishop. To the Talmud and Jerome, Gerdsa and Gilead were synonymous, and similarly Mukkadsi calls Jebel 'Ajlūn, Jebel Jerash, Tughtakin. The atabeg of Damascus, had there a castle which was taken and destroyed by Baldwin II (1121). The Arabic geographer Yākūt, on the evidence of an eyewitness, reports it in ruins at the beginning of the 13th century. The "Gerasenes" of Matthew viii, 28 were not natives of Gerasa, as might be thought, but must be sought elsewhere (Khersa?).

Archaeology.—Of the many beautiful architectural monuments beyond Jordan, the fruit of Roman administration, the ruined grandeur of Gerasa supplies the finest. Laid out on a definite scheme with colonnaded main and cross streets, it is an early example of enlightened town planning. The city was surrounded by walls, 8 ft. thick, with a total circuit of 3,000 yd., and had six gates, the principal ones being north and south. The stream, near to which and roughly parallel to it ran the main street, divided the city in two, but the main public buildings were on the west bank and on the west side of the road. The approach to Jerash from the south passes a triumphal arch 300 yd. from the south gate. Between this and the gate on the left hand side are the ruins of a *naumachia* or tank for naval displays (170 × 60 yd.) and contiguous to it a stadium (100 × 60 yd.). Within the walls are found the main objects of interest: a fine peripteral temple; a theatre (south) in a good state of preservation; a colonnaded loop in the road generally, but doubtfully, regarded as the forum; a basilica or senate house; the great sun temple; a tetrapylon at the crossroads; and a theatre (north).

The outstanding feature of the site is undoubtedly the profusion of columns, of which over 200 still stand. "A catalogue of the visible monuments alone can convey little impression of their supreme beauty from the point of view of classical art, and not only are the buildings in themselves triumphs of architecture, but they are strikingly placed so that each one meets the eye as a distinct feature, while from the distance they compose themselves readily into a single harmonious picture." The decay of the city resulted partly from a decrease in water supply and from seismic disturbances, as well as from political vicissitudes.

The Trans-Jordan government in 1926 cleared the main street and retrieved and consolidated dangerous parts of the ruins. Excavation was begun on the temple area, and tourists were given facilities to visit Jerash by the government. (E. Ro.)

GERBIL, a small, jumping rodent (*q.v.*) of the deserts of Asia and Africa. The typical genus *Gerbillus*, along with *Meriones, Tatera* and others, form a special subfamily of the Cricetidae. Gerbils have unusually large eyes and ears, elongated hind limbs and long hairy tails; they progress by leaps, in the same manner as jerboas (*q.v.*).

These sandy-coloured herbivores live in burrows furnished with numerous exits and containing large grass-lined chambers. Most of them are active only during the day.

GERENUK, a gazellelike antelope, commonly known as Waller's gazelle (*Litocranius walleri*), having exceptionally long limbs and a long. slender neck. It ranges in east Africa from Somaliland to Kilimanjaro. being found in family groups. The gerenuk is noted ior its ability to stand on its hind limbs while browsing on branches and leaves of trees and shrubs. The horns of the buck are heavy and have a peculiar forward curvature at the tips; the coat is reddish-brown mith a broad darker band down the back.

See ANTELOPE.

GERGOVIA (modern Gergovie), in ancient geography, the chief settlement of the Arverni. situated in the Auvergne, 8 mi. from the Puy de Dôme. France. Julius Caesar attacked it in 52 B.C., hut was beaten off. Some walls and earthworks, probably of this period, survive.

Later, when Gaul had been subdued, the place was dismantled and its Gaulish inhabitants resettled 4 mi. away in the plain at the new Roman city of Augustonemětum (modern Clermont-Ferrand).

GERHARD, JOWANN (1582–1637), German Lutheran theologian, chairman of every major Lutheran theological assemhly of the period, biblical and patristic scholar of the first rank and a formidable polemicist, was born of a prominent Quedlinhurg family on Oct. 17, 1582. Profoundly influenced in his youth by the great Lutheran theologian-mystic Johann Arndt (*q.v.*), Gerhard studied philosophy, medicine and theology at the universities of Wittenberg, Marburg and Jena (D.Th., 1605). He became superintendent of the churches of Heldburg in the duchy of Coburg (160j); in 1615 he was appointed general superintendent of all churches in the duchy. The next year he rejoined the Jena theological faculty, where he remained until his death, Aug. 17, 1637.

Gerhard's theological system—most fully set forth in his monumental nine-volume *Loci theologici* (1610–22), the most important dogmatic work of the era of Lutheran orthodoxy—is deliberately designed to be both catholic and evangelical. Though constructed, after the fashion of the times, on a neo-Aristotelian framework, it recognizes the Sacred Scriptures as its only "principle" and breathes a profoundly practical and ethical concern throughout.

His other major works are the four-volume *Confessio catholica* (1634–37), a defense of the catholicity of the Lutheran position; *Meditationes sacrae* (1606), a small devotional manual that has been translated into almost every European language; *Harmonia evangelistarum* (1626–27), a harmonization of and commentary on the Gospels which completed the earlier work of Martin Chemnitz (*q.v.*) and Polycarp Leyser; and his posthumously published *Patrologia* (1653).

See E. R. Fischer, *Vita Ioannis Gerhardi* (1723); B. Hägglund, *Die Heilige Schrift und ihre Deutung in der Theologie Johann Gerhards* (1951), with detailed bibliography. (A. C. PN.)

GERHARDT, CHARLES FRÉDÉRIC (1816–1856), French chemist and theorist on organic compounds, was born at Strasbourg on Aug. 21, 1816. After attending the gymnasium at Strasbourg and the polytechnic at Karlsruhe. he mas sent to the school of commerce at Leipzig, where he studied chemistry under Otto Erdmann. Later he worked for some time with Liebig at Giessen. At Liebig's recommendation he was appointed demonstration assistant to Dumas in Paris. In 1841 he received the doctorate at the University of Paris. He became professor of chemistry at Montpellier in 1844, and in 1855 at Strasbourg, where he died on Aug. 19. 1856.

Although Gerhardt did some noteworthy experimental work—for instance, his preparation of acid anhydrides in 1852—his contributions to chemistry consist not so much in the discovery of new facts as in the introduction of new ideas that vitalized and organized an inert accumulation of old facts.

In 1839 he revived the old radicle theory of organic compounds under the title of the "theory of residues." In 1845 he invented the theory of homologues, which proved very useful in determining what members were still missing in the various series of compounds. Gerhardt first suggested that many organic substances were "conjugated" or "copulated" compounds formed by the union of two residues. In 1842 he attempted the first definite classification of organic compounds, but owing to the obscurity of some of his concepts, little progress was made until he cooperated with Auguste Laurent (*q.v.*).

Eventually Gerhardt introduced the idea that all substances were based on four main types; viz., hydrogen, hydrochloric acid, water and ammonia. Although these ideas were later abandoned they play an important part in the development of structural organic chemistry.

His chief works were *Précis de chimie organique* (1844–4j), and *Traite de chimie organique* (1853–56).

GERHARDT, ELENA (1883–1961), Germanmezzo-soprano singer. was born at Leipzig on Nov. 11, 1553. She studied at the Leipzig conservatory under Marie Hedmondt. and afterward received help in interpretation from Arthur Nikisch. who frequently accompanied her at concerts. As a lieder singer. and especially as an interpreter of Schubert. she set a high standard of purity and simplicity. She died in London on Jan. 11, 1961.

GERHARDT, PAUL (1607–1676), German hymn writer, was born at Grafenhainichen on March 12, 1607. After tutoring in Berlin. in 1657 he became "diaconus" to the Nicolaikirche there. Because of his uncompromising Lutheranism he refused to accept the elector Frederick William's "syncretistic" edict of 1664, and was deprived of his office in 1666. In spite of a public petition in 1667, he refused to resume an office which, he thought, implied at least a tacit repudiation of the Formula Concordiae. In 1668 he was appointed archdeacon of Lubben, Saxe-Mersburg, where he died on June 7, 1676.

Gerhardt is the greatest German hymn writer of the 17th century. Many of his best-known hymns first appeared in church hymnbooks, as for example in the Brandenburg hymnal in 1658; others in Johann Criiger's *Geistliche Kirchenmelodien* (1649), and *Praxis pietatis melica* (1656). The first complete set is the *Ceistliche Andachten* (1666–67), edited by Ebeling, music director in Berlin.

The life of Gerhardt has been written by Roth (1829), by Langbecker (1841), by Schultz (1842), by Wildenhahn (1845), by Bachmann (1863) and by H. Petrich (1914); also by Kraft in Ersch u. Gruber's *Allg. Encycl.* (1855).

The best modern edition of the hymns, published by Wackernagel in 1843, has often been reprinted (Eng. trans. by Kelly, *Paul Gerhardt's Spiritual Songs,* 1867).

See also T. B. Hewitt, *Paul Gerhardt as a Hymn-writer and His Influence on English Hymnody* (1918).

GERIATRICS: *see* GERONTOLOGY AND GERIATRICS.

GÉRICAULT, JEAN LOUIS ANDRÉ THÉODORE (1791–1824), French painter who influenced the romantic and realist movements, was born at Rouen on Sept. 26, 1791. He studied under Carle Vernet, who introduced him to the traditions of English sporting art, and then under Pierre Guérin, absorbing the methods of classicist figure construction and composition. At the Salon of 1812, he attracted notice with his "Charging Chasseur" (Louvre, Paris), executed in an impetuously dynamic, colourist style inspired by Gros and Rubens. Already he had begun to develop along two divergent lines shown in the visual realism of his many small studies of horses and soldiers, as against the grander, more severe style of his mythological compositions and landscapes (*cf.* the two "Heroic Landscapes," Chrysler collection). At the Salon of 1814, his "Wounded Cuirassier" (Louvre) shocked critics with its ponderous forms and sombre colours. Géricault spent 1816–17 in Florence and Rome, where his chief project was the unfinished "Race of the Riderless Horses," a huge, heroic frieze composition, surviving in a series of studies (Baltimore, Md.; Lille; Louvre; Rouen).

BY COURTESY OF MUSÉE DE LYONS

"A MAD WOMAN WITH A MANIA OF ENVY," ONE OF A SERIES OF FIVE PORTRAITS OF THE INSANE BY GÉRICAULT. IN LYONS MUSEUM

Returning to France in 1817. Géricault drew a group of military lithographs reckoned among the early masterworks in this medium. His sensational "Raft of the Medusa" (Louvre) was suggested by a contemporary shipwreck. In this enormous canvas he tried to raise a contemporary event beyond the triviality of reportage to the dignity of monumental art. The two aspects of his style here became united: starting with a close inquiry into its visual aspects (*cf.* the portraits of cadavers). he developed his theme into a carefully constructed dramatic composition. This controversial work marked the beginning of the struggle between the classicist and romantic movements. Disappointed by its hostile reception, Géricault left for England (1820) where, again influenced by British genre art, he produced lithographs, watercolours and oils ("Epsom Downs Derby," Louvre) of superb colour and grandly simple forms. The most significant of his last works are the portraits of the insane (Louvre; Lyons; Ghent; Winterthur and Springfield, Mass.). He died from the consequences of a fall from his horse on Jan. 26, 1824. in Paris.

See C Clement, Th *Géricault,* 2nd ed (1879) ; G. Oprescu, *Géricault* (1927); K. Berger, *Th. Géricault* (1952), Eng. trans. by Winslow Ames (1955); D. Aime-Azam, *Maeeppa* (1956). (L. E. A. E.)

GÉRIN-LAJOIE, ANTOINE (1824–1882), Canadian writer, librarian and leader in the early literary movement of French Canada, was born at Yamachiche, Aug. 4. 1824. He was educated at the Collège de Nicolet, where he wrote the first French-Canadian play, *Le jeune Latour.* In 1844 he joined the staff of the Montreal newspaper *La Minerve,* of which he soon became editor. At the same time he studied law and he was called to the Quebec bar in 1848. but he never practised law. In 1852, he was appointed translator to the legislative assembly of Canada; four years later he was made assistant librarian of parliament, a post which he held until 1880.

Gérin-Lajoie was one of the founders of the Montreal club, Institut Canadien and of the literary magazines *Les Soirées canadiennes* (1861–65) and *Le Foyer canadien* (1863–66). He was the author of *Catéchisme politique* (1851); *Dix Ans au Canada, de 1840–1850* (1888), the history of the advent of responsible government in the colony; and of a novel in two parts, *Jean Rivard, le de'fricheur* (1862) and *Jean Rivard, l'économiste* (1864), a portrayal of rural life in French Canada in mid-19th century. He died at Ottawa on Aug. 4, 1882. (G. J. SE.)

GERIZIM, a mountain in Jordan (mod. Jabal at Ṭūr), 2,890 ft. above sea level. With its companion mountain, Ebal, it flanks the valley in which lies Nāblus (Neapolis), the ancient Shechem.

History.— It was on Ebal and Gerizim that the tribes assembled under Joshua to hear the curses and the blessings connected with the violation and observance of the law (Deut. xi). The distance from Ai and the position of Ebal and Gerizim in the midst of a hostile country have constituted difficulties which Eusebius, Epiphanius and others met by associating Ebal and Gerizim with hillocks in the lower Jordan valley—a solution that has never found favour. From Gerizim—a prominent rock is still pointed out as his pulpit—Jotham addressed his parable to the treacherous elders of Shechem (Judges ix). This mountain is the holy place of the Samaritan community. About 432 B.C., following on the refusal of the Jews returned from the Exile to recognize the Samaritans, the latter erected on the mount a temple as rival to that at Jerusalem. This was probably destroyed by John Hyrcanus (c. 110 B.C.). The Samaritans were expelled from Gerizim by the emperor Zeno, who built a church (484). In the course of his struggle with the Samaritans, Justinian surrounded this church with a fortress.

Archaeology.— A small level plateau near the summit marks the site of the schismatic temple and an important link with the past was the celebration near this spot of the Passover by the Samaritans, comprising a small body in modern times. "As the sun sets on Passover eve the seven lambs are slain, ceremonially examined and roasted in the oven pit. At midnight the covering is removed and the flesh is eaten by the standing elders with their families in the improvised tents. Anything left over is scrupulously collected and consumed, so that the letter of the commandment may be kept." Excavations carried out by the German Archaeological institute uncovered Zeno's basilica. This building (121 ft. by 98 ft.), which was built over the ruins of the Samaritan temple, exhibits a well-preserved octagonal ground plan. Two side chapels with handsome mosaics were also disclosed. The abundance of fragments suggested that it would be possible to determine accurately the details of architectural design. (E. Ro.)

GERLACH, HELLMUT VON (1866–1935), German pacifist. radical journalist and political leader, a courageous opponent of German nationalism under William II, the Weimar republic and the Hitler regime, was born on Feb. 2, 1866. at Mönchmotschelnitz in Silesia. The descendant of a family of Prussian administrators, Gerlach held the conservative views of his class; but during his studies at Geneva. Strasbourg, Leipzig and Berlin he was influenced by Christian Socialism and Lord Randolph Churchill's "Tory democracy" won his admiration. In 1887 he entered the Prussian civil service but left it for journalism. working for Adolf Stocker (who combined Christian Socialism with anti-Semitism) on the newspaper *Das Volk.* Gerlach's political ideas were too radical for the paper, however, and Stocker dismissed him in 1896. In the same year Gerlach nas a co-founder. with Friedrich Naumann, of the National Social association (Nationalsozialer Verein) and, after visiting England and the Balkans. joined the staff of Naumann's new paper *Die Zeit.* In 1901 he became editor of the Berlin democratic newspaper *Die Welt am Montag,* and from 1903 to 1906 he represented the National Social party in the *Reichstag.* After losing his seat he visited Africa, where he became an admirer of British colonial methods.

During World War I Gerlach openly championed pacifist views. After the revolution he was undersecretary of state in the Prussian ministry of the interior (Nov. 1918–March 1919). where his conciliatory and liberal policy toward Poland earned him the hatred of the German nationalists. He remained, however, an active supporter of pacifist and radical-democratic organizations. In 1933 he emigrated, becoming the recognized head of German exiles in Paris. where he died on Aug. 2, 1935. His books include *Der Zusammenbruch der deutschen Polenpolitik* (1919); *Meine Erlebnisse in der preussischen Verwaltung* (1920); *Erinnerungen eines Junkers* (1924); *Von Rechts nach Links,* ed. by Emil Ludwig (1937).

GERLACH, LEOPOLD (1790–1861) and **ERNST LUDWIG VON** (1795–1877), brothers, mere leading figures in the movement of romanticism and reaction that determined Prussian politics from the Napoleonic Wars to the end of Frederick William IV's reign, after which Ernst Ludwig lived on to represent conservative opposition to Bismarck's power politics. Leopold was born in Berlin on Sept. 17, 1790, Ernst Ludwig on March 7. 1795. Leopold served as an officer in the war of 1806 and again in that of 1813–15. in which his brother also served as a volunteer. The romantic and conservative spirit of the Wars of Liberation against the French inspired both brothers with a lifelong belief in a greater Germany: with revolutionary France as its hereditary enemy; and therefore also with a readiness to side with Austria. In 1811, together with the poets Achim von Arnim and Heinrich von Kleist, Leopold joined the Christlich-Deutsche Tischgesellschaft (Christian-German Dining club); and from 1816 to 1819 both brothers were members of the Christlich-Germanische Tischgesellschaft favoured by the crown prince, the iuture Frederick William IV. Both identified themselves with the strict pietism of the postwar years, taking their political principles from Albrecht von Haller and, above all, from Friedrich Julius Stahl. After Frederick William had come to the throne (1840), Leopold, who had formed a close friendship with him, rose to be his adjutant general (1849) and became the most influential man of his entourage. In the fight against the revolution of 1848 he was the moving spirit of the "Camarilla" at court which, though it had to put up with the constitution of Nov. 1850, did its utmost to revise it in a conservative direction.

Meanwhile Ludwig, who in 1844 had been appointed president of the Magdeburg appeal court; founded the conservative newspaper *Kreuzzeitung* in 1848, in which his monthly commentaries appeared until 1857. Even more dogmatic than Leopold, he was second only to Stahl as a leader of conservative thought. In 1849 the brothers. uncompromisingly opposed to the liberal idea of a German nation, persuaded Frederick William IV to refuse the imperial dignity offered to him by the Frankfurt assembly. Both vigorously fought the German politics of J. M. von Radowitz, welcomed the Olmutz agreement (1850) and vainly sought to persuade the king to join Russia during the Crimean War. Leopold's correspondence with Bismarck. in its discussion of Napoleon III as a potential ally, shows that he early opposed his young friend's *Realpolitik,* though he had himself recommended Bismarck as Prussia's representative at the federal diet in Frankfurt. However, the brothers' narrow dogmatism, which regarded the movement toward German unity only as a "nationalist swindle," represented a lost cause even before Frederick William IV was dead.

Leopold died at Pocsdam on Jan. 10, 1861. eight days after Frederick William IV. His memoirs, in two volumes. were published in 1891–92 and his correspondence with Bismarck, ed. by H. Kohl. in 1896.

During the decade after 1862 Ludwig lived to see Bismarck completely abandon the ideas of traditional conservatism. His protest against the Prussian annexations of 1866 completed the breach between the former friends. Ludwig joined the Centre party as guest member, since throughout his life he had combined a firm Protestant conviction with respect for the ordered authority of the Roman Catholic Church. He died in Berlin on Feb. 18. 1877. There are *Aufzeichnungen aus seinem Lehen und Wirken,* ed. by his son, 2 vol. (1903).

See G. Ritter, *Der preussische Konservativismus und Bismarcks drutsche Politik, 1858–66 (1913)*; H. J. Schoeps, *Das andere Preussen (1952).* (HA. H.)

GERLACHE, ÉTIENNE CONSTANTIN, BARON DE (1785–1871), Belgian Catholic statesman and historian. was born at Biourge. Luxembourg, on Dec. 26, 178.5. He studied law in Paris and practised there for some time, but he settled in Liege after the establishment oi the kingdom of the Netherlands. As a member of the states-general, he was an energetic leader of the opposition. He supported the alliance of the Belgian Catholics with the Liberal party, which paved the way for the revolution of 1830. On the outbreak of the insurrection in Aug. 1830 he still. however, thought the Orange-Nassau dynasty and the union with the Dutch provinces essential; but his views changed, and after holding various offices in the provisional government. he became president of the national congress and brought forward the motion inviting Leopold of Saxe-Coburg to become (on July 21 1831) king of the Belgians. In 1832 he was president of the chamber of representatives, but on Oct. 4, when Pope Gregory XVI, in the encyclical *Mirari vos,* condemned H. F. R. de Lamennais's conception of liberty, he resigned. accepting the Holy See's ultramontane ideas. On Oct. 13. 1832, the king appointed him president of the *cour de cassation* (supreme court of appeal), and he kept that office for 35 years. He was created a baron on Jan. 16, 1844. He also presided over the Catholic congresses held at Malines between 1863 and 1867. That his early liberal views underwent some modification was plain from the conservative principles enunciated in his *Essai sur le mouvement des partis en Belgique* (1852). As a historian his work was strongly coloured by his anti-Dutch feelings and his Catholic predilections. His *Histoire du royaume des Pays-Bas de 1814 jusqu'en 1830* (1839), published in two volumes, was a piece of special pleading against the Dutch domination. A complete edition of his works. 6 vol. (1874–75), includes a biography by J. J. Thoniisen. He died in Brussels on Feb. 10, 1871.

See Pierre de Gerlache, *Gerlache et la fondation de la Belgique (1931).* (C. VE.)

GERLACHE DE GQMERY, ADRIEN VICTOR JOSEPH DE, BARON (1866–1934), Belgian naval officer and polar explorer who led the first truly scientific expedition to the antarctic, was born at Hasselt. Limburg, on Aug. 2, 1866. He made his antarctic voyage in the "Belgica" (1897–99). After making new discoveries north of Graham Land, De Gerlache navigated into the pack ice. The vessel was beset there for 13 months, and thus became the first ship to winter in the antarctic. Despite extreme hardships the expedition completed valuable scientific work.

In 1901 De Gerlache led an expedition in the "Sélika" to the Persian gulf to collect zoological specimens. In 1905, again in the "Belgica." he carried out important oceanographical work off the east coast of Greenland. He led similar expeditions to the Barents and Kara seas in 1907 and to the Barents and Greenland seas in 1909, traversing the latter from west to east along latitude 78°. In 1913–14 he assisted Sir Ernest Shackleton in the organization of the Imperial Transantarctic expedition (1914–17), selling to the latter his yacht "Polaris," which was rechristened "Endurance." De Gerlache was granted the title of baron by a royal decree of Nov. 9, 1924.

He died in Brussels on Dec. 4, 1934. (H. G. Kc.)

GERLE, CHRISTOPHE ANTOINE (1736–*c.* 1801), French revolutionist and mystic, was born at Riom in Auvergne. He entered the Carthusian order and became prior of Laval-Dieu in Perche and afterward of Pont-Sainte-Marie at Moulins. He was elected deputy to the states-general in 1789 and in 1792 was chosen elector of Paris. During the revolutionary turmoil he developed a strong vein of mysticism. mingled with ideas of reform. He served as co-president with Catherine Théot (*q.v.*) at her meetings. She: Gerle and others were arrested, but he was later released by the Directory. Gerle. who renounced his monastic vows in Paris, became one of the editors of the *Messager du soir* and later was in the office of Pierre Bénézech. minister of the interior.

GERMAIN, SOPHIE (1776–1831), French mathematician, made notable contributions to the study of acoustics. elasticity and the theory of numbers. Born in Paris, April 1. 1776. she took correspondence courses from the École Polytechnique which did not accept women in the school itself. Her most fruitful contribution was the demonstration of the impossibility of solving Fermat's Last Theorem if x, y, z are not divisible by an odd prime, n.

After Ernst Chladni had demonstrated his vibrating plates. she presented three memoirs on ihe theoretical explanation of the phenomenon. in 1811, 1813 and 1816. This last memoir was awarded a prize offered by the Institut de France on the suhjecc, even though the equation was not yet rigorously demonstrated. She later succeeded in establishing the equation for the normal vibrations of a plate.

She was a friend of the mathematicians J. L. Lagrange and Carl Gauss. with whom she corresponded under her pseudonym M. Le Blanc before revealing her identity. Sophie Germain was highly esteemed by the great Gauss. who recommended her for an honorary degree from the University of Gfttingen. She died in Paris, June 26, 1831, before the degree could be awarded.

GERMAN, SIR EDWARD (1862–1936), English composer of light operas who was a follower of Sir Arthur Sullivan. His real name was Edward German Jones. Born at Whitchurch, Shropshire, on Feb. 17, 1862, he studied at the Royal Academy of Music, London. where his operetta The Rival Poets was performed in 1886. Beginning his career as an orchestral violinist and conductor at the Globe theatre, London, he became known as a composer of graceful incidental music for plays, including Richard *III* (1889). Henry *VIII* (1892) and *Nell* Gwynn (1900). Sets of dances from his music for the tno last-named plays won wide popularity. In 1901 German completed the score of The Emerald Isle, left unfinished by Sullivan, and during the next few years he composed four light operas,: *Merrie* England (1902), *A* Princess of *Kensington* (1903), *Tom* Jones (1907) and Fallen Fairies, on a libretto by W. S Gilbert (1909). Among German's orchestral works are two symphonies, three suites. *Welsh Rhapsody, Theme and Six* Diversions and a symphonic poem, *Hamlet;* he also wrote a number of successful songs. His music has melodic charm and distinction, a high standard of craftsmanship and. in the light style that he cultivated, a marked national character. He was knighted in 1928. He died in London on Nov. 11, 1936.

See W. H. Scott, *Edward German, an Intimate Biography* (1932). (H. Ru.)

GERMAN BAPTIST BRETHREN: see BRETHREN, CHURCH OF THE.

GERMANDER, the name given to plants of the genus Teu*crium,* mint family (Labiatae). comprising about 100 species distributed all over the world, a few of which are grown for ornament or fragrance. The common North American forms (T. *canadense* and T. occidentale) and the common British species (T. scorodonia) are frequently known as wood sage. The plants are small, uith small flowers remarkable for the slight development of the upper lip. T. chamaedrys, wall germander, forms low tufts; T. *fruticans,* brush or tree germander, is an evergreen shrub.

The so-called germander speedwell, Veronica chamaedrys, belongs to the figwort family (Scrophulariaceae).

GERMANIC LANGUAGES are a group of related languages comprising the modern and earlier forms of English, Frisian, Netherlandish (Dutch, Flemish), German (High and Low), Icelandic, Norwegian, Danish, Swedish, and a number of extinct languages, notably Gothic. The earliest recorded Germanic consists of mere fragments: from the 3rd to the 1st century B.C., a single inscription in North-Etruscan letters on a helmet unearthed near Negau, southern Austria: harigasti teiwa "Harigasti (owner of the helmet?) Teiwa (name of a god)"; and, beginning in the 1st century B.C., isolated Germanic words and names recorded by classical authors (Caesar, Tacitus, Pliny and others). The earliest extensive Germanic text is the (fragmentary) Gothic Bible translated by the Visigothic bishop Ulfilas (c. A.D. 350), written in a 27-letter alphabet of his own invention. From c. 200 to 800 there are scattered early Norse inscriptions, written in the 24-letter runic alphabet, *e.g.,* the inscription on a golden horn found in Gallehus (now Møgeltønder), Denmark, dating from c. 400: ek *hlewagastiʀ holtijaʀ horna tawido* "I, Hlewagast of Holt [Holstein], made [this] horn." Derivatives of this runic alphabet were used sparingly in England, Germany and particularly in Scandinavia. All extensive later texts use adaptations of the Latin alphabet. Old English (Anglo-Saxon) texts date from the early 7th century; Old High German from the middle 8th; Old Low German (usually called Old Saxon) from the early 9th; Old Norse (Old Icelandic and Old Norwegian) from the middle 12th (though many poems preserve an older form of the language); Old Netherlandish (Old Dutch) from the late 12th; Old Frisian from the early 13th; Old Swedish and Old Danish from the end of the 13th. (The following abbreviations will be used: Gmc., Germanic; Got., Gothic; ON, Old Norse; OE, Old English; OF, Old Frisian; OS, Old Saxon: OHG. Old High German.) See GOTHS; RUNE.

Proto-Germanic. — The statement that the languages named are related is based on the technical linguistic usage: related languages are variant historical developments of a single earlier language. Thus the Romance languages (French, Spanish, Italian, etc.) are said to be related because they can be shown to be variant developments of a single earlier language, Latin, of which there are extensive written records. In the case of Germanic, no written records of the parent language exist; but much of its structure can be deduced by the comparative method of reconstruction. (A reconstructed language is called a proto-language; reconstructed forms are marked with an asterisk.) For example, a comparison of Runic *-gastiʀ*, Got. *gasts,* ON gestr, OE *giest,* OF *iest,* OS and OHG *gast* "guest" leads to the reconstruction of the Proto-Germanic (PGmc.) form **ḡástiz.* Similarly, a comparison of Runic horna, Got. *haurn,* ON, OE, OF, OS and OHG horn "horn" leads to the reconstruction of PGmc. **hórnan.*

Such reconstructions are in part merely formulas of relationships: the *ḡ* of **ḡástiz* is the particular phoneme of PGmc. which by regular phonetic change gave Got., ON, OS and OHG g-, but (before an a which had changed to e) OE gi- and OF i-. Likewise, the *o* of **hórnan* is the particular phoneme of PGmc. which, in this environment, gave au in Gothic, o in the other languages. In other environments, *e.g.,* when followed by nasal plus consonant, the same phoneme gave *u* in all the languages: PGmc. **dumbaz,* Got. dumbs, ON dumbr, OE, OF and OS dumb, OHG tumb "dumb." What may be deduced is that in some environments the phoneme sounded more like o, in others more like *u.* It may be written *u∼o,* indicating that it varied between these two pronunciations.

The example of PGmc. *u∼o* shows that the reconstructions are more than mere formulas: they also give some indication of how PGmc. actually sounded. Sometimes the correctness of these deductions is independently confirmed. For example, OE cyning and OS and OHG kuning "king" are the basis for the reconstruction of PGmc. **kúningaz;* this is confirmed by Finnish kuningas, which must have been borrowed from Gmc. at a very early date.

As reconstructed, PGmc. had the following system of vowels and consonants:

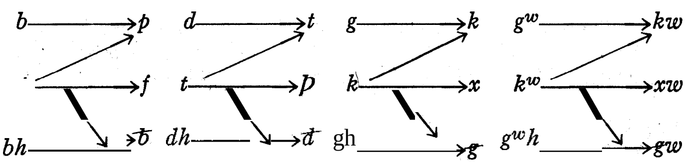
		ī			*p*		*b∼ƀ*				
i∼e	*u∼o*	ē		*ō*	*iu∼eu*	*t*	f	*d∼đ*	*s*	*z*	*m*	*n*
					ai au		*þ*					
	a		*ǣ*			k	*h∼x*	*g∼ḡ*	*w*	*j*	*l*	*r*

The *þ* represents the *th* of *thin, x* the *ch* of German *ach, j* the y of *yes.* To the above should perhaps be added long nasalized *į̄ ą̄ ų̄,* which resulted when inx anx unx changed to *į̄x ą̄x ų̄x.* The phonemes noted as *b∼ƀ, d∼đ, g∼ḡ* were the stops b d *g* in some environments, the spirants *ƀ đ ḡ* in others. (This type of alternation is not unusual; it occurs, for example, in modern Spanish.) The distribution seems to have been: all were stops'after nasal (mb nd ng) and when doubled (bb dd gg); *d∼đ* was also a stop initially and after l (d- ld); *b∼ƀ* was also a stop initially (b-); in other environments all three were spirants. The phoneme noted as h—x seems to have been h initially (h-), but *x* elsewhere.

Development. — By pushing the comparative method still farther back, relationships can be established between Germanic and other language groups, notably Celtic, Italic, Greek, Baltic, Slavonic, Iranian and Indic. All of these can be derived from a still earlier parent language, Proto-Indo-European (PIE).

A comparison of PGmc. with the PIE from which it developed reveals the many changes that occurred.

Consonants. — PIE had the spirant *s,* a few obscure consonants called "laryngeal," and at least the following stops (perhaps more): *p* t k k^w, b d g g^w, bh dh gh g^wh. By a change known as the Gmc. consonant shift (Grimm's law), the stops developed as follows:



Examples of b d g are: Lithuanian bald and Latin decem and genus but p t k in English pool, ten and kin. Examples of bh dh gh are: Sanskrit *bhū-*, dhd-, hd- (from **ghē-*) but b d g in English be, do, go. As for *p* t k, in the clusters *sp* st sk *pt* kt they gave PGmc. *sp* st sk f t xt: Greek *spáthē, stásis, skiá, skāpton* and *oktṓ* and also English spade, stead, shine (OE *scīnan*), shaft (OE *sceaft*) and eight (OE eahta). (By a special development, tt gave ss: Sanskrit sattci-, OE sess "seat".) Elsewhere, *p* t and k seem to have first become the voiceless spirants f *þ* and x. They remained so initially and after an accented vowel: Latin *piscis, tenuis* and *centum* but *f* th h in English fish, thin, and *hund(red)*; but, by a change known as Verner's law, after an unaccented syllable all voiceless spirants became voiced. Thereby f *þ* x coalesced with the new *ƀ đ ǥ* and *s* became *z:* Sanskrit *upári, mātár-, švašrū́-* (from **suekrū́-*) and *šašá-* (from **kasó-*) but OE *ofer* (from **oƀar,* cf. OHG *obar*) "over," *mōdor* "mother," *sweger* "mother-in-law" and *hara* (from **haza-*) "hare." PIE g^w k^w g^wh developed parallel to g *k gh;* but whereas they were separate phonemes in PIE (contrasting with the clusters *gu̯ ku̯ ghu̯*), in Gmc. they coalesced with these clusters and gave *kw xw gw*.

These changes gave the 11 stop and spirant phonemes assumed for PGmc. Reconstructions from the individual Gmc. languages then indicate that some of these began to undergo further changes: *ƀ đ ǥ* changed from spirants to stops in certain positions; and *x* changed to h initially.

Vowels.—Besides the above obstruents (stops and spirants), PIE had two other classes of phonemes: vowels and resonants. The vowel of any given root was not necessarily fixed, but varied in an alternation termed ablaut. Thus the root "sit" was alternately **sed-, *sod-, *sd-, *sēd-,* or **sōd-* (Eng. "sit" is from **sed-,* "sat" from **sod-,* "seat" from **sēd-*); and the root "do" was **dhē-, *dhō-,* or **dhə-* (Eng. "deed" is from **dhē-,* "do" from **dhō-*). Other vowels were a, *ā, ī, ū*. The PIE resonants were *i∼i̯, u∼u̯, m̥∼m, n̥∼n, l̥∼l, r̥∼r*. They were syllabic in some environments, nonsyllabic in others. Thus **bhr̥tó-* (Sanskrit *bhr̥tá-* "borne") had syllabic *r̥*, but **bhéreti* (Sanskrit *bhárati* "he bears") had nonsyllabic r. (Eng. "bear" is from **bher-,* "barrow" from **bhor-,* "burden" from **bhr̥-,* "bier" from **bhēr-.*)

This PIE system of vowels vs. resonants was reshaped by a number of changes. Syllabic *i u m̥ n̥* l *r̥* gave the vowels i u and the sequences *um un ul* ur; nonsyllabic *m* n *l* r gave the consonants m *n l r;* nonsyllabic *i̯ u̯* before vowels gave the consonants j w, though after vowels they continued to form diphthongs (*ei ai oi, eu au ou*). The resulting vowels and diphthongs then developed as follows:

i e a a o *u* e ē ō *ū* *ai oi* *eu* au *ou*

i∼e *a* *o∼u* *ī* *ē* *ǣ* *ō* *ū* *ai* *iu∼eo* *au*

These changes gave the PGmc. system of three short vowels (counting *i∼e, u∼o* as one each), five long vowels, and three diphthongs (counting *iu∼eo* as one). The variants *e, o, eo* occurred before a low vowel in the following syllable; the variants *i, u,* iu occurred before a high vowel (or j, *w*) in the following syllable, or before nasal plus consonant. Compare the following: PGmc. **béranan,* OE *beran* "to bear," but **biriþi,* OE *bir(e)þ,* "beareth"; PGmc. **gólþan,* OE *gold* "gold," but **gúlþjanan,* OE gyldan "to gild"; PGmc. **leoxtan,* OE *lēoht* "light," but **liuxtjanan,* OE liehtan "to give light."

Accent.—The PIE pitch accent which could fall on any syllable of a word was replaced in PGmc. by a stress accent on the first syllable. This seems to have led to a progressive reduction of unstressed syllables, *e.g.,* PIE **sodéi̯onom,* PGmc. **sátjanan,* OE *settan,* Middle Eng. *sette(n)*, modern "set." Strong initial stress is also reflected in the basic unit of old Gmc. poetry: two half lines, each with one of a small number of stress patterns, linked by the alliteration of stressed initial consonants or vowels (*e.g.,* Beowulf, li. 18: *Bḗo-wùlf* was *brḗme / blǽd wíde* spring "Beowulf was famous, his renown went far").

Declensions.—PGmc. kept the PIE system of three genders (masc., neut., fem.) and three numbers (sing., dual, plur.), though the dual was obsolescent. It reduced the PIE system of eight cases to six: nominative, accusative, dative, genitive, instrumental, vocative (though the last two were obsolescent). In the adjective declensions it made two innovations: (1) To the PIE vocalic types (*o-,* ō-, *i-,* u-stems) it added some pronominal endings to give the Gmc. "strong" adjective declension. (2) The PIE n-stem endings were extended to all adjectives to give the Gmc. "weak" adjective declension (*e.g.,* mod. German, strong: gutes Bier "good beer," but weak: das gute Bier "the good beer").

Conjugations.—The PIE verb seems to have had five moods (indicative, imperative, subjunctive, injunctive and optative), two voices (active, mediopassive), three persons (first, second, third), three numbers (sing., dual, plur.) and several infinitives and participles. In Gmc. these were reduced to: indicative, imperative, subjunctive-optative (usually called subjunctive, but containing the functions of both and actually derived from the PIE optative); a full active voice, plus an obsolescent passive (found only in Gothic); three persons: full singular and plural forms, plus an obsolescent dual (found only in Gothic); and one infinitive (present) and two participles (present and past). The PIE tense-aspect system (present, imperfect, aorist, perfect) was reshaped to a single tense contrast: present *v.* past. The past showed two innovations. On the one hand, in the "strong" verb, PGmc. transformed the ablaut of PIE into a specific tense marker, *e.g.,* PIE *bher-, bhor-, bhēr-, bhr-* in OE *beran* "bear," past singular *bær,* past plural *bǣron,* past participle boren. On the other hand, in the "weak" verb, it formed a completely new past and past participle, *e.g.,* OE *fyllan* "fill," past *fylde,* participle *gefylled.* Weak verbs fell into three classes depending on the syllable preceding the endings, *e.g.,* OHG full-e-n (from *full-*ja-n*) "fill," mahh-ō-n "make," sag-ē-n "say." Gothic also had a fourth type: *full-nō-da* "it became full."

Many PGmc. strong verbs showed a consonant alternation ("grammatical change") between *f/ƀ, þ/đ, x/ǥ, s/z*. This was the result, through Verner's law, of the alternating position of the PIE accent:

PIE **prḗu̯sonom*	PGmc. **fréosanan*	OE *frēosan* "to freeze"
**próu̯re*	**fráus*	*frēas* "(it) froze"
**prusń̥t*	**frúzunþ*	*fruron* "(they) froze"
**prusénos*	**frózenaz*	*froren* "frozen"?

In this particular word, English has generalized the *s* (now *z*): *freeze, froze, frozen;* German has generalized the z (now *r*) *frieren,* fror, gefroren; Dutch still shows the alternation: vriezen, vroor, *gevroren*. English has preserved grammatical change only in was, were and in a few isolated forms such as sodden, *(for)lorn,* the old past participles of seethe, lose.

Germanic Dialects.—Archaeological evidence suggests a relatively uniform Germanic people c. 750 B.C., located in southern Scandinavia and along the North sea and Baltic coasts from Holland to the Vistula. By c. 250 B.C., they had spread farther south and five general groups were distinguishable: (1) along the North sea coast and in Jutland; (2) along the middle Rhine and Weser; (3) along the middle Elbe; (4) along the Oder and Vistula; and (5) in Scandinavia (excluding Jutland).

Another 500 years later (A.D. 250) the division was much the same, though the Elbe group had spread southward to the Danube and the Oder-Vistula group southeast into the Carpathians and beyond.

Then came the great tribal migrations: part of the Korth sea group (Bede identifies them as Angles, Saxons and Jutes) conquered much of England; the Rhine-Weser group (Franks) conquered northern France; the Elbe group (Alemannians, Bavarians, Lombards) vacated the north and spread south; the Oder-Vistula group (Goths, Burgundians, Vandals) left to begin their many wanderings.

This five-way division of the Germanic peoples is based on nonlinguistic evidence; but it agrees well with the linguistic picture derived by the comparative method from earliest texts. Five groups were indeed distinguishable, though they were linked in sets of two, three or four through common linguistic innovations. Thus the East Gmc. group (Oder-Vistula) shared innovations with the North Gmc. group (Scandinavian): there PGmc. jj, *ww* (e g., **twajj-, *treww-,* cf. OHG zweiio "of two," *triuwi* "faithful") developed to long stop plus semivowel (cf. ON tueggia, tryggr, Got. *twaddjē, triggws*). On the other hand, North Gmc. and the three West Gmc. groups (North sea, Rhine-Weser, Elbe) shared certain later innovations: coalescence of *z* with *r* (Got. *maiza* "more," but OK *meire,* OE. OF *mára,* OS *mêro,* OHG *mēro*) and the loss of the reduplicative past of certain strong verbs (Got. *lailōt* "let," but ON, OE, OF, OS *lēt,* OHG *liaz*). The West Gmc. groups also showed innovations of their own: replacement of the *d*~*đ* alternation by simple *d* (PGmc. **blṓđan* "blood," Got., ON *blōþ,* but OE. OF. OS *blōd,* OHG *bluot*); the loss of final *-z* after unstressed vowels (PGmc. **dágaz* "day," Got. *dags,* ON *dagr,* but OE *dæg,* OF *dei,* OS *dag,* OHG *tag);* and the doubling of consonants in certain positions. especially before j (Got. *satjan* "set:" ON *setia,* but OE *settan,* OF *setta,* OS *settian,* OHG *setzen;* though ON also showed the doubling of *g* and k: Got. *lagjan* "lay," but ON *leggia,* OE *lecgan,* OF *ledza,* OS *leggian,* OHG *leggen).* Within West Gmc.. the North sea group showed innovations of its own: a single ending in the plural of verbs (where the others have one for each of the three persons); loss of the reflexive pronoun; loss of *-z* in certain pronoun forms (PGmc. **wīz* "we," Got. *weis,* ON *vēr,* OHG *wir,* but OE *wē,* OF, OS wi). The North sea group also shared some innovations with Korth Gmc.: loss of nasals before spirants (Got. *fimf, munþs, uns,* OHG *fimf, mund, uns* "five!" "mouth," "us.!' but OE. OF. OS *fif,mūþ* or *mūth, ūs;* in ON. only before *f* and *s: fifl* from **fimfill* "giant," *6s* "us") and i-umlaut, *i.e.,* the raising or fronting of stressed vowels before unstressed *j, i,* i (*cf.* the words "sit" and "lay" above; umlaut was just spreading into OHG at the time of the earliest texts). Within the North sea group, OE and OF showed still further innovations of their own: raising of *a* to *æ* and *e* (*dæg, dei* above) and palatalization of gg before *j* (*lecgan, ledza* above). Finally, to complete the circle, the Elbe group (from which came southern OHG) shared a few innovations with North and East Gmc.: the spread of the nominative and accusative singular neuter pronoun ending **-at(a)* to strong adjectives (OE. OF *hāl* "whole," OS *hêl,* but Got. *hailata,* ON *heilt,* OHG *heilaz*); and it shared certain forms with East Gmc. (PGmc. **iz* "he" in Got. *is,* OHG *ir, er,* but **h-* forms in ON *hann,* OE, OF, OS *he).* *See* also under the names of individual languages.

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GERMANIC LAWS, EARLY. After the foundation of the greatest kingdoms of the Teutonic tribes on the soil of Roman civilization. the necessity for a written codification of the inherited tribal laws arose. This necessity evidently arose out of permanent intercourse with a native population which had been living under different laws. Thus the Visigoths: Burgundians and Salic Franks had already. at the turn of the jth and 6th centuries, codified their law. One and a half centuries later the Lombards did the same. The Teutonic tribes. living in the interior. owe their codification to the influence of the Frankish suzerainty; the Ripuarians, Alemans and Bavarians to the Merovingians; the Chamavic Franks. Saxonians. Thuringians and Frisians to Charlemagne. For the edict of Theodoric I *see* Roman Law.

The leges germanorum are codifications of the valid criminal law and the law of procedure, hut do not offer an exhaustive regulation of these and are not, on the other hand. solely confined to them. In substance they consist partly of already existing customary law and also partly of new statutory laws. Whether it is possible to distinguish among such varied forms: contained within a lex. the different strata of text is a question not definitely settled. It was thought. but has not as yet been proved. from the tradition of the Salic law that it was originally composed of primitive tariffs of composition. to which. later. constitutions were added with the intention of creating a new law. Moreover such constitutions (capitularia) are preserved to us partly as amendments (novellae) to older leges and partly as special laws. The capitularies of Charlemagne and of his son Louis were of particular importance in the development of the law. All *leges* and *capitularia* are in Latin, but in most cases there is also an admixture of Germanic legal terminology. We possess fragments of the Lex Salica and of the Carolingian capitulary in an old High-German translation.

For the whole body of the Germanic laws *see* P. Canciani, *Barbarorum leges antiquae* (Venice, 1781–1789); F. Walter, *Corpus juris germanici antiqui* (Berlin. 1824); *Monumenta Germaniae historica, Leges.* For further information on the codes in general *see* J. E. O. Stobbe. *Geschichte der deutschen Rechtsquellen* (Brunswick, 1860–1864); Paul Viollet. *Histoire du droit civil français,* 2nd ed. (Paris. 1893); H. Brunner, *Deutsche Rechtsgeschichte,* 2nd ed. (Leipzig, 1906); Brunner-Heymann, *Grundzüge der deutschen Rechtsgeschichte,* 7th ed. (Leipzig, 1925).

Leges **Visigothorum.**—It is now certain that the earliest written code of the Visigoths dates back to King Euric (466–485). Of this code. fragments of chapters cclxxvi to cccxxxvi have been discovered in a palimpsest manuscript in the Bibliotheque Nationale at Paris (Latin coll., no. 12161). The *lacunae* in these fragments have been filled in by aid of the law of the Bavarians, where the chief provisions are reproduced. Euric's code was used for all cases between Goths. and between them and Romans; in cases between Romans. Roman law was used.

Euric's code remained in force among the Visigoths of Spain until the reign of Leovigild (568–586), who made a new one, improving upon that of his predecessor. This work is lost, and we have no direct knowledge of any fragment of it. In the 3rd codification: however. many provisions have been taken from the 2nd. and these are designated by the word "antiqua"; by means of these "antiqua" we can reconstruct the work of Leovigild.

After the reign of Leovigild the legislation of the Visigoths underwent a transformation. The new laws made by the kings were declared to be applicable to all the subjects in the kingdom, of whatever race—in other words, they became territorial, and this principle of territoriality was gradually extended to the ancient code. Moreover. the conversion of Reccared I (586–601) to orthodoxy effaced the religious differences among his subjects, and all subjects, *qua* Christians. had to submit to the canons of the councils. which were made obligatory by the kings. After this change had been accepted. Recessvind (649–672) made a new code. which was applicable to Visigoths and Romans alike. This code. known as the *Liber judiciorum,* comprises 324 constitutions taken from Leovigild's collection. a few of the laws of Reccared and Sisebut, 99 laws of Chindasvind (642–653), and 87 of Recessvind. A recension of this code of Recessvind was made in 681 by King Ervig (680–687) and is known as the *Lex Visigothorum renovata;* and finally some additamenta were made by Egica (687–702). The texts of the *Leges Visigothorum* have been published by K. Zeumer in the 40 series of the *Mon. Germ. hist.* *Cf.* Zeumer's articles in the *Neues Archiv.,* vol. xxiii, xxiv and xxvi; H. Brunner. *Deutsche Rechtsgeschichte,* 2nd ed. (Leipzig, 1906); Ureña y Smenjaud. *La Legislacion Gotico-hispana* (Madrid, 1905); E. de Hinojosa, *Das germanische Element im spanischen Rechte* vol. 31 (*Zeitschrift der Savigny-Stiftung*).

Lex **Burgundionum.**—This code was compiled by King Gundobad (474–516). very probably after his defeat by Clovis in 500. Some additamenta were subsequently introduced either by Gundobad himself or by his son Sigismund. This law bears the title of *Liber Constitutionum,* which shows that it emanated from the king: it is also known as the *Lex Gundobada* or *Lex Gonzbata.* It was used for cases between Burgundians. but was also applicable to cases between Burgundians and Romans. The law of the Burgundians shows strong traces of Roman influence. It recognizes the will and attaches great importance to written deeds. but, on the other hand. sanctions the judicial duel and the *cojuratores* (sworn witnesses]. The vehement protest made in the 9th century by Agobard. bishop of Lyons, against the *Lex Gundobada* shows that it was still in use at that period. As late as the 10th and even the 11th centuries we find the law of the Burgundians invoked as personal law in Cluny charters, but doubtless these passages refer to accretions of local customs rather than to actual paragraphs of the ancient code.

The text of the *Lex Burgundionum* was published by F. Bluhme in the *Mon. Germ. hist., Leges,* iii, 525; by Karl Binding in the *Fontes rerum Bernensium,* vol. i (1880); by J. E. Valentin Smith (Paris, 1889 *seq.)*; and by von Salis (1892) in the quarto series of the *Mon. Germ. hist.,* cf. R. Dareste. "La Loi Gombette." in the *Journal des Savants* (July 1891); K. Zeumer in the *Neues Archiv.,* vol. xxv; Petot, "Un nouveau manuscr. de la loi Gombette." *Nouv. Rev. hist. de Droit* (1913).

Leges **Langobardorum.**—We possess a fair amount of information on the origin of the laws of the Lombards. The first part, consisting of 388 chapters, is known as the *Edictus Langobardorum,* and was promulgated by King Rothari at a diet held at Pavia on the 22nd of November, 643. This work, composed at one time and arranged on a systematic plan, is very remarkable. The compilers knew Roman law, but drew upon it only for their method of presentation and for their terminology; and the document presents Germanic law in its purity. Rothari's edict was augmented by his successors; Grimoald (668) added nine chapters; Liutprand (713–735), 15 vol., containing a great number of ecclesiastical enactments; Ratchis (746), eight chapters; and Aistulf (755), 13 ch. After the union of the Lombards to the Frankish kingdom, the capitularies made for the entire kingdom were applied to Italy. There were also special capitularies for Italy, called *Capitula Italica,* some of which were appended to the edict of Rothari.

At an early date compilations were formed in Italy for the use of legal practitioners and jurists. Eberhard, duke and margrave of Rhaetia and Friuli, arranged the contents of the edict with its successive additamenta into a *Concordia de singulis causis* (829–832). In the 10th century a collection was made of the capitularies in use in Italy, and this was known as the *Capitulare Langobardorum.* Then appeared, under the influence of the school of law at Pavia, the *Liber legis Langobardorum* also called *Liber Papiensis* (beginning of 11th century) and the *Lombarda* (end of 11th century) in two forms—that given in a Monte Cassino ms. and known as the *Lombarda Casinensis,* and the *Lombarda Vulgata.*

There are editions of the *Edictus,* the *Concordia,* and the *Liber Papiensis* by F. Bluhme and A. Boritius in the *Mon. Germ, hist., Leges,* iv. Bluhme also gives the rubrics of the *Lonzbarda,* which were published by F. Lindenberg in his *Codex. legum antiquarum* in 1613. For further information on the laws of the Lombards *see* J. Merkel, *Geschichte des Langobardenrechts* (1850); A. Boritius, *Die Kapitularien im Langobardenreich* (1864); Schupfer, *Manuale di storia del diritto italiano,* 2nd ed. (1895); Solmi. *Diritto longobardo e diritto nordico* (1898); C. Kjer, *Edictus Rotari* (Copenhagen, 1898), C. Kjer, *Dansk og langbardisk Arveret* (1901); J. Ficker, *Das langobardische und die skandinavischen Rechte* (Mitteilungen des Instituts fiir oesterreichische Geschichtsforschung, vol. xxii); Cf. R. Dareste, in the *Nouvelle Revue historique de droit français et étranger,* p. 143 (1900).

Pactus Alamannorum and Lex **Alamannorum.**—Of the laws of the Xlamanni we possess two different texts. 'The earlier text, of which five short fragments have come down to us, is known as the *Pactus Alamannorum,* and from the persistent recurrence of the expression "et sic convenit" was most probably drawn up by an official commission. The reference to affranchisement *in ecclesia* shows that it was composed at a period subsequent to the conversion of the Xlamanni to Christianity. There is no doubt that the text dates back to the 7th century. The later text, known as the *Lex Alamannorum,* dates from a period when Alamannia recognized the theoretical suzerainty of the Frankish kings but was ruled by national dukes and may be placed between the years 717 and 719.

The two texts have been published by J. Merkel in the *Mon. Germ. hist.,* Leges, iii, and by Karl Lehmann in the quarto series of the same collection. Cf. Heinrich Brunner. "Über das Alter der Lex Alamannorum" *(Berliner Sitzungsberichte,* 188j); Karl Lehmann. in the *Neues Archiv.,* vol. x; Bruno Krusch. *Die Lex Bajuvariorum,* mit zwei Anhangen: *Lex Alamannorum* und *Lex Ribuaria* (1924); Franz Beyerle, in the *Savigny-Zeitschrift fiir Rechtsgeschichte,* vol. xxxv; Bruno Krusch. Neue Forschungen uber die drei oberdeutschen Leges: *Bajuvariorum, Alamannorum* und *Ribuariorum* (1927).

Lex **Baiuvariorum.**—The law of the Bavarians has, in some parts, been taken directly from the Visigothic law of Euric and from the *Lex Alamannorum* and the *Lex Salica.* The Bavarian law. therefore. is later than that of the Alamanni. It dates. probably. from a period when the Frankish authority was very strong in Bavaria when the dukes were vassals of the Frankish kings. The date of compilation may be placed between 740 and 748.

The text of the *Lex Baiuvariorum* has been published by J. Merkel in the *Mon. Germ. hist., Leges,* iii, 183; by E. von Schwind (1927) in the quarto series of the same collection, and by Konrad Beyerle (München, 1926). Cf. von Schwind's articles in the *Neues Archiv.,* vol. xxxi, xxxiii and xxxvii; H. Brunner, Über ein verschollenes merowingisches Konigsgesetz des 7 Jahrhunderts, *Berliner Sitzungsberichte* (1901); V. Kralik, "Die deutschen Bestandteile der *Lex Baiuwariorum," Neues Archiv.,* vol. xxxvii; Bruno Krusch. *Die* Lex Bajuvariorum, *Textgcschichte, Handschriftenkritik und Entstehung* (1924); Franz Beyerle, in the *Savigny-Zeitschrift fiir Rechtsgeschichte,* vol. xlv. Ernst Heymann. "Zur Textkritik der *Lex Bajuwariorum," Kehr-Festschrift* (1925); Bruno Krusch, *Neue Forschungen uber die drei oberdeutschen Leges* (1927); Karl August Eckhardt, *Die* Lex Baiuvariorum, *eine textkritische Studie* (1927).

Lex Saxonurn. — The *Lex Saxonum* has survived in two manuscripts and two old editions (those of B. J. Herold and du Tillet). The law contains ancient customary enactments of Saxony, and, in the form in which it has reached us. .is later than the conquest of Saxony by Charlemagne. It is preceded by two capitularies of Charlemagne for Saxony—the *Capitulatio de partibus Saxoniae,* which dates undoubtedly from 782, and is characterized by great severity, death being the penalty for every offense against the Christian religion; and the *Capitulare Saxonicum,* of the 28th of October. 797, in which Charlemagne shows less brutality and pronounces simple compositions for misdeeds which formerly entailed death. The *Lex Saxonicum* apparently dates from 802, since it contains provisions which are in the *Capitulare legi Ribuariae additum* of that year. The law established the ancient customs, at the same time eliminating anything that was contrary to the spirit of Christianity; it proclaimed the peace of the churches. whose possessions it guaranteed and whose right of asylum it recognized. There is an edition of the *leges Saxonum* by Karl von Richthofen in the *Mon. Germ. hist., Leges,* and another by Cl. von Schwerin in the octavo series of the same collection (1918). Cf. von Schwerin, in the *Savigny-Zeitschrift fur Rechtsgeschichte,* vol. xxxiii; Martin Lintzel, in the *Sacigny-Zeitschrift fiir Rechtsgeschichte,* vol. xlvii.

Lex **Thuringorum.**—A collection of laws has come down to us, in one ms. and one old edition, bearing, in the ms., the name *Lex Thuringorum* and in the edition the name *Lex Angliorum et Werinorum, hoc est Thuringorum.* In early times there dwelt, south of the river Unstrut, the Angli, who gave their name to the *pagus Engilin* or *Englide,* and to the east, between the Saale and the Elster. the *Warni* (*Werini* or *Varini*) whose name is seen in *Werinofeld.* Cf. Hoops, *Reallexikon,* 1, 86, iv. 483. This text is a collection of local customs arranged in the same order as the law of the Ripuarians. Parts of it are based on the *Capitulare legi Ribuariae additum* of 803, and it seems to have been drawn up in the same conditions and circumstances as the law of the Saxons.

There is an edition of this code by Karl von Richthofen in the *Mon. Germ. hist., Leges,* v. 103, and another by Cl. von Schwerin in the octavo series of the same collection (1918).

Lex **Frisionum.**—This consists of a medley of documents of the most heterogeneous character. Some of its enactments are apparently pagan. Thus one paragraph allows the mother to kill her newborn child, and another prescribes the immolation to the gods of the defiler of their temple; others are purely Christian such as those which prohibit incestuous marriages and working on Sunday. The law abounds in contradictions and repetitions and the compositions are calculated in different moneys. From this it would appear that the documents were merely materials collected from various sources and possibly with a view to the compilation of a homogeneous law. These materials were apparently brought together at the beginning of the 9th century, at a time of intense legislative activity at the court of Charlemagne.

There are no manuscripts of the document extant; knowledge of it is based upon B. J. Herold's edition (*Originum ac Germanicarum antiquitaturn libri,* Basel, 1557), which has been reproduced by Karl von Richthofen in the *Mon. Germ. hist., Leges,* iii, 631 and by De Geer (1866). Cf. Patteta, *La Lex Frisionum* (1592); Hugo Jaekel, in the *Neues Archiv.,* vol. xxxii; Siegfried Rietschel, *Das Volksrecht der Friesen* (1911); Philipp Heck, *Die Entstehung der Lex Frisionum* (1927). (C. Pf.; K. A. Eck.)

GERMANICUS CAESAR (15 B.C.–A.D. 19) inherited his name Germanicus from his father Nero Claudius Drusus, brother of Tiberius and favourite stepson of Augustus. He was also great-nephew to Augustus, for his mother was the younger Antonia, daughter of Octavia and Marcus Antonius. When, therefore, Augustus adopted Tiberius in A.D. 4 he required him to adopt Germanicus, although Tiberius had a son of his own; and about the same time Germanicus married Augustus' granddaughter, Agrippina. Quaestor at the age of 20, he then served under Tiberius in Illyricum and won triumphal insignia. In A.D. 11 he accompanied Tiberius in his campaign on the Rhine. In 12 he was consul and was appointed to command Gaul and the two German armies. After Augustus' death (14), when Germanicus was superintending a Gallic census at Lugdunum (Lyons), a mutiny broke out among his legions on the lower Rhine. Germanicus quelled this with difficulty, partly by concessions, for which the authority of Tiberius was forged, but chiefly because of his personal popularity. He was apparently pressed to claim the empire for himself, and on one view this was the main purpose of the rising. In order to calm the excitement he determined at once on an active campaign. Crossing the Rhine, he attacked and routed the Marsi and ravaged the valley of the Ems. Next year he marched against Arminius, the conqueror of Varus, and performed the last rites over the remains of the Roman soldiers who lay unburied in the Teutoburg forest; but Arminius, favoured by marshy ground, was able to hold his own, and two Roman columns narrowly escaped disaster in their retreat. In 16 Germanicus tried again. A combined movement by land and water enabled him to concentrate his forces against the main body of the Germans encamped on the Weser, but his tactical victory still brought no end to the war. He was now recalled by Tiberius, who claimed that the Germans could be better managed by diplomacy than by arms, and who had work for his adoptive son in the east.

On May 26, 17, Germanicus celebrated a triumph, and became consul for the second time the following year. But before the office began he received supreme command over all eastern provinces and proceeded by easy stages to his duties, visiting Actium, Athens, Ilium and other places of historic interest. Meanwhile Tiberius had appointed Gnaeus Calpurnius Piso, a senior consular and a violent member of the old nobility, to govern Syria, and throughout Germanicus' tour Piso criticized, frustrated and even reversed his decisions. Nevertheless Germanicus settled the Armenian succession, organized Cappadocia and Commagene as provinces and negotiated successfully with Parthia and other eastern states.

Early the next year (19) he paid a somewhat theatrical visit to Egypt and incurred strong censure from Tiberius; for Augustus had forbidden Romans of rank to enter Egypt without permission. On his return to Syria the differences with Piso became intolerable and Piso now left the province, perhaps under his superior's orders. But shortly afterward Germanicus died at Antioch, convinced that Piso, through his wife Plancina, had poisoned him. He was hurriedly cremated, his ashes being deposited in Augustus' mausoleum. His death plunged Rome and the empire in gloom. and lavish honours were paid to his memory. The poisoning was not substantiated. Piso's suicide during his trial was caused by his fear of Tiberius on other charges. But Tiberius never emerged from suspicion. if not of instigating Germanicus' murder. at least of prompting the enmity which seemed to have issued in tragedy.

Germanicus and Agrippina had nine children, six of whom, three sons and three daughters, survived him, among them the emperor Gaius (Caligula) and Agrippina, mother of Nero.

The character and achievements of Germanicus are a notable enigma, mainly because Tacitus cast him as the hero to play against his villain Tiberius. It is not known whether there were serious differences between him and his uncle on German policy, on the treatment of the Greek-speaking provinces and cities or on the fundamental issues of the Roman constitution; whether Tiberius actually feared him as a rival to his power; and whether his visit to Egypt was prompted by thoughtlessness or by sinister motives. He is credited with a desire to restore the republic and has also been compared with Alexander, a combination hardly likely in a man of full political maturity. Yet, although his handling of the German mutiny lacked firmness, his other actions, even his German campaigns, were not marked by any proved incompetence; and it is hard to doubt his contemporary popularity. He had literary and oratorical abilities, and probably great personal charm.

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(G. E. F. C.)

GERMANIUM. This chemical element notable for its remarkable electrical properties, is a silvery gray, metallic-appearing solid but is generally regarded as a metalloid with properties somewhere between a true metal and a nonmetal. It is in the fourth group of the periodic table (see Periodic Law) between silicon and tin. Its symbol is Ge, atomic number 32, atomic weight 72.60. It has nine isotopes with masses from 69 to 77.

In 1871, D. I. Mendeléyev predicted the existence and properties of an hypothetical element between silicon and tin which he called eka-silicon. In 1886, C. Winkler, in analyzing the sulfide mineral argyrodite, found a previously unknown constituent which he succeeded in isolating and to which he gave the name germanium after his native country. Further investigation definitely fixed the position of germanium in the periodic table between silicon and tin, confirming Medeléyev's predictions.

Even though germanium had been known for many years?it attained importance only after 1945 when it may be said to have initiated a revolution in electronics. This application is based upon the fact that being a metalloid it belongs to a class of materials known as semiconductors, *i.e.,* with electrical conductivity midway between a metal and a nonmetal. This permits the use of germanium devices as replacements for many applications of vacuum tubes, rectifiers, etc. See *Uses* below.

Source and Preparation.— Germanium is a rare element, its occurrence in the earth's crust being estimated at about 0.0004% to 0.0007%. This exceeds the content of such elements as beryllium, boron, arsenic, silver, gold, platinum and uranium but is considerably lower than that of elements such as lead, zinc and tin. The problem of recovery is complicated by the fact that there is very little natural concentration such as occurs with the other elements mentioned.

Germanium is never found in the free state. It is a constituent of the following uncommon minerals: argyrodite (Ag_8GeS_6—6% to 7% germanium); germanite (7 CuS.FeS.GeS_2—8.7% germanium); and renierite. The last two minerals have been found in southwest Africa and the Belgian Congo. The two chief sources are the zinc sulfide concentrates of the zinc–lead mining district of Missouri. Kansas and Oklahoma. which contain about 60% zinc and 0.010% to 0.015% germanium, and copper-zinc concentrates derived from certain African mining operations. A low-grade germanium concentrate results as a by-product of metallurgical steps directed toward the production of zinc metal. This is treated with strong hydrochloric acid and the resulting germanium tetrachloride is distilled off. This crude chloride is purified by successive distillations. The highly pure product is hydrolyzed in water to form germanium dioxide, which is then reduced to powdered metal by hydrogen at a temperature of about 650° C. The powdered metal is melted into ingots or billets in an inert atmosphere at about 1,100° C.

Germanium also occurs in minute amounts in bituminous coals from many parts of the world, including the United States. Under proper conditions of combustion germanium will concentrate in flue dusts, from which it can be extracted. However, so far as is known, only in England and Japan has this source of germanium been exploited. The process is rather complicated, but eventually a step is reached wherein a crude germanium tetrachloride is distilled off and purified much the same as described above.

The germanium ingots or billets produced as above require further purification for electronic purposes. The usual method for accomplishing this is "zone refining" and consists of passing the billet of germanium through successive heat zones. Only a very small segment of the germanium billet is melted at any one time and as it recrystallizes the impurities are swept to one end of the billet. The final step is to melt the germanium and draw a single crystal of the metal by using a seed crystal as a nucleus and carefully controlling the temperature.

Properties. — Germanium has valences of both two and four but compounds of the latter valency are more stable and more numerous. The metal is quite stable at atmospheric temperature. At 600° to 700° C. oxidation in air or oxygen proceeds. Germanium reacts readily with the halogens to form corresponding tetrahalides. Of the common acids, only nitric acid and aqua regia will attack germanium appreciably. Caustic solutions have little or no effect on germanium, but it will quickly dissolve in molten sodium or potassium hydroxide, forming the germanates.

Some Physical Properties of Germanium

Crystal structure	Octahedral
Ductility	Frangible
Hardness, Mohs' scale	6.25
Index of refraction	4,068–4.143
Density at 25° C. (g. per c.c.)	5.35
Melting point ° C.	958.5
Specific heat at 25° C. (cal. per g.)	0.086
Volume resistivity at 25° C. (microhmcentimetre)	60×10^6

Compounds. — The two most important compounds are the dioxide and the tetrachloride, both intermediate products in the processing of raw materials to metal. The dioxide is a white crystalline material while the tetrachloride is a volatile colourless liquid boiling at 84° C. Tests indicate that neither germanium nor germanium dioxide are toxic, though the tetrachloride causes irritation when inhaled, undoubtedly because of hydrolysis which frees hydrochloric acid.

Germanium may be determined analytically by first distilling off as the tetrachloride, precipitating as the sulfide in acid solution, followed by conversion to the dioxide and weighing. Spectrographic methods are usually employed for the analyses of most raw materials because of their low germanium content.

Uses. — The availability of germanium of an extraordinarily high degree of purity has been responsible for the revolution in electronics which began toward the close of World War II. This application is by far the major use of germanium. A succession of devices such as diodes, transistors and rectifiers have been developed which perform most of the functions of vacuum tubes plus others that a tube will not handle. These devices are characterized by simplicity and ruggedness, low power consumption and little heat emission. They begin to function immediately since there is no filament to heat.

The germanium diode consists of a fine wire of a proper conductive metal pressing against a thin waferlike disk of properly prepared germanium. Wire and germanium disk are soldered to separate electrical conductors and the unit is embedded in plastic or enclosed in glass. The complete assembly is smaller than a grain of corn. An interesting property of germanium diodes is their photoelectric effect, commercially utilized in the photodiode, said to have definite advantages over the "electric eye."

In 1948 the germanium triode or transistor (point-contact type) was announced (see TRANSISTOR). Since then further developments, particularly the junction transistor, have taken place. Transistors have proved of immense value in many applications; one example is in hearing aids, where their use has resulted in smaller and more dependable units. Their use has also simplified the construction of computers, the so-called "electronic brains." Still later, germanium junction rectifiers, both air and water cooled, with much higher capacity than selenium and copper oxide devices, were developed, with larger units in prospect.

Germanium is transparent to infrared light—in fact, thickness of several centimetres will give appreciable transmission over broad regions of the spectrum. Because of this property, germanium lenses are used in industrial and scientific infrared work.

The silica content of glasses may be replaced wholly or in part by germanium dioxide. Optical glasses so constituted will show an extension in range of properties, particularly in index of refraction and dispersion. Glasses of high refractive index have been mentioned for use in wide-angle lenses, in microscope objectives and for military purposes. Germanates, particularly of magnesium and zinc, are used in phosphors in fluorescent lamps.

Germanium forms alloys with many elements but commercial uses are limited. Perhaps the most promising alloys are those with silicon, a continuous series of solid solutions being formed which may have electronic applications. Germanium, like bismuth (and water), has the peculiar property of expanding upon freezing; even when alloyed with as much as 92% gold this property persists, suggesting the use of this alloy for precision castings such as dental inlays, the colour being that of 18 k. gold. An alloy with magnesium (Mg_2Ge) reacts with dilute acids to give a mixture of volatile hydrides (germanes) similar to the methane series of hydrocarbons.

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GERMAN LANGUAGE. German is the national language of Germany and of Austria, and one of the four national languages of Switzerland. It is spoken throughout these areas and in adjacent parts of several neighbouring countries. Until the end of World War II the German-speaking area extended considerably farther to the east and there were many isolated German-speaking communities in Estonia, Latvia, Lithuania, Poland, Czechoslovakia, Hungary, Yugoslavia, Rumania and Russia. The language has been carried to other parts of the world as well: there are German-speaking communities in North and South America, South Africa and Australia. German is widely studied as a foreign language and is one of the main cultural languages of the western world.

As a written language (Schriftsprache) German is quite uniform; it differs in Germany, Austria and Switzerland no more than written English does in the United States and the British empire. As a spoken language, however, German exists in far more varieties than English. At one extreme is Standard German (Hochsprache), which is used in radio, television, public lectures, the theatre, schools and universities. This is based on the written form of the language and is relatively uniform except that speakers often show by their accents the general areas from which they come. At the other extreme are the local dialects (Dialekte, *Mundarten*), which differ from village to village—more in some areas, less in others. A local dialect is largely or even completely unintelligible to a German-speaker from another area. Between the extremes is a continuous scale of speech forms, which in the cities are close to the standard and are called Colloquial German (*Umgangs*sprache). Only in Switzerland is there anythihg resembling a second spoken standard. Besides the regular standard and the dialects (in great variety), there are two semistandards based on the speech of Bern and Ziirich, respectively, but they hardly exist in written form.

The foreign visitor who has learned Standard German will have little difficulty in most parts of the German-speaking area, since he will find everywhere persons who speak and understand the standard language. In the more remote areas, however, he may find unintelligible dialects.

STANDARD GERMAN

Sounds and Spelling

Vowels and Diphthongs. — In phonemic notation, the vowels and diphthongs are:

Checked:	i	u	u	Free: i:	u:	u:	*Diphthongs:*	ai	oi au
	e	o	o	e:	o:	o:	Unstressed:		a
		a			a:				

Checked Vowels.—These are short and occur only before consonants. Vowels /i e a o u/ are much like the vowels of English mit, bet, hot, gonna, puss: mit "with," Bett "bed," hat "has," Gott "god," mu8 "must." (Note that nouns are capitalized.) The tongue position of /ü ö/ is that of /i e/ but the lips are rounded as with /u o/: *Stücke* "pieces," Stocke "sticks." German spelling often shows that stressed vowels are checked and short by following them with double consonants.

Free Vowels.—The free vowels are long and occur in all positions. The vowels of English see, say, so, shoe are relatively lax and glide upward; German /i: e: o: u:/ are tense and steady, nith no glide: Sie "you," See "sea." so "so," Schulz "shoe." The /a:/ is much like the vowel of English spa: sah "saw." The /ü: ö:/ have the tongue position of /i: e:/ but the strong lip rounding of /u: o:/ as fruh "early," *schön* "beautiful." In spelling a stressed vowel is often shown to be free and long either by the absence of anything after it (as so); by an unpronounced h after it (sah); by the doubling of the vowel letter (See); or by the spelling of /i:/ as *ie* (Sie).

Diphthongs.—These are also free; much like the diphthongs of light, lout, Hoyt: leite "(I) lead," Laute "sounds," Leute "people." Also /ai/ is sometimes spelled ai: Kaiser "kaiser."

Unstressed.—This /ə/ is also free, but never stressed; it is like the e of begin, pocket: beredete /bə-ré:dətə/ "persuaded."

Umlaut Vowels.—The regular spellings for /ü ü:/ and /ö ö:/ are *ü* and *ö*. They often alternate with /u u:/ and /o o:/ as in the following forms with plain singular and umlauted plural: Mutter, Mutter "mother(s)," Bruder, *Brüder* "brother(s)," Tochter, *Töchter* "daughter(s)," Sohn, Sohne "son(s)." Sometimes /e e: oi/ are spelled a, a, *äu,* regularly so when they alternate with /a a: au/ as in *Mann, Männer* "man," "men," Vater, Vater "father(s)," Braut, Braute "bride(s)." Where a stands for a long vowel, it is often pronounced in formal speech with a vowel like that of fair: *Väter* / fɛ́:tər/, instead of everyday /fé:tər/.

hᵀasalized Vowels.—Such vowels are often used in loan words from French—for example, Teint /téⁿ/ "complexion," Chance /šáⁿsə/ "chance," Pardon /pardóⁿ/ "pardon," Verdun /verdöⁿ/ "Verdun." Less elegantly these are simply pronounced as a vowel plus /ŋ/: /téŋ, šáŋsə, pardóŋ, verdöŋ/.

Consonants. — The consonants, in phonemic notation, are as follows:

Obstruents, fortis:	p	t	k	f	s	š	x	Nasals:	m	n	ŋ
lenis:	b	d	g	v	z	ž	h	*Other:*	j	1	r

The fortis consonants are pronounced with strong muscular tension and are voiceless; the lenis consonants are pronounced with weak muscular tension and are usually voiced.

Fortis *Obstruents.*—The German /p t k f s/ are much like the corresponding English sounds. Initial /f/ is spelled f or *v: fiel* "fell," *viel* "much," both /fí:l/. The /s/ is spelled *ss* intervocalically after a checked vowel, otherwise ß : Masse /másə/ "mass," but *Maße* /má:sə/ "measures" and also *miß* /mís/ "measure!" er mißt /mist/ "he measures." The /s/ is spelled *s* before /p t k/ and finally: Wespe "wasp," Liste "list," Maske "mask," das "that." The /š/ is like English sh, but with lip rounding—it is usually spelled sch as in *Schiff* "ship." After open juncture, /šp št/ are spelled *sp,* st as in spat /špé:t/ "late," *verstehen* /fer-šté:ən/ "understand." The /x/ is a voiceless velar spirant [x] after /a a: o o: u u: au/, but a voiceless palatal spirant [ç] elsewhere; it is spelled ch as in *Bach, Bäche* [bbx, béçə] "brook(s)," *Buch, Bücher* [bu :x. bii:çər] "book(s)."

Lenis Obstruents.—The obstruents /b d g v z/ are much like the corresponding English sounds. The /v/ is usually spelled *w* in native words: Winter "winter," but v in loan words: Vase "vase"; /z/ is spelled *s* as in sie /zí:/ "she," lesen /lé:zən/ "to read." Both *z* and *tz* stand for /ts/: *zu* /tsú:/ "to," sitzen /zítsən/ "sit." The rare /ž/ of loan words is like the *z* of azure: Garage /gará:žə/ "garage." German /h/ is like English *h;* it occurs only after open juncture: hier "here," *geheim* (ga-hbim) "secret."

Lenis-Fortis Alternations.—Lenis obstruents cannot occur before other obstruents or before open juncture; hence they are often replaced in pronunciation (though not in spelling) by the corresponding fortis obstruents: leben "live," but er lebt /lé:pt/ "he lives," *lebhaft* /lé:p-hàft/ "lively"; *Räder* "wheels," but das Rad /rá:t/ "the wheel," des Rads /rá:ts/ "of the wheel"; Tage "days," but der Tag /tá:k/ "the day," *täglich* /té:k-lix/ "daily"; Motive "motifs," but das Motiv /mo:tí:f/ "the motif," des Motivs /mo:tí:fs/ "of the motif"; lesen "to read," but lesbar /lé:s-bà:r/ "legible," er las /lá:s/ "he read."

Nasals.—The nasals /m n/ are like English *m, n;* /ŋ/ is like the ng of singer, and it is spelled n before k, otherwise ng: *trinken* /tríŋkən/ "drink," Finger /fíŋər/ "finger."

Other.—German /j/ is like English y: *ja* "yes." The /1/ is never velarized ("dark") as in English full, but always the "bright" *l* which many English speakers use in million. The /r/ has two sounds: when it is followed by a vowel, most German speakers pronounce it as the voiced velar or uvular spirant [R] ; but when it is not followed by a vowel, they pronounce it as the vowel [ʌ], much like a in sofa. These two sounds thus alternate: [R] in lehren [lé:Rən] "teach," *bessere* [bésəRə] "better ones," but [a] in lehrt [lé:ʌt] "teaches," leer [le:ʌ] "empty," besser [bésʌ] "better." Instead of velar or uvular [R], some speakers use an apical flap or trill.

Stress.—German has four distinctive degrees of stress. The loudest (marked /°/) is the main stress of any stress group. Thus *Hans wohnt hier* may be /°háns vó:nt hí:r/ "Hans lives here" or /háns °vó:nt hi.r/ "Hans lives here" or /háns vó:nt °hí:r/ "Hans lives here." Other syllables in a stress group may have loud stress (marked /ʼ/): die Frau (di: °fráu/ "that woman"; medial stress (marked /ˋ/): die Frau /dì °fráu/ "the woman"; or weak stress (unmarked), like the syllable /zə/ in diese Frau /dí:zə °fráu/ "this woman." Most native German words are stressed on the first syllable: arbeitete /árbaitətə/ "worked," unless they begin with an unstressed prefix: bearbeitete /bə-árbaitətə/ "worked upon."

Intonation.—German has three distinctive degrees of pitch: low /^{1}/, middle /^{2}/ and high /^{3}/: Wo wohnt er? /^{2}vó: ^{3}°vó:nt e:r^1/ "Where does he live?" It also has three terminal contours. Two are used at the ends of sentences: (1) rising, used typically in questions without a question word: *Wohnt er* hier? /^{2}vó:nt è:r ^{3}°hí:r^3↑/ "Does he live here?"; and (2) falling, used typically in questions with a question word: Wo wohnt er? /^{2}vó: ^{3}°vó:nt è:r^1↓/ "Where does he live?" and in statements: Er wohnt hier /^{2}è:r vó:nt ^{3}°hí:r^1↓/ "He lives here." The third type, level, occurs typically at breaks within sentences: Er wohnt hier, ich *wohne* dort /^{2}é:r vó:nt ^{3}°hí:r^3|^{2}íx vó:nə^3°dórt^1↓/ "He lives here, I live there."

Open Juncture.—The open juncture between words (indicated by a space) and between certain parts of words (indicated by a hyphen) is usually sharply marked in three ways. (1) It often falls at the places where onset of pitch and of loud and middle stress occur. (2) It is reflected in the privileges of occurrence of certain phonemes—checked vowels, lenis obstruents and /j/ never occur before open juncture; /ŋ/ never occurs after open juncture; /h/ occurs only after open juncture. (3) It is reflected in the pronunciation of certain phonemes: a vowel following open juncture is usually pronounced with a glottal stop (marked [ʔ]): *eine* alte Erinnerung [ʔàinəʔáltəʔer-°ʔinəruŋ] "an old memory"; /p t k/ follotving open juncture are strongly aspirated: contrast the [tʰ] of *Fleischtopf* [fláiš-tʰòpf] "flesh pot" with the [t] of Bleistift [blái-štìft] "pencil."

MORPHOLOGY

German has two classes of inflected words, verbs and substantives.

Conjugation.—Verbs are inflected for the following categories (illustrated here by the strong verb *sprechen* "speak" and the weak verb *sagen* "say"):

Finite forms:	indicative present	indicative past	subjunctive general	subjunctive special	Imperative
(we, they)	*spreclzen* *sagen*	*sprachen* *sagten*	*sprächen* *sagten*	*sprechen* *sagen*	
(I)	*spreche* *sage*	*sprach*	*spräche* *sagte*	*spreche* *sage*	
(he, she, it)	*spricht* *sagt*				
(you, sing.)	*sprichst* *sagst*	*sprachst* *sagtest*	*sprächest* *sagtest*	*sprechest* *sagest*	*sprich* *sag(e)*
(you, pl.)	*sprecht* *sagt*	*spracht* *sagtet*	*sprächet* *sagtet*	*sprechet* *saget*	*sprecht* *sagt*

Nonfinite forms: infinitive, *sprechen; sagen* participle, *gesprochen gesagt*

(The above second person forms are familiar; in normal polite address, third plural forms are used: *Sie sprechen* "you speak," etc.)

Declension. — Substantives are inflected for case (nominative, accusative, dative, genitive) and number (singular, plural); and, in the singular, some are inflected for gender (masculine, neuter, feminine). Pronouns show highly irregular inflection. Only the third person pronoun (masc. *er*, neut. *es*, fem. *sie)* and the demonstrative–relative pronoun (masc. *der*, neut. *das*, fem. *die)* are inflected for gender. Nouns are inflected for case and number and are classifiable (though not inflected) for gender.

Adjectives agree in gender, number and case with a following modified noun. All adjectives take strong endings. In addition, descriptive adjectives take weak endings when they are preceded by certain inflected limiting adjectives. Thus, nom.-acc. pl. *frische grune Bohnen* "fresh green beans," with the strong ending *-e;* but *diese frischen grünen Bohnen* "these fresh green beans." with the weak ending *-en,* because of the preceding limiting adjective *diese.*

Syntax. — Clause structures are of two major types. In the subject–predicate (S–P). the subject is usually a nominative substantive expression; the predicate is always a finite verb expression which agrees with the subject in person and number. Either part may be a word: *Vater* ↔ *kommt* "father is coming"; or a modifier–centre phrase: (*mein* → *Vater*) ↔ (*kommt* ← *zurück*) "my father is coming back"; or a centre–centre phrase: (*Vater* ← *und* → *Mutter*) ↔ (*kommen* ← *und* → *gehen*) "father and mother come and go"; or a comhination of these. Less often the subject is an adverb: *heute* ↔ *(ist Montag)* "today is &Ion-day"; or a centreless phrase: *(was er sagt)* ⊚ *stimmt* "what he says is right."

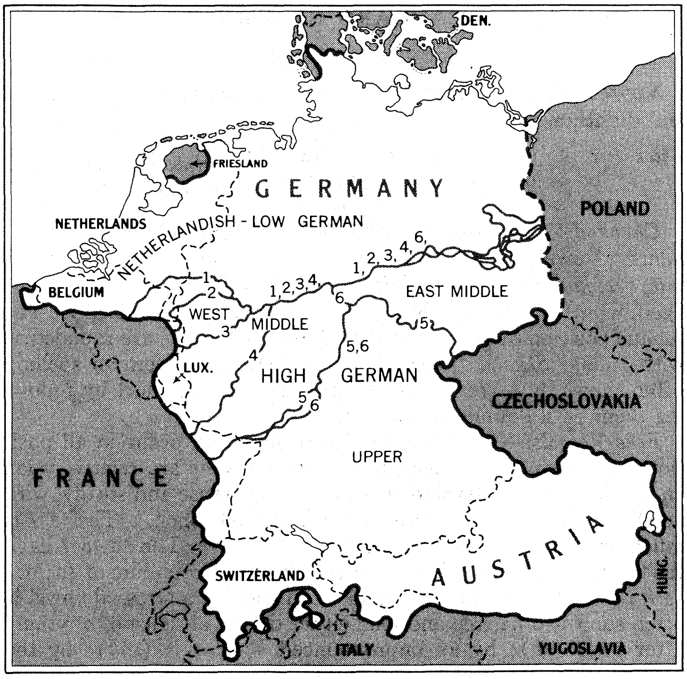
The other major clause structure is the plain predicate (PP), in which the predicate is again always a finite verb expression, either a word: *komm* "come!"; or a modifier–centre phrase: *mich* → *friert* "I'm cold" ("me freezes"); or a centre–centre phrase: *komm* ← *und* → *sieh* "come and see."

Major clause arrangements are: (1) Statement, with finite verb always second. S–P: *jetzt kommt er* "now he's coming"; PP: *mir ist kalt* "I'm cold" ("to-me is cold"). (2) Word question, with question word usually first, finite verb always second. S–P: *wann kommt er* "when is he coming"; PP: *wann wird gegessen* "when do we eat" ("when gets eaten"). (3) Order question, with finite verb always first. S–P: *kommt er jetzt* "is he coming now"; PP: *friert dich* "are you cold" ("freezes you"). (4) Command, with finite verb in the imperative or special subjunctive. S–P: *bleib du hier* "you stay here!," *seien Sie ruhig* "be quiet!," *Gott bewahre* "God forbid!"; PP: *komm* "come!"

The favourite sentence type consists of a major clause (or two or more in co-ordinate structure) with a rising or falling terminal contour: *Kommt er?* /$^{3°}$kómt è:r^{3}↑/ "Is he coming?"; *Er kommt* /^{2}è:r $^{3°}$kómt^{1}↓/ "He's coming"; *Komm!* /$^{3°}$kóm^{1}↓/ "Come!"

DIALECTS

Netherlandish-German Dialect Area. — Within the area outlined on the accompanying map, two standard languages have arisen out of the local dialects: Netherlandish in the Netherlands (Holland, where it is called Dutch) and Belgium (where it is called Flemish), and German elsewhere. From the point of view of local dialects, houever, all of this is a single speech area. One can start at the North sea coast of the Netherlands or Belgium, travel eaat into Germany and then south into Switzerland or Austria and never encounter a village where the local speech is suddenly different. The only sharp breaks occur when one enters the Frisian-speaking part of the northern Netherlands (the province of Friesland) or of Germany (the North Frisian islands and the adjacent coast of Schleswig), the French-speaking parts of Belgium and France.



MAP OF NETHERLANDISH-GERMAN DIALECT DIVISIONS
Numbers indicate isoglosses described in the text

Although within this area the differences from village to village are slight, their cumulative effect can be very great. This is particularly true in the west and centre of the area. where the rural population has been settled for 1,500years or more. Inhabitants often find it difficult to understand the dialect of a village 50 mi. away and at twice this distance the dialect may be practically unintelligible. This extreme variation results from the stability of the population and the fact that the area was for so long split into a multitude of small political units. Where these conditions have not obtained. the results are different. Thus Bavaria, though long settled, is relatively uniform linguistically because it has been unified politically for 1,000 years. In the northeast and southeast, which was not colonized by German speakers until the 10th century or later, the dialects show less variation—though even there it far exceeds anything known in the English of North America. (Until the end of World War II, the German speech border extended farther to the east—particularly in the northeast. where it went as far as East Prussia. The inhabitants of these areas were expelled immediately after the end of the war.)

In the south of this German-speaking area, nearly everyone grows up speaking the local dialect (though he is taught Standard German in school) and continues to use it with family, friends and neighbours. In northern Germany, on the other hand, many city dwellers grow up speaking only the local variety of Standard German and never learn the local dialect. Everywhere dialects have been affected by the great increase in communication and social mobility that developed during the late 19th and 20th centuries. Dialects are not dying out, but they are more and more being leveled and influenced by the standard language.

Low and **High** German. — The most striking dialect differences uithin the Netherlandish–German area are those which divide it into Netherlandish–Low German in the lowlands of the north and High German in the highlands of the south. When the Germanic tribes migrated into southern Germany during the early centuries of the Christian era, their speech had the voiceless stops *p* t k in much the same distribution as modern English. Then, probably during the 6th century, in what is called the "High German consonant shift," these stops when initial (*p*- t- k-) or long (*pp* tt kk) came gradually to be pronounced as affricates, and when following a vowel (*Vp* Vt Vk) to be pronounced as long spirants. The modern results, compared with related English words, are:

p-	pound	pfund	*pp*	apple	apfel	Vp	sheep	schā*f*
t-	ten	zehn	*tt*	sitting	sitzen	*Vt*	bite	beissen
k-	can	khann*	kk	lick	lekchen	Vk	make	machen

**khann* and lekchen, with affricates, are dialect forms; standard German has stops: *kann*, *lecken*

It is not known just where these changes originated, though it was most probably in southern Bavaria and adjacent Austria. Once the new pronunciations had arisen, they spread rapidly, though not uniformly. The situation at the end of the 19th century was that indicated on the map. Line 2, *maken/machen* (*i.e.*, unshifted k north of this line, shifted ch south of it), is generally chosen as the Low German/High German boundary, since it is typical for the shift of *Vp* Vt Vk (*schāp/schāf* "sheep," *bīten/beissen* "bite," *maken/machen* "make") and of t- (*tēn/zehn* "ten") and tt (*sitten/sitzen* "sit"). Where exceptions occur, they are usually at the western or eastern ends of the line. Thus, line 1, *ik/ich* "I," shows that shifted k spread unusually far to the northwest in this word; line 3, *dorp/dorf* "village" (cf. archaic English thorp) shows that shifted *p* after r and 1 spread less far than usual; and line 4, *dat/das* "that," shows that shifted t spread still less far in this word (and a few others: *dit/dies* "this." *it/es* "it." *wat/was* "what"). The striking way in which these lines radiate in the west has led to their being called the "Rhenish fan."

Shifted *p*- and *pp* spread still less far than other sounds. Line 5, *appel/apfel* "apple," lies wholly within the High German area, and is customarily used to subdivide it into Middle German (appel) and Upper German (apfel). Line 6, *pund/pfund* "pound," largely coincides with this in the west, but then runs north to join the *maken/machen* line; it is customarily used to distinguish Rest Middle German (*appel*, *pund*) from East Middle German (appel, fund—the latter being commoner than Upper German *pfund*). The shift of k- and kk presents special problems. Initial k- appears as kh- in much of the High German area (though as ch- in most of Switzerland); exact limits are unknown. Double kk appears as kch in most of Switzerland and as kch or kh along the southern border of Austria; elsewhere it changed to k.

HISTORY

Preliterary Period (to c. **A.D. 750**).—Netherlandish–Low German and High German belong to the Germanic languages (*q.v.*), specifically to the subgroup West Germanic (which also includes Frisian and English). Although the earliest written records are from *c.* 750, some of the developments of the immediately preceding centuries can be reconstructed.

Consonants.—West Germanic showed contrasts bet-ween (1) voiceless stops: short *p* t k, long *pp* tt kk; (2) voiceless spirants, short *f þ s* h, long *ff þþ ss hh;* and (3) voiced sounds, of which d was a stop in all positions (d dd); b was a stop initially, after nasal and when long (b- mb bb), but a spirant elsewhere (ƀ); and g was a stop after nasal and when long (ng gg), but a spirant elsewhere (*ǥ*). In the north, all voiceless stops, long voiceless spirants and voiced stops were kept as such; but f þ s h became voiced medially (f coalescing with 8), and 8 *ǥ* became voiceless finally (coalescing with f h). In the south, a totally different system evolved. First, *ƀ g* seem to have become stops, giving the system: *p* t k; *pp* tt kk; b d g; bb dd gg; f *þ s* h; *ff þþ ss hh.* Then the consonant shift took place, producing the following contrasts: long or fortis affricates, *pf tz* kh (from *p*- t- k-, *pp* tt kk); long or fortis stops. written either bb dd gg or *pp* tt kk (from bb dd gg); short lenis stops, written either b d g or *p* t k (from b d g); long or fortis spirants, *ff* (from *Vp* and *ff*), tth (from *þþ*), ʒʒ (from Vt), *ss* (from ss), hh (from Vk and hh); and short lenis spirants, f th *s* h (from f *þ s* h). Both north and south kept the nasals *m n,* liquids *l r* and semivowels w j.

Vowels.—West Germanic showed contrasts between (1) five short vowels, *i e a o u;* (2) five long vowels i *ē ā ō ū;* (3) three nasalized vowels *į ą ų;* and (4) four diphthongs, *ai* au eo *iu*. Probably quite early in this period, *į ą ų* lost their nasalization and coalesced in the Netherlandish–German area with *ī ā ū*. Kext, by a change which began in the north and spread south, *ai* au became partially monophthongized. In the north (where ai became ɛ̄ except before j, and au became ɔ̄ except before *w*), this gave a system of seven long vowels: *ī ē ɛ̄ ā ɔ̄ ō ū*. In the south (where ai became *ē* only before old h, r or *w* and au became *ō* only before old h and dentals), the change was accompanied by the diphthongization of old *ē* to ie, old *ō* to uo, giving *ī ē ā ō ū* plus ie uo. Where old ai au were kept as diphthongs, they seem to have changed to ei *ou;* and old eo seems to have changed to io. Finally, another vowel change must have started in the north and have spread south: i-umlaut, uhereby stressed back (or low) vowels were gradually fronted (or raised) if a following syllable contained an unstressed j, *i* or i. By the end of this period, the only phonemic umlaut was that of a to e, coalescing with old e, as *gast* "guest," pl, gesti. This change was just reaching the south as the earliest extant documents were written.

Old Period (**c. 750–1050**).—In the south (Old High German), the first German writings begin to appear during the second half of the 8th century. Their language is best described as a collection of monastery dialects: there is a certain uniformity in the writings of any given monastery, but none for the area as a whole. The documents show the monks struggling to express new concepts in German, first through translations of Latin word lists, then in prose translations—some highly skillful (Isidor, c. 800), others less so (Tatian, *c.* 830)—and in a new verse form (Otfrid, c. 870); they culminate in the able translations and interpretations of Notker Labeo (d. 1022). From the north (Old Low German, but usually called Old Saxon), almost the only writings preserved are a life of Christ in alliterative verse (Heliand, *c.* 830) and a fragment of a similar Genesis translation.

Consonants.—In the south. a new lenis stop arose through the change of th to d: thiob "thief" became diob, contrasting with *tiof* "deep." This change seems to have started in the southeast as early as the 8th century and to have spread during the next three centuries throughout the entire area. In the north, the new and old d coalesced: Middle Low German dbf "thief" like *dēp* "deep." Long tth in the course of this period changed so that it eventually coalesced with tt.

Vowels.—By the end of this period, *iu* had coalesced with a new (umlaut) vowel *ǖ* (see below); *io* had coalesced in the north with *ē,* in the south with ie; and unstressed vowels had begun to coalesce as a.

Middle Period (**c.** 1050–1350).—The number of written documents increased greatly in both north and south, and writing became independent of the monasteries. In the south especially, a highly sophisticated literature developed (courtly epic, Minnesang). There is clear evidence of a trend along with it toward a standard Middle High German literary language, though it seems to have had no influence on ordinary speech.

Consonants.—In the south and spreading into much of the north, a new phoneme arose through the change of sk to fortis S, spelled sch: OHG waskan, MHG *waschen* "wash." Fortis *s* then began to merge either with the new S (cf., with unchanged spelling. modern *spinnen* /špinən/ "spin," *stellen* /štelən/ "put") or nith fortis ʒʒ (cf. MHG *messe* "religious mass," *meʒʒen* "to measure," modern *Messe, messen*). In both north and south, final lenis stops became fortis: OHG gab "gave," RIHG gap.

Vowels.—In both north and south, most unstressed vowels (long and short) coalesced in a single vowel a. usually written e. Largely because of this, the various umlaut sounds became phonemic. The resulting vonel system for Middle Low German was: short. i e a o *u* plus the o *u;* long, *ī ē ɛ̄ ā ɔ̄ ō ū* plus the new a ɔ o *u;* and diphthongs, ei ou plus the-new *öü*. The resulting vowel system for Middle High German was: short, *i e* a o *u* plus the new e a o *ü;*

long, *ī ē ā ō ū* plus the new *ǟ ȫ ǖ;* and diphthongs, *ie uo ei ou* plus the new *iie öü.*

Early Modern Period (*c.* 1350–16501.—Four events—the growth of trade, the rise of a middle class, the invention of printing and the Reformation—were of great influence on the development of the language. In the north, resulting from the prosperity of the Hanseatic league, a standard Low German written language began to develop, though it never reached full growth and probably had little influence on everyday speech. In the south, the dialects which had developed in the recently settled East Middle German area were relatively uniform and contained elements from both West Middle and Upper German. Gradually they came to be used as the official languages of the chancelleries of the area, including that of Saxony; on this latter Martin Luther based the language of his widely read Bible translation (1j22–34). This type of German then grew gradually into modern Standard German. Its growth was aided by the fact that printers preferred it as a means of making their books appeal to the widest possible audience.

Consonants.—In nearly the entire area, intervocalic h was lost with lengthening of the preceding vowel, *e.g.,* [zéhən] "see" became [zé:an]. In a smaller area, medial [ŋg] changed to [ŋŋ], *i.e.,* [zíŋgən] "sing" became [zíŋŋən]; and then this and all other long consonants were shortened, *e.g.,* [zíŋŋən, zinnan] "sing." "think" became [zíŋən, zinan]. In a still smaller area, [w] changed to [v]. *e.g.,* [wás] "what" became [vás]. In each case, the old spelling nas kept. *sehen, singen, sinnen, was.*

Vowels.—In the southeast, as early as the 12th century, i *ǖ ū* began to be diphthongized to *ei öü ou;* by the 1jth century these had spread to East Middle German. where they coalesced nith the old *ei öü ou.* (They give modern standard /ai oi au/.) Spreading from the north, as early as the 13th century, short vowels in open syllables were lengthened (*e.g., geben* "give" became *gēben*) and coalesced with the corresponding long vowels. In a contrary development. many long vowels in closed syllables were shortened (*e.g., brāchte* "brought" became *brachte)* and coalesced with the corresponding short vowels. By a specifically Middle German development, *ie üe uo* were monophthongized to i *ǖ ū.* Finally, short e *e* a coalesced as *e,* long *ē ǟ* as *6.* These changes give the modern standard vowel system.

Modern Period (*c.* 1650 to the Present).— The outstanding developments of the modern period have been the increasing standardization of Standard German and its increasing acceptance as *the* supradialectal form of the language. In writing, it is almost the only form used; in speech, it is the first or second language of nearly the entire population.

Though Standard German is clearly based on the East Middle German dialects, it is not identical with any of them. It has accepted and standardized many forms from other areas. notably Upper German *pf* (*Pfund, Apfel)* and also large numbers of individual words in the form of other dialect areas. Since it is the only form of German taught in schools, its spoken form is based to a large extent on its written form; and the spoken form that carries the greatest prestige (that of stage, screen, radio, etc.) uses largely a Low German pronunciation of this written form. As a result, Standard German has been called—and not only facetiously—"High German with Low German sounds."

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(W. G. Ms.)

GERMAN LAW. German law[1] belongs to the systems of law which even today remain under the influence of "the Reception" of the *Corpus Iuris (see* COMMON *LAW).* It was only on the basis provided by the Reception of Roman law that from the 15th century onward a legal profession became established in Germany: with the appearance of a legal profession came a system of common law developed by lawyers (*Juristenrecht*). Although in Germany some important legal works by private authors had appeared at an early date (*e.g.,* the *Sachsenspiegel, c.* 1220. by the Saxon knight Eike von Repkow and the *Schwabenspiegel, c. 1260*). nevertheless the law which they contained was not developed in any systematic way. Roman law enabled German law to make the transition to activity inspired by theoretical thinking. Thus it was the Pandectists (the commentators on the *Pandectae,* for which *see* ROMAN LAW) who. under the influence of Kant's teaching. developed from the autonomy of the moral person the basic concepts of a subjectively conceived system of law. The development of these concepts into a system has ever since been regarded as a special strength of German law. To the influence of the *Corpus Iuris* may also be partly attributed the fact that German law is not a case-law system but has been codified on the model of Justinian's Digest in the law of the Pandectists. In Germany, therefore. the making of law is a process of applying the legal principle to the individual case. and the courts have never played the same dominating role as they are able to play in England under the case-law system.

Another factor which has had a lasting influence on German law is also connected with the Reception of Roman law in Germany in the form which had been given to that law by the Italian glossators. This factor is the conception of state sovereignty and the connected idea of the monopoly by the state of the legislative function. In Germany Roman law assisted in the growth of the national state. With the comparatively late transition to systematic legal study went an almost revolutionary change in the nature of individual responsibility for the development of the law. Unpaid leading men of the old Estates without legal training were replaced by the legally trained bureaucracy of the princes and the towns. The authority of these bureaucrats was based not on their independent decisions in legal cases but on the authority of the ruler of their state. His authority was limited by the then prevailing Christian and customary conceptions of political ethics, but he was nevertheless sovereign. This monopoly of judicial authority by the sovereign against which not even the vigorous resistance of peasants and citizens could prevail. has, until the present day. influenced German law in a number of different ways.

The union of the sovereign state with Roman law encouraged in Germany the early introduction of codified laws which, breaking with tradition. could be used as a means to establish the supremacy of the will of the ruler over the life of the community. This union also accelerated the development of bureaucracy. This is the reason for the characteristic of German life that social justice is generally introduced by state authority, that is to say by the bureaucracy; also why the German judge is a university-trained official who has taken up a judicial career and gives his opinion as an expert under the authority and anonymity of the court.

Modern German law is a mixture of various elements; a desire to rationalize and humanize the legal system is blended with democratic, liberal and social ideals: its aim is to achieve a social state based on the rule of law. It is aware that the coming era will be one of rationalized social integration and of co-operation under administrative control; in this era German law will seek to strengthen the individual's obligation to behave in a social, responsible way and to play his part in the common tasks of the community. The law, therefore, has not merely to prohibit what is antisocial but also to impose a positive duty to do what is social. German law takes the view that in the future society must be conceived as a democracy, involving social obligations rather than merely conferring individual rights; the modern mass state cannot evade its responsibility for social welfare.

These ideas have been developed in German legal theory from the basis provided by a close fusion of various elements from Roman law, Christian morality. the philosophy of the Enlightenment and the experience of the French Revolution. They are closely connected with the idea of a "natural legal order" based

[1]This surrey does not concern itself with law as practised in the German Demacratic Republic.

on a law of reason; the postulates of this theory are to be found by the exercise of reason and experience in a spirit of critical rationalism. This is the way in which planned codifications supersede tradition.

German law tended in the past to prefer constructions based on abstract concepts which assume the autonomy of the legal system and seek timeless solutions of problems. Today. with the aid of legal sociology:?;.supporters of the "jurisprudence of interests" and of "causal legal thinking" attempt, by an exact analysis of reality. to treat legal phenomena as a means to an end. Modern German legal theory goes beyond the mere investigation of external reality to consider the elements of man's community life. It assesses the principal factors in this community life in order that it may ensure that the judge applies to the different interests involved the scale of values laid down by the legislator.

It is true that this way of regarding the law cannot of itself create binding value-concepts. In German law under the Federal Republic. therefore. an attempt was made again to work out a practical system of legal ethics to replace the positive legal order which broke down under national socialism. It is generally recognized that the crisis of the law can only be overcome through a better understanding of the forms of human co-operation. To this end modern Catholic natural lam seeks to renew scholastic philosophy. while the philosophy of justice of the Neo-Kantians endeavours to reconstruct the law on the principle of a humanistic ethic of reason. Phenomenology similarly relies on an objectively conceived ethic of value.

CIVIL LAW

The German "Legal Family."—The expression German "legal family" usually signifies those legal systems which have developed from the basis provided by the German civil code. The central point of this group is not constitutional law or criminal law but civil law and as with the French legal family it is codified civil law. The importance of German law. therefore. for the world as a whole depends primarily on the civil code and on the laws of procedure associated with it. The Japanese civil code of 1898 appeared before the German civil code but was based on the first draft of the latter. The civil code of Siam of Jan. 1, 192j, and the Chinese civil code of 1929–31 also followed the German civil code. In Europe the Swiss civil code of 1907–12, in spite of some original ideas. owes much to the same source. The Swiss civil code is the most significant and finest product in a legislative framework of German-speaking legal learning in the 19th century. It inspired to an even greater extent than the German civil code the movement toward codification and the reception of foreign law which has given the German legal family an honourable position beside the Anglo-Saxon and French legal families. This influence is shown in its most striking form in the adoption of the Swiss civil code by Turkey as part of Mustafa Kemal Atatürk's scheme for secularizing and Europeanizing that country. It also had an influence together with the German civil code on the legislation supplementing the Austrian civil code. on the Soviet civil code of Oct. 31. 1922. on the Polish Law of Obligations of Oct. 27, 1933, on the Czechoslovakian civil code of Oct. 25, 1950, and on the legislation of Hungary, Yugoslavia. the Scandinavian countries. Peru and other states. In spite of the events of World War II, the makers of the Greek civil code of 1946 turned to the German civil code, a remarkable tribute to that system of law.

The Codification of Civil Law.—Before the foundation of the German-speaking legal family by the codification of German and Swiss civil law, there had already been some German examples of codification by the individual states. This legislation of the individual German states took the place of the so-called common law (*Gemeines Recht*), which was a combination of Roman, canon and German law and as *usus modernus pandectarum* had prevailed since the reception. Hopes of legal unity under the leadership of a revived Roman law faded when the imperial power collapsed. The desire for legislation in the German language and for the abrogation of obsolete lams and the modernization of outdated ones could only be effected, in view of'the distribution of strength in the Holy Roman empire, by the sovereign power within the different states. This tended to perpetuate differences between the lags of the states. From the middle of the 18th century, therefore, a movement came into being to codify the law in a form which would exclude other sources and provide one easily accessible and unified system. This movement was inspired mainly by ideas of the law of nature and by the Enlightenment.

The movement toward codification began with the Bavarian *Codex Maximilianeus Bavaricus Civilis* (*Kurbayerisches Landrecht*) of 1756. In its purest manifestation, however, the spirit of the time. which was characterized by the union between the law of reason and the state planning of the Enlightenment. is to be found in the Prussian code of 1794, the *Preussische Allgemeine Landrecht*. This "Prussian Natural Law," as Wilhelm Dilthey called it. contains a comprehensive plan for the organization of the state. The code in its 17,000 paragraphs aims at settling every conceivable legal situation once and for all. In an attempt to cover the entire Prussian law, the code became lost in a mass of exaggerated casuistical reasoning to which it resorted out of fear of problems of interpretation and in order to avoid the arbitrary decisions of judges in cases of uncertainty in the text of the code. For this reason it forbade any legal development by precedent. commentaries or "learned hair-splitting."

In contrast. the Austrian civil code of 1811. the *Allgemeine Bürgerliche Gesetzbuch,* which was also based on the law of reason. set out the private law in a compressed form (only 1.502 sections). It mas nevertheless the only permissible source of private law; although amendments have been made. it has continued in force until the present day and has proved its practical value.

The civil code of Saxony of 1863 was the first of a number of German civil codes based on the Pandects. It was a late-comer in the process of codification by the individual states. but in its scheme of concepts it was a forerunner of, and a kind of rehearsal for. the later German code. It is true. however. that in being limited to the state of Saxony it did not meet the growing desire for a unified civil law in the whole of Germany. This desire for legal unity had already been the occasion for the famous dispute between the law professors A. F. J. Thibaut and F. K. von Savigny. Thibaut, under the influence of the War of Liberation, had in 1814 demanded in his article "Concerning the Need for a General Civil Code for Germany" a unified civil code for the whole of Germany. In the same year Savigny (1779–1861), the most outstanding German jurist in the 19th century, replied with his article "The T'ocation of Our Time for Legislation and Legal Study." Savigny rejected codification because in his view law was the product of history; *i.e.,* it grows according to the inner convictions of the people. He believed codification at that time would have been either superfluous or harmful and that only few periods have the capacity and vocation for codifying activities of a significant kind.

At first this dispute was settled in practice by the course of political events. when the setting up of the German confederation as a union of sovereign states failed to provide a basis for a unified codification of civil law. However. commercial law called for legislative settlement in a way not confined to the individual states. because trade does not stop at the frontiers of the smaller countries. This commercial pressure led to the acceptance of the law concerning bills of exchange (*Allgemeine Deutsche Wechselordnung*) of 1848 which was brought into effect by the individual states of the confederation. In the same way with the help of the German confederation the General German commercial code (*Das Allgemeine Deutsche Handelsgesetzbuch*) of 1861 came into force. When in 1871 the German empire was established the idea of a comprehensive codification of a unified civil law was again mooted. It was first put into effect in the imperial laws on judicial administration but the first commission for the drafting of a unified civil law was set up as early as 1874; on Xug. 18, 1896, the civil code was promulgated and came into effect on Jan. 1, 1900.

CIVIL CODE

Character of the Civil Code.—The Civil Code is divided into four parts: law of obligations; property law; family law; and succession. A "general part!' precedes these four parts; in this general part elements common to the four separate parts are summarized. The general part does not, however. gather together the political and ethical principles of social life and set them out at the head of the code as guiding maxims for the practice and application of law. The creators of the code had rather in mind Gaius' threefold division into "persons. things and actions" and sought similarly to arrange the fundamental elements of civil law theory, that is the subjects, objects and transactions of the law. They hoped in this way, in the interests of brevity and logical completeness, to avoid constant repetitions. The third section of the general part deals with legal transactions and discusses the common elements in every possible kind of legal transaction in the law of obligations, the law of property, family law and in the law of succession; it was a notable innovation in the history of legislation.

This technique of constructing a general part consisting of rules drawn from other parts of the code is to be seen also within the law of obligations. Here, too, there is a general part *(Bürgerliches Gesetzbuch* ss. 242–432) and a special part *(BGB* ss. 433–835). The general part of the law of obligations contains rules which are common to all obligations whether arising by contract. delict, unjust enrichment or in any other way. The special part of the law of obligations, on the other hand, deals with individual obligations such as sale, tenancy, gift. mandate and suretyship. In this scheme of the civil code may already be seen an extraordinary mastery over the subject matter, clearness of arrangement and skilful handling of concepts. These qualities, however. expressed in a precise and often abstract way, have deprived the code of any wide measure of popularity. The civil code is written by jurists for jurists. In its highly developed use of concepts, generalizations and references, which are necessary in order to avoid casuistical reasoning. it lacks the intuition, close contact with life and comprehensibility of the Swiss civil code. These characteristics are the result of the way in which it was made, that is, by a committee of competent legal technicians. It is not the work of a single outstanding man in the same way as the Swiss civil code is the work of Eugen Huber. nor was the spirit of the time when it was made under the influence of a revolutionary mood as when the French civil code was made: on the contrary. the spirit which governed its creation was without passion. matter of fact and neutral. The German civil code did not attempt to exercise a broad educational influence or to emphasize ethical imperatives. though it contains an express prohibition against breaches of customary morals (*guten Sitten*), against abuse of right and against underhanded legal transactions (*Schikane*).

It should further be noted that the civil code did not give expression to a new pattern of society. Legal practice and theory, however, to a greater extent than was expected, adapted the code to the changes and upheavals of the 20th century and in particular to the problems created by an economic and cultural life deprived of its traditional standards. The main method nhereby this was effected was by resort to the so-called "general clauses." They provided a general directive which, in leaving the creation of more specific norms to the judge, may be said both to free him from and subject him to legislative restrictions. Thus the German legislator. through clauses more or less wide according to the circumstances. was able to take into account a new legal and economic ethical system and this has given to the German civil code a lasting character which is extremely important. These general clauses made use of such words as "good faith" (*Treu und Glauben*), "commercial custom" (*Verkehrssitte*), "customary morals" (*guten Sitten*). "important reason" (*wichtiger Grund*), "lack of proportion" (*Unverhältnismässigkeit*), "exploitation of necessity" (*Ausnutzung von Sotlagen)* and "inexperience" (*Unerfahrenheit*).

The General Part of the Civil Code.—The German civil code takes human personality as its starting point. It states in its first section that every natural person acquires on birth the capacity to hold rights and duties. This *Rechtsfähigkeit* means that every human being by virtue of his or her dignity as such is a subject in a legal sense and that the law does not recognize slavery and civil death. From this principle should be distinguished the capacity of the infant in law to enter into legal transactions at six years of age provided they are profitable to that infant (ss. 106 ff.). At 21 years every person acquires full capacity to act in a legal sense (*Geschäftsfahigkeit*). Until that age is reached a legal representative has to look after the interests of the minor. German law does not know the concept or doctrine of the trust; it makes use of the institution of legal representation nhereby an adult acts for the minor. It differs, therefore, from English law in that the rights and duties belong to the child alone. that they are exercised only in the name of the child and that there is always one and the same person to represent the child.

German law recognizes a general personal right (*allgemeines Persönlichkeitsrecht*) to which every individual is entitled. This conception of a general personal right covers many aspects of human personality such as the right not to be physically injured, to be protected against attacks on one's dignity as an individual, to possess a recognized name and to develop one's abilities in any desired direction The fact that some of these rights have been given specific recognition by the civil code does not now prevent the courts from protecting other unspecified expressions of human personality If this general personal right is violated the aggrieved party is entitled not only to the protection of the criminal law but also to ask for damages at civil law and if the defendant has been negligent or acted intentionally, for an injunction (*allgemeine Unterlassungsklage*).

General rules about legal personality are next considered *(BGB* ss. 21–54) The civil code mentions in this connection only associations (*Vereine,* ss. 55–79) and foundations (*Stiftungen,* ss. 80–88). Other kinds of legal persons are defined in the commercial code or in special laws. The civil code requires associations to have a statute. German law. unlike English law. makes no distinction between a memorandum and the articles of association. It requires every legal person to have a board (*Vorstand*) and a general assembly of the members (*Mitgliederversammlung*) as its "organs." This is a characteristically German conception unknown to English law and emphasizing the "personal" character of legal persons. The general assembly elects the board which acts as agent for the *Verein* without being limited by a doctrine of *ultra vires,* which is unknown to German law. A *Verein* may be incorporated by registration in the register of *Vereine* at the district court (*Amtsgericht*), provided it satisfies a number of conditions imposed in the interests partly of the community, partly of the members.

Concerning voluntary legal transactions (*Rechtsgeschäfte*), the code requires for a contractual agreement only two corresponding declarations of intention (*Willenserklärungen*). It demands neither consideration, as in English law. nor a justifying interest, as in modern Italian law. All declarations of intention become effective (s. 130), when they reach their addressee; it is not necessary that the addressee has actual knowledge of them. It is sufficient if he has been put into a position where. in accordance with ordinary business usage, he can be expected to have knowledge of them.

According to German law normally a voluntary legal transaction does not require any special form. The exceptions are expressly prescribed and involve writing (*Schriftform*) or public certification of the signature by a court or notary (*öffentliche Beglaubigung*) or public authentication.

A legal transaction is void if it is contrary to a statutory provision; *e.g.,* immoral, fictitious or not seriously intended. But mistake does not render a legal transaction void as it does in English law. It may, however, render it voidable. according to s. 119. In German law a party is less strictly bound by the letter of the transaction than he is in English law. He is in certain circumstances entitled to be released from his obligation because he acted under a mistake. On the other hand the party who avoids his own declaration is liable to the other party to the extent to which the latter has suffered damage by relying on the validity of the declaration. A declaration induced by fraud or threat is also voidable and a duty to disclose facts which are economically relevant to a transaction is much more readily assumed in German than in English law.

S. 133 deals with interpretation. It requires the true intention of the parties to be ascertained. "Interpretation must not cling to the literal meaning of words" and s. 158 adds that agreements are to be interpreted in accordance with the requirements of good faith, ordinary usage being taken into consideration.

S. 164 ti. contain general rules about agency. The civil code strictly separates, according to the ideas of R. von Jhering and P. Laband. the unilateral act, the "grant of authority." from the underlying contract which normally is effected when the power is granted. In contrast to the grant of authority dealt with in the general part the contract of agency is to be found in the law of obligations under such headings as mandate, contract of service and partnership. Agency denotes the external aspect, and mandate and the contract of employment are among the various possible internal aspects of the same situation. According to German law there is in principle no undisclosed agency by which both principle and agent are liable. The civil code distinguishes between contracts in the name of another person which bind that person alone and contracts in the name of the agent by which he only is bound.

The concluding section of the general part concern limitation (*Verjährung*) and exercise of rights (*Rechtsausübung*). German law regards limitation as an institution of substantive law, not of the lam of procedure, so that it does not treat this question as relating nearly to the limitation of actions. The regular period of limitation lasts 30 years, but there are so many far-reaching exceptions to this rule that frequently under German law much shorter periods of limitation apply than in similar cases under English lam-. Restrictions on the exercise of a right cannot be imposed for longer than 30 years; the entail (*fideicommissum*) was abolished after World War I.

Law of Obligations. — The general part of the law of obligations opens with the important rule of s. 242: "the debtor is bound to effect performance according to the requirements of good faith, ordinary usage being duly taken into consideration." This rule embodies the idea that a judge has not only to interpret legal concepts in accordance with the facts of life, to *subsumieren,* but also to fill. up the gaps by norm-creating decisions. The famous s. 1 of the Swiss civil code expresses this principle in specifying that a judge has to fill a gap in the code according to the rule which he would himself enact were he a legislator. German law regards this judge-made law as *Rechtsfindung* under BGB s. 242. This section gives the judge on the one hand power to dismiss a claim, although founded on an express rule of law, if the enforcement of the claim in the particular case would be contrary to good faith. On the other hand, it empowers him to grant a right to a person although there is no special rule to support it on the basis alone that good faith requires this result. S. 242 has thus considerably increased the freedom of the courts in interpreting contracts, a feature which has no exact parallel in modern English law. It has frequently enabled the courts to avoid giving a decision which public opinion would have considered inequitable. Although German law has no dual legal system — as had both English and Roman law — many of the functions performed in English law by the development of equity have been performed in German law by a wide application of the principle of s. 242. This was especially necessary in a period such as the first half of the 20th century when rapidly changing conditions required the adaptation of codified law to unprecedented situations. In this respect s. 242 gives to the German court even greater possibilities of creating new solutions than is possible in English law by appeal to the principle of equity.

The ensuing sections contain some general provisions relating to obligations, such as the rule that in Germany specific performance is to be regarded as the general. and damages as the exceptional, remedy. Justice Holmes's theory regarding Anglo-American law that contract involves merely liability to pay damages if the promise is not fulfilled is not applicable to German law. The debtor who has promised to do something is primarily liable to fulfil his promise and this liability will be enforced by the German courts. In the same way compensation according to German law (BGB s. 249) has in principle to be effected in kind and not by payment of money. A negligent failure to mitigate damage is specifically dealt with in s 254.

The civil code then deals with time and place of performance, forms, content and types of contract and with the various kinds and consequences of breach of contract: delaykd performance (*Verzug*); and subsequent impossibility of performance (*Unmöglichkeit*). They are followed by sections which set out the various nays of discharging an obligation (ss. 362–397) and the ways in nhich obligations may be transferred from one creditor to another (ss. 398–413).

The special part of the lam of obligations first deals with the law of sale; the rules contained in ss. 433–51j cover in principle not only the sale of goods and other chattel-interests but also the sale of immovable property In the same way the civil code attempts in the rules concerning tenancy which follow to make no distinction between the letting of movables and the letting of immovables. Nevertheless, the legislator has been forced in view of the special position of tenancies of immovables to make a number of rules which apply exclusively to such tenancies This tendency has become more pronounced in emergency legislation protecting tenants against termination of contract, giving them authority to sublet and to exchange their dwellings and determining rents and controlling housing. The ensuing sections of the special part deal with other customary parts of contract such as mandate, gaming and betting suretyship and liability of innkeepers.

The last 40 sections of the special part of the law of obligations deal with tno very important topics in German law: unjust enrichment (ss 812–822) and delicts (ss. 823–853). The civil code distinguishes between the general rule of unjustifiable enrichment stated in s. 812 and the special situations which are discussed in the ensuing sections. S. 812. which is very widely phrased, reads as follows: "Anyone who through an act performed by another or in any other way acquires something at the expense of that other without legal justification is bound to return it to him." The section has. however. been given a restricted interpretation by the courts and by legal writers.

The 30 sections that deal with delicts differ from the English law of torts in their extreme brevity. They are. however. supplemented by a number of important special statutory enactments such as the *Reichshaftpflichtgesetz* of June 7. 1871. the *Strassenverkehrsgesetz* of Dec. 19, 1952, and the *Luftverkehrsgesetz* of Aug. 1, 1922. Ss. 823 I and II and 826 are in the nature of general clauses. They are followed by a small number of special delicts. According to s. 823 I any person who intentionally or negligently injures unlawfully the life, body, health, freedom. property or any other absolute right of another person is bound to compensate him for any damage arising therefrom. S. 823 II gives a civil remedy for violation of a statutory duty. The third general clause (s. 826) reads "a person who intentionally causes damage to another in a manner contra bonos mores is bound to compensate him for such damage."

Apart from these delicts based on the culpability of the defendant German law in certain cases admits liability without fault. Such liability arises where a person has set objects into motion or put things to use which by their very nature endanger others and of which he enjoys the profits. In these circumstances it appears equitable that he should also bear the risk so created. Motor cars, railways and aeroplanes are outstanding examples of such objects Strict liability in the case of motorcar accidents is limited to a maximum of 5,000 DM for damage to property and 25,000 DM. for personal injury. but a higher sum may be claimed on the grounds of negligence under the civil code.

Strict liability for motorcars and aeroplanes is supplemented by a system of compulsory insurance in favour of third parties.

Law of Property. — In the third book of the civil code real and personal property are separately treated, but a number of rules are peculiar either to real or to personal property. A clear distinction is made between the treatment of property in the third book and the law of obligation. Acts of the parties under the rules of the law of property are "abstract" while acts of the parties under the law of obligations are "causal." The transfer, therefore: of a movable or immovable is valid) even though the contract of sale relating to it is invalid on the grounds of error or immorality. Property and obligations are kept distinct in order that a third party need not be concerned about the contractual background of the transfer of property. The necessary adjustment can be made by the rules relating to unjust enrichment.

The German law of property begins first with the regulation of possession (BGB ss. 854–872) and ownership (ss. 903–1007). The idea that ownership means a right to do anything that the owner pleases was replaced in the constitution of 1919 by the principle that '(ownership entails obligations. Its use should be service to the common meal." This statement is approved in all German constitutions since 1945. It implies that in the exercise of his right the owner must pay due regard to the interests of the community. This is especially true in regard to land. Every landowner has a duty to cultivate his land, an obligation which is also enforced in various mays by control council law no. 45. In an extreme case his land may be put under a trustee or may even be expropriated. This leads to the important question of agricultural reform, the details of which have not yet been worked out in legislation.

The general principles of the law of immovable property (BGB ss. 873–902) contain the rule that a disposition is valid only if it is entered in the land register (*Grundbuch*). This is a register of titles kept by the district court (*Amtsgericht*) which shows the legal position of the immovable property to which it relates. There is a land register for all real estate in Germany, so that every creation, transfer, encumbrance and cancellation of a right in respect of immovable property requires registration in addition to the agreement of the parties (s. 873).

The requirement of publicity which in the case of immovables is satisfied by registration is achieved as Ear as movables are concerned by possession. BGB s. 929 lays down in principle that transfer of movable property requires delivery of possession by the owner to the transferee plus agreement between the owner and the transferee that property should pass. Corresponding rules apply to the creation of a pledge (ss. 1205 ff.).

Possession of movables and registration of immovables is the basis of the wide protection afforded to good faith in German lam. Thus a person acquires ownership from a nonowner when he relies in good faith on the assumption that the man in possession of a thing—or registered in the land register—is its owner. This protection of the bona fide transferee does not apply if the transferor has acquired possession against the will of the true owner. as would be true of a finder or thief. This far-reaching acquisition of full and unencumbered property by transfer from a nonowner is among the most remarkable provisions of German law, although the courts generally apply the rule with caution.

The third book concludes with numerous provisions concerning restricted rights in respect of another man's property. German law recognizes hypothecs, land charges and annuity charges (BGB ss. 1113 ff.). The lack of a dual legal system comparable to common law and equity gives the creditor in a German hypothec or land charge only a restricted legal right. The creditor is empowered to take various steps to obtain, with the assistance of the court, satisfaction of his claim from the property of the mortgagor by way of foreclosure or sequestration. Other sections deal with ownership of a flat as distinct from the ownership of the house or of other flats (*Gesetz über Wohnungseigentum*, March 1;, 1951), with servitudes over land (BGB ss. 1018 ff.), with limited personal servitudes (ss. 1090 ff.), with rights or preemption over land (ss. 1094 ff.), with perpetual charges on immovables (ss. 1095 ff.), with heritable building rights (*Verordnung über* das *Erbbaurecht*, 1919) and with homesteads (*Reichsheimstättengesetz*, 1920).

Law of Domestic Relations.—The law of domestic relations is codified in the fourth book of the civil code and in the *Ehegesetz* of Feb. 20, 1946 (Control Council law no. 16). The latter contains the rules concerning celebration and nullity of marriage and the rules with regard to divorce. The civil code regulates all other questions relating to husband and wife. affinity and guardianship, including guardianship and curatorship over persons other than minors. Since April 1, 1953, however. in accordance with articles 3 II and 117 of the Basic law all ruies are annulled which contradict the principle of equality (*Gleichberechtigung*) between husband and wife. But no legal ordinance carrying out the principles of the articles had by the beginning of 1955 been issued. Faced by this legal vacuum the courts were forced to decide which parts of the old law were no longer compatible with the Basic law and which parts were in accordance with the principle of equality between the sexes. This duty fell on the courts as the constitutional rule was not a vague declaration of a future political program but an immediate binding injunction. The question has to be decided in each individual case as German law does not in general recognize the binding force of precedent. It has further to be decided. if a rule is rejected as contrary to the Basic law, with what principle it shall be replaced. Article 117 of the Basic law is only negative. It abolishes all legal provisions which discriminate between husband and wife, but creates no new rules. The legal situation is, therefore, as follows: Compensation for breach of promise to marry (BGB ss. 1298 ff.) may be demanded by both parties on the same grounds. There is no longer a special claim on the part of the woman. The sections concerning celebration of marriage (*Ehegesetz* ss. 11 ff.) are unaffected. Since the time of Bismarck (1875) they have required a secular celebration. Only a registrar can celebrate a marriage and a priest cannot, be a registrar. The religious celebration of marriage in church has to take place after the couple have been married in the registry office. A marriage may be voided on several grounds (Ehegesetz ss. 16 ff.) such as adultery and affinity: but this does not necessarily mean that the children are illegitimate. There are various ways in German law of treating marriage which are intermediate between complete nullity and full validity; the tendency is to treat the defective marriages in the same way as those which have been terminated by divorce.

The right to determine all questions relating to the matrimonial life has now to be decided by both spouses. Nevertheless. in case of disagreement the majority view is that the husband should decide doubtful issues, in the well-understood interest of both parties. A minority would prefer the decision of the court. Not only the wife but also the husband has the right to pledge the credit of the other spouse as an agent of necessity (BGB s. 1357). Each spouse is liable to maintain the other. The wife has in principle the same duties as the husband.

The doctrine of the equality of the sexes has also deeply influenced the law relating to the matrimonial regime (*Güterstand*); *i.e.*, the pecuniary relationship between the spouses (BGB ss. 1363 ff.). The hitherto existing legal "ordinary statutory regime" with the right of the husband to administer the estate of his wife and to use it as if he had a usufruct in it has been replaced by the regime of the separation of goods (BGB ss. 1426 ff.j. Reforms projected in 1955, however, would impose on both spouses some limitation with regard to their power of disposal over household property and would require in case of dissolution of the marriage participation of the other spouse in any profit earned by one spouse during the marriage.

The rules as to divorce. which have been relaxed in a liberal spirit. demand that the spouse be guilty of a matrimonial offense; alternatively. it is sufficient to prove as an objective fact a deep-rooted incurable disruption of marital relations which must be evidenced by the parties not having lived together for three years. The last-mentioned provision (Ehegesetz s. 48) has been by far the most important rule in the entire German law of divorce. Such a divorce. however, can be opposed by the partner who did not cause the disruption and must not be granted if. in the real interest of one or more minor children of the marriage, the continuance of the marriage is desirable. After the divorce has been granted the welfare of the children is the principle consideration in determining which party is to be granted custody. Questions relating to furniture and living accommodations have to be decided by the lower courts which have final and exclusive jurisdiction: On this question they have a very wide discretion. Joint property is presumed in earnings during the marriage.

The law relating to parent and child is based on the parental power (BGB s. 1626) which now belongs, according to the principle of equality between the sexes, to both spouses. Parental power has three aspects: care for the person; care for the property; and power to act as legal representative of the child According to s. 1666 the court for the protection of wards may take steps to prevent dangers threatening the child by reason of neglect on the part of the parents.

The position of the illegitimate child is determined by article 6 of the Basic law which lays down that legitimate and illegitimate children shall be put on equal footing. The relationship of the illegitimate child to the mother is given in every respect the same legal significance which the law attaches to any other mother and child relationship. The German civil code, however does not recognize a family relationship between the father and his illegitimate child; but the child is entitled to be maintained by the father according to the station in life of the mother.

Law of Succession.—The German law of succession, regulated in the fifth book of the civil code, is no longer based on the idea of family and community. It is merely a distribution of goods mortis causa. According to s. 1922 all rights and liabilities of a person pass immediately and automatically to his heirs on his death. The heir may be appointed by will or may take under the rules governing intestate succession.

There are private and public wills. Private wills, which require only handwriting and signature, are very informal documents. Moreover, the German courts interpret the rules governing private wills in a very liberal way. The will is opened at a special hearing of the lower court which issues on application a certificate of inheritance (Erbschein, ss. 2353 ff.). Public wills have to be made in the form of an oral declaration before a notary, who records them, or the testator may hand over to the notary a document and declare that it is his last will. If a near relative has not been appointed as heir he is entitled to receive from the heirs a sum equal to one-half of his share on intestacy (ss. 2303 ff.).

For the purposes of intestate succession in German law (ss. 1924 ff.) the relatives of the deceased are divided into groups called *Parentelen*. The first *Parentel* consists of the descendants of the testator, the second of his parents and their descendants, the third of his grandparents and their descendants and so on. There is no limitation of succession to the near relatives of the deceased. As long as one relative of a nearer *Parentel* is living at the death of the testator he excludes all other relatives of the next group. Apart from the succession of blood relatives. the testator's spouse has a right to a share in the capital of the estate (s. 1931). The share of the surviving spouse varies with the degree of nearness of those blood relations with whom the estate has to be shared.

Every heir has the right to disclaim the estate (ss. 1942 ff.), but this right must be exercised within a limited period; otherwise he is as a rule personally liable for the debts of the estate.

A testator may appoint an executor (*Testamentsvollstrecker*—ss. 2197 ff.). His legal position differs from that of an executor in English law in that neither rights nor liabilities pass to him. The latter remain vested in the heirs. He is merely a person entitled to act for and on behalf of the heirs. to dispose of the estate within the limits set by the law and the will by which he has been appointed, and to exercise such other powers as may have been granted to him by the will.

Special laws deal with succession to farmers. Their basic aim is to prevent the splitting up of farms, but they do not in general interfere with the capacity of the testator to dispose of his farm by will. They merely apply to cases of intestacy.

COMMERCIAL CODE; OTHER COMMERCIAL LAWS

Principles of the Commercial Code.—German law still maintains separate civil and commercial codes in contrast to the more modern Swiss law which deals with civil and commercial matters in one codification. The present commercial code. which has been in force side by side with the civil code since Jan. 1, 1900, dates in its main features from the General German commercial code of 1861 and paved the way for later codification in other spheres. It has been supplemented by many special laws dealing with commercial matters. In commercial questions the commercial code and its supplementary laws are primarily applicable; only where there is no special commercial rule has the court to apply the appropriate section of the BGB (introductory law to the commercial code s. 2).

The central feature of German commercial law is the subjective conception of "merchant"; French commercial lam, in contrast, is based on the objective concept of an "act of commerce." A merchant is a person who "exercises a commercial profession" (*Handelsgesetzbuch* s. 1). Some undertakings are commercial by reason of their nature and some are commercial by registration in the *Handelsregister*. There are, moreover, merchants by virtue of their organization, such as the company limited by shares, the private limited company and the co-operative society. A single merchant, a partnership and a company all possess a *Firma;* this means a commercial name under which the business is carried on. The civil name and the commercial name as well as the seat of the enterprise have to be registered in a special commercial register. This *Handelsregister*, which is kept by the district courts, is designed to show the legal position of merchants in regard to such matters as bankruptcy and the appointment of general agents called *Prokuristen*.

The special rules governing commercial acts which are prescribed in the third book of the commercial code are of great practical importance It is their function to reconcile freedom of trade nith the public interest. They have been mostly developed by mercantile custom.

The second book of the commercial code (ss. 105 ff.) deals with commercial associations in the form of ordinary commercial partnership (*offene* Handelsgesellsclzaf t), limited partnership (*Kom*mandztgesellschaft), and an association with a sleeping partner (stzlle Gesellschaft). In contrast with French and Italian law. the German commercial partnership is not a legal person but an association nhich belongs to all the partners in common (*Gesamthand*). All the partners are liable to an unlimited extent to creditors of the partnership. not only in respect to the property of the firm but also in regard to their own private property. The *offene* Handelsgesellschaft differs in this respect from the *Kommanditgesellschaft* in which one or more members have limited and the others unlimited liability. It also differs from a society with a sleeping partner where the sleeping partner is not liable to the creditors directly but only, within limits, to the other partners.

In the commercial code there is a fourth book which contains the maritime law. Its most important provisions deal with associations of part owners of seagoing ships (Reederezen or *Parten*reedereien) and with marine insurance.

Company Law.—The law referring to joint stock companies regulates the Aktiengesellschaft, a legal person corresponding to the English company limited by shares This is a corporation aggregate based on a capital (*Grundkapital*) divided into shares (Aktzen). The minimum capital is fixed at 500,000 DM.; thus the Aktiengesellschaft is confined to major business undertakings; smaller enterprises are intended to become private companies (Gesellschaften *mit beschränkter* Haftung). These shares are taken up by shareholders who have to contribute at least the nominal amount of the shares. Both bearer shares and shares registered in the name of a specific individual are known to German law, but whereas in England the latter are common and the former rare, in Germany the reverse is true. Bearer shares are transferred to a purchaser by an informal agreement by delivery of the certificate.

A joint stock company has three organs; the general assembly of shareholders (*Hauptversammlung*), the supervisory board (*Aufsichtsrat*) and the administrative board (*Vorstand*). Under German law a company is run by the administrative board. which is closest in function to the English board of directors. The administrative board is the representative and administrator of the company. The general assembly of the shareholders can only decide about the distribution of profits and not about the bnlance sheet, profit and loss account or amount of profits to be held in reserve; these matters are decided by the supervisory board and the administrative board. The supervisory board appoints the members of the administrative board. supervises them and receives their report. The supervision is done with the aid of auditors.

Two important new laws are the federal Law on Workers' Participation in the Coal and Steel Industries of May 21, 1951, and the Law Relating to the Organization of Undertakings of Oct. 11, 1952. The latter law lays down that representatives of the employees, electec! by secret ballot. shall occupy one-third of the seats on the supervisory board. Two of the seats must come from actual employees of the company; the others may be filled by "outsiders"; *i.e.*, representatives of the German Trades Union federation. The law for the coal and steel industries goes further and gives the workers the same number (five seats) on the supervisory board as the shareholder. It permits the trades union to fill three-fifths of thr workers' seats and to control the nominations made by the works council. The 11th neutral member is chosen by a complicated system xvhich may ultimately involve appeal to the court. The law for the coal and steel industries further compels the supervisory board to appoint to the administrative board a labour manager. who has equal rights with the other members of the hoard and is responsible for the social and personnel problems of the undertaking.

The law relating to private companies with limited liability (*Gesellschaften mit beschränkter Haftung*) of 1892 is more the product of theory than of practice and tradition. The intention was to create a form of enterprise in which liability is limited but which does not require the large minimum capital of 500,000 DM. prescribed for the foundation of a joint stock company. But it remains very doubtful if this form of private company can be reconciled n-ith principles of free competition, as it makes it possible to restrict the risk in a way which is not available to the individual merchant or the partnership. This is especially striking in the case of a "one-man company," where all the shares are vested in one person.

The *Gesellschaft mit beschränkter Haftung* is a legal person, with a minimum capital of 20.000 DM. dix-ided into share; called *Stammeinlagen* and with the rights of the members to participate. this right being called the *Geschäftsanteil*. The transfer of the share is rather complicated, and requires an agreement before a notary, the shares being not negotiable on the stock exchange. A member is liable to the amount of his share. The GmbH must have one or more managers (*Geschäftsführer*) corresponding to the administrative hoard of the *Aktiengesellschaft*. A supervisory board can. but need not, be appointed.

'Ihe co-operative society (*Erwerbs- und Wirtschaftsgenossenschaft*) was first organized in Germany in 1849 by F. H .Schulze-Delitzsch on the English model. The existing law treats a co-operative society as a legal person x~ithno fixed capital and no predetermined numher of members or shares. The voting rights of the members are equal. without respect to their different financial interests. There are societies n-ith unlimited and some with limited liability. In both cases ihe liability of the member is to the society and only arises when the society goes bankrupt. Co-operative societies have been very successfully de\-eloped.

Negotiable Instruments, Patents, Copyright.— A law of 1933 governs negotiable instruments such as bills of exchange, cheques and promissory notes. Here. however. German law has no great peculiarities. It has accepted the international convention of Geneva of 1930–31. International agreements are also the basis of the legal protection oi parents. copyright and designs in Germany. The various laws on this subject date from the conventions of Paris (1833) and Berne (1886).

PUBLIC LAW: CONSTITUTIONAL

The existence of "families of law" may he seen not only in civil but also in constitutional law. at least since the 13th century. Thus. the French constitution of 1814 and the Belgian constitution of 1831 were the model for similar legitimist constitutions in other parts of Europe; and in the same way German constitutions inspired other countries. The German monarchical constitution of 1871 had an effect even in China (1908) and in Japan (from 1889 onward). The Weimar constitution of 1919 influenced such constitutions as that of Finland. Lithuania and Latvia and was, in its last stages, the model for the Spanish constitution of 1931.

Nevertheless. it would be very misleading to draw too many conclusions from this phenomenon. Written constitutions are often of transient significance. They may remain on paper as a façade without being formally repealed. It is a characteristic of modern dictatorship to cloak the coup d'état with constitutional legality. Constitutions are. moreover, subject to fashion and conditioned by their times and above all by external political forces.

The. Weimar constitution was deeply influenced by French, Swiss. British and U.S. precedents. It is obvious that a constitutional convention after a lost war will look toward those political systems which have shown themselves most capable of carrying a nation to victory or of enabling it speedily to reintegrate itself into the international community. The Basic law of the German Federal Republic of 1949 must be seen. moreover: in the light of the defects of the past, against which they reacted.

The Frankfurt Constitution.— The first German constitution in which western ideas on the separation of powers, parliamentary institutions and guarantees of personal freedom came to prevail over the traditional autocratic system of most of the states was the Frankfurt constitution of March 28. 1849. It was the result of a new revolutionary movement in Germany which sympathized with the French r-evolution of 1848 and attempted to achieve the twofold purpose of establishing liberal constitutional government and of bringing about national unity. It aimed at a governmental structure consisting of a federally organized constitutional empire with a parliament of two houses. manhood suffrage and a responsible ministry. But these efforts failed. The constitution never became effective; the revolution lost its force and the princes succeeded in rejecting the whole plan.

The 1871 Constitution.— Incontrast to the paper constitution of Frankfurt the Bismarck constitution of 1871was a concise. clear and practical instrument based on agreement between the rulers of the states and fitted into the autocratic empire of that time. It contained no bill of rights. but this did not mean that no human rights were recognized. The sphere of liberties of the individual was regulated apart from provisions in the constitutions of the states by special laws; *e.g.*, with regard to arbitrary arrest, freedom of movement. freedom of the press. and freedom of trade arid of assembly. Such laws. however. could be changed at will, since there existed no definition of human rights which was binding on the legislature. Most of the rules of the Bismarck constitution were concerned with the relations between the states and the empire and were designed to ensure that the real power rested with the latter. The powers of the imperial government were enumerated and delegated while those of the states were enumerated and residual. Legislative power was vested in the federal council (*Bundesrat*) and the federal assembly (*Reichstag*).

The outstanding feature of this federal system was the hegemony of Prussia which rested on the traditional authority of a constitutional monarchy, the civil service and the army.

The **Weimar** Constitution.— The Weimar constitution of 1919was strongly influenced by the movement in favour of democratic self-determination which s\%-eptover Europe after World War I. The constitution provided for the separation of powers and for a court to decide in cases of conflict between the authorities. Under the constitution there were a president, chancellor and cabinet, a *Reichsrat* to represent the states and a *Reichstag* to represent the people. The chancellor was responsible to the *Reichstag*, which became a legislative body with real powers. The president was directly elected by the people. He appointed the chancellor and could dissolve the house and order new elections. In times of crisis, under the famous article 48, he was empowered together with the chancellor to legislate by decree. In contrast to the United States constitution the constitution of Weimar could be changed by the legislature. Thus, although human rights were recognized by the constitution, they were largely subject to legislative discretion. Whenever a question of human rights arose it was necessary to ascertain whether the rights in question were subjective and binding even on the legislature. or instructions to the executive or to the courts, or only mere declarations of future policy. The Weimar constitution was in many of its social provisions ahead of its era. But it proved an ineffective barrier against an authoritarian exploitation of governmental powers.

Lander Constitutions after **World War** 11.—The first German constitutions after World War II were those of the *Lander* of the *U.S.* and French zones. They were drafted in 1946 by Germans and approved by the occupying powers. The *Lander* of the British zone followed in 1950. For lack of new ideas these constitutions bear a fairly close resemblance to the Weimar constitution and to the constitutions of the *Lander* of 1919–23. In the constitutions of Bavaria and of the *Lander* of the French zone a religious influence is apparent. There are also some constitutional innovations, especially in economic and social matters.

The Basic **Law.**—New ideas combined with resemblances to the Weimar constitution are to be found in the German constitution on the national level, the Basic lam (*Grundgesetz*) of Bonn of 1949. The German people had not full autonomy in the drafting of their constitution. Numerous objections, mostly in favour of a federal solution; were raised by the military governors. Moreover, the Occupation statute remained in force besides the Basic law. The term "Basic law" was used because the idea of a dismembered Germany was abhorrent and the word constitution implies permanency. "The Basic law," according to its last article, "loses its validity on the day when a new constitution approved by the German people in a free vote comes into force."

With regard to fundamental rights of a political, economic, family, religious and social nature, a complete change has taken place since the Weimar constitution. The fundamental rights of the Basic law are no more mere declarations of a future political program. They are immediately binding on the legislature, the executive and the judiciary. for, according to article 19, "in no circumstances may the substance of any fundamental right be interfered with." These natural rights. which are conceived as existing before the coming into being of the state, are not subject to political control and are intended to prevent a despotic use of power by the legislature.

Other articles deal with the relations between the federation and the *Lander,* with the central government, legislation. and execution and administration of the law. The Bonn Basic law is more federal than the Weimar constitution. In the Basic law all state authority emanates from the people (article 20). There is a federal council *(Bundesrat)* and a federal assembly (*Bundestag)*. Through the *Bundesrat* the *Lander* participate in the legislation and administration of the federation. The president, as in France, is elected by the *Bundesversammlung* (the *Bundestag* and members of the parliaments of the *Lander);* his powers are not extensive. The chancellor dominates the cabinet and without his countersignature the president cannot act. The president appoints the chancellor, but the parliament elects him. The problem of governmental stability has been settled in a new way: to guard against reckless votes of censure the Basic lam (article 67) makes the overthrow of the government dependent on the election of the next chancellor; a vote of no confidence does not of itself bring about the fall of the government.

The dominant organ of the Basic law is the federal constitutional court (*Bundesverfassungsgericht*), which controls the legislature. the executive and the ordinary courts. Due process of law and the independence of the judiciary are guaranteed (article 97). The scope of judicial review has been much extended by the Basic law. Even an individual whose human rights have been violated has a constitutional complaint (*Verfassungsbeschwerde*). The control exercised by the court. however, is in the form of a legal decision, and it is difficult to define the border-line between a legal and a political decision.

Local Government. — Local government legislation has preserved a more characteristically German tradition. Germany has had two notable periods of local self-government, of which traces are still to be seen. The first, which reached its climax between the 13th and 15th centuries, was associated with the rise of mediaeval towns and with the Hanseatic and other leagues of cities. The second period dates from the Stein-Hardenberg reforms in Prussia (1807 onward) and lasted until the National Socialist regime. The Stein-Hardenberg reforms were the cornerstone of municipal self-government in all parts of Germany. They were based on the principle that the participation of the people in public affairs must begin at a level at which the individual citizen can himself co-operate in a practical way and where he is able to take a broad view of the situation. At this level the function of the state is to act as a kind of umpire. maintaining a balance and effecting compromises. The idea that the state's role is to solve internal tensions by assuming a judicially impartial attitude is one which is deeply rooted in Germany and may be equally adopted in economic and social conflicts.

The local governments codes (*Gemeindeordnungen*) issued after World War II took these ideas into account. The communes (*Gemeinden*) have full powers of local self-government and the task of executing the work for which the federal and *Lander* governments are responsible. except where the law expressly provides otherwise. Provision is made for the active participation of as many persons as possible in local affairs. Most of the larger units of local government have the so-called *Magistratsverfassung* whereby the legislative power is vested in a popularly elected council (*Gemeindevertretung*), the *Magistrat* being the *Kollegium* of officials entrusted with municipal administration. The *Magisfrat* consists of the *Bürgermeister* and two groups of officials, one professional and the other nonprofessional. All members of the *Magistrat* are elected by the *Gemeindevertretung.*

PUBLIC LAW: ADMINISTRATIVE

Administrative lam in Germany serves many purposes. It includes the activities of the communes, municipalities and other public corporations in such spheres as social insurance, public health, welfare, housing and reconstruction. Moreover, the organization of road traffic, posts and railways, electricity, water supply, taxes, public education, cultural activities, customs and excise and poor relief are within its scope. Although there is a tendency toward wider codification, only parts of German administrative law (*e.g.,* tax law by federal legislation and police lam by the *Länder*) have been as yet codified. In particular, the general rules of administrative law (*e.g.,* those governing the validity or revocability of administrative acts) are for the greater part uncodified. They have been developed by the courts and jurists under the stimulus of comparative studies, especially of French law (O. Mayer). This has led to a peculiar doctrine of the administrative act, which contrasts with the doctrine of the juristic act of private law. An administrative act is, as a matter of principle, and without prejudice to its possible illegality, deemed to be binding until it has been withdrawn by the public authority issuing it or has bren quashed either by some higher authority or by an administrative court. The principle applied is that the activities of administrative authorities are not subject to the same rules as those which govern relations between citizens, although general rules developed in civil law are sometimes applied *mutatis mutandis* to administrative lam.

The question whether a particular act or regulation of an administrative authority is or is not *ultra vires* is now more strictly construed than before 1933, after which the administrative courts played a role of decreasing importance. The excesses and abuse of power under Hitler's regime have provoked a reaction in favour of restricting administrative discretion.

If a civil servant exceeds his official duty, whether by intention or negligence, while acting within the scope of his official activities, only the state or other public corporation concerned may be sued for damages (Basic law, article 34). These provisions are widely interpreted by the courts, especially where a public authority has undertaken a dangerous activity. In the case of gross negligence or intention on the part of the civil servant the state may claim an indemnity from the official.

PUBLIC LAW: LABOUR

In contrast to England, the intervention of the state by means of legal regulations has played and continues to play a significant part in German labour relations. The central purpose of these regulations was from the outset more to protect the workers than to develop independent collective bargaining, which grew up more slowly than in England. Thus the German laws sought to protect workers against accidents while at mork by introducing precautions or by insisting on less dangerous methods of mork and by providing inspectors and controliers. They also prohibited child labour and Sunday work and ensured adequate social insurance. These laws were relatively early in date and have since been much developed.

German legislation has further given attention to the economic protection of the worker who is dependent on his place of work and wages. Laws requiring the payment of wages in cash (Truck acts) and prohibiting escessir-e deductions from wages were developed at an early date; the protection of the worker against unjustified termination of his contract of employment (*Kündigungsschutz*) came somewhat later. The *Kündigungsschutzgesetz* of Xug. 10, 1951, gave general protection against socially unjustified dismissals and provided special measures in case of mass discharge irom employment. The laws concerning unemployment insurance. the conducting of employment agencies and exchanges also tend to favour dismissed workers.

German law has also dealt with the question of collective bargaining, but although the system of labour regulations is as complete as possible the contractual function of collective agreements will always tend to remain in the sphere of social facts rather than in that oi the law. In Germany the revolution of 1918 and the Weimar constitution resulted in the recognition of trade unions and stimulated co ‹ective bargaining. After World War II the freedom to organize in trade unions—Germany has now only one unified Trades Union federation—and the right to strike was constitutionally guaranteed. A new law on wage scale contracts (*Tarifvertragsgesetz*) was passed in 1949; this defined the contractual function of the collective agreement, giving it an "extended" or compulsory normative effect (*Allgemeinverbindlichkeit*). Furthermore, the terms of the German wage-scale contract automatically became the terms of all individual contracts of employment (*Unabdingbarkeit*). An elaborate statutory machinery was set up by law for the settlement of minimum wages and with regard to holidays. The ministers of labour have also certain powers of intervention either by way oi conciliation or by bringing about voluntary or compulsory arbitration. The most important labour law has been the Lam Governing Industrial Relations Between Employers and Employees in Private Economy (*Betriebsverfassungsgesetz*) of Oct. 11, 1952, which is not remedial but a general comprehensive and systematic treatment of a part of labour law. It deals with the compulsory works councils (*Betriebsräte*) which have now acquired a far-reaching right of co-management especially in social and personnel questions. The agreements between the employer and the works council in the individual enterprise are, apart from the wage-scale contracts, an important source of German labour law. (See also under *Company* Law above.)

PUBLIC LAW: CRIMINAL

Early Criminal Codes.—Since the 6th century, beginning with the Lex *Salica,* there have been written collections of criminal lam in German territory. Rut it was not before the 15th and 16th centuries, at the time oi the reception of Roman law, that the first comprehensive codifications of criminal law were inade (the so-called *Halsgerichtsordnungen*) in some of the individual German states. The first authoritative code ior the whole of Germany was the Constitutio *Criminalis* Carolina of 1532, the *peinliche Gerichtsordnung* of Charles V, which remained in iorce for three centuries. It mas a reasonable compilation based in part on the union of German and Italian ideas and it was written in excellent German. The centuries following the enactment of the Carolina were notable for the juristic writings of such advocates of reform as Benedikt Carpzov (1595–1666), J. S. F. Bohmer (1704–72) and Paul Anselm von Feuerbach (1775–1833), the able author oi the Bavarian criminal code of 1813. During this period criminal law, influenced by the Enlightenment, became more humane, and the same influence led to the abolition of the inquisitorial procedure at the time oi the French Revolution.

The Federal Criminal Code.—After the unification of Germany the federal criminal code was issued in 1871. It is still in force, although several general schemes for the reform of criminal law have meanwhile appeared. They have had a considerable influence on the reform of criminal law in foreign countries; *e.g.,* in Switzerland (1942 onward) and in Scandinavia (criminal codes in the 20th century). But in Germany the reform movement succeeded only in replacing a few sections of the criminal code by means of supplementary laws. The criminal code is therefore still based on the ideals of liberal individualism. It would be more exact to say that it is again in force, ior Hitler eliminated the rule of law and the principle of *nullum crimen sine lege,* mhich at the time of the Enlightenment and the French Revolution had been introduced as a safeguard of individual liberty. In accord with the spirit of the times, however, some new social ideas have found expression. Thus, the obligation to go to the help of another person is now recognized by the German criminal code. Under *Strafgesetzbuch* s. 330a it is a punishable offense for anyone, in case of accident, public danger or emergency, not to give the assistance which may normally be expected of him, in particular when requested by the police to render such help.

The general part of the criminal code first deals with the nature of offenses in general and of the punishments which mav be inflicted. It explains the various forms a d degrees of crime, the objective and subjective elements of an offense (carefully distinguished in German criminal theory), the reasons for exemption irom punishment and the circumstances excludihg guilt; these are precisely defined, particular attention being paid to the question of mistake. The general part also sets out the various stages in the commission of an offense, explaining what constitutes an attempt and defining the different ways of participating in a crime; *e.g.,* aiding and abetting. Conspiracy, however, is unknown to German law.

German jurists have been particularly interested in the subjective constituents of a crime. There are various distinctions in German law such as direct and indirect intent or unconscious and aggravated negligence (*i.e.,* recklessness), but there are scarcely any presumptions of guilt. In this field the modern "doctrine of final action" (*Finale Handlungslehre*) of H. Welzel has made some interesting suggestions. It distinguishes between causality and finality. This starting point leads to new solutions, for example, to the problems of error, especially in cases of punishable negligence. StGB ss. 13–42 deal mith kinds of punishment and have been altered on a number of occasions, as national and authoritarian political ideas and liberal economic ideas have given way to the conception of the welfare state. The most important alteration, made in 1953, introduced "conditional suspension of sentence on probation" (*Strafaussetzung auf Bewährung*) which resembles the French sursis and the English probation. This idea had been worked out 70 years before by the German jurist, Franz von Liszt, professor of criminal law at Marburg, who in 1882, under the influence of Darwinism, produced his famous "sociologial" scheme *Der Zweckgedanke im* Strafrecht.

German lam no longer permits capital punishment; it was abolished by article 102 of the Basic law. Three forms of confinement are recognized: the severest form is penal servitude (*Zuchthaus*), which is considered more dishonourable than imprisonment (*Gefängnis*) but in practical effect differs little from it; detention (*Haft*), the mildest form of confinement, is imposed mostly ior petty offenses in breach of police regulations. There are, moreover, special preventative measures of security and reform, such as confinement in an asylum for mental cases, or in an institution for alcoholics or for drug addicts, or in a workhouse. These measures may be additional to punishment, as German law in this respect follows the so-called "double-track" system.

The *Jugendgerichtsgesetz* of 1953 provides special punishments for juveniles. The law distinguishes between an educational. disciplinary and punitive sanction. Any one of these three sanctions may be imposed on young persons between 14 and 18, and also on persons between 18 and 21 if the court decides in the circumstances to apply the law appropriate to the younger age group. Juveniles under punishment must not have contact mith adults undergoing punishment. The educational sanction mav take the form of a reprimand or of an order to the young person to adopt a certain way of life: *e.g.,* to live in a particular house, to do some special kind of work, not to smoke, etc. The court may also order a period of probation under supervision or send the offender to a reformatory school (*Schutzaufsicht* or *Fürsorgeerziehung*). The disciplinary sanction may involve seeking pardon of the injured person or attending for one or more weekends at a juvenile detention centre. In serious cases the juvenile may be sent to a juvenile prison for a specified or for an indeterminate period.

The special part of the criminal code (StGB ss. 80–3jo) deals with particular offenses. The difficulties of codification are very evident, as every special part of a criminal code must necessarily have a fragmentary and incomplete character. Because of social changes many offenses cannot be included in the criminal code; there are, for example, a number of special laws relating to taxation, economic matters and police regulations which impose punishment on the offender.

LAW OF PROCEDURE: CIVIL

Development.— The German civil lawyer thinks in terms of rights and duties, in contrast to the common lawyer who has, at all events until recent times, tended to think in terms of remedies; but the development of the German law of procedure since the ioundation of the empire in 1871 has tended to narrow the gulf between the two ways of legal thinking. This development is associated with such men as Adolf Wach, Konrad Hellwig, James Goldschmidt and Leo Rosenberg.

The present German law of procedure is based upon Romanized canon and Germanic law. From these two systems a form of procedure was developed mhich was taken from northern Italy to Germany at the time of the Reception. The laws of the various states and the decisions of the courts transformed it into the so-called Get*meine* Prozess. During the 18th century this system of procedure was influenced by the ideas of the Enlightenment and later by the French Code de *Procédure* Civile (1806). The desire for a uniform law of procedure, which is always stronger than the demand ior a uniiorm private law, grew more insistent during the 19th century. In 1877 the four great Judicature acts (*Reichsjustizgesetze*) were published: the law on the constitution of the courts (*Gerichtsverfassungsgesetz*), the code of civil procedure (*Zivilprozessordnung*), the code of criminal procedure (*Strafprozessordnung*) and the bankruptcy act (*Konkursordnung*). Supplementary laws later reformed these basic laws. These more recent lams show the influence of the Austrian code of civil procedure, which was published at the end of the 19th century and reveals a new awareness of social problems under the influence of the teaching of Franz Klein. Two years aiter the promulgation of the German Judicature acts a supreme court (*Reichsgericht*) mas established at Leipzig. Its predecessor, the ***Reichskammergericht,*** founded in 1495, had come to an end mith the Holy Roman empire in 1806.

Organization of the Courts.— The organization of the German civil courts is based on the proiessional judge, a civil servant, who must have studied at a university and who is appointed by the government aiter having passed two state examinations. His appointment as a judge is in Germany the beginning oi his career. The German judge is not subject to the decisions of a higher court (no binding force of precedents). The ordinary courts, which are at the local level *Amtsgerichte,* at the county level *Landgerichte,* and in respect of larger areas *Oberlandesgerichte,* are all part of the judicial system of the *Land.* In the *Amtsgericht* a single judge presides but in the *Landgericht* there are in civil cases a number of courts (*Zivilkammern*) each with a *Kollegium* of three judges. Where the amount in issue exceeds 1,000 DM. the case has to be brought beiore the *Landgericht* as the court of first instance. The *Oberlandesgerichte* function as courts of appeal ior a number oi *Landgerichte* and sit in senates of up to five members. Above them is the highest German civil court (*Bundesgerichtshof*) which sits at Karlsruhe. Practising lawyers, called *Rechtsanwälte,* combine the functions of solicitor and barrister. They prepare the cases and appear in court on behalf of their clients.

Principles of Procedure. — The German lam oi civil procedure is governed by the idea that the court is in principle restricted to a consideration of those facts which the parties have placed before it. The opposite inquisitorial system where the judge must ex officio investigate the circumstances is employed only in cases relating to status; *e.g.,* in divorce. German procedure requires as a rule an oral hearing in public. But preparations ior the trial involve the exchange of written pleadings) and the oral hearing often consists in little more than a formal reference to the pleading. The German law of procedure permits the free assessmrnt of evidence (ZPO s. *286).* According to this *Prinzip der freien Beweiswürdigung* the courts are not fettered by any formal rules of evidence; they can evaluate the ex-idence in their own iree and reasonable discretion. Any kind of evidence is admissable and the court has to decide how much weight to give to it.

The ordinary civil courts are replaced in certain matters by special courts which are subject not only to the *Zivilprozessordnung* but also to special laws of procedure. Of these courts the most important are the labour courts. They are regulated by the *Arbeitsgerichtsgesetz* of Sept. *3.* 1953. There are three instances, *Arbeitsgerichte, Landesarbeitsgerichte* and the final court of appeal, the *Bundesarbeitsgericht* at Kassel. They deal with disputes arising out of individual or collective agreements between employers and employees, and with wrongful acts connected with industrial disputes.

LAW OF PROCEDURE: ADMINISTRATIVE

In Germany administrative law is as a rule a concern of administrative courts. They are either general administrative courts (*Verwaltungsgerichte, Landesverwaltungsgerichte, Bundesverwaltungsgericht*) or special administrative courts such as fiscal courts *(Finansgerichte, Landesfinanzgerichte, Bundesfinanzgericht*) for taxation questions, courts for disputes about social insurance *(Sozialgerichte)* and the tribunal for patent questions *(Patentanrt).*

The separation of ordinary and administrative courts is generally deiended on the grounds that the administrative courts are more specialized and therefore better able to deal with such technical matters as administration and taxation. There are, however, signs of a movement in favour oi assimilating the different types of jurisdiction or rather of developing general conceptions common to all of them. Under the influence of this movement the scope of administrative law has been extended since the war. The Prussian system of enumerative clauses has been given up for the so-called general clause. Any administrative act and not only cases specifically mentioned in the statute may now come before an administrative court.

At present the main laws of administrative procedure are laws of the *Lander.* The cases which come before an administrative court relate to a challenge to an administrative act (*Anfechtungsverfahren*) or to some other kind of public law dispute (*Parteistreitverfahren*) or to an inquiry into the validity of subordinate legislation *(abstraktes Normprüfungsverfahren)* in order to test its conformity with the parent statute. If all remedies of the administrative courts have been exhausted, every private individual has the possibility of bringing a constitutional complaint before the federal constitutional court. This complaint, in which protection is sought in accordance with the fundamental rights of the Basic law against both administrative acts and against statutes and ordinances, subordinates the state in its executive iunctions to the rule of law.

LAW OF PROCEDURE: CRIMINAL

The German law of criminal procedure is characterized by a division between the function of the court and that of the public prosecutor *(Staatsanwalt).* The courts are the same as those sitting under civil procedure, but the *Amtsgerichte* may sit with lay assessors (*Schöffengerichte*) and the *Lnizdgerichte* may sit with three professional judges and six laymen who decide together on guilt and punishment (*Schwurgerichte).*

In contrast with the judges the public prosecutors are subject to the orders and directives of their superiors. The principle was borrowed from the French *Code d'instruction criminelle* of *1806.* The *Staatsanwaltschaft* has as its head the minister of justice and has offices attached to every lan- court. The judges and the public prosecutors have a duty to find out the "material truth." Their methods, however, differ. The prosecutor is the adversary of the accused. He has the duty to investigate where there is sufficient reason to assume that an offense has been committed (StPo s. *160).* If he is not convinced of the guilt of the accused person. he has to close the proceedings. Otherwise he applies to the court to hold the trial. At the trial he has an equal right with the accused to be heard, to produce evidence and to lodge an appeal. He has. however, special powers—he may order the police to assist him and he may arrest suspected persons whenever delay in obtaining a warrant is likely to hinder the prosecution. In the latter case the conditions which would have justified the issue of a warrant must have been fulfilled. The arrested person must be brought within *24* hours before a judge who must either issue a warrant or release the accused.

Although in Germany, as in England, the accusatory and not the inquisitorial system prevails, the position of the judge in a German criminal case is very different irom that oi an English judge in criminal proceedings. In Germany the presiding judge takes the evidence, interrogates the witnesses and experts and in general conducts the trial. The prosecutor and the defendant or his counsel can only interrogate witnesses by permission of the judge which must. however, be given. It should finally be added that the benefit of the doubt has always to be given to the accused.

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GERMAN LITERATURE. The literary history of the German-speaking peoples of the continent of Europe may conveniently be divided into seven sections: (1) Old High German period. from the earliest records to the middle of the 11th century: *(2)* Middle High German period, from the middle of the 11th to the end of the 14th century; (3) transition period. covering the 1jth and 16th centuries; (4) Renaissance and Baroque periods, covering the 17th century; (j) age of Enlightenment; (6) age of Goethe; and (7) period following Goethe's death.

OLD HIGH GERMAN PERIOD

There are no records to suggest that the continental Germanic tribes possessed a written literature before the age of Charlemagne. When the vernacular literature began to emerge in the 9th century, it was merely a faint reflection of the activity of the monasteries; and this, with very few exceptions, Old High German literature remained. Translations of the liturgy, of Tatian's *Gospel Harmony (c.* 835) and of fragments of sermons form a large proportion of it. Rarely, as in the so-called *Monsee Fragments* and at the end of the period in the prose of Notker Labeo (d. 1022), does this ecclesiastical prose attain any kind of literary style. Without vitality of its own, it virtually sprang into existence at the command of Charlemagne, whose policy with regard to the use of the vernacular in place of Latin was liberal and farseeing; it docilely obeyed the tastes of the rulers that followed, becoming severely orthodox under Louis the Pious and consenting to extinction when the Saxon emperors withdrew their favour from it. Of the poetic fragments the most interesting are the *Meseburger Zaubersprüche* (*Merseburg Charms*), the *Wessobrunner Gebet* (*Wessobrunn Prayer) (c.* 789), the *Muspilli,* an imaginative description of the Day of Judgment, and the *Ludwigslied* (881), the first German historical ballad. The *Evangelienbuch, Liber evangeliorum* or *Gospel Book* of Otfrid of Weissenburg (c. 868) was the earliest attempt to supersede alliteration in German poetry by rhyme. The only genuine poetry of this epoch arose among the Low German races. To Saxon tradition we owe the earliest extant fragment of heroic legend, the *Hildebrandslied (Lay of Hildebrand*) (*c.* 800), and a Saxon poet was the author of a vigorous alliterative version of the Gospel story, the *Heliand* (c. 830). Of the existenct of a lyric poetry we only know by hearsay; and the drama had nowhere in Europe at that time advanced beyond an ecclesiastical function. Literature in the 10th and 11th centuries again reverted to Latin. The *Waltharilied (Lay of Walter) (c.* 930), *by* Ekkehard of St. Gall; the moralizing dramas of the nun Hrosvitha of Gandersheim; the *Ecbasis captivi* (*c.* 940), earliest of all the beast epics; and the romantic adventures of

Ruodlieb (*c.* 1030), although not in German, foreshadow the future developments of German poetry.

MIDDLE HIGH GERMAN PERIOD

At the middle of the 11th century, when the linguistic change from Old to Middle High German was taking place, a religious asceticism, originating in the Burgundian monastery of Cluny, cast a blight over secular poetry. Lugubrious in their asceticism are poems like *Memento mori* (*c.* 1070), *Vom Glauben,* a verse commentary on the creed by a monk Hartmann (*c.* 1140), and verses on "the remembrance of death" (*Von des tôdes gehugede*) by Heinrich von Melk (c. 1160). But in the *Ezzolied* (1063), a spirited lay by a monk of Bamberg on the life, miracles and death of Christ, and in the *Annolied* (*c.* 1080), a poem in praise of the archbishop Anno of Cologne, the tone is simpler and more popular.

A freer spirit is to be seen, too, in the lyric poetry inspired by the Virgin and in the *Kaiserchronik* (*c.* 1150), a long. confused chronicle of world history. The national legends begin to emerge in the popular literature. To the wandering *Spielleute* we owe the romance of *Konig Rother* (*c.* 1160), and the kindred stories of *Orendel, Oswald* and *Salomon und Morolf.* These poems bear witness to the influence of the crusades, as do also the *Alexanderlied* (*c.* 1130), and *Herzog Ernst* (*c.* 1180), which point the way to the court epic. The *Chanson de Roland* was, about 1135, reproduced in German by Konrad of Regensburg as the *Rolandslied.*

The court epic begins in Germany with the *Tristrant* (*c.* 1180) of Eilhart von Oberge, and a knightly romance of *Floris und Blancheflur* (*c.* 1170). In these years, too, the beast epic was reintroduced into Germany by an Alsatian monk, Heinrich der Glîchezâre, who based his *Reinhart Fuchs* (*c.* 1180) on the French *Roman de Renart.* Lastly, the *Minnesang,* or lyric, burst out with extraordinary vigour in the last decades of the 12th century. It is debatable how much in it is indigenous and national, how much the result of French and Provencal influence; but the freshness and originality of the earliest German singers, such as Kiirenberg, Friedrich von Hausen and Dietmar von Aist, are not to be questioned. Heinrich von Morungen's poetry displays marked Romance elements. The satirical *Spruchdichtung* is represented by two poets who call themselves Herger and "Der Spervogel" and was less dependent on foreign models.

Such was the preparation for the extraordinarily briiliant although brief epoch of German mediaeval poetry which was contemporary with the reigns of the Hohenstaufen emperors Frederick I (Barbarossa), Henry VI and Frederick II. National epic, court epic and *Minnesang,* to which may be added as a smaller group didactic poetry, comprise virtually all that survived in Middle High German. A Middle High German prose hardly existed and the drama, such as it was, was still essentially Latin.

The first place among the national epics belongs to the *Nibelungenlied,* which received its modern form in Austria about the end of the 12th century. It combines elements from various heroic cycles—the lower Rhenish legend of Siegfried, the Burgundian legend of Gunther and Hagen, the Gothic legend of Dietrich and Etzel—and its dramatic intensity and singleness of purpose reveal that its author possessed a lofty imagination and high epic gifts (*see* NIBELUNGENLIED). Less imposing is the second of the German national epics, *Gudrun:* as it survived it is the work of an Austrian, but the home of the story is on the shores of the North sea. Dietrich von Bern (*i.e.,* of Verona), or Theodoric the Great, who was looked upon for hundreds of years by the German people as their national hero, has been celebrated in no epic comparable to the *Nibelungenlied* but he appears in the background of a number of romances—Die *Rabenschlacht, Dietrichs Flucht, Alpharts Tod, Biterolf und Dietlieb, Laurin,* etc.—which make up what is usually called the *Heldenbuch.*

The court epic, or romance of chivalry, the influence of which is also apparent on all these popular epics, forms the greatest group of German mediaeval poetry. The poet who established the court epic in Germany was Heinrich von Veldeke, a native of the lower Rhineland; his *Eneit* (*c.* 1175–1186) is based on a French original. Other poets of the time, such as Herbort von Fritzlar, the author of a *Liet von Troye,* followed Heinrich's example. With the three masters of the court epic, Hartmann von Aue, Wolfram von Eschenbach and Gottfried von Strassburg—all of them contemporaries—the Arthurian cycle became the established theme of this type of romance and the embodiment of the ideals of the knightly classes. Hartmann was a Swabian, Wolfram a Bavarian, Gottfried presumably a native of Strasbourg. Hartmann, in his *Erec* and *Iwein,* provided the court epic of the age with its best models; his *Gregorius* and *Der arme Heinrich* are stories of religious contrition. Of all the mediaeval court poets he had the most delicate sense of style. Wolfram and Gottfried, on the other hand, represent two extremes of poetic temperament. Wolfram's *Parzival* is filled with mysticism and obscure spiritual significance, while Gottfried's *Tristan* is as lucid as Hartmann's *Iwein.*

Pareival and *Tristan* are the greatest of the German court epics, and the subsequent development of that literary form stands under the influence of the three poets Hartmann, Wolfram and Gottfried. To the followers and imitators of Hartmann belong Ulrich von Zatzikhoven (*Lanzelet, c.* 1195); Wirnt von Gravenberg, a Bavarian (*Wigalois, c.* 1205); the versatile Spielmann known as "Der Stricker"; and Heinrich von dem Tiirlin, author of an unwieldy epic, *Die Krone* ("the crown of all adventures," *c.* 1220). Wolfram's mysticism is to be seen in *Der jüngere Titurel* of a Bavarian poet, Albrecht von Scharfenberg (*c.* 1270), and in the later *Lohengrin* of an unknown poet; whereas Gottfried von Strassburg dominates the *Flore und Blanscheflur* of Konrad Fleck (*c.* 1220) and the work of two important poets of the later 13th century, Rudolf von Ems, who died in 1254, and Konrad von Würzburg, who lived until 1287. Of these Konrad alone carried on worthily the traditions of the great age; he excels in short romances such as *Die Herzemaere* and *Engelhard,* though he becomes diffuse and wearisome in his enormously long *Trojanerkrieg* and *Partonopier und Meliur.*

The most conspicuous changes which came over the narrative poetry of the 13th century were, on the one hand, a steady encroachment of realism and, on the other, a tendency to didacticism. The "fact" of the chronicle takes the place of the freer imaginings of the earlier poets in the work of Rudolf von Ems; while the growth of realism appears in the *Pfaffe Amis,* a collection of comic anecdotes, in the admirable peasant romance *Meier Helmbrecht,* written about 1250 in Bavaria, and in the adventures of Ulrich von Lichtenstein (*Frauendienst,* 1255; *Frauenbuch,* 1257).

One of Germany's greatest lyricists, Walther von der Vogelweide, summed up in himself all that was best in the *Minnesang;* in love song high and low, in religious poetry, in patriotic and political *Spruche*—*in* all he was a master. The originality and purity of his inspiration place him in the highest rank. He was born about 1170 and died about 1228; his art he learned in Austria—he calls the elegiac poet Reinmar von Hagenau his master—whereupon he wandered through Germany, where his championship of what he regarded as the national cause in the political struggles of the day won him foes as well as friends (*see* WALTHER VON DER VOGELWEIDE). Among Walther's immediate contemporaries, the highborn poets, whose lives were passed at courts, naturally cultivated the conventional lyric; but others availed themselves of the freedom of his poetry of uncourtly love. This was Walther's most valuable legacy to his successors, the greatest of whom was Neidhart von Reuental (*c.* 1180—*c.* 1250), who found the themes of his *Höfische Dorfpoesie* in the village and depicted the peasant with humorous banter or biting satire. The *Spruchdichter* came best out of the ordeal of the changing fashions of the later 13th century, favoured by the increasing interest in the moral and didactic applications of literature. The *Spruchdichtung* was in fact the connecting link between the *Minnesang* of the 13th and the lyric and satiric poetry of the 15th and 16th centuries.

A critical and didactic spirit was gradually taking the place of the idealism of chivalry. In the early decades of the 13th century, *Der Winsbeke,* by a Bavarian, and *Der welsche Gast* (1216), by Thomasin von Zirclaere, a native of Friuli, still inculcate the duties and virtues of the knightly life. But in the *Bescheidenheit* (*c.* 1230) of a wandering singer who called himself Freidank is found for the first time an antagonism to the unworldly code of chivalry and a sign of the changing social order, brought about by the rise of the middle class. In Der Renner by Hugo von Trimberg, written at the very end of the century, the terseness and wit of Freidank have given place to diffuse moralizing and allegory.

TRANSITION PERIOD

To End of the 15th Century. — By the middle of the 14th century knighthood was rapidly declining and the conditions under which mediaeval poetry had flourished were passing. But the stories of chivalry were still popular although the feeling for beauty of form and expression was lost. As time went on, prose versions of the old stories became more general, and out of these developed the *Volksbücher,* which were the favourite reading of the German people for centuries. The Buch der Abenteuer of Ulrich Fuetrer, written at the end of the 1 jth century, and Der Weisskonig and *Teuerdank* by the emperor Maximilian I (1459–1519), printed in the early years of the 16th. may be regarded as the last monuments of the decadent narrative literature of the middle ages. At the beginning of the new epoch the *Minnesang* could still point to two poets of distinction, Hugo von Montfort (1357–1423) and Oswald von Wolkenstein (1367–1445); but as the lyric passed into the hands of the middle-class poets of the German towns, its emotional sensitiveness gave place to moral and religious dogmatism; and the simple forms of the older lyric were superseded by ingenious metrical distortions. Under the influence of writers like Heinrich von Meissen ("Frauenlob," *c.* 1250–1318), Heinrich von Miigeln and Michael Beheim (1416–*c.* 1480), the *Minnesang* passed over into the Meistergesang. In the later 15th and in the 16th centuries all the south German towns possessed flourishing hfeistersinger schools in which the art of writing verse was taught and practised according to complicated rules.

The great lyric poetry of these transition centuries was not the *Meistergesang,* but the Volkslied. Never before or after did Germany have so rich a harvest of popular poetry—songs of love and war, hymns and drinking-songs, songs of spring and winter and historical ballads. In prose the most popular form was the Schwank or comic anecdote. Collections of such Schwanke range from the practical jokes of Till *Eulenspiegel* (1515), and the coarse witticisms of the *Pfaffe vom* Kalenberg (end of 14th century) and Peter *Leu* (1550), to the religious and didactic anecdotes of J. Pauli's *Schimpf und Ernst* (1522) and the more literary *Rollwagenbüchlein* (1555) of Jörg Wickram and the *Wendunmut* (1563 et seq.) of H. W. Kirchhoff. Of the first importance is the *Narrenschiff* (1494) of Sebastian Brant, a landmark on the way to the Reformation. The beast fable and beast epic appealed with peculiar force to the new generation. At the very close of the hfiddle High German period, Ulrich Boner revived the Aesopic fable in his *Edelstein* (1349), and in the century of the Reformation the fable became, in the hands of Burkard Waldis (*Esopus,* 1548) and Erasmus Alberus (*Buch* von der *Tugend* und *Weisheit,* 1550), a favourite vehicle of satire and polemic. A still more popular form of the beast fable was the epic of Reinke de Vos, which has come down to us in a Low Saxon translation, published at Liibeck in 1498.

The drama, as in all European literatures, emerged slowly and with difficulty from the church liturgy. As time went on the vernacular was substituted for the original Latin and, with increasing demands for pageantry, the scene of the play was removed to the churchyard or the market place; finally the drama was completely separated from ecclesiastical ceremony. The mimic representations, originally allegorical in character, with which the people amused themselves at the great festivals of the year, were interspersed with dialogue, and performed on an improvised stage. This was the beginning of the Fastnachtsspiel or Shrovetide-play which came to be a widespread dramatic feature. Among the earliest cultivators of this type of play were Hans Rosenplut (fl. c. 1460) and Hans Folz (fl. *c.* 1510), both of Nuremberg.

The Reformation. — The coming of the Protestant Reformation was prepared by mysticism and humanism, With Meister Eckhart (c. 1260–1327), Heinrich Seuse or Suso (c. 1300–66) and Johannes Tauler (*c.* 1300–61), mysticism was an essentially personal interpretation of Christianity and as such naturally conducive to the individual freedom of Protestantism. To the mystics we owe the early translations of the Bible into German; one was printed at Strasbourg in 1466. Johann Geiler von Kaisersberg (1445–1510), a pupil of the humanists and a friend of Sebastian Brant, linked mysticism with humanism. Humanism was transplanted to German soil with the foundation of the University of Prague in 1348 but its immediate influence was restricted by the fact that the pre-Reformation humanists despised the vernacular and wrote only in Latin. Thus, although neither Johann Reuchlin of Pforzheim (1455–1522) nor the patriotic Alsatian Jakob Wimpfeling (or Wimpheling) (1450–1528) nor the great Dutch humanist Erasmus of Rotterdam (1466–1536) has, strictly speaking, a place in the history of German literature, the battle of the humanists for liberalism in thought and scholarship cleared the way for a healthy national literature. The *Ackermann* aus Bohmen (c. 1401) by Johann von Saaz (Johann von Tepl), a prose dialogue between Death and a bereaved Plowman, in which Wycliffite affinities are noteworthy, should be mentioned for its style, individualism and religious discontent. Moreover, to humanistic stimulus we also owe many translations from the Latin and Italian, prominent among the translators being Niklas von Wyl (d. c. 1478), chancellor of Wiirttemberg, and Albrecht von Eyb (1420–75).

Martin Luther (1483–1546) demands a large share of attention in a survey of its literature; for his translation of the Bible (1522–34) is, like the English Bible, a great literary monument. Well aware that this Bible must be the keystone to his work, he gave himself endless pains to produce a work German both in language and in spirit. He chose his language, in respect of vocabulary and forms, so that it might be read without difficulty in wide circles of the population; and thus the Lutheran Bible became a factor of the first importance in unifying the speech of the nation. As a hymn writer (Geistliche Lieder, 1524–45) Luther was equally mindful of the importance of adapting himself to popular needs and his hymns form the starting point for a vast development of German religious poetry which was to culminate in the following century; English renderings were made by Miles Coverdale.

The most virile literature of this age was inspired by religious strife. Amongst Luther's henchmen, Philipp Melanchthon (1497–1560), the "praeceptor Germaniae," and Ulrich von Hutten (1488–1523) were powerful allies in his cause, although they had intellectual sympathies with the humanists. The satirical dramas of Niklas Manuel (1484–1530), a Swiss Protestant, and the polemical fables of Erasmus Alberus (c. 1500–53) were, however, insignificant compared with the fierce assault on Protestantism by the Alsatian monk Thomas Murner (1475–1537), the most ruthless of all German satirists. It was not until the following generation that the Protestant party could point to a writer who in genius and power was at all comparable to Murner, namely, Johann Fischart (c. 1550–*c.* 1591). His chief work, the *Affentheuerliche Naupengeheurliche Geschichtklitterung* (157j), a Germanization of the first book of Rabelais's satire, is a witty and ingenious monstrosity, a satirical comment on the life of the 16th century.

On the whole the form of literature which succeeded best in extricating itself from religious polemics in the 16th century was the drama. Protestantism proved favourable to its development, and the humanists, who had always prided themselves on their imitations of Latin comedy, introduced into it form and proportion. The Latin school comedy in Germany was founded by Wimpfeling and J. Reuchlin, and in the 16th century the chief writers of Latin dramas were Thomas Kirchmair or Naogeorgus (1511–63), Caspar Briihlom (1j85–1627), and Nikodemus Frischlin (1547–90). The Jesuits cultivated the Latin religious drama for propaganda purposes; at a somewhat later date, Jacob Bidermann (1578–1639) was the most important figure in this genre. In Basle Pamphilus Gengenbach produced moralizing *Fastnachtsspiele* in 1515–16; and in Berne Niklas Manuel employed the same type of play for anti-Catholic propaganda. Burkard Waldis (c. 1490–1556), Sixt Birck (1501–54) and Paul Rebhun (c.

1500–46) wrote dramas treating biblical themes on humanistic lines. In another important literary centre of the 16th century, Nuremberg, the drama developed on more indigenous lines. Hans Sachs (1494–1576), the Nuremberg cobbler and Meistersinger, left behind him a vast literary legacy embracing every form of popular literature from *Spruch* and *Schwank* to complicated *Meistergesang* and lengthy drama. But in the progress of the German drama he played an even smaller role than his Swiss and Saxon contemporaries; for his tragedies and comedies are little more than stories in dialogue. In the *Fastnachtsspiele,* where dramatic form is less essential than anecdotal point and brevity, he is at his best. After 1586 troupes of English actors began to tour the principal German cities; they at first played in English and their attraction was in their miming, music and acrobatics, especially in the antics of the clown; the more melodramatic products of the Elizabethan stage were prominent in their varied repertoire. They introduced the dramatic and theatrical element which had hitherto been lacking in the German drama. This is to be seen in the work of Jakob Ayrer (d. 1605) and Heinrich Julius, duke of Brunswick (1564–1613). But unfortunately these beginnings had hardly made themselves felt when the full current of the Renaissance swept across Germany, bringing with it the Senecan tragedy. Then came the devastation of the Thirty Years' War, which made the creation of a popular and national theatre impossible.

The novel was less successful than the drama in emancipating itself from satire and religious controversy; Fischart was too dependent on foreign models and too erratic to create a national form of German fiction. The most important novelist was a much less talented writer, the Alsatian Meistersinger and dramatist Jorg Wickram (d. *c.* 1560), who has been already mentioned as the author of a popular collection of anecdotes, the *Rollwagenbüchlein.* His *Der Knabenspiegel* and *Der Goldfaden,* are in form, and especially in the importance they attach to psychological developments, the forerunners of the modern German novel. But Wickram stands alone. The old *Volksbucher* were the real novels of the Reformation age; of these the most famous is *Doctor Johann Faust,* published at Frankfurt in 1587.

THE RENAISSANCE AND THE BAROQUE

The 17th century in Germany presents a complete contrast to its predecessor; the fact that it was the century of the Thirty Years' War, which crippled prosperity and frustrated social development, explains much, but it can hardly be held entirely responsible for the intellectual apathy and slavery to foreign ideas.

There were, however, some branches of German poetry which escaped this foreign influence. The hymn, continuing the great Lutheran traditions, shows extraordinary richness both in quality and quantity. Paul Gerhardt (1607–76), the greatest German hymn writer, was only one of many Lutheran pastors who in this age contributed to the German hymnal. On the Catholic side, the theosophic aphorisms of Angelus Silesius (Johann Scheffler) (1624–77) showed what a wealth of poetry lay in the mystic speculations of Jakob Boehme, the gifted shoemaker of Gorlitz (1575–1624), while Friedrich von Spee (1591–1635), another leading Catholic poet of the century, cultivated the pastoral allegory of the Renaissance. The revival of mysticism associated with Boehme gradually spread through the whole religious life of the 17th century. But all else was profoundly affected by foreign literary influences, French. Spanish, English, Dutch and Italian.

The first focus of the Renaissance literature was Heidelberg, where, under the leadership of J. W. Zincgref (1591–1635), a number of scholars further pursued that interest in the vernacular which had been shown a little earlier by the German translator of Clément Marot, Paul Schede or Melissus (1539–1602). G. R. Weckherlin (1584–1653), a native of Wiirttemberg who had spent the best part of his life in England, wrote *Oden und Gesänge* (1618–19), occasional verse and sonnets in alexandrines of great promise. But the greatest, or at least the most influential, writer of this group was Martin Opitz (1597–1639), a native of Silesia. Strongly influenced by the Renaissance breeding of Pierre Ronsard, Joseph Scaliger and Daniel Heinsius, he deplored the low state of German literature, experimented with every kind of poetry and translated a great deal, including John Barclay's novel *Argenis* (1626) and Ottavio Rinuccini's opera *Dafne* (1627). His *Buch von der deutschen Poeterey* (1624) gave the German Renaissance its theoretical textbook. This tract surveyed the categories of literature, asserted that accent and not syllable-counting was fundamental to German verse, turned poetry into an expression of learning and refinement, and regulated German literature for the next hundred years or so.

The work of Opitz as a reformer was furthered by another institution of foreign origin, namely. literary societies modelled on the *Accademia della Crusca* in Florence. These societies, of which the chief were the *Fruchtbringende Gesellschaft* or *Palmenorden* (founded 1617), the *Elbschwanenorden* in Hamburg and the *Gekronter Blumenorden an der Pegnitz* or *Gesellschaft der Pegnitzschäfer* in Nuremberg, although they produced much that was trivial, did German letters an invaluable service by their attention to the language, one of their chief objects being to purify it from foreign and un-German ingredients. J. G. Schottelius (1612–76) wrote his important grammatical works to further the objects of the *Fruchtbringende Gesellschaft.* Meanwhile the poetic centre of gravity had shifted from Heidelberg to Königsberg, where a group of academic poets gave practical expression to the Opitzian theory, chief among them being Simon Dach (1605–59), a gentle, elegiac writer. In Hamburg in the hands of Johann Rist (1607–67) and Philipp von Zesen (1619–89), in Silesia and Middle Germany in those of Paul Fleming (1609–40) and Andreas Gryphius (1616–64) and, rather later, Christian Hofmann von Hofmannswaldau (1617–79) and Daniel Caspar von Lohenstein (1635–83), the lyric moved steadily from earnestness of expression and feeling towards greater rhetorical affectation and extravagance, the last two poets especially cultivating the bombastic and euphuistic style of the Italians G. B. Guarini and G. B. Marini and the Spaniard Luis de Góngora.

Satire was cultivated by two Low German poets, J. Lauremberg (1590–1658) and J. Rachel (1618–69); but there is satire, too, in the powerful and scathing sermons of J. B. Schupp (1610–61), an outspoken Hamburg preacher, and in the scurrilous tracts and sermons of the Viennese monk Abraham a Sancta Clara (1644–1709), who had inherited something of his predecessor Murner's gift. In an adjacent sphere is Friedrich von Logau (1604–55), Germany's greatest epigrammatist; his 3,000 epigrams *(Deutsche Sinngedichte,* 1654) reflect admirably the intellectual temper of their age.

In the drama, while the influence of the English players was still effective, the models of Andreas Gryphius, the chief dramatist of the century, were mainly Dutch. Like Opitz he was a Silesian and a lyric poet of no mean ability, especially in the field of the sonnet, but his tragedies, modelled on the stiff Senecan pattern, suffered from his ignorance of the more highly developed drama of France, not to speak of England. In comedy he was less hampered, and his *Horribilicribrifax* and *Herr Peter Squentz*—the latter an adaptation, probably through a Dutch intermediary, of the comic scenes of *A Midsummer Night's Dream*—are the best German plays of the 17th century. Molière's influence is to be seen in the didactic and satirical works of Gryphius' successors, Christian Reuter (b. 1665) and Christian Weise (1642–1708).

The German novel of the 17th century was largely a product of foreign influence, Spanish and French. *Don Quixote* had been partly translated early in the century and the picaresque romance had found its way to Germany still earlier; while J. M. Moscherosch (1601–69) in his *Gesichte Philanders von Sittewald* (1642–43) made the *Sueños* of Quevedo the basis for vivid pictures of the life of the time, interspersed with satire. The best German novel of the 17th century, *Der abenteuerliche Simplicissimus* (1669) by H. J. Christoffel von Grimmelshausen *(c.* 1625–76), is picaresque, but it owed little more than its form to the Spaniards. It is in great measure the autobiography of its author and describes with uncompromising realism the social disintegration and the horrors of the Thirty Years' War. Christian Weise wrote a few satirical novels, but his realism and satire are too obviously didactic. He is seen to better advantage in his numerous dramas. The real successor of *Simplicissimus* in Germany was the English *Robinson Crusoe,* a novel which on its appearance was immediately translated into German (1721); it called forth hundreds of imitations *(Robinsonaden),* the vogue of which was to be kept alive by *Der schweizerische Robinson* of J. R. Wyss (1812 *et seq.).* With the exception of J. G. Schnabel's *Insel Felsenburg* (1731–43), the literary value of these imitations is slight, but they represented a healthier development than the "gallant" novels of French provenance, written by authors like Philipp von Zesen (1619–89), Duke Anton Ulrich of Brunswick (1633–1714), A. H. Buchholtz (1607–71), H. A. von Zeigler (1653–97)— author of the famous *Asiatische Banise* (1685)— and D. C. von Lohenstein; Grimmelshausen himself contributed specimens in the "gallant" vein.

AGE OF ENLIGHTENMENT

The Baroque exaggerations were of short duration. Although socially the recovery of the German people from the desolation of the war was slow and laborious, the intellectual life of Germany recuperated rapidly. Samuel Pufendorf (1632–94), Christian Thomasius (1655–1728), Christian von Wolff (1679–1754) and, above all, Gottfried Wilhelm Leibnitz (1646–1716), first of the great German philosophers, laid the foundations of rationalism. The next half century or so was dominated by the philosophical outlook of the Enlightenment *(Aufklarung).* German religious life was strengthened and enriched by a revival of pietism under mystic thinkers like Philipp Jakob Spener (1635–1705), a revival which left its traces on religious poetry. Christian Weise's sober lyrical work led the reaction against bombast. Mediocre though they were, the so-called "court poets," Rudolph von Canitz (1654–99), Johann von Besser (1654–1729) and Benjamin Neukirch (1665–1729), substituted the "good taste" of Nicolas Boileau for the extravagance of Marini; and from their midst sprang one lyric poet, Johann Christian Giinther (1695–1723), of high gifts. In Hamburg Barthold Heinrich Brockes (1680–1747), who was deeply impressed both by Wolffian rationalism and by English nature-poetry, gave the artificiality of poetic expression its death-blow. Ubiquitous translations and imitations of the English *Spectator, Tatler* and *Guardian*— the so-called *Moralische Wochenschriften*—helped to regenerate literary taste and strove to improve the morals of the German middle classes. Between 1724 and 1740 Johann Christoph Gottsched (1700–66) succeeded in establishing in Leipzig, then the metropolis of German taste, literary reforms in accord with French 17th-century classicism. He purified the stage by abolishing irrelevant buffoonery and provided it with a repertory largely of French origin; and in his *Kritische Dichtkunst* he laid down the principles according to which good literature was to be produced and judged.

Reform was necessary, but the Francophile limitations of Gottsched soon encountered resistance, and important opponents arose in the Swiss scholars, J. J. Bodmer (1698–1783) and J. J. Breitinger (1701–76). Basing their arguments on John Milton's *Paradise Lost,* which Bodmer had translated into prose, the Swiss demanded room for the play of genius and inspiration; they insisted that the imagination should not be dominated by the reason. The effects of the controversy appear in a group of Leipzig writers of Gottsched's own school, the *Bremer Beiträger,* as they usually are called after their literary organ. These men—C. F. Gellert (1715–69), author of graceful fables and tales in verse, hymns, moralizing comedies and a sentimental novel; G. W. Rabener (1714–71), mild satirist of Saxon provinciality; the dramatist J. Elias Schlegel (1719–49); and a number of minor writers—were in sympathy with many of the views which the Swiss had advocated. And in the *Bremer Beiträge* there appeared in 1748 the first instalment of an epic by F. G. Klopstock (1724–1803), *Der Messias,* which with Rlopstock's Odes inaugurated the great age of German literature in the 18th century. His rising interest in Germanic antiquity, accompanied by the enthusiasm that was awakened in Germany for James Macpherson's *Ossian,* aided the growth of the so-called bardic movement which was led by H. W. von Gerstenberg (1737–1823), K. F. Kretschmann (1738–1809) and Michael Denis (1729–1800). Signs of growth were also noticeable elsewhere. At Halle, before Klopstock's name was known at all, two young poets, J. I. Pyra (1715–44) and S. G. Lange (1711–81), wrote in rhymeless metres such as Klopstock advocated. The later Prussian poets, J. W. L. Gleim (1719–1803), J. P. Uz (1720–96) and J. N. Gotz (1721–81), who were associated with Halle, and K. W. Ramler (1725–98), in Berlin, cultivated mainly Anacreontic lyric and the Horatian ode; and Friedrich von Hagedom (1708–54) in Hamburg showed to what perfection the lighter *vers de société* could be brought. The Swiss physiologist Albrecht von Haller (1708–77) was the first German poet to give expression to the beauty and sublimity of Alpine scenery in *Die Alpen,* and a Prussian officer, Ewald Christian von Kleist (1715–59), author of *Der Frühling,* wrote admirable nature-poetry. Salomon Gessner (1730–88) became a European figure with his prose pastoral idylls.

As Klopstock had been the first of modern Germany's inspired poets, so Gotthold Ephraim Lessing (1729–81) was the first critic who brought credit to the German name throughout Europe. Like his predecessor Gottsched, whom he vanquished more effectually than Bodmer, he had unwavering faith in classicism, but classic meant for him, as for his contemporary, J. J. Winckelmann (1717–68), Greek art and literature, not French pseudo-classicism. He went, indeed, still further, and asserted in his *Literaturbriefe* (1759–65) and *Hamburgische Dramaturgie* (1767–68) that Shakespeare, with all his irregularities, was a more faithful observer of the spirit of Aristotle's laws than were the French dramatists. He looked to England and not to France for the regeneration of the German theatre and his own dramas were pioneer-work in this direction. *Miss Sara Sampson* is a *bürgerliches Trauerspiel* on the English model; *Minna von Barnhelm,* a comedy in the spirit of Farquhar; in *Emilia Galotti,* again, he remoulded the "tragedy of common life" in a form that came to be acceptable to the *Sturm und Drang;* and finally in *Nathan der Weise* he won acceptance for iambic blank verse as the medium of the higher drama. His two most promising disciples, J. F. von Cronegk (1731–58) and J. W. von Brawe (1738–58), unfortunately died young; but another of his friends, C. F. Weisse (1726–1804), was the most successful playwright of his day. Lessing's name is associated with Winckelmann's in *Laokoon* (1766), a treatise which defines the boundaries between plastic art and poetry, and with those of the Jewish philosopher Moses Mendelssohn (1729–86) and the Berlin bookseller C. F. Nicolai (1733–1811) in the famous *Literaturbriefe.* The last years of Lessing's life were embittered by conflict with Lutheran orthodoxy and intolerance.

To the widening of the German imagination C. M. Wieland (1733–1813) contributed by introducing the Germans to remote and exotic literary settings, largely under French inspiration. With the exception of his verse-romance *Oberon,* his work fell into neglect; he did, however, excellent service to the development of German prose fiction with his psychological novel *Agathon* and with his humorous satire *Die Abderiten.* He also translated 22 plays of Shakespeare. Wieland had a considerable following, including M. A. von Thummel (1738–1817), the Austrians Aloys Blumauer (1755–89) and J. B. von Alxinger (1755–97), who wrote travesties and epics under his influence, and K. A. Kortum (1745–1824), author of the most popular comic epic of the time, the *Jobsiade.* The German novel owed much to the example of *Agathon,* but the groundwork and form were borrowed from English models; Gellert had begun by imitating Samuel Richardson in his *Schwedische Gräfin* and he was followed by J. T. Hermes (1738–1821), Sophie Laroche (1730–1807), A. von Knigge (1752–96) and J. K. A. Musaus (1735–87), the last mentioned being, however, better known as the author of a collection of *Volksmärchen* (1782–86). Meanwhile rationalism was spreading rapidly. Men like Knigge, Mendelssohn, J. G. Zimmermann (1728–95), T. G. von Hippel (1741–96), Christian Garve (1742–98), J. J. Engel (1741–1802), as well as the educational theorists J. B. Basedow (1723–90) and J. H. Pestalozzi (1746–1827), wrote books and essays on popular philosophy which were as eagerly read as had been the *Moralische Wochenschriften.* In this context must also be mentioned the most brilliant of German

18th-century aphorists, G. C. Lichtenberg (1742–99).

THE AGE OF GOETHE

Sturm und Drang.—The periods of classicism and romanticism, together the greatest epoch in German literature, fell within the lifetime of Johann Wolfgang von Goethe (1749–1832). His youth and early manhood belonged to, and profoundly affected, the movement known as *Sturm und Drang* (Storm and Stress), which aimed at supplanting the Enlightenment, and all it stood for. Seeds of the new growth were to be found in Klopstock, in the spiritual force of pietism, and in the rising resistance to French classical taste, while the influence of Jean Jacques Rousseau, Edward Young and Macpherson, and of the recently translated Shakespeare was of prime importance. The critical writings of Gerstenberg (*Briefe uber Merkwürdigkeiten der Litteratur*, 1766–70) stressed personal feeling in matters of taste, but the chief impetus came from the oracular utterances of Johann Georg Hamann (1730–88), the "Magus im Norden," who observed that the basic verities of existence are to be apprehended through faith and the experience of the senses, emphasized the inspirational and symbolical function of language and pointed out the value of primitive poetry, such as that of the Bible. Poetry, he declared, was the mother tongue of the human race and not the product of learning and precept. His pupil was Johann Gottfried Herder (1744–1803). Herder grasped as no thinker before him the idea of historical evolution. Beginning with literary criticism, which engendered the main current of the *Sturm und Drang,* he ended as a philosopher of history and religion, writing on biblical interpretation, aesthetics, history of literature, and many other fields allied to his great objective, the history of mankind; his doctrine of *"Humanitat"* is fundamental to German classicism. He stressed the value of historical continuity in literature, finding therein the reason for the greatness of other literatures; he rejected imitation, discussed the essentials of a poetic language, explained original genius and pointed to the folksongs, ballads and romances of the middle ages as sources of inspiration, to which Percy's *Reliques* had recently drawn attention. Among his many works may be mentioned his *Fragmente uber die neuere deutsche Litteratur* (1767), *Kritische Wälder, Über den Ursprung der Sprache,* contributions to the collection *Von deutscher Art und Kunst, Volkslieder* (1778–9), *Zdeen zur Philosophie der Geschichte der Menschheit.* Percy's *Reliques* also affected the work of a group of poets who, adoring Klopstock and hating Wieland, founded in 1772 the Gottingen *Bund* or *Hain,* and published their poetry in the *Gottinger Musenalmanach.* With the exception of the two brothers, Christian zu Stolberg (1748–1821) and F. L. zu Stolberg (1750–1819), the members of this coterie belonged to the peasant class or the lower bourgeoisie; J. H. Voss (1751–1826), the leader of the *Bund*, and author of the famous idyll, *Luise* (1784), was a typical north German peasant. L. H. C. Holty (1748–76) and J. M. Miller (1750–1814), again, excelled in simple lyrics in the tone of the *Volkslied.* Closely associated with the Gottingen group were M. Claudius (1740–181j), an even more unassuming representative of the German peasant in literature than Voss, and G. A. Biirger (1747–94), author of the famous ballad of *Lenore.*

The *Sturm und Drang* was intimately associated with Goethe. As a student in Leipzig, Goethe had written lyrics in the Anacreontic vein and dramas in alexandrines; but in Strasbourg, where he continued his studies in 1770–71, he made the personal acquaintance of Herder, who interested him in Gothic architecture, the *Volkslied* and Shakespeare. The pamphlet *Von deutscher Art und Kunst,* to which, besides Goethe and Herder, the historian Justus Moser (1720–94) contributed, was a kind of manifesto of the *Sturm und Drang.* The new ideas seemed at once to set Goethe's genius free, and from 1772–75 he was extraordinarily fertile in poetic ideas. His *Gotz von Berlichingen* (1773), the first important drama of the *Sturm und Drang,* was followed within a year by the first novel of the movement, *Die Leiden des jungen Werther* (1774). He dashed off *Clavigo* and *Stella* in a few weeks in 1774 and 1775, and wrote a large number of *Singspiele,* dramatic satires and fragments—including *Faust* in its earliest form (the so-called *Urfaust*)—not to mention matchless lyrics. In all forms of literature he set the fashion for his time; tne Shakespearian restlessness of *Götz von Berlichingen* found imitators in J. M. R. Lenz (1751–92), F. M. von Klinger (1752–1831), J. A. Leisewitz (1752–1806), H. L. Wagner (1747–79) and Friedrich Miiller, better known as Maler Muller (1749–1825). The dramatic literature of the *Sturm und Drang* was its most characteristic product—indeed, the very name of the movement was borrowed from a play by Klinger; it was inspired by the desire to present upon the stage figures of Shakespearian grandeur impelled by gigantic passions, all considerations of plot, construction and form being subordinated to character and all accepted authority, literary, social, political or moral, rejected. The fiction of the *Sturm und Drang,* again, was in its earlier stages dominated by *Werthers Leiden,* as may be seen in the novels of F. H. Jacobi (1743–1819) and J. M. Miller, already mentioned above. Later, it was developed in a broader and less turbulent spirit by J. J. W. Heinse (1749–1803), author of *Ardinghello,* Klinger and K. P. Moritz (1757–93), whose *Anton Reiser* foreshadows *Wilhelm Meister.*

With the production of *Die Räuber* (1781) by Johann Friedrich Schiller (1759–1805), the drama of the *Sturm und Drang* entered upon a new phase. Schiller's tragedy was more skilfully adapted than those of his predecessors to the exigencies of the theatre; it and the succeeding dramas, *Fiesco* and *Kabale und Liebe—all* three in prose—were masterpieces of high promise. In his fourth drama, *Don Carlos,* he abandoned prose for iambic blank verse. In Swabia, however, the *Sturm und Drang* had also been displayed in the irritable C. F. D. Schubart (1739–91). Other eminent dramatists of this time were O. von Gemmingen (1755–1836), an imitator of Denis Diderot, F. L. Schroder (1744–1816) and A. W. Iffland (1759–1814), the two latter the greatest actors of their time. Germany owed to the *Sturm und Drang* its national theatre; permanent theatres were established in these years at Hamburg, Mannheim and Gotha, and the Hofburgtheater was founded at Vienna in 1776.

Classicism.—The *Sturm und Drang* soon exhausted itself. For Goethe this phase in his development came to an end with his departure for Weimar in 1775, while after *Don Carlos* Schiller turned aside from poetry to study history and philosophy; not until the very close of the century did he, under the stimulus of Goethe's friendship, return to the drama. The first ten years of Goethe's life in Weimar were marked by his renewed friendship with Herder, whose ideal of *"Humanität"* was now maturing, by an interest (which was to be lifelong) in scientific research, by his public service as a minister of state, and by his emotional attachment to Frau von Stein. He did not arrive at clearness in his ideas until after his sojourn in Italy (1786–88). Italy was, in the first instance, a revelation to Goethe of the antique; here he conceived that ideal of a classic literature which for the next 20 years dominated German literature. In Italy he gave *Iphigenie auf Tauris* its final form, he completed *Egmont*—like the exactly contemporary *Don Carlos* of Schiller, a kind of bridge from *Sturm und Drang* to classicism—and *Torquato Tasso. Wilhelm Meisters Lehrjahre* (1795–96), Goethe's most important novel, which had been originally concerned only with the theatre, became now a book on the conduct of life.

Before *Wilhelm Meister* appeared, however, German thought and literature had arrived at that stability in form and ideas essential to a great literary period. In the year of Lessing's death, 1781, Immanuel Kant (1724–1804), the great philosopher, had published his *Kritik der reinen Vernunft* and this, together with the two later treatises, *Kritik der praktischen Vernunft* and *Kritik der Urteilskraft,* placed the Germans in the front rank of philosophy. Under the influence of Kant, Schiller turned to the study of aesthetics, the first fruits of which were his wonderful philosophic lyrics, and his treatises *Anmut und Würde, Ästhetische Erziehung des Menschen* and *Über naive und sentirnentalische Dichtung.* Schiller's histories *(Geschichte des Abfalls der vereinigten Niederlande* and *Geschichte des dreissigjährigen Krieges)* show much literary quality but scarcely entitle him to rank alongside Johannes von Miiller (1752–1809), the greatest historian of the time in Germany.

The years 1794–1805, when in Jena and Weimar Goethe and Schiller wore united by a close friendship, mark the culmination of literary classicism. Schiller's treatises provided a theoretical basis; his new journal *Die Horen* and his *Musenalmanaclz*—in which the two poets published their magnificent ballad poetry—were its literary organs. Goethe, as director of the ducal theatre, influenced the whole dramatic production of Germany. Under his encouragement Schiller turned from philosophy to poetry and wrote the splendid series of classic dramas, the trilogy of *Wallenstein, Maria Stuart, Die Jungfrau von Orleans, Die Braut von Messina, Wilhelm Tell,* closing with the fragment of *Demetrius;* while to Goethe we owe the idyllic epic of *Hermann und Dorothea;* his severely classical plays *Die natürliche Tochter* and *Pandora* are less important; but it was chiefly owing to Schiller's stimulus that in those years Goethe brought the first part of *Faust* (1808) to a conclusion.

Although acknowledged leaders of German letters, Goethe and Schiller met with considerable opposition, especially from representatives of the once dominant rationalistic movement. But, apart from the two great poets, literature was in no very healthy condition; the stage was dominated by the extraordinarily popular plays of A. von Kotzebue (1761–1819); and there is a wide gap between Moritz's *Anton Reiser* or the philosophic novels which Klinger wrote in his later years, and Goethe's *Meister.* In lyric and epic poetry, it is impossible to regard poets like the gentle F. von Matthisson (1761–1831), or the less inspired G. L. Kosegarten (1758–1818) and C. A. Tiedge (1752–1841), as worthy of an age that produced Goethe and Schiller. Georg Forster (1754–94), however, who accompanied Captain James Cook round the world, provided a model of lucid descriptive writing.

The supreme work of Goethe's latter years is *Faust,* Germany's greatest contribution to the literature of the world. Although Part I was published in 1808, Part II was not completed until shortly before Goethe died and was published in 1832. In Part I is set out Faust's despair, his pact with Mephistopheles and his love for Gretchen; Part II covers the magician's life at court, the winning of Helen of Troy and Faust's purification and salvation. The doctrine of the fulfilment of life by striving and selfless activity, with the problems contained within it, is fundamental to Goethe's mature wisdom. *Wilhelm Meisters Wanderjahre,* with its social utopianism and teaching of restraint, offered a criticism of the rise of industrialism. The tragic novel *Die Wahlverwandtschaften* had similarly insisted upon the theme of renunciation. The autobiographical *Dichtung und Wahrheit* affirmed the causality existing within individual development. Dramatic pieces, a periodical *Über Kunst und Altertum,* scientific writings, the *Italienische Reise* and *Kampagne in Frankreich,* lyrics (especially *Der Westostlicher Divan)* of an intensely personal and philosophical kind indicate the many-sidedness of Goethe's achievement. Letters, diaries and conversations afford a very complete picture of his old age. His house at Weimar became a place of pilgrimage; his visitors and correspondents belonged to all countries, and his influence was extremely widespread.

The Romantic Movement.—The romantic movement began not so much as a protest against the classicism of Weimar, with which many romanticists were in sympathy, as a radical extension of some of its beliefs and interests. Friedrich Holderlin (1770–1843), one of Germany's greatest lyrical poets and author of the novel *Hyperion,* grew up as an admirer of Schiller; he sank into despair on realizing the impossibility of his longing for an age of heroic idealism and beauty such as that of ancient Greece; the Hellenic interests of the age were linked by him with an intense patriotism. Jean Paul Friedrich Richter (1763–1825), known as Jean Paul, was a disciple of Herder. His sentiment, ingenuity, whimsical style and lavish detail gained for his shapeless novels a vast degree of popularity; his sustained attention to contemporary life, rather than antiquity or the middle ages, and particularly to the smaller problems of life. was a new feature and his work foreshadowed the *Dorfgeschichte* of later decades. His principal novels were *Hesperus, Quintus Fixlein, Siebenkäs, Titan* and *Flegeljahre;* his *Vorschule der Ästhetik* reveals a historical grasp of literary growth and *Levana* is a treatise on education. The first romantic school proper was founded at Jena in 1798, appropriately near to Weimar. Ludwig Tieck (1773–1853), a leading member of the school, early developed a lifelong enthusiasm for Shakespeare and the Elizabethan and Spanish drama. Gruesome plays and fairy tales, novels and fantastic comedies full of wit and mockery were his earliest works. The short stories of his later period were more valuable. The theoretic basis of romanticism was laid down by the two brothers August Wilhelm and Friedrich Schlegel (1767–1845 and 1772–1829), who, accepting in great measure Schiller's aesthetic conclusions, adapted them to their own needs. These romantic critics maintained that the first duty of criticism was to understand and appreciate; the right of genius to follow its natural bent was sacred. The *Herzensergiessungen eines kunstliebenden Klosterbruders* by Tieck's school friend W. H. Wackenroder (1773–98) contained the romantic theory of art. The greatest imaginative achievement is to be found in the lyrics and fragmentary novels of Novalis (Friedrich von Hardenberg) (1772–1801), in which Christian mysticism, romantic mediaevalism and symbolism transfer the reader into the realm of the *Märchen;* this is particularly so in Novalis' *Heinrich von Ofterdingen* (1802). The novel was the romantic art-form *par excellence* and was attempted by almost every one of the romanticists. The universal sympathies of the movement were exemplified by the many admirable translations, produced under its auspices, of which the greatest was A. W. Schlegel's *Shakespeare,* and by A. W. Schlegel's courses of lectures at Berlin and Vienna. The critical essays and aphorisms of F. Schlegel are among the most important features of the movement; they argued that modern (or romantic) literature, as distinct from ancient (or classical), should deal with modern life in all its manifestations without any restriction, and put forward *Wilhelm Meister* as the model to be followed. The literary organ of the school was the *Athenaum* (1798–1800). J. G. Fichte (1762–1814) and to a much greater extent, F. W. J. von Schelling (1775–1854) were the exponents of the romantic doctrine in philosophy, while the theologian F. D. E. Schleiermacher (1768–1834) demonstrated how vital its individualism was for religious thought.

The first romantic school had dispersed by 1804. Two years later, however, another phase of romanticism was initiated in the town of Heidelberg. The leaders of this second romantic school were Klemens Brentano (1778–1842), L. A. von Arnim (1781–1831) and J. J. von Gorres (1776–1848); their organ was the *Zeitung für Einsiedler,* or *Tröst-Einsamkeit,* and their most characteristic production the collection of *Volkslieder* published under the title *Des Knaben Wunderhorn* in 1805–08. Compared with the earlier school, the Heidelberg writers were practical; they, too, were interested in the German past, but they put aside the idealizing glasses of their predecessors: they wrote historical works, not stories of an imaginary mediaeval world as Novalis had done, and they collected *Volkslieder* and *Volksbücher.* Their immediate influence on German intellectual life was consequently greater; they stimulated the interest of the German people in their history and we owe to them the foundations of the study of German philology and mediaeval literature, the brothers Jakob and Wilhelm Grimm (1785–1863 and 1786–1859) having been in touch with the circle in their early days. Again, the Heidelberg poets strengthened the national and patriotic spirit of their people; they prepared the way for the rising against Napoleon in 1813, which produced an outburst of patriotic song, the chief voices being those of E. M. Arndt (1769–1860), K. Th. Korner (1791–1813) and M. von Schenkendorf (1783–1817). When, about 1809, the Heidelberg school broke up and Arnim and Brentano settled in Berlin, the romantic movement followed two clearly marked lines of development, one north German, the other associated with Wiirttemberg. In the north Heinrich von Kleist (1777–1811), Prussia's greatest dramatic poet, created a romantic drama and short story of high poetic achievement; he was a leading writer in the patriotic movement against Napoleon. His plays, such as *Amphitryon, Der zerbrochene Krug, Das Käthchen von Heilbronn, Die Hermannsschlacht* and *Der Prinz von Homburg,* express the belief that the only security in life is to be found in the unconscious voice of feeling and instinct. Zacharias Werner (1768–1823), an undisciplined and unbalanced dramatic genius, sounded depths of mysticism and fatalism. There were at the same time some elements of decadence;

Friedrich de la Motte Fouqué (1777–1843), for instance, shows how easy it was for the mediaeval tastes of the romanticists to be satisfied with mediocre novels and plays. E. T. A. Hoffmann (1776–1822), a novelist of indubitable genius, cultivated for preference in his stories a morbid supernaturalism and gave European currency to German romanticism. The north German romantic circle could point to one lyric poet of the very first rank, the Silesian J. von Eichendorff (1788–1857); while A. von Chamisso (1781–1838), a French *émigré,* developed into a German poet of the purest water. Others, like Friedrich Ruckert (1788–1866), sought new inspiration in the poetry of the east; and Wilhelm Müller (1794–1827) following Lord Byron's example, stirred German sympathy for the oppressed Greeks and Poles.

The last phase of romanticism is represented by the Swabian school. Its chief representative Ludwig Uhland (1787–1862), himself a disciple of the Heidelberg school, as a ballad-poet is second only to Schiller in popular esteem. One might say that the mission of the Swabian circle, the chief members of which were J. Kerner (1786–1862), G. Schwab (1792–1850), W. Waiblinger (1804–30), W. Hauff (1802–27) and, most gifted of all, E. Morike (1804–75), was to preserve in both poetry and prose the romantic traditions from the disintegrating influences to which their north German contemporaries were exposed in the next generation.

GERMAN LITERATURE AFTER GOETHE'S DEATH

The Biedermeier Age and After.—With Goethe's death a great age in German poetry came to a close. In philosophy Schelling had given place to G. W. F. Hegel (1770–1831) and the Hegelian metaphysics proved a less fruitful influence on literature than did that of Fichte and Schelling. The transference of romantic ideas to religion and politics had led to reaction; and romantic politics, as enunciated by men like F. von Gentz (1764–1832) and Adam Müller (1779–1829) was an apology for the Metternich regime in Austria. Only at the universities—in Gottingen, Heidelberg and Berlin—did the movement continue, in the best sense, to be productive; German philology, historical science and jurisprudence benefited by romantic ideas, long after romantic poetry had been superseded. The day of romanticism was over; but a return to the classic and humanitarian spirit of the 18th century was impossible. The social condition of Europe had been profoundly altered by the French Revolution; the rise of industrialism had created new economic problems: the march of science had overturned old prejudices. The age of Goethe had, however, seen the growth of a unified German cultural life, conveniently described as German idealism, long before political unification became practicable. The frustration of political hopes after the fall of Napoleon thrust the middle classes, which had been the chief bearers of this culture, back into intellectual pursuits, while only the younger generation at the universities sought to prolong the struggle for liberalism and unity.

A number of important writers aimed at continuing the work of the previous age in the new conditions, expressing a restricted, private and passive spirit of compromise between frustrated idealism and possible achievement. The mood of the *Biedermeier* epoch is one of resignation. For the first time since the middle ages, Austrian literature steps into the forefront, combining the heritage of the Baroque and the Enlightenment of Joseph II's time with the impact of idealism. Franz Grillparzer (1791–1872), Austria's greatest dramatist, aimed at reconciling, as Kleist had attempted to do, the classicism of Goethe and Schiller with the romantic and modern spirit. The drama of idealism becomes, in his hands, the drama of renunciation. His plays—*Sappho, Das goldene Vliess, Konig Ottokars Gliick und Ende, Der Traum, ein Leben, Weh' dem, der liigt!* and others, stress the value of the inward life and the acceptance of tragedy as inherent in life itself. The popular farces of F. Raimund (1790–1836) and J. Nestroy (1801–62) continued, in a satirical vein, the Baroque and Italian comedy. E. von Bauernfeld (1802–90) wrote society comedy; Friedrich Halm (the pseudonym of E. F. J. von Munch-Bellinghausen, 1806–71), once extremely popular, later was no longer read. Much of the temper of the Austrian *Biedermeier* in the realm of regional fiction appears in the work of Adalbert Stifter (1805–68); he eschewed passion and glorified scenery rather than men. His novel *Der Nachsommer* (1857) which has a didactic flavour, extols the virtues of resignation and simplicity in family life, in a reposeful and pictorial style; short stories *(Studien, Bunte Steine)* and a historical novel *Witiko* (1865–67) should also be mentioned. Karl Immermann (1796–1840), in northwestern Germany, more vigorously reveals the perplexities of his transitional age; his novels *Die Epigonen,* which gave its name to the whole group of postclassical and postromantic writers, and *Miinchhausen* satirized the mediocrity of the time and discovered strength in peasant life; his dramas were unsuccessful.

The melancholy frustration of the age was reflected in the work of poets whose temperaments were more extreme than those of the *Biedermeier* writers. Nikolaus Lenau (1802–50), a Hungarian by birth, plumbed depths of poetic melancholy not before touched; lyrical epics in the Byronic mode (*e.g., Faust, Savonarola, Die Albigenser, Don Juan)* expressed Byron's discontent without his defiance. Morike embodied the idyllic modesty of the *Biedermeier* and probed deeply in his novel *Maler Nolten* into the artist's problems. Annette von Droste-Hulshoff (1797–1848), Germany's greatest poetess, found solace in a firm religious faith which she combined with a realistic attention to landscape. These lyrical poets stood much nearer to the romantic school than their contemporaries in the drama. C. D. Grabbe (1801–36), an extravagantly rebellious genius, scorned the accepted middle-class values and depicted the struggles between heroism and mediocrity in historical plays such as *Kaiser Friedrich Barbarossa, Napoleon, oder die hundert Tage* and *Don Juan und Faust.* Rebellious pessimism occurs also in the work of Georg Büchner (1813–37), whose social radicalism attracted political persecution; *Dantons Tod* deals with the impossibility of greatness in human life; a fragment *Woyzek* depicts proletarian misery. The greatest dramatic figure, however, was that of Friedrich Hebbel (1813–63), who evolved a profound theory of the tragedy that is inherent in historical progress, the sacrifice of the individual being necessary for the life of society; tragic guilt being independent of moral guilt. The spirit of Hegel's dialectic is in Hebbel's dramas, as well as Buchner's belief in the inevitable suffering of greatness. Hebbel's greatest works are *Judith, Maria Magdalene, Agnes Bernauer, Herodes und Mariamne, Gyges und sein Ring* and *Die Nibelungen.* His contemporary Otto Ludwig (1813–65), an expert dramatic theorist, displayed realism and psychological skill in his tragedies *Der Erbförster* and *Die Makkabaer* and his novel *Zwischen Himmel und Erde.*

In lyrical poetry the attack upon romanticism was conducted by A. von Platen-Hallermunde (1796–1835). The least subjective of all German lyricists, despising the political cares of his fellows, he became a supreme master of artistic form, especially in the field of the sonnet as he shows in his *Sonette aus Venedig;* he cultivated oriental modes in the lyric and aristophanic satire in his plays. His classicism stood alone, until much later when, between 1852 and 1860, Maximilian II of Bavaria gathered round him at Munich some of the representative poets of the day. A leading spirit of this group was E. Geibel (1815–84); F. von Bodenstedt (1819–92) revived the oriental interest in his *Mirza Schaffy;* other lyricists were H. Lingg (1820–1905), M. Greiff (1838–1911) and the Swiss, H. Leuthold (1827–79), all of them concerned with formal elegance. The chief prose writer of the group was Paul Heyse (1830–1914), notable for his short stories and his novels *Kinder der Welt* and *Im Paradiese.* Not far remote from these writers was J. V. von Scheffel (1826–86), who won popularity with his historical novel *Ekkehard* and his verse romance *Der Trompeter von Sackingen.*

Young Germany.—Political resistance to the romantic reaction was expressed in the 1830s in the work of a number of writers who came to be known as Young Germany. They did not form a school in the accepted sense; the group was called into being in 1835 by a decree suppressing the writings of Heinrich Heine, Karl Gutzkow, Ludolf Wienbarg, Theodor Mundt and Heinrich Laube. Of these men, Heine (1797–1856) is by far the most famous. He had made his reputation in 1826 and 1827 with *Die Harzreise* and his *Buch der Lieder,* both of which show how deeply he was immersed in the romantic traditions. The *Buch der Lieder* is, in fact, one of the most famous German songbooks. But Heine felt more acutely than any other man of his time how the ground was slipping away from beneath his feet; he hailed the July revolutions as the first stage in the "liberation of humanity" and sought in France the freedom and intellectual stimulus which Germany withheld from him. These sympathies were always counteracted, however, by doubts whether, after all, life had not been better in that old romantic Germany of his childhood for which, to the last, he retained so warm an affection. To these doubts were added bitter disappointments and the sufferings caused by spinal disease, and the gifted poet-satirist was often overshadowed by the cynic.

Heine's contemporary, Ludwig Borne (1786–1837), was a more wholehearted representative of the Young German point of view; and his brilliant *Briefe aus Paris* form a landmark in the development of German prose style. Karl Gutzkow (1811–78) had become a man of letters under the influence of the July revolution, and in an early novel, *Wally, die Zweiflerin,* then regarded as atheistic and immoral, he fought for the new ideas. His best literary work was the comedies with which he enriched the German stage of the 1840s, and the long novels *Die Ritter vom Geiste* and *Der Zauberer von Rom.* Heinrich Laube (1806–84), critic and author of social novels, was another of the leaders of the new movement, but he is best remembered as Germany's greatest theatre manager, being director of the Vienna Burgtheater from 1850 to 1867. The scholarship and learning of this period were strongly infused with Hegelianism, the leading spirits being D. F. Strauss (1808–74), author of the *Leben Jesu,* the historians G. G. Gervinus (1805–71) and W. Menzel (1798–1873), and the philosopher L. A. Feuerbach (1804–72).

The political ideas of the Young German movement gained ground in the unsettled conditions prevailing between the revolutions of 1830 and 1848. The early 1840s were marked by an outburst of political poetry, which may be compared with the national and patriotic lyric of 1813. Initiated by mediocre talents like N. Becker (1809–45) and R. E. Prutz (1816–72), the movement found a vigorous champion in Georg Herwegh (1817–75), who in turn succeeded in winning Ferdinand Freiligrath (1810–76) for the revolutionary cause. Others joined in the revolutionary cry—F. Dingelstedt (1814–81), A. H. Hoffmann von Fallersleben (1798–1874) and a number of Austrians. But the best Austrian political poetry, the *Spaziergänge eines Wiener Poeten* (1831), by "Anastasius Grün" (Graf A. A. von Auersperg, 1806–76), belonged to a decade earlier. E. Geibel was only temporarily interested in the political movement. The promising talent of M. von Strachwitz (1822–47) did not feel at home in the political atmosphere and he won greater fame as a ballad-writer.

Realism.—The growth of natural science combined with the decline of religious faith gave rise to a regard for the processes of nature as the only reality. On the one hand was the belief in man's power to harness nature to his needs, on the other an increased consciousness of man's dependence upon nature. Materialism and determinism followed in the wake of Feuerbach's agnosticism. After the revolution of 1848 a spirit of passivity came over literature; it was not wanting in achievement, but it lacked conviction and enthusiasm. Hegel's influence gave place to that of the chief exponent of philosophic pessimism, Arthur Schopenhauer (1788–1860). Schopenhauer's chief work, *Die Welt als Wille und Vorstellung,* had appeared, it is true, as far back as 1819; but the century was more than half over before pessimism became a dominant force in German intellectual life.

The function of literature in this context was not to proclaim idealized regions beyond the sphere of actuality; the poet, being dependent upon and conditioned by his world, did not set out to be its master. The caprices of romanticism were no more. It was natural that prose narrative should be the most suitable form in which realism expressed itself. In historical fiction realism showed itself in the descriptions of scenes and customs rather than in characterization. The influence of Sir Walter Scott and the heritage of the historical novels of Arnim and Hauff were taken further in the work of Willibald Alexis (the pseudonym of Wilhelm Häring, 1798–1871); after frankly imitating Scott in *Walladmor,* he turned to his own province of Brandenburg, and a series of novels between 1840 and 1856, from *Der Roland von Berlin* to *Dorothe,* reveal an increasing independence of his master. But Alexis had no successor and the historical novel later made way for the "antiquarian" novels by Georg Ebers (1837–98) and Felix Dahn (1834–1912). The greatest master of realistic historical fiction was Conrad Ferdinand Meyer (1825–98), a Swiss writer of short stories, lyrics, ballads and a poetic narrative *Huttens letzte Tage;* his work is dominated by a nostalgic admiration of great personalities and is marked by a magnificent smoothness of style and power of compression. *Jiirg Jenatsch* and *Der Heilige* began a series of finely polished stories. Ernst von Wildenbruch (1845–1909) may be mentioned here as a once popular writer of patriotic historical plays about the Hohenzollerns and mediaeval emperors; *e.g., Die Quitzows.* Under James Fenimore Cooper's influence American life and adventure came into vogue. The chief German writers who made these their theme were K. A. Postl, who wrote under the pseudonym of Charles Sealsfield (1793–1864), Friedrich Gerstacker (1816–72) and Karl May (1842–1912).

Of much importance was the novel of peasant and provincial life, of which Immermann had given an excellent example in *Der Oberhof,* a short story embedded in his *Miinchhausen.* A Swiss pastor, A. Bitzius, better known by his pseudonym Jeremias Gotthelf (1797–1854), was, however, the real founder of the peasant romance; and his simple, unvarnished stories of Swiss life were followed not long afterwards by the more famous *Schwarzwalder Dorfgeschichten* (1843–54) of Berthold Auerbach (1812–82). These village stories now seem lacking in naïveté, but they enjoyed a wide popularity in their day. The Low German peoples benefited by the revival of interest in dialect and peasant life; Fritz Reuter (1810–74) brought honour to the *Plattdeutsch* of the north, with his Mecklenburg novels, especially *Ut de Franzosentid, Ut mine Festungstid* and *Ut mine Stromtid,* books which have a place beside the best High German fiction of the period; what Reuter did for *Plattdeutsch* prose, his contemporary, Klaus Groth (1819–99), the author of *Quickborn,* did for its verse. Another north German, Theodor Storm (1817–88), is the author of short stories of delicate, lyric inspiration, steeped in that elegiac romanticism which harmonized so well with mid-century pessimism. In Switzerland Gottfried Keller (1819–go), a native of Ziirich, was a modern romanticist of a more robust type; his magnificent autobiographical novel, *Der griine Heinrich,* might be described as the last in the great line of romantic fiction that had begun with *Wilhelm Meister,* and his volumes of short stories, *Die Leute von Seldwyla* and *Züricher Novellen,* contain masterpieces of the first rank.

In Austria the story of peasant life was continued by Peter Rosegger (1843–1918), Marie von Ebner-Eschenbach (1830–1916) and Ferdinand von Saar (1833–1906), while in the field of regional drama Ludwig Anzengruber (1839–89) moved in the direction of naturalism. The humourists Wilhelm Busch (1832–1908) and Heinrich Seidel (1842–1906) may be mentioned in this general association.

Several important novelists stand aside from these trends. Gustav Freytag (1816–95) glorified the sturdy qualities of the middle class in commerce (*Soll und Haben*) and scholarship (*Die verlorene Handschrift*) and presented popular pictures of the German past in *Bilder aus der deutschen Vergangenheit* and *Die Ahnen.* Friedrich Spielhagen (1829–1911) followed in the wake of Gutzkow, holding up the mirror to social problems in a series of novels from *Problematische Naturen* to *Sturmflut.* Wilhelm Raabe (1831–1910) mingled pessimism with humour, and his works. such as *Die Chronik der Sperlingsgasse, Der Hungerpastor* and *Stopfkuchen,* are marked by nostalgic reminiscence, resignation and sentiment; his historical novels—Nach *dem grossen Kriege* and others—emphasize his doubts about his own time. Theodor Fontane (1819–98), a ballad-writer (under English influence) and author of social and historical novels, was concerned with caste problems, which he depicted with masterly realistic detail and psychological insight in *Vor dem Sturm, Irrungen, Wirrungen, Stine, Effi Briest* and others; like so many he perceived the crisis that faced German middle-class values and was as eager as Raabe for genuineness of feeling.

The Franco-German War had little or no immediate effect on literary development. Political and economic problems engrossed public attention. The dominant force in literature continued to be the philosophy of Schopenhauer. The novel was the most popular genre of the day. The drama showed little promise, except for the stage improvements following the artistic reforms introduced by the duke of Meiningen in his court theatre and the ideals of a national theatre realized at Bayreuth by Richard Wagner (1813–83), whose tetralogy *Der Ring des Nibelungen* was first performed there in 1876. The shortcomings of the contemporary outlook were sharply brought out in the works of Friedrich Nietzsche (1844–1900). Beginning as a disciple of Schopenhauer and friend of Wagner, he became militantly individualistic and strengthened the current of arrogant "titanism" that was developing. The individual, not the herd, the *Herrenmensch*, not the slave, self-assertion, not renunciation, are the ideas on which his ethics pivot. He looked forward to the emergence of the human race from the effete culture of tradition and its re-establishment upon a basis in harmony with man's primitive instincts. Nietzsche was a stylist of the first rank and his literary masterpiece *Also sprach Zarathustra* (1883–91) is one of the most important books of its time.

The Naturalist Movement.—Nietzschean individualism was only one of many factors which profoundly affected literature. The realistic movement as it had developed in France, Russia and Scandinavia became a dominant force in Germany towards the end of the century and, with the impact of Darwinism and the rising force of social democracy, the last step was taken in the abjuration of romanticism in the form of naturalism. The centre of this new movement was Berlin, which was rapidly becoming the literary metropolis. Literature became markedly tendentious: slum scenery, unadorned, even vulgar language, sex, alcoholism, poverty and the effects of heredity were exploited as its main features. The movement was founded by the review *Kritische Waffengänge* (1882–84), run by the brothers Heinrich and Julius Hart, and by M. G. Conrad's magazine *Die Gesellschaft* (1885–1902). The realistic novels of Conrad (1846–1927), K. Bleibtreu (1859–1928), M. Kretzer (1854–1941) and H. Conradi (1862–90), the tragedy *Jugend* by Max Halbe (1865–1944) and the satirical comedies of O. E. Hartleben (1864–1905) were less important than the sketches *Papa Hamlet* by Arno Holz (1863–1929) and Johannes Schlaf (1862–1941), their drama *Die Familie Selicke*, and the early works of Hermann Sudermann (1857–1928) and Gerhart Hauptmann (1862–1946). Sudermann, beginning as a novelist with *Frau Sorge*, won rapid fame in the drama with *Die Ehre* and *Heimat*, but later works (*e.g.*, *Es war* and *Das hohe Lied*) suffered from crass sensationalism. Hauptmann came to be one of the outstanding figures of 20th-century German literature. His drama *Vor Sonnenaujgang* (1887) made him head of the new movement; it was the first of a series of naturalistic plays of which *Die Weber* was the most powerful. Poetic mysticism joined forces with realism in *Hanneles Himmeljahrt*, historical realism came in *Florian Geyer*, and allegory in *Die versunkene Glocke*. Hauptmann's development was exceedingly varied and belonged to many fields, tragedy, fantasy, legend, lyric, comedy with *Der Biberpelz*, epic with *Till Eulenspiegel* and *Der grosse Traum*, novel and short story. His principal novels were *Der Narr in Christo Emanuel Quint*, the tragedy of a would-be religious leader, *Atlantis*, a study of the weakness of contemporary culture, *Der Ketzer von Soana*, a pagan glorification of sex, *Die Insel der grossen Mutter*, a utopian story of a matriarchy, and *Im Wirbel der Berufung*, a "Hamlet" story. *Das Buch der Leidenschajt* and *Das Abenteuer meiner Jugend* are autobiographical. During World War II, Hauptmann worked on a cycle of dramas on the Atrides, stressing the timeless values of humane classicism. His vast range and creative power, with his strong sense of compassion, made him a national figure.

The incompatibility of naturalism and artistic achievement was quickly apparent, as Hermann Bahr (1863–1934) explained in *Die Uberwindung des Naturalismus*. The range of literature had, however, been immensely widened, and in the many cross-currents that followed, the problems first adumbrated by the naturalists, especially those of sex and proletarian misery, recurred. Once the philanthropic zeal of naturalism was withdrawn, there remained, in the movement known as impressionism, merely a positivistic attention to reality. often only the sordid and obscene. At the same time other trends emerged—symbolism, an off-shoot of romanticism; expressionism, an incoherent and eccentric reaction against materialism for its neglect of ethical considerations; and neoclassicism, which looked back to the values of Lessing and Schiller.

20th-Century Verse.—Verse showed the most significant progress of all branches of literature in 20th-century Germany. The first poet to break with tradition was Detlev von Liliencron (1844–1909) in his *Adjutantenritte;* a soldier and sportsman, he resisted false sentiment and romanticism and wrote fluent ballads, realistic lyrics, an epic, dramas and novels. In the ballad he was followed by F. Avenarius (1856–1923), B. von Miinchhausen (1874–1945), Agnes Miegel (1879–) and Lulu von Strauss und Torney (1873–). O. J. Bierbaum (1865–1910) wrote in a cabaret-like vein, which was sustained in his plays and novels of bohemianism. Arno Holz in *Das Buch der Zeit* and *Phantasus* introduced novel theories of poetical form and his phrase-rhythms gave new flexibility to German poetry. G. Falke (1853–1916), J. H. Mackay (1864–1933) and Karl Henckell (1864–1929) belonged to the school of the naturalist lyric. Epic form was chosen by Heinrich Hart (1855–1906) in *Das Lied der Menschheit*, by the Viennese Marie delle Grazie (1864–1931) and by the Swiss Nobel laureate Karl Spitteler (1845–1924). Spitteler's *Prometheus und Epimetheus* and *Olympischer Frühling*, evincing Nietzsche's hatred of banality, foreshadowed other myth-making cosmic poems, such as *Dm Nordlicht* by T. Daubler (1876–1934) and the works of O. zur Linde (1873–1938) and A. Mombert (1872–1942). Richard Dehmel (1863–1920), whose verse (*e.g.*, *Erlosungen*, *Aber die Liebe*, *Zwei Menschen*) defended country life and depicted social, especially sexual, problems, was more reflective and tortuous than his friend Liliencron. Stefan George (1868–1933) cultivated the supremacy of aesthetic values, translated with distinction, and founded an esoteric circle of disciples around his journal *Blatter für die Kunst*. His sense of dignity and hatred of decadence were to be seen not only in the content of his verse, but in the typographical devices adopted to keep it from the vulgar herd (see *Die Biicher der Hirten und Preisgedichte*, *Der siebente Ring*, *Der Stern des Bundes*, *Das neue Reich*). In Vienna, Hugo von Hofmannsthal (1874–1929) realized the shortcomings of his initial impressionism and demanded a recasting of modern culture in a conservative sense; a perfect stylist, he was primarily a lyricist, but also achieved fame with his lyrical dramas (*Der Tor und der Tod*, *Elektra*, *etc.*), librettos, such as *Der Rosenkavalier*, narratives, and with his revival of the mediaeval mystery play with *Jedermann* and *Das Salzburger Grosse Welttheater*. The greatest and most influential of modern German lyricists is Rainer Maria Rilke (1875–1926), who extended the spiritual profundity and stylistic wealth of German poetry to an unparalleled degree. With his mystical humility and indifference to social reality and remote aestheticism alike. he stood aside from contemporary trends in *Das Stundenbuch* (1905), *Neue Gedichte* (1907–8). Translations, prose narratives, and an autobiographical novel *Die dufzeichnungen des Malte Laurids Brigge* were produced alongside lyric poetry; his *Duineser Elegien* (1923j and more exuberant *Sonette an Orpheus* (1923) form the most considerable poetic sequence in modern European poetry. Maximilian Dauthendey (1867–1918) juxtaposed effectively impressions of sound and colour, while Christian Morgenstern (1871–1914) combined a bizarre humour with melancholy yearning.

Among more traditionalist poets may be mentioned R. von Schaukal (1874–1942), R. Borchardt (1877–1945), R. A. Schroder (1878–) and A. Schaeffer (1885–1950). The expressionists G. Heym (1887–1912), G. Trakl (1887–1914) and E. Stadler (1883–1914) were filled with horror at the chaos they thought they perceived around them; their followers were such men as P. Zech (1881–1946), Franz Werfel (1890–194j), who is much better known as a novelist, K. Broger (1886–1944), H. Lersch (1889–1936), M. Barthel (1893–), R. Schickele (1883–1940), K. Heynicke (1891–), E. Lasker-Schiiler (1876–1945), W. Flex (1887–1917), and J. Becher (1891–1958). G. Benn

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GERMAN AUTHORS

1. Walther von der Vogelweide (c. 1170–c. 1230). 2. Martin Luther (1483–1546). 3. Friedrich Gottlieb Klopstock (1724–1803). 4. Gotthold Ephraim Lessing (1729–81). 5. Johann Gottfried von Herder (1744–1803). 6. Johann Wolfgang von Goethe (1749–1832). 7. Johann Christoph Friedrich von Schiller (1759–1805). 8. Johann Christian Friedrich Holderlin (1770–1843). 9. Bernd Heinrich von Kleist (1777–1811). 10. Heinrich Heine (1797–1856). 11. Eduard Friedrich Mörike (1804–75). 12. Christian Friedrich Hebbel (1813–63). 13. Gottfried Keller (1819–90). 14. Gerhart Hauptmann (1862–1946). 15. Hugo von Hofmannsthal (1874–1929). 16. Rainer Maria Rilke (1875–1926). 17. Thomas Mann (1875–1955). 18. Franz Kafka (1883–1924)

(1886–1956), a surgeon who wrote poems about his profession, came to occupy a leading place in the German lyric after World War II.

J. Weinheber (1892–1945) came to the fore in the prewar years, and R. Hagelstange (1912–) and H. E. Holthusen (1913–) during the war; with them may be mentioned A. Goes (1908–), E. Langgasser (1899–1950), W. Borchert (1921–1947), Horst Lange (1904–) and J. Gunert (1903–). After World War II a religious flavour was strongly represented, as may be seen in the *Dies irae* of W. Bergengruen (1892–) and in the works of R. Schneider (1903–), while nature poetry was provided by W. Lehmann (1882–), Oda Schafer (1900–), G. Eich (1907–) and K. Krolow (1915–).

20th-Century Drama.—The drama saw many experiments after the days of naturalism, but less work of merit is to be recorded than in the spheres of the lyric and the novel. The verse dramas of Hofmannsthal had parallels in those of R. Beer-Hofmann (1866–1945). A. Schnitzler (1862–1931), a physician, drew marionettelike characters in impressionistic plays and dramatic dialogues (*Anatol, Liebelei, Der grüne Kakadu, Reigen, Der Sckleier der Beatrice, Der junge Medardus*) in which the libidinous element was monotonously present, though his *Professor Bernhardi*, like his novel *Der Weg ins Freie*, bad a polemical purpose. The miracle play of Max Mell (1882–), the grim dramas about the Austrian peasantry written by Karl Schonherr (1868–1942), and the psychopathically morbid works of K. Vollmöller (1878–1948) soon lost popularity. Neoclassical tendencies were to be seen in Paul Ernst (1886–1933), whose austere style and heroic ethics were displayed in historical plays, short stories and criticism.

W. von Scholz (1874–), more mystically minded than Ernst, S. Lublinski (1868–1910), Hans Franck (1879–), W. Schmidtbonn (1876–1952) and H. Eulenberg (1876–1949) belong to the same austere current, with W. Schafer (1868–1952) and R. Binding (1867–1938) representing kindred attitudes in the narrative field. The expressionist drama, with its symbolical figures and frenzied concentration of language, aided by remarkable advances in stage technique. owed much to Maurice Maeterlinck and August Strindberg, and to Frank Wedekind's (1864–1918) grotesquely naturalistic dramas on sexual obsessions. R. Sorge (1892–1916), G. Kaiser (1878–1945) and W. Hasenclever (1890–1940) inaugurated the new movement. It was markedly tendentious, its ethical purpose being stated with restless extravagance. Its representatives were P. Kornfeld (1889–died in imprisonment during World War II), C. Sternheim (1878–1943), E. Toller (1893–1939), R. Goering (1887–1936), F. von Unruh (1885–), B. Brecht (1898–1956) (who adapted *The Beggar's Opera* in *Die Dreigroschenoper* and whose *Mutter Courage und ihre Kinder* was very successful), E. Barlach (1870–1938), J. Becher (1891–1958), A. Wildgans (1881–1932), O. Kokoschka (1886–) and Hans Henny Jahnn (1894–1959). After the first two decades of the 20th century, other trends were visible. Carl Zuckmayer (1896–) moved from unintelligible plays to realistic comedies (*Der Hauptmann von Köpenick*) and scored successes after World War II with *Des Teufels General, Gesang im Feuerofen* and *Das Kalte Licht*. W. Goetz (1885–) revived the historical drama. There followed H. Rehberg's (1901–) Hohenzollern plays and the propagandist works of Hanns Johst (1890–). After World War II the excesses of the past were avoided, and G. Hermann Mostar (1901–), Hermann Rossmann (1902–), who wrote successful plays with topical significance: joined Brecht. Jahnn and Zuckmayer in the leadership in the field of dramatic composition. Of Austrian writers, Alexander Sacher-Masoch (1901–) and F. T. Csokor (1885–) may be mentioned, as well as the brilliant satirist Karl Kraus (1874–1936), whose plays, lyrics and essays earned wide approval.

20th-Century Novels.—Narrative prose produced important figures, though the new literary theories directed undue attention to psychological interests and the sordid topics already noted in connection with other genres, and accentuated that tendency toward formlessness which always had been a weakness of the German novel. The once popular works of W. von Polenz (1861–1903), G. von Ompteda (1863–1931) and Rudolf Herzog (1869–1943) gave way to productions of a less traditional kind. Otto Ernst (1862–1926) wrote delightful books for children and revived the *Bildungsroman* with *Asmus Sempers Jugendland* and others. Satanism and sex occur in the works of Stanislaus Przybyszewski (1868–1927) and H. H. Ewers (1871–1943). More important writers came to the fore under the influence of impressionism. Hermann Hesse (1877–), a Swabian who lived mainly in Switzerland, penetrated into the problems of the artist in *Peter Camenzind* and *Der Steppenwolf* and of adolescence in *Demian*, and treated with deep symbolism the duality of human existence in *Narziss und Goldmund*. Heinrich Mann (1871–1950) became famous for his bitter political and social satire and the riotous Italianate passion of his stories, such as *Im Schlaraffenland, Professor Unrat, Das Kaiserreich*. Heinrich's brother Thomas Mann (1875–1955) became the best known of modern German novelists; his constant theme is the contrast between the normal man and the artist. *Buddenbrooks* (1900) expounds the thesis that artistic refinement and physical decay go hand in hand. *Tonio Kroger* and *Der Tod in Venedig* (1912) develop the same problem, until in *Der Zauberberg* (1924) the pathological stress on decline and disintegration becomes oppressive. as all pre-1914 culture is analyzed. Four novels on the biblical theme of Joseph (*Joseph rrnd seine Briider*, 1933–44) again express the enmity of spirit and flesh. *Lotte in Weimar* (1939) deals with the sacrifices involved in being near the great. The postwar *Dr. Faustus* (1947) combines in a modernized version of the story the problem of the disintegration of artistic genius with a study of the degeneration of German culture into nazidom. *Der Erwahlte* revives the legend of St. Gregory. His final works, the brutally cynical *Die Betrogene* (1953) and buoyantly parodistic *Bekenntnisse des Hochstaplers Felix Krull* (1954) (of which the beginnings date back to 1911), each deal with the importance of discipline and responsibility as against the frivolous and tainted balance of the misfit. Essays, stories, political and literary criticism complete Mann's work. J. Wassermann (1873–1934) taught the doctrine of compassion and spiritual redemption in a series of valuable novels, such as *Caspar Hauser, Christian Wahnschaffe, Der Fall Maurizius* and *Etzel Andergast*.

In addition to less well-known men, such as Emil Strauss (1866–), author of *Freund Hein*, and W. Bonsels (1881–1952), who wrote *Die Biene Maja und ihre Abenteuer*, a number of women writers must be mentioned. Radical feminism occurs in the work of Gabriele Reuter (1859–1941) and Helene Bohlau (1859–1940), naturalism in Clara Viebig (1860–1952), romanticism in Isolde Kurz (1853–1944), history and religious tolerance in Enrica von Handel-Mazzetti (1871–1955) and regionalism in Helene Voigt-Diederichs (1875–), Agnes Miegel and Lulu von Strauss und Torney. The most significant, however, both in range and artistry is Ricarda Huch (1864–1947); her *Erinnerungen von Lzrdolf Ursleu dem Jüngeren* (1893) anticipated Mann's studies of decadence; *Vita Somnium Breve* traced the decline of a business firm; her main eminence. however, is in historical narrative, where she combines rich imagination and real scholarship in her tales of Garibaldi and the Risorgimento and *Der grosse Krieg in Deutschland*. Two excellent volumes on German romanticism, studies of Luther, Keller and German history, lyrics and *Novellen* indicate her wide scope. Ina Seidel (1885–) evoked the atmosphere of the French Revolution and German reactions to it in *Das Labyrinth* and *Das Wunschkind*.

The historical novel acquired a symbolical and allegorical value as a mirror for modern problems. *Tycho Brakes Weg zu Gott* (1916) by Max Brod (1884–) and *Amor Dei* and the Paracelsus novels (1917–25) of E. G. Kolbenheyer (1878–1962) shifted the interest from the historical scene to the state of mind of past thinkers. The native heroism of the Germans was stressed in *Der Sclziller-Roman* and other books by W. von Molo (1880–). Lion Feuchtwanger (1884–1958) showed much less profundity, but Stefan Zweig (1881–1942) composed a series of analytical historical narratives and portraits, and A. Neumann (1895–1952) combined history with the macabre. In Bruno Frank (1887–1945) a critical approach was united with an enlightened sensitivity. The regionalist trend, revived as a counterblast to the naturalist stress on urban life, grew into a powerful aid to nationalism and racialism; it was marked by the impressionist attention to environment as the ruling influence on character. The *Heimatkünstler* include F. Lienhard (1865–1929) of Alsace, A. Bartels (1862–1945) of Dithmarschen, R. H. Bartsch (1873–1952) of Styria, L. Ganghofer (1855–1922) of Bavaria, H. Hansjakob (1837–1916) of the Black Forest. G. Frenssen (1863–1945) of Holstein, H. F. Blunck (1888–1961) of Hamburg (who combines regionalism with an affection for Teutonic antiquity), H. Lons (1866–1914) of the Liineburg heath (likewise with an interest in history) and J. Ponten (1883–1940) of the Rhineland. *Volk ohne Raum* by Hans Grimm (1875–1959) united *Heimatkunst* with the study of colonial life, which was also the subject of numerous short stories. F. Griese (1890–), W. Vesper (1882–) and other; mostly younger men took regionalism to more extreme limits, but E. Wiechert (1887–1950) used regionalism to deal with the problem of man's rehabilitation in *Die Jerominkinder* and *Missa sine Nomine*. H. Stehr (1864–1940), though deeply attached to Silesia, mas really concerned with the quest for religious certainty (*Der Heiligenhof*).

Of the expressionist authors Kasimir Edschmid (1890–) became a leading representative of postwar writing with *Dns gute Recht* (1946) and other works. Klabund (Alfred Henschke) (1891–1926) excelled in exotic tales. Franz Kafka (1883–1924), in *Der Prozess* and *Dns Schloss*, studied with mystical symbolism and allegory man's forlorn efforts to integrate himself in the world. A. Doblin (1878–1957), whose style is influenced by James Joyce, reviews the former state of Germany in *November 1918*. F. Werfel moved from expressionist extravagance to religious yearning in *Barbara oder die Frömmigkeit* (1929) and *Das Lied der Bernadette* (1941). The children's novels of E. Kästner (1899–) and Hans Fallada's (1893–1947) books on the nothingness of "little men" have become well-known. Closely allied to expressionism was the vogue for books about World War I, usually on the pacifist side. with E. M. Remarque (1898–) and L. Renn (1889–) scoring popular success; A. Zweig (1887–), W. Flex (1887–191j), E. E. Dwinger (1898–) and E. Jiinger (1895–) are somewhat more considerable.

Hans Carossa (1878–1956) wrote a series of autobiographical stories dealing with the question of responsibility and the ripening and saddening effect of experience (*Rumänisches Tagebuch, Eine Kindheit, Verwandlungen einer Jugend, Das Jahr der schönen Täuschungen* and other works). Questions of guilt and reconstruction dominate the field and are mirrored in various ways in the novel of the vears following World War II. Hermann Broch (1886–1951; *Der Tod* des *Vergil*), Stefan Xndres (1906– ; *Die Sintflut*), T. Plievier (1892–1955; *Stalingrad, Mosknu* and *Berlin*). E. Langgasser (*Das unauslöschliche Siegel, Das Labyrinth*), W. Bergengruen (*Der Sternenstand, Pelegeja, Das Feuerzeichen*), G. von Le Fort (1876– ; *Der Kranz der Engel*), H. Kasack (1896– ; *Die Stadt hinter dem Strom*), E. Jiinger (1895– ; *Heliopolis*) and E. von Salomon (1902– ; *Der Fragebogen*) may be mentioned. R. Musil's (1880–1942) exposure of artificiality in *Der Mann ohne Eigenschaften* (1930–43) became more widely known later.

In Austria. the works of A. Lernet-Holenia (1897–), Alexander Sacher-Masoch and R. Brunngraber (1901–) gained much attention.

Literary Criticism.—At all times in German literary history, greater importance is attached to the transmission of ideas than to form. This point has been equally illustrated by developments in criticism, which has tended to relegate aesthetic appreciation to a secondary position. After the positivistic source study which was in vogue at the end of the 19th century receded. various currents and schools emphasized such things as sociological. ethnological and political factors in literary production. and literature was studied in terms of the history of problems and ideas. Generally speaking, criticism in Germany has rarely disengaged itself from the historical approach to literature, and. while surveys of whole epochs are numerous, critical biographies of importance are by comparison less frequent. Mediaeval studies have been consistently maintained; great attention is given to Goethe and to early romanticism, while the Baroque period was the subject of a considerable degree of interest, especially after World War I. Following World War II there was a marked tendency to relate literary criticism to contemporary problems.

Besides work published in German-speaking countries, much research of the highest scholarly value has come from England, France and the United States, where German studies have reached a high standard and are frequently combined with the study of comparative literature.

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GERMANOS (Loukas Strenopoulos) (1872–1951), Greek archbishop of Thyateira and a leader of the ecumenical movement (*q.v.*), was born at Delliones in eastern Thrace on Sept. 15, 1872. He was educated in Constantinople and at the theological college at Halki. and in 1900 went to Germany for further study. He returned to be a professor at Halki (1904) and was ordained priest, later becoming also the director of the college (1907). In 1912 he was made metropolitan of Seleucia. but retained his position at Halki until 1922. when he became metropolitan of Thyateira and exarch of western and central Europe with his headquarters in London. In 1924 he was also named special representative of the patriarch of Constantinople to the archbishop of Canterbury, and in 1912 was awarded the Lambeth cross for his services to Anglican-Orthodox understanding. He played an important part in the formative years of 20th-century Christian co-operation. becoming a first president of the World Council of Churches on its establishment in 1948. His guidance helped bring the Orthodox churches into fuller association with the western churches. He died in London. Jan. 23. 1951. (H. M. W.)

GERMAN SILVER: see Nickel Silver.

GERMANTOWN, a section of Philadelphia. Pa.. which before 1851 was a separate borough, is one of the most historic communities in the state. It lies 6 mi. N.W. of the centre of Philadelphia and extends for more than a mile along Germantown avenue. formerly High street. Its first settlers were part of the vanguard of the great Germanic invasion of colonial Pennsylvania. William Penn's promise that his colony would offer an asylum where men might worship God as they chose early attracted Pietists from the Rhineland. and in 1683 a group of such people. chiefly from Frankfurt and Crefeld, founded Germantown. The principal figure among them was Francis Daniel Pastorius (*q.v.*).

Germantown quickly became a prosperous settlement. developing various handicraft industries. Weaving, tanning and wagon building were especially noteworthy. On the Wissahickon creek William Rittenhouse in 1690 built the first paper mill in the British colonies. In 1738 Christopher Sauer and his son established in Germantown a printing press which became perhaps the largest in colonial America. Sauer's German Bible was the first to be printed in a European language in America. One of his employees. Jacob Bey. was the first manufacturer of printing types in the British colonies.

Germantown soon ceased to be a wholly German community. and especially after the middle of the 18th century the English influx was great. Most of the fine buildings for which Germantown avenue is famous, symmetrical stone houses characterized often by the Germantown pent-roof and by inviting benches flanking the doorway, date from the middle and late 18th century. Outstanding among them is Cliveden (1763), planned by Chief Justice Benjamin Chew, an especially good example in stone of the monumental late Georgian style of the Philadelphia area. Grumblethorpe (1744) is lighter in style and a more typical Germantown home. The Morris house (1772) served as the presidential mansion of the United States when the yellow fever epidemic of 1793 drove George Washington from Philadelphia and is a graceful Pennsylvania Georgian town house. The original building of the Germantown academy (1760) still stands. From an earlier period (1690 and later) Wyck survives. and from a later period (1798) there, is Upsala, an example of the delicate federal style in Pennsylvania. Various organized groups are dedicated to the preservation of these buildings and of whole neighbourhoods of the colonial village.

On Oct. 4. 1777, several of the Germantown houses figured in military history, when Washington's continental army fought the battle of Germantown among them in an effort to break the defenses of British-occupied Philadelphia. After entering Philadelphia late in September. British Gen. Sir William Howe had divided his army in order to attack the forts down the Delaware river and to maintain his communications. Thus his main force at Germantown numbered less than 9,000, and Washington decided to attack with a reinforced army of 11,000. He planned a complicated double envelopment, but because his flank columns consisted of militiamen the plan did not work out and the brunt of the battle had to be borne by two columns of continental troops. making virtually a head-on assault on the British centre. The attack came close to success and might have prevailed but for an unnecessary loss of time spent trying to drive a British garrison from Cliveden and a confused collision in a fog between two American columns. As it was. Washington had to retreat.

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GERMAN VOLGA REPUBLIC (Nemtsev Povolzhya A.S.S.R.) was from 1921 to 1911 one of the ten autonomous Soviet Socialist republics of the Russian federation. It was surrounded on west. north and east by the Saratov region (*oblast*) and bounded south and southwest by the Stalingrad region. Its area was 10,888 sq.mi., one-fourth lying on the right and three-fourths on the left bank of the Volga river. The country on the left bank is a plain. with chestnut-coloured soil passing into salt steppe in the southeast where it nears the Caspian depression. The right bank area is a plateau, cut by rivers into ravines which give it a hilly appearance. and it has some forest. Except for the Volga river the streams are shallow. liable to dry up. and not suitable for navigation. The climate is distinctly continental.

The chief crops are wheat, barley, rye. millet, maize and sunflower seed; in pre-1914 times wheat was largely produced for export. but the subsequent poverty and famine altered the balance of crops in favour of barley, rye, millet and sunflower seed; maize is also more widely grown thanformerly.

The industries include flour milling, tobacco making from local makhorka, begun in 1922, a leather factory built at the town of Golom-Karamysh in the right bank district, bacon factories and a factory built in 1926 at Marxstadt (formerly Katherinenstadt) on the left bank of the Volga for the manufacture of oil tractors. There are small sawmills in the forest area and a large one at Engels (formerly Pokrovsk), the administrative centre on the left bank of the Volga opposite to Saratov. Engels had in 1926 a population of 34.345 which by 1939 was increased to 73,279.

History.—About 27.000 German colonists were settled on the Volga river in 1760 and 1761 at the invitation of Catherine II by special manifesto. The climatic difficulties of their new environment. lack of capital, oppression by officials and attacks by Kirghiz and Kalmucks diminished their numbers by 50% in the first ten years. They were at first given special privileges, including exemption from army service, but in the mid-19th century these privileges were annulled. About 1870 the small measure of autonomy remaining to them was cancelled and the colonies broken up.

When World War I broke out, the German colonists were persecuted, and in Feb. 1915 an Imperial ukase ordered the destruction of their settlements in frontier areas. In Feb. 1917 another ukase prescribed the transportation of the Volga Germans to Siberia. Before this was carried out, the 1917 revolution took place. In early 1918, a commission was organized at Saratov to organize Soviet rule among the Volga Germans. and at that town in June 1918 the first Soviet congress of the Volga Germans expressed a wish for autonomous government.

On Oct. 19, 1918, the Autonomous German Volga district was created by decree. and it became a republic on Feb. 20, 1924. Of its 12 cantons, 5 had purely German inhabitants, 4 mixed German-Russian or German-Ukrainian inhabitants and 3 were predominantly Russian or Ukrainian. By 1939 the republic's population was 605.542 of which 67% was German. 20% Russian and 12% Ukrainian. The republic was abolished on Sept. 24, 1941. three months after the German aggression; its territory was divided between the Saratov and Stalingrad *oblasts* and its German inhabitants transported to Siberia.

GERMANY (*Deutschland*), a country of central Europe bordering on the Netherlands. Belgium, Luxembourg, France. Switzerland, Austria, Czechoslovakia and Poland. The area of Germany is 137,535 sq.mi. The German republic. which was founded in 1918, mas known after 1933 as the Third Reich. After a series of annexations beginning with that of Austria in March 1938. followed by the so-called Sudeten districts of Czechoslovakia in September and the larger part of the rest of Czechoslovakia in March 1939. Hitler's troops invaded Poland on Sept. 1. 1939. and in the course of World War II conquered further substantial areas. which were placed under German domination. At the end of the war. in 1945. the governments of the United Kingdom, the United States, the U.S.S.R. and France assumed supreme authority in Germany without however annexing it, and the country within its 1937 frontiers was divided into four zones of occupation, as was also Berlin itself. By the Potsdam agreement of Aug. 2, 1945. it was decided to transfer the city of Konigsberg (renamed Kaliningrad) and the adjacent area of East Prussia to the U.S.S.R., while, pending the final determination of Poland's western frontier at the peace treaty, the area of 1937 Germany east of the Oder-Neisse line, together with the city of Danzig (Gdanskj and the remainder of East Prussia. was placed under Polish administration. Simultaneously it was agreed that all Germans remaining in Poland, Czechoslovakia and Hungary should be transferred to Germany. In Nov. 1947 the Saar was placed under a special regime, being economically united with France and politically separated from Germany. It was reunited politically with the German Federal Republic on Jan. 1, 1957, and economically in July 1959.

The year 1949 saw the emergence of two separate republics in Germany: the German Federal Republic for the area of the three western zones of occupation and the German Democratic Republic for the eastern zone. Berlin was similarly divided into a western and an eastern municipality, eastern Berlin acting as capital of the German Democratic Republic. The capital of the German Federal Republic was Bonn. Although, because of its isolation, western Berlin could not become a constituent part of the Federal Republic, close ties were maintained between the two areas.

PHYSICAL FEATURES

Geology.—Germany consists of a floor of Palaeozoic rocks upon which rest unconformably the comparatively little disturbed beds of the Mesozoic system, while in the north German plain a covering of modem deposits conceals the whole of the older strata from view, excepting some scattered and isolated outcrops of Cretaceous and Tertiary beds. The rocks which compose the ancient floor are thrown into folds which in the western half of Germany run approximately from west-southwest to east-northeast. They are exposed on the one hand in the neighbourhood of the Rhine and on the other hand in the Bohemian massif. With the latter must be included the Frankenwald, the Thuringenvald and even the Harz. The oldest rocks, belonging to the Archaean system, occur in the south, forming the Vosges and the Black Forest in the west, and the greater part of the Bohemian massif, including the Erzgebirge, in the east. They consist chiefly of gneiss and schist, with granite and other eruptive rocks. Farther north, in the Hunsruck, the Taunus, the Eifel and Westenvald, the Harz and the Frankenwald, the ancient floor is composed mainly of Devonian beds. Other Palaeozoic systems are, however, included in the folds. The Cambrian, for example, is exposed at Leimitz near Hof on the eastern side of the Frankenwald, and the important coal field of the Saar lies on the southern side of the Hunsrück, while Ordovician and Silurian beds have been found in several localities. Along the northern border of the folded belt lies the coal basin of the Ruhr in Westphalia, which is the continuation of the Belgian coal field, and bears much the same relation to the Rhenish Devonian area that the coal basin of Liège bears to the Ardennes. The Permian, as in England, is not involved in the folds which have affected the older beds, and in general lies unconformably upon them. It occurs chiefly around the masses of ancient rock, and one of the largest areas is that of the Saar.

Between the old rocks of the Rhine on the west and the ancient massif of Bohemia on the east a vast area of Triassic beds extends from Hanover to Basle and from Metz to Bayreuth. Over the greater part of this region the Triassic beds are free from folding and are nearly horizontal, but faulting is by no means absent, especially along the margins of the Bohemian and Rhenish hills. The Triassic beds must indeed have covered a large part of these old rock masses, but they have been preserved only where they were faulted down to a lower level. Along the southern margin of the Triassic area there is a long band of Jurassic beds dipping toward the Danube; and at its eastern extremity this band is continuous with a synclinal of Jurassic beds, running parallel to the western border of the Bohemian massif, but separated from it by a narrow strip of Triassic beds. Toward the north, in Lower Saxony and North Rhine-Westphalia, the Triassic beds are followed by Jurassic and Cretaceous deposits, the latter being here the more important. As in the south of England, the lower beds of the Cretaceous are of estuarine origin and the Upper Cretaceous overlaps the Lower, lying in the valley of the Ruhr directly upon the Palaeozoic rocks. In Saxony also the Upper Cretaceous beds rest directly upon the Palaeozoic or Archaean rocks. The Eocene system is unknown in Germany except in the foothills of the Alps; but the Oligocene and Miocene are widely spread, especially in the great plain and in the depression of the Danube. The Oligocene is generally marine. Marine Miocene occurs in northwest Germany and the Miocene of the Danube valley is also in part marine, but in central Germany it is of fluviatile or lacustrine origin. The lignites of Hesse, the Cassel area, etc., are interstratified with basaltic lava flows which form the greater part of the Vogelsberg and other hills. The trachytes of the Siebengebirge are probably of slightly earlier date. The precise age of the volcanoes of the Eifel, many of which are in a perfect state of preservation, is not clear, but they are certainly Tertiary or post-Tertiary. Leucite and nepheline lavas are here abundant. In the Siebengebirge the little crater of Roderberg, with its lavas and scoriae of leucite basalt, is posterior to some of the Pleistocene river deposits.

A glance at a geological map will show that the greater part of north and central Germany is covered by Quaternary deposits. These are in part of glacial origin, and contain Scandinavian boulders; hut fluviatile and aeolian deposits also occur. Quaternary beds also cover the floor of the broad depression through which the Rhine meanders from Basle to Mainz, and occupy a large part of the plain of the Danube. The depression of the Rhine is a trough lying between two faults or systems of faults. The broader depression of the Danube is associated with the formation of the Alps, and was flooded by the sea during a part of the Miocene period. (P. LA.; I. L. G.)

Physical Geography. — Germany may be described broadly as the country from the Alps to the North and the Baltic seas, and it includes a number of very diverse zones and physical units; less than many other countries does it approach any real unity of structure or physical geographical character. The country may be divided into four areas: (1) the north German plain lying between the North and Baltic seas and the north edge of the mid-German hills; (2) the mid-German hills consisting of broken highlands running from the Ardennes to the northern side of the Bohemian block; (3) southern Germany including the Main and Neckar basins, the Swabian and Franconian Jura, the Danube basin and the Bavarian Alps; and (4) the Rhine valley.

The North German Plain. — This area is flat to the west of the Berlin area but to the east it consists of morainic hills more or less parallel to the Baltic coast and usually less than 600 ft. high.

In the western section the land lies low, with reclaimed coastal marshes providing rich pasture land behind which lie moors and sandy heaths. Of the two morainic belts in this area one contains many lakes; the other is practically a continuation of the Fläming and is called the Altmark toward its eastern end, and the Lüneburg heath in the centre, from which it dies down toward the North sea coast south of Cuxhaven.

A great difference is to be remarked between the coast of the North sea and that of the Baltic. On the former, where the sea has broken up the ranges of dunes formed in bygone times and divided them into separate islands, the mainland has to be protected by massive dykes, while the Frisian Islands are being gradually washed away by the waters. There are now only seven of the East Frisian Islands, of which Norderney is the best known; of the North Frisian Islands, on the western coast of Schleswig, Sylt is the most considerable. Besides the ordinary waste of the shores, there have been extensive inundations by the sea within the historic period, the Gulf of the Dollart having been so created in the year 1276. Sands surround the whole coast of the North sea to such an extent that the entrance to the ports is not practicable without the aid of pilots. Heligoland is a rocky island, but it also has been considerably reduced by the sea. The tide rises to the height of 12 or 13 ft. in the Jade bay and at Bremerhaven, and 6 or 7 ft. at Hamburg.

The coast of the Baltic, on the other hand, possesses few islands, the chief being Alsen and Fehmarn off the coast of Schleswig-Holstein, and Rügen off Pomerania. It has no extensive sands, though on the whole it is very flat; it has no perceptible tides; and a great part of its coastline is covered with ice in winter which also blocks up the harbours so that navigation is interrupted several months every year. Its *Haffs* (lagoons), fronting the mouths of the large rivers, are extensions of the rivers rather than sea bays cut off, though coastal subsidence has contributed to their evolution. Parallel to the Baltic shore is a fertile plain behind which are lines of wooded and heath-covered uplands, scattered with small lakes. Wide, marshy plains alternate with cultivated land in the valleys.

The rivers of the great lowland, the Ems, Weser, Elbe and Oder, are naturally navigable and need very few locks. Post-Pleistocene land sinking has brought the sea up the river mouths so that most of Germany's ports are river ports and have developed outports below themselves, as Bremerhaven below Bremen on the Weser, Cuxhaven below Hamburg on the Elbe and Warnemünde below Rostock on the Warnow. The east-west sections of two rivers in different parts of the same low area between morainic hills have been linked together in many cases by canals, so that a system of river and canal communication crosses Germany from its eastern to its western border. This system converges upon Berlin and helps to account for the phenomenal growth of the city from its insignificant position in the middle of the 17th century. The Oder from Raciborz in Poland and large sections of the Havel, Spree and Saale are navigable; the Elbe itself can be navigated right up into Bohemia, and its tributary, the Moldau (Vltava), as far as Prague. The development of this system of communications and of its focus at Berlin may be said to have changed the face of Germany.

The Mid-German Hills. — Where these hills merge into the northern plain is an area of rolling country called the Borde. The subsoil is largely loessic, making it very fertile. From prehistoric times this area has been inhabited. Running into the hills from the plain are great bays of lowland, the two biggest being the Cologne and Leipzig bays. In the western half of the central plateau the hills trend almost southwest to northeast, the main lines being sharply cut at right angles by the Rhine gorge from Bingen to Bonn. Beyond the eastern rim of the Rhine basin are large volcanic masses, the chief of which are the Vogelsberg (2,539 ft.) and the Rhon (3,045 ft.). This is an area of much faulting, drained mainly by the Weser and its tributaries which start close to the northern tributaries of the Main. There is thus a way through the mid-German hills from Frankfurt-on-Main in the south via Cassel to Hanover in the north, an important factor of the greatness of these cities. East of the Weser the hill lines of the Harz mountains (highest point the Brocken 3,747 ft.) and the Thuringian uplands are outlined and cut by faults with the result that both, and especially the Harz, have long been famed for the mining of metals.

The southeastern end of the Thuringian uplands and the northeastern end of the Franconian Jura approach one another and the mountains further east (the Erzgebirge and the Bohemian plateau) in the Fichtelgebirge (3,448 ft.). These mountains seem to be a centre of radiation of hills and rivers; from them the Naab goes south between the Franconian Jura and the Bohemian plateau to the Danube, the Main goes west to the Rhine between the Thuringian uplands and the Jura, the Saale and its tributaries flow north between the Thuringian uplands and the Erzgebirge, while from Bohemia the Eger flows east between the Erzgebirge and the Bohemian plateau. Eastward beyond the Thuringian uplands the hills trend northeastward in the Erzgebirge (4,082 ft.), which is the northern edge of the Bohemian block, as far as the sharp break by which the Elbe passes from Czechoslovakia to Germany. Beyond the Elbe the hills trend southeastward as the Riesengebirge (5,259 ft.) and the Sudetes, forming the northeast side of the Bohemian block.

Southern Germany. — The Main and Neckar are right-bank tributaries of the Rhine. Their basins are framed by the Swabian and Franconian Jura on the south and east, the Black Forest on the west and the mid-German hills on the north. The climate in these lowlands is warm and dry and they are among the most fertile lands in Germany. growing mainly vines and grain. The Neckar escapes to the Rhine south of, and the Main north of, the Odenwald. In the Neckar basin Stuttgart is the chief focus. In the valley of the Main Nürnberg, Bamberg, Würzburg and Frankfurt are the great centres; the river joins the Rhine just above Mainz.

The Swabian and Franconian Jura are built mainly of porous, Mesozoic rock dipping southward and the drainage is in many parts in deep-cut valleys. The ridge exceeds 3,000 ft. in only a few places in Germany, but the southeast border reaches nearly 4,900 ft. in the Bohemian plateau, which has the lower Bavarian forest in front of it. The Swabian Jura is higher and less broken than the Franconian, and from the rawness of winter on it a large part is known as the Rauhe Alb. The dip slopes of the Jura rise from the left bank of the Danube; the scarp slopes face north or northwest and are steep where they face the Neckar.

The main part of the Danube rises in the Black Forest and the basin is framed by Lake Constance and the Bavarian Alps on the south, and by the Alpine foreland (Jura) and the southwest border of the Bohemian block on the north. The river flows near the northern side of its basin, following the line of the Jura down to Regensburg, beyond which it flows beneath and parallel to the granite edge of the Bohemian block, and then onward past Passau. The large tributaries of the right bank are the Iller, Lech, Isar and Inn; on the left bank the Womitz, which joins the Danube at Donauworth, flows through the Jura zone between the Swabian and Franconian Jura, and the Altmiihl and its feeders' make use of a number of minor breaks in the sharp curve of the Franconian Jura. Linking the Danube and the Main and using parts of the Altmuhl a canal has been built from Regensburg through Nuremberg to Bamberg. Much land on the south of the Danube basin is poor, but some areas toward the centre, where the subsoil is loess, are fertile.

It is only the northern fringe of the Alps, from Lake Constance to about Hallein, that is in Germany and the frontier here lies along the northernmost of the east-west ridges of the Alps; the highest point in Germany, the Zugspitze (9,720 ft.), stands on the border of Tirol. The Bavarian Alps are of great beauty, with some exquisite mountain lakes, and farther down the northward valleys long lakes behind morainic dams, one of which, the Würmer See, has given its name to a moraine held by Albrecht Penck to mark one of the ice maxima of the Pleistocene glaciation. The slopes toward the Danube have much boulder clay and there are large swampy areas called Moose, but the better-drained valleys are relatively rich.

The Rhine Valley.—From Basle to Mainz the Rhine flows through a remarkable rift valley. On the east the upstanding edge is the sharp western slope of the Black Forest (the Feldberg is 4,898 ft. high) as far north as the latitude of Karlsruhe; recognizable again farther north is the Odenwald (c. 1,700 ft.). West of the Rhine the upstanding edge is the Vosges (in France), becoming lower and smoother north of Saverne but rising again in the Hardt (highest point, Donnersberg 2,254 ft.). The continuous block that once included the Vosges and the Black Forest was a Hercynian massif, and the rift has given a section of the Rhine with a broad valley floor and parallel sides. The course of the river is rough in places, and a volcanic mass, the Kaiserstuhl, stands out in the middle; the banks of the rapid river are rough land with few towns in the south, but many from Speyer northward. From Mainz to Bingen the Rhine flows from east to west, from the rift valley to the gorge cutting through the mid-German hills. From Worms through Mainz to Bingen the land is relatively low and has loess subsoil making it one of the best agricultural parts of the country. It is an area of ancient settlement where rich finds of prehistoric objects of several periods have been made.

Climate.—The climate of Germany is intermediate between the oceanic and continental climates of western and eastern Europe respectively. The differences in the range of temperature and the amount of rainfall throughout Germany are not so great as they would be were it not that the elevated plateaus and mountain chains are in the south, while the north is occupied by low-lying plains. In the northwest no chain of hills intercepts the warmer and moister winds which flow from the Atlantic, and these accordingly influence at times even the eastern regions of Germany. The mean annual temperature of southwestern Germany, or the Rhine and Danube basins, is about 52° to 54° F., that of central Germany 48" to 50° and that of the northern plain 46° to 48°. The difference in the mean annual temperature between the southwest and northwest of Germany amounts to about 3°.

The valley of the Rhine above Mainz has the greatest mean heat, the mildest winter and the highest summer temperature. The Baltic has the lowest spring temperature, and the autumn there is not much warmer. In central Germany the high plateaus of the Erz- and Fichtelgebirge are the coldest regions. In south Germany the upper Bavarian plain experiences a harsh winter and a cold summer. The warmest districts are the Rhine valley from Karlsruhe downward, less than 300 ft. above sea level, and protected by mountains. The same holds true of the valleys of the Neckar, Main and Moselle. Hence the vine is everywhere cultivated in these districts. The mean summer temperature there is 66" and upward, while the average temperature of January is above 32° F. The climate of northwestern Germany is oceanic, the summers not being too hot (mean summer temperature 60° to 62°), and snow in winter remains but a short time on the ground. West of the Weser the average temperature of January exceeds 32° (it is 34° at Cologne); to the east it sinks to 30°, and the Elbe is generally covered with ice for several months of the year, as are also its tributaries. The farther one proceeds to the east the greater are the contrasts of summer and winter.

Rain falls at all seasons, but chiefly in summer. The rainfall is greatest in the Bavarian tableland and the hilly regions of western Germany. For the Eifel, Sauerland, Harz, Thuringian forest, Rhon, Vogelsberg, Spessart, the Black Forest, the Vosges, etc., the annual average may be stated at 34 in. or more, while in the lower terraces of southwestern Germany, as in the Erzgebirge, it is estimated at 30 to 32 in. only. The same average obtains also on the humid northwest coast of Germany as far as Bremen and Hamburg. In the remaining parts of western Germany, it amounts to upward of 24 in. In the best wine districts, *i.e.*, in the valley of the Rhine below Mannheim and also in the valley of the Main, no more than from 16 to 20 in. fall. Eastern Germany as far south as the Thuringian forest has an annual rainfall of only 16 to 20 in. Thunderstorms are most frequent in July. The soil of Germany, in correlation with these facts of climate, is generally of the brown group (see EUROPE), moderately leached except near the sea where the leaching has generally been more intense and where the glacial subsoil often includes much sand. The soils on the Jurassic rocks of the south are specially rich in humus.

Vegetation.—Approximately 27% of the whole area of Germany is still covered with forest. About 45% of this forest is pine, about 40% beech and about 8% oak. Though plantations are extensive, there is still a certain amount of natural forest.

Beech (*Fagus* sylvatica) forest is found on all well-drained soils in the temperate regions, from sea level up to 2,000 ft. in the Harz mountains and 4,500 ft. in the Bavarian Alps. Associated with beech are silver fir, spruce, pine and oak. Where there is enough light and good soil the ground flora consists of dog's mercury, sweet woodruff, violets, etc.; higher up in wet places it includes balsam, willow herb and monkshood; on acid soils bilberry, wavy hair-grass and mosses are found.

On poorer, lighter soils, especially in the northeast, the forests are of Scots pine (*Pinus sylvestris*). They ascend to 4,000 ft. in the Black Forest mountains and 5,000 ft. in the Bavarian Alps. Most of these forests are planted, and there are also many plantations on inland sand dunes, for example along the Rhine valley floor above Mainz. The plantations have little or no ground flora, but the native forests often contain juniper, bilberry and heather, mosses and lichens. Many are mixed with oak, beech and hornbeam.

Extensive plantations of spruce (Picea abies), or spruce mixture, make up 20% of the productive forest of Germany. More tolerant of extreme cold than beech, it grows as a native tree on the upper slopes of the central and southern mountain areas where it is found up to the highest limit of trees. This limit is higher in the south than it is in the north. There are vast areas of spruce in the Black Forest. In the younger plantations the ground is covered with fungi, especially in autumn.

The oak forests on the light, sandy, acid soils of the northwest are generally mixed with birch. Beneath the trees grow broom, heather, bilberry, bracken, etc. The oak forests in the west are mixed with hornbeam with a well-developed shrub layer and ground flora. The northern and eastern oakwoods are mixed with pine. The two oaks found most in Germany are Quercus *robur*, which occurs everywhere, and Q. petraea, which occurs more in the east.

Alder (*Alnus* glutinosa) dominates the peaty fen woods and is the characteristic tree of river valleys, often with willow and poplar where it is very wet, or oak, ash, elm and hornbeam where it is drier. Willows, poplars, elms, chestnuts, walnut, maples and ash are locally common.

The silver fir (Abies alba) is a native of the central and southern mountains, being especially abundant on the western slopes of the Black Forest. In the Thuringian forests it grows up to 2,600 ft. and in the Bavarian Alps it reaches 5,000 ft. Above the silver fir is the larch (*Larix* decidua). which grows up to 6,500 ft., mixed with spruce and Arolla pine (*Pinus cembra*). Above the upper limit of forest the mountain pine (*Pinus mugo*) occurs as a prostrate shrub and beyond this rhododendrons and alpine plants.

Heathland is characteristic of the northwest with heather (*Calluna vulgaris*), whins, grasses, mosses and lichens where it is dry, and cross-leaved heath (Erica tetralix), club mosses, sundews and cotton grass in the wetter parts. Much land from the saltings and estuarine marshes of the North sea coast has been reclaimed and is now grassland. Reclamation of fens and marshes in areas where the soil contains lime has turned these into rich pasture. In places where the soil is acid, especially in the wide coastal belt, are many bogs containing Sphagnum, cotton grass, sundews, etc. In the north German plain sandy heaths, moors and bogs are being reclaimed.

Fauna. — The felling of trees in all the forested areas and the draining of the northern marshes for the reclamation of land brought about great changes in the fauna of Germany, which is characteristically mid-European. Hunting also helped to exterminate some animals, for instance the brown bear, lynx, ibex and bison, though it preserved others such as roe deer and red deer and wild boar. There are still chamois in the Bavarian Alps. Marmots, foxes, martens, weasels, badgers (becoming less common), beavers, otters and other small beasts are found in the mountains, forests and rivers. The elk has been reintroduced in certain places in northeast Germany and herds of bison are kept in some parks.

Many of the birds are migrants that cross the country in a northeast-southwesterly direction. Some, such as the red-backed shrike, and the white stork from north and east Germany, fly southeast, but the white stork from the west flies southwest. Geese, ducks and snipe are among the birds seen on the northern marshes and plains, and capercaillie among those found in the pine forests.

Germany is not rich in amphibians or reptiles. Carp are abundant in ponds and lakes and there are salmon, trout, eels and crayfish in the rivers. The salmon Salmo salar is not found in the Danube but there is another kind called huchen (Salmo hucho) in the river. Along the coast mussels and oysters are found, and the seas produce herring and cod. Insects are varied and numerous.

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HISTORY

Classical writers from the time of Thales (c. 600 B.C.) were acquainted with the amber of the North German coasts, and the traveller Pytheas (c. 300 B.C.) certainly visited Germany and may have reached the Vistula. But there seem to have been few contacts between the classical and the Germanic world before the Cimbri and Teutoni, who probably came from Jutland, invaded the Mediterranean regions and Italy itself (113–101 B.C.). Ancient writers were uncertain of the distinction between Germans and Celts which mas not clearly recognized until the Gallic campaigns (58–51 B.C.) of Julius Caesar brought more exact knowledge. (See TEUTONIC PEOPLES for an ethnological and anthropological account of the prehistoric Germans.)

ANCIENT HISTORY

Caesar's conquest of Gaul halted the German pressure on the Celts, which had virtually driven them from the eastern bank of the Rhine and had led to Ariovistus' settlements on the upper Rhine in 71 B.C. and to extensive infiltration (attested by archaeology and by Caesar himself) on the middle and lower Rhine by the Treveri, Nervii and others. An invasion of Usipetes and Tencteri, repressed in 55 B.C., led Caesar to undertake two punitive expeditions across the Rhine in 55 and 53 B.C., neither intended to penetrate far. The province of Gaul as created by him in 51 B.C. extended to the Rhine, which he regarded as an ethnic frontier.

Augustus (31 B.C.–A.D. 14) seems at first to have held Caesar's view of the Rhine frontier, but in 12 B.C. his stepson Nero Claudius Drusus undertook what was evidently understood as a combined campaign of Gaul and Roman against the traditional enemies of both. It is not clear, however, how far Augustus intended annexation to go. Drusus himself died soon after reaching the Elbe (g B.c.), but his work was resumed by his brother,' the future emperor Tiberius from 9 to 7 B.C. Meanwhile the growth of a German empire under Maroboduus in Bohemia was engaging Roman attention; between 7 B.C. and A.D. 4 a series of expeditions penetrated into Germany across the Danube; and in A.D. 5 Tiberius subdued the Cimbri in Jutland by amphibious operations. A grand campaign in A.D. 6 was forestalled, however, by a revolt in Pannonia, and in A.D. 9 overenthusiastic efforts at provincialization led to a revolt in the west under Arminius and to the death of the governor P. Quinctilius Varus, with the loss of three legions, in the *saltus* Teutoburgiensis (probably near Paderborn). Augustus, who now appreciated the insuperable difficulties of conquering a wild country with a backward political organization, bequeathed to his successors the doctrine that the Rhine and the Danube were the frontiers of the empire. Only along the North sea coast (Frisii) and in the Wetterau and Taunus, where the Chatti. the most civilized German tribe, commanded the trade route. did Rome have interests beyond the Rhine; and the campaigns of Germanicus (A.D. 14–16), floridly described by Tacitus. are to be regarded as determined by this fact and by the need of re-establishing prestige. All garrisons across the Rhine were withdrawn under Claudius (41–54), and the Romans confined themselves to diplomatic intrigue, a method that had proved successful against Arminius (slain by his own kin in 19).

A new approach to the German problem was seen under the Flavian dynasty (Vespasian, Titus and Domitian, 69–96). Roman control of Friesland was reasserted, and the Chatti were subdued in two campaigns of Domitian (83 and 88). To shorten the line of the Rhine-Danube re-entrant, the defenses enclosing the area conquered from the Chatti up to the crest of the Taunus were extended southward and eastward to join the Danube near Regensburg, and the frontier works were improved and extended by Hadrian (117–138) and Antoninus Pius (138–161), bringing Roman dominion and even the outward signs of Roman civilization up to the Central German or Hercynian forest. An accompaniment of the policy was the creation by Domitian of the two provinces of lower and upper Germany, the former (carved out from Gallia Belgica) consisting of the more or less germanized tribes along the western stretches of the lower and middle Rhine, the latter comprising in the main the new conquests. Meanwhile a changed attitude to the nature of German dangers was seen in the disposition of the legionary garrisons. Whereas under Tiberius (14–37) there had been eight legions on the Rhine and five on or near the Danube, a century later the proportion was four to nine.

Western and Eastern Germans. — Tacitus' study of the Germans, published in A.D. 98, divides them into three groups, the Ingaevones of the northwest, the Hermiones of the interior and the Istaevones of the Rhine. These names are not fitted by Tacitus into his description of individual tribes and clearly derive from an earlier period during which Germans had hardly penetrated across the Elbe; they prepare for the distinction, only slightly blurred by tribal migrations, between western and eastern Germans, a distinction of great importance in their subsequent relations with Rome.

In Tacitus' time the most important tribes along the Rhine were the Frisii and the Batavi at its mouth, the Tencteri between the Ruhr and the Lahn and the Mattiaci opposite Coblenz. Behind them were the Chauci on the coast between the Ems and the Elbe, the Cherusci (Arminius' tribe) round Minden, the Chatti in Hesse-Cassel and the Hermunduri of Franconia, who were taken into the empire, as were the Mattiaci and some of the Chatti, in course of the new conquests. East of the Chauci along the Elbe were the Langobardi and on the middle Elbe the Suebi

Most of these names disappeared, to be replaced by greater political units. the Saxons, the Franks and the Alamanni. This development Hans Delbriick supposed to have been the result of deforestation, as the uninhabited wastes with which the tribes in Caesar's time had surrounded themselves for security and prestige (cf. De Bello Gallico, vi, 23, 1) were won for agriculture. These confederacies were becoming a menace to Rome in the 3rd century: in 276, Franks and Alamanni overran the whole of Gaul; and about this time the limes was finally abandoned. Attacks on Britain by the Saxons then began in earnest and the *Litus Saxonicum* may even commemorate their settlements as well as the defense against them. Diocletian (284–305) and his successors Constantine (306–337), Julian (who was in Gaul from 355 to 360) and Valentinian (364–375) encouraged campaigns and fortification, and a frontier along the Rhine was maintained, though Julian had to agree to a treaty allowing the Franks to settle in much of modem Flanders.

The Bastarnae in the Carpathians, known to Polybius in the 3rd century B.C., were the advance guard of a migration of Germans to the lands between the Elbe and the Vistula that took place about the beginning of the Christian era. By the time of Tacitus the lands immediately across the middle Danube were occupied by the Marcomanni and the Quadi, both scattered fragments of western Germans from the empire of Maroboduus. Tacitus' knowledge of the tribes behind these is dim, but the Burgundians and Gotones (the later Goths) can already be distinguished along the Warte and Vistula.

The Marcomanni and the Quadi gave trouble to Rome under Domitian (89 and 92) and Nerva (97). In 166 they took advantage of a plague and a Persian war to burst the frontier, penetrated into Italy itself and were only pacified by Marcus Aurelius after a series of exhausting campaigns lasting until his death (180). Commodus (180–192) entered into treaty with them and fortified the Danube yet more intensively.

These tribes continued to be dangerous neighbours to the empire, but their place as its principal assailants was taken in this sector by the Goths, who reached the Black sea early in the 3rd century and attacked the Danube frontier in 238. A succession of emperors (one of whom, Decius, met his death at their hands in 251) failed to check their forays, which extended over Greece and Asia Minor until Claudius II, surnamed Gothicus, defeated them in 269. His successor Aurelian (270–275), however, abandoned Dacia to them, and about this time the distinction between Visigoths and Ostrogoths begins to appear, the former in Dacia, the latter still in southern Russia. Warfare and fortification along the Danube frontier are attested notably in the reigns of Constantine and his sons and of Valentinian I.

The *Volkerwanderung* or Great Migrations. — Germans had for two centuries been infiltrating into the empire as soldiers and as captives settled in groups for agriculture; but their permanent entry in mass was part of the Volkerwanderung precipitated in Europe by the western movement of the Huns. About 370 the Ostrogothic kingdom was destroyed and soon after both branches of the Gothic nation requested asylum within the empire. Dissension with their hosts soon broke out, and the Romans were decisively defeated at Adrianople (378), after which the Goths were never expelled. Under their king Alaric (c. 365–410) and his successors, the Visigoths wandered over the empire seeking lands and political privileges and sacking Rome on the way (410). They finished in occupation of a kingdom embracing southwestern Gaul and most of Spain with its capital at Toulouse. During this period the principal general of the western Roman empire, Stilicho, himself of Vandal origin, was compelled to remove the garrisons of the Rhine for the defense of Italy, and the frontier was crossed at the end of 406 by a mixed host of Germans, mainly Vandals—actually migrants from eastern Germany—who penetrated first into Spain and then into Africa, where their leader, Gaiseric, founded a kingdom at Carthage in 439.

The first half of the 5th century is marked by complicated military and diplomatic manoeuvring between the rulers and generals of the eastern and western empires, the German tribes and the Huns, whose empire under Attila (433–453) embraced virtually all Germany. It was probably not least in order to escape this rule that the Saxons and kindred tribes from the seaboard in the next generation invaded Britain, which had been denuded of its Roman troops in 410. But Attila himself was defeated by Romans and Visigoths at Châlons (451), and the whole Hunnish empire broke up after the defeat of his successors by eastern German tribes in the battle of the Nedao river (454). During this period the situation of German tribes in the west begins to crystallize. Franks, Alamanni and Burgundians appear in Gaul, their areas of extensive settlement (as opposed to conquest) being still on the whole discernible from the linguistic frontier between German and French. In the eastern empire, Goths had overrun Asia (399) and attempted to act as emperor makers in Constantinople. But the eastern emperors succeeded in eliminating them; the most important incident was the emperor Zeno's transference from the Balkans to Italy of the Ostrogothic bands under Theodoric, who was to gain the mastery (489–493) over the mixed body of mercenary Germans that had already ejected the last western Roman emperor in 476. This process left a vacuum in the Danube basin, subsequently filled by Slavs and Ugrians, so that only enclaves—remnants for instance of the Gepidae—survived there of the eastern Germans.

The ancient period of German history may be said to close with the gradual extension of Frankish rule under Clovis (481–511) and his sons. Of the great confederacies only the Saxons and Alamanni remained in Germany, to be absorbed eventually in the new Germanic empire of Charlemagne. In Italy, Theodoric's successors failed to hold their ground against the generals of Justinian (518–565), under whom Africa too was regained for the eastern empire. A last chapter of the Volkerwanderung was the entry of the Langobardi (Lombards) into Italy in 568. The stage was then set for the Germany of the middle ages.

These tribal movements did not usually involve large numbers (the total of Vandals invading Africa is given as 80,000) and the Germans came more as conquerors than as settlers. They accepted the late Roman social structure of landlord and serf, the varying relationships being regulated by individual codes of law. For this reason there is virtually no archaeology of the migrations, the vestiges even of such settling migrants as the Rhineland Franks following late Roman typological developments. The long contacts with Rome had had their effects, not least in the conversion of the principal tribes to Christianity, which followed rapidly on the mission of Ulfilas to the Goths (c. 360). That Ulfilas happened to be an Arian caused the majority of German tribes (the Franks, led to conversion by Clovis, being the notable exception) to accept Arianism; and this created a religious cleavage between conquerors and conquered that had important political consequences as it worked against the social tendencies to fusion to which the archaeological evidence bears witness. Only the Anglo-Saxons in England, pagans and removed from contacts with the empire, preserved that model of a prehistoric German migration which had been familiar to Rome in the distant days of the Cimbri and Ariovistus. (C. E. S.)

MEROVINGIANS AND CAROLINGIANS

When the original western empire came to an end, the German tribal lands lying east of the Rhine had no unity, geographical or political. Divided from each other by forest or water, the German tribes were further subdivided by the varying degrees of romanization that they had experienced. Archaeology suggests that their social habits followed the same general pattern, and philology confirms that, despite dialectal differences, they spoke the same language. Nevertheless, "Germania" meant nothing to them, and their drawing together to form a mediaeval state was not an inevitable process but the outcome of a series of unpredictable accidents.

Merovingian Germany. — The Franks (*q.v.*), settled for the most part in, romanized Gaul, were nevertheless drawn toward the Rhineland and thus into the feuds and rapidly shifting alliances of the Germans on the eastern bank. Of these interventions we have intermittent literary evidence from the 6th century onward. They may be said to start with the wars of Clovis, during which the Merovingian dynasty of the Salian Franks established its authority over the Ripuarian or Rhineland Franks in part of what was later to be called Austrasia. With much less success, Clovis and his successors attempted to dominate the Thuringians of central Germany and the Alamanni and Bavarians of southern Germany. The latter in particular could often look for help from the masters of Italy; and thus the Catholic Franks found that their raiding and counterraiding across the Rhine helped to embroil them with the Arian Goths. However, it would be folly to elevate these clashes to the rank of wars of religion; no serious attempt seems to have been made to convert the Germans; rather, the intention was to exact tribute from them (in the case of the Saxons this usually took the form of cattle), to use them as mercenaries and to trade with them when possible. Certainly the spirit of tribal or national independence was unaffected, and the threat to the Rhineland remained. Meanwhile, the eastern borders of Germania became the prey of the land-seeking Slavonic peoples; and occasionally, as in the reign of Dagobert I, the Germans were glad enough of Merovingian help against their supplanters in the east. In the course of the 8th century, Frankish occasions of intervention tended to increase, and chieftains were deposed or, as occasion offered, imposed on recalcitrant tribes. But this relationship was too spasmodic to justify thinking that the Germans were subjected to any effective Frankish high kingship.

The Rise of the Carolingians and Boniface.—The Carolingian dynasty, which with papal backing supplanted the Merovingians in 751, was Austrasian and drew its strength from extensive estates in the lands between the Meuse and the Rhine. It had grown up in the atmosphere of Rhenish prosperity and likewise of Rhenish insecurity and was directly interested, in a way in which the Merovingians had never been, in the fate of the Rhineland and the behaviour of the German peoples beyond. It also saw clearly that effective control over them would necessitate their conversion to Christianity, and hence from the earliest days of their power the Carolingian mayors of the palace supported missionary work, both Irish and Roman. The pattern of Frankish penetration was always the same; small communities or churches were settled upon land newly won from forest or marsh, granted them by their Carolingian protectors. Thus, from Frisia in the north to Bavaria in the south, religious and economic penetration went hand in hand. A distinguished part was played by Anglo-Saxon missionaries, who linked the Frankish world not only with the high culture of the churches (notably York) from which they set out but also with Rome, the ultimate source of their inspiration. Chief among them were Willibrord (658–739), who worked among the Frisians and later the Thuringians, and St. Boniface (c. 673–754), the real founder of the German church. Supported by Charles Martel against the aristocratic Frankish clergy, who perhaps feared the growing influence of Rome, Boniface led missions into Franconia, Thuringia and Bavaria, where he founded or restored a primitive diocesan organization. In 742 he played a large part at the first council of the new German church. However, all this work was a mere beginning; the surface of paganism had scarcely been scratched, and the north, where the Saxon tribes lived. was untouched and hostile. But when Boniface finally left his beloved monastery of Fulda to seek martyrdom, with a few companions, among the northern Frisians, he had made a vital and doubtless unintentional contribution to the political unification of the German peoples. All except the Saxons had now begun to pass under the yoke of Rome.

Charlemagne.—What St. Boniface began, Charlemagne took one stage further. Contemporary writers were vastly impressed by the great warrior's almost ceaseless German campaigning. Both the East Frisians and the Saxons (whom archaeologists find difficulty in distinguishing) now came within the orbit of his missionary enterprise, and both resented it. In the wake of the missionaries, Frankish counts and other officials moved into northeastern Frisia. raising contingents for the royal host and doing the other business of secular government. One unforeseen effect of this subjugation of Frisia was the crippling of the only independent seapower that could protect the Frankish and English coasts from the marauding Norsemen. As for the Rhineland, the richer it grew the more necessary it became to protect its hinterland, Hesse (or Franconia) and Thuringia, from Saxon raids. But this was a hard task, since east of the Rhine there was no natural barrier to hold. Thus, each of Charlemagne's punitive expeditions hit deeper than its predecessor into the heart of Germany, leaving behind it bitter memories of forced conversion, deportations and massacre. It should not, however, be thought that Charlemagne's treatment of the Saxons sprang only from political considerations. He was as sincerely resolved to fulfil with fire and sword his missionary duty as a Christian ruler as were the Saxons to resist conversion and to uphold the bloodthirsty pagan rites of their antestors. Whenever Charlemagne's attention was distracted to some other part of his dominions, the Saxons could be counted on to revolt, to slaughter the Frankish officials and priests in their midst and to raid as far westward as they could manage. Charlemagne, in his turn, would punish the offending tribes and garrison the defense points abandoned by the Saxons. (These defense points, *werls*, or burgs, must have been centres for trade as well as defense, for coin hoards have often been found in their vicinity.) The most famous leader of Saxon resistance was a certain Widukind, who is to be distinguished from the Saxon historian of the same name. Widukind, for longer than any other Saxon, succeeded in keeping together a majority of the chieftains in armed resistance to the Franks. His difficulty was not that they tolerated the Franks but that their own feuds were too deep and complex to permit of serious political coherence. Resistance gave the Saxons a certain sense of racial unity that never deserted them; but they were not yet politically united among themselves, let alone with other Germans. They continued to live, much as in the days of Tacitus, upon their estates among the forest clearings—edhelingi (nobles), *frilingi* (freeman), *lazzi* (half-free) and unfree—a hierarchized society bound to the soil and little interested in common means of action. Widukind finally surrendered and was baptized; the Rhineland and the East Frankish church were saved, but at the cost of most savage repression in Saxony, which is reflected in the *Capitulatio* de *partibus Saxoniae*. The extreme north, looking to the Baltic and enjoying Danish support, was impossible to control; but finally, in 797, Charlemagne negotiated a form of peace with the remaining Saxons, the terms of which were embodied in the *Capitulare Saxonicum,* a statesmanlike measure. The battle for the north continued. but Saxony as a whole was slowly becoming integrated with the other national areas of Germany under Frankish control and had become part of the great march protecting the Frankish world from Danes, Slavs and Avars.

In the Bavarians Charlemagne found a people as independent as the Saxons but more civilized. They had commercial and dynastic contacts with Lombardy that made them (and to some extent the Alamanni of Swabia also) a southward-looking people. Italian preoccupations were, as much as anything, responsible for Charlemagne's decision to end the spasmodic control exercised by the Franks over the powerful Bavarian ducal dynasty of the Agilolfings and to establish a direct supervision. This was achieved. Bavaria was not francified, but Carolingian rule replaced Agilolfing, and Frankish churchmen and officials (such as the counts and *missi dominici*) moved as freely about Bavaria, seeing to the enforcement of the royal will, as they did in Saxony. But, as northern Frisia became the Frankish march against the Danes and Saxony that against the Slavs, so did Bavaria, together with Lombardy, become the march against the Avars. Only Christianity did as much to draw the regions of Germany together as did the powerful administrative'measures taken by the Franks to weld them into a protective march against the central European threat. But it was Francia, not Germany, that was protected.

The Kingdom of Louis the German.—Charlemagne's successor as emperor, Louis I the Pious, was not unpopular with his German subjects; on two occasions he owed his restoration to power largely to their support. In 825 his son, Louis the German, was entrusted with the government of Bavaria, whence he was gradually to extend his power over all Carolingian Germany. This was the first time that the German nations had had a ruler whose authority was confined to their own lands and whose time was largely taken up with defending them from Slavonic penetration;

but this was by no means the sum of ambition for Louis the German, who tended, like all his house, to regard the whole of Francia as a partible family inheritance of which each member, in each generation, should take for himself and his followers what he could get. Louis was thus satisfied neither with the partition treaty of Verdun (843), by which he obtained the bulk of the lands east of the Rhine together with the districts round Mainz, Worms and Speyer on the left bank, nor with that of Mersen (870), by which he settled a dispute with Charles the Bald of France over the middle kingdom of their nephew Lothair *(see* LORRAINE). Under the latter treaty Louis's dominions reached almost the proportions of mediaeval Germany. On the east they were bounded by the Elbe and the Bohemian mountains; on the west, beyond the Rhine, they included the districts afterward known as Alsace and Lorraine. Ecclesiastically they included the provinces of Mainz, Trier, Cologne, Salzburg and Bremen. But Charlemagne's capital at Aachen and the rich family estates in Lotharingia were never finally abandoned by either branch of the Carolingian dynasty, although the bulk of the lands that they controlled increasingly assumed the separate outlooks of France and of Germany. An example of this increasing separation is provided by the oaths sworn at Strasbourg in 842 by Louis and Charles, the former swearing in his brother's language, Romance, the latter, conversely, in German; but this drifting apart is in some ways less significant than the things that still held France and Germany together.

The ceaseless external blows from Danes, Saracens and Magyars that fell upon the Carolingian world in the 9th century did not have the effect of uniting it in resistance. Not only the Carolingians themselves but their followers also were prepared to take advantage of each other, to compromise with the enemy and to carve out ever more estates from each other's lands. They did not see great issues quite as clearly as historians now may. Nor are the motives that led them to behave thus quite as simple as at first they may look. So, in 887, Arnulf, an illegitimate son of Louis the German's son Carloman, led an army of Bavarians against Charles the Fat, in part because Charles was not defending the Rhineland from the ravages of the Danes, in part because his aim was the full Carolingian inheritance. But Arnulf was not equally successful in defending his eastern possessions. After his death in 899 the German kingdom came under the nominal rule of his young son, Louis the Child, and in the absence of strong military leadership became the prey of the Magyar horsemen and other invaders from the east.

Rise of the Duchies.—The rise of the German duchies was a direct outcome of the Carolingian decision, avoidable or not, to leave defense in the hands of those who were attacked; in other words, to decentralize military command and with it, inevitably, something else of the royal authority. The new *duces* were not, as was once thought, appointed by the peoples concerned, nor were they the descendants of the tribal chieftains of the post-migration period. It seems more likely that they were Carolingian counts who took the initiative in organizing defense on a local basis, without thereby seeking to shake men's loyalty to the house of Charlemagne, of which the German church was a natural champion. All the same, their initial success (the East Frankish kings eventually resumed leadership in the person of Henry the Fowler) established them in the hearts of those whom they protected. This was particularly the case with the Saxons, whose dukes, the Liudolfings, were descended from the military commanders first sent by Louis the German to defend east Saxony. Similarly, the Swabian dukes began with a military title *(duces Raetianorum)*; so did the Bavarian ducal family of Liutpold. The origins of the short-lived duchy of Thuringia are less easy to determine. Franconia naturally remained the German duchy most intimately associated with the East Frankish kingship. How, in practice, the lives of the German land-owning or land-renting freemen were affected by these changes is a matter largely of guesswork. Perhaps it is true that political insecurity and its economic consequences tightened the lord-man relationship, as in France and elsewhere. However, nothing is more striking than the variety, between region and region, of German social organization. Perhaps much more of tribal ways of local government survived the Carolingians and the Magyars than was once thought possible.

(J. M. W.–H.)

THE TENTH AND ELEVENTH CENTURIES, TO 1056

Conrad I (911–918).—When in 911 Louis the Child, last of the East Frankish Carolingians, died without leaving a male heir, it seemed quite possible that his kingdom would break into pieces. In at least three of the four stem lands, Bavaria, Saxony and Franconia, the ducal families were established in the leadership of their tribes. In Swabia (Alamannia) it is true, two houses were still fighting for hegemony; but only the church, fearing for its endowments, had an obvious interest in the future of the monarchy, its ancient protector. Against the growing authority of the dukes and the deep differences in dialect, in customs and in social structure between the tribes there stood only the Carolingian tradition of kingship; but, with Charles the Simple as holder of the West Frankish kingdom, its future was uncertain and not very hopeful. Only the Lotharingians put their faith in the ancient line and did homage to Charles, its sole reigning representative. The other component parts of the East Frankish kingdom did not follow suit.

We can only guess at the motives of the Saxon and Frankish tribal hosts who on Nov. 10, 911, elected Conrad, duke of the Franks, as their king at Forchheim in Franconia. At the opening of the 10th century the Germanic peoples settled in the lands east of the Rhine and west of the Elbe, the Saale and the Bohemian forest, rude and thinly spread though their settlements were, had to face even more savage and pagan races pressing in from further east, especially the Magyars. The Saxons, headed by their duke Otto, of the great race of the Liudolfings, were threatened by more enemies on their frontiers than any other tribe; Danes, Slavs and Magyars simultaneously harassed their homeland. A king who commanded resources further west in Franconia might therefore prove to be of help. The Rhenish Franks on the other hand, having hitherto given their royal house, the Carolingians, to the other tribes, did not wish to abdicate from their position as the leading and kingmaking people, which gave them many material advantages.

Conrad, elected by Franks and Saxons, was soon recognized also by Arnulf, duke of Bavaria, and by the Swabian clans. In descent, honours and wealth, however, he was no more than the equal of the dukes who had accepted him as king. To gain a lead over them, to found a new royal house and to acquire those wonder-working attributes which the Germans venerated in their rulers long after they had been converted to Christianity he had yet to prove himself able, lucky and successful. The reason why the relations between the German kings and a few score families of magnates seemed eventually to make up the sum of political events was that, at the very foundation of the German kingdom, circumstances had long favoured those men whom birth, wealth and military success raised well above the ranks of the ordinary free members of their tribe. Their estates were cultivated in the main by half-free peasants. slaves who had risen or freemen who had sunk. The holdings of these dependents fell under the power of the lord to whom they owed service and obedience. Already they were tied to the lands on which they laboured and already they received justice for many offenses at the hands of their protectors. For many reasons ordinary freemen tended generally to lose their independence and had to commend themselves to more fortunate and powerful neighbours and thus lost their standing in the assemblies of their tribe. Everywhere except in Friesland and parts of Saxony the nobles wedged themselves between king or duke and the rank and file. They alone could become prelates of the church, and they alone could compete for the possession and enjoyment of governmental rights. Besides the dukes of the stem lands who owed nothing in their position to the crown the bulk of administrative authority, jurisdiction and command in war lay with the margraves and counts whose hold on their charges hardened by and large into hereditary right. The commended men and the half-free disappeared from the important functions of public life. In the assemblies of the county they could no longer be dooms-men but came only to pay dues and to receive orders, justice and penalties. Their political role was passive. Those lords whose protection was most worth having also had the largest throng of dependents and thus became more formidable to their enemies and to the remaining freemen. Lordship and submission to it were hereditary, and thus the horizon of the dependent classes narrowed until eventually the lord and his officials filled the place of all secular authority and power in their lives. Military strength, the possession of arms and horses, and the habit of using them were decisive. Most dependent men were disarmed; that became part of their degradation.

Henry I (919–936).—Conrad I was quite unequal to the situation in Germany. According to the feeling of contemporaries his failure meant that his house was luckless and without the prosperity-bringing virtues which belonged to true kingship. On his deathbed in 918 he had therefore to propose that the crown, which in 911 had remained with the Franks, should now pass to the leading man in Saxony, the Liudolfing Henry (called the Fowler). Henry was elected by the Saxons and Franks at Fritzlar, their ancient meeting place, in 919. With a monarch of their own race the Saxons now took over the burden and the rewards of being the kingmaking people. The centre of gravity shifted to the east, where the Liudolfing lands and their power lay.

The transition of the crown from the Franks to the Saxons for a time enhanced the self-sufficiency of the south German tribes. The Swabians had kept away from the Fritzlar election. The Bavarians believed that they had a better right to the Carolingian inheritance than the Saxons (who had been remote outsiders in the 9th century) and in 919 elected their own duke Amulf king. They too wanted to be the royal and kingmaking people. Henry I's regime rested in the main on his own position and family demesne in Saxony and on certain ancient royal seats in Franconia. His kingship was purely military. He hoped to gather authority by waging successful frontier wars and to gain recognition in the first place by concessions rather than to insist on the sacred and priestlike status of the royal office which the church had built up in the 9th century. At his election he refused to be anointed and consecrated by the archbishop of Mainz. In settling with the Bavarians he abandoned the policy of supporting the internal opposition that the clergy offered to Duke Arnulf, a plank to which Conrad had clung. To end Arnulf's rival kingship he formally surrendered to him the most characteristic privilege and honour of the crown: the right to dispose of the region's bishoprics and abbeys. Arnulf's homage and friendship entailed no positive obligations toward Henry. and the Bavarian duke pursued his own tribal interests—peace with the Hungarians and expansion across the Alps—as long as he lived.

Policy of the Saxon Dynasty (919–1024).—From these unpromising beginnings the Saxon dynasty not only found its way back to Carolingian traditions of government but soon got far better terms in its relations with the autonomous powers of the duchies, which had gained such a start on it. However, the constitution that it bequeathed to its Salian successors was self-contradictory; while seeking to overcome the princely aristocracies of the stem lands by leaving them to themselves, the Saxon kings came to rely more and more both for the inspiration and for the practice of government, on the prelates of the church, who were themselves recruited from the ranks of the same great families. They loaded bishoprics and abbeys with endowments and privileges and thus gradualiy turned the bishops and abbots into princes with interests not unlike those of their lay kinsmen. These weaknesses, however, lay concealed behind the personal ascendancy of an exceptionally tough and commanding set of rulers up to the middle of the 11th century. Thereafter the ambiguous system could not take the strain of the changes fermenting within German society and even less the attack on its values that came from without: from the reformed papacy.

The Liudolfing kings won military success, and with it they gained that respect for their personal authority which counted for so much at a time when the great followed only those whose star they trusted and who could reward services with the spoils of victory. In 925 Henry I brought Lotharingia back to the East Frankish connection (see **LORRAINE**). Whoever had authority in this half French-speaking, half German-speaking region could treat the neighbouring kingdom of the West Franks as a dependent. The young Saxon dynasty thus won for itself and its successors a hegemony over the west and the southwest which lasted at least up to the middle of the 11th century. The Carolingian kings of France and the great feudatories who sought to dominate if not to ruin them became in turn petitioners and even vassals of the German court during the reign of the Ottos. The kings of Burgundy, whose suzerainty lay over the valleys of the Saône and the Rhône and over Provence, likewise fell under the tutelage of the masters of Lotharingia. Rich in ancient towns this region, once the homeland of the Carolingians, was more thickly populated and wealthier than the stem lands east of the Rhine. What little international trade came their way entered the Rhine valley through Lotharingia.

The Eastern Frontier.— Greater prestige still and a claim to imperial hegemony fell to the Saxon rulers when they broke the back of the Hungarian invasions against which the military resources and methods of western European society had almost wholly failed for several decades. In 933, after long preparations, Henry routed a Hungarian attack on Saxony and Thuringia. In 955 Otto I (936–973), at the head of a force to which all the tribes had sent mounted contingents, annihilated a great Hungarian army on the river Lech near Augsburg. The battle again vindicated the efficiency of the heavily armed man skilled in fighting on horseback.

With a Saxon dynasty on the throne, Saxon nobles gained office and power with opportunities for conquest along the eastern river frontiers and marches of their homeland. Otto I indeed had an eastern policy which aimed at getting more than slaves, loot and tribute. Between 955 and 972 he founded and richly endowed an archbishopric at Magdeburg which he intended to be the metropolis of a large missionary province beyond the Elbe, among the heathen Slavs. This would have brought their tribes under German control and exploitation in the long run; but the ruthless methods of the Saxon lay lords clashed with the church's efforts at peaceful penetration. In the 10th century there was little or no German agricultural settlement beyond the Elbe. Far too much forest clearing remained to be done in all the regions of western and southern Germany. The Saxon conquests up to the Oder were secured by military strongholds, called burgwards, and lasted only as long as their garrisons had the upper hand. Behind the Slav peoples of Brandenburg and Lusatia, moreover, new powers rose: the Poles under Mieszko and, to the south, the Czechs under the Premyslides received missionaries from Passau and Magdeburg without falling permanently under the political and ecclesiastical domination of Bavarians and Saxons. The heathen Elbe-Slavs, kept under by the Saxon margraves, rose in 983 when the military occupation collapsed and with it the missionary bishoprics which had been founded at Oldenburg, Brandenburg and Havelberg. Farther south the defenses of the Thuringian marches between the Saale and the middle Elbe remained in German hands, but only after a long and fierce struggle against Polish invaders early in the 11th century. The northern part of the frontier reverted to what it had been before Otto's trustees. Hermann Billung and Gero, opened their wars. Missionary enterprises directed from Bremen and Magdeburg achieved little before the 12th century. The Saxon ruling* class, bishops and margraves, must bear the responsibility for the fiasco of eastward expansion in the 10th century. The prelates too saw their missions as means to found ecclesiastical empires with subject dioceses and tithes on Slav soil. The tribes across the Elbe therefore remained unconverted and implacable foes, a standing menace to the nearby churches. The wars also left a legacy of savagery on both sides so that from *c.* 1140 onward the substitution of German settlers for the native Slavs became the common policy of both the church and the princes.

Government and the Nobility.—Conrad I's and Henry I's kingship rested on the will of the tribes or rather on that of their leaders and of the higher aristocracy. It was in the first place an arrangement between the Franks and the Saxons which the Bavarian and Swabian dukes recognized at a price by acts of personal homage. But the German kings, of whatever dynasty, had to live under Frankish law. After the death of Conrad I's brother Eberhard in 939 Otto I kept the Franconian dukedom vacant and the Franconian counts henceforth stood under the immediate authority of the crown. In Saxony too nobody succeeded to the dukedom of Otto's ancestors. The march-duchy of the Billungs, a bulwark raised against the Danes and the northern Slav tribes, did not give that family authority over all the other Saxon princes. In the south the Ottonians sought to turn the dukedoms of the stem lands into offices held of the crown as fiefs and to supplant native dynasties by aliens and members of their own clan. When even that did not stop rebellions under the banner of tribal self-interest, they began to break up the ancient Bavarian stem land by creating a duchy in Carinthia to cut off the spearhead of Bavarian expansion southward. The first two Salians, Conrad II (1024–39) and Henry III (1039–56) also bestowed vacant duchies quite freely on their own kin and on men from outside the stem boundaries. They competed against ducal power but could neither abolish nor replace it. In the 11th century as before, the dukes held assemblies of their folk, led the tribal host in war and enforced peace. The counts, who were the ordinary officers of justice in serious, criminal cases, obeyed the ducal summons, but for the most part they received their "ban," the power to do blood justice, from the king himself. The fiefs and the customary rights attached to their office, and indeed the office itself not only became hereditary but also came to be treated more and more as a patrimony to which they had an inherent right against all men, king and duke included. Even so, however, a good many comital families died out and their counties fell back into the king's hands. From Otto III's reign (983–1002) onward it became not at all unusual to bestow these on bishoprics and certain great abbeys rather than to grant them out again to other lay magnates. The bishops however could not perform all the functions of the counts; in particular their holy orders forbade them to pass judgments of blood. They needed officials called advocates to take charge of the higher jurisdiction in the counties and franchises that their churches possessed by royal grant. In the 10th and 11th centuries these advocates had to be recruited from the aristocracy, the very class whose greed for hereditary office was to be checked, because ordinary freemen could not enforce severe sentences or defend the privileges of the church against armed intrusion. Dangerous neighbours of bishoprics and abbeys in any case, the nobles as advocates and protectors of ecclesiastical possessions were anything but reliable servants of their ecclesiastical overlords. Thus there arose in nearly all German lands, whether the ducal office survived or not, powerful lines of margraves, counts and hereditary advocates who enriched themselves at the expense of the church (which meant also the crown) and in competition with one another. From the abler, more fortunate and longlived races among these dynasts sprang the territorial princes of the later 12th and 13th centuries, absorbing and finally inheriting most of the rights of government from the Reich itself.

The king was the personal overlord of all the great. His court was the seat of government and it went with him on his ceaseless journeys. The German kings, even more than other mediaeval rulers could only make their authority respected in the far-flung regions of their kingdom by travelling ceaselessly from duchy to duchy, from frontier to frontier. Wherever they stayed their jurisdiction superseded the standing powers of dukes, counts and advocates and for a brief while they could collect the profits of local justice and wield some control over it. As they came into each region they summoned its leaders to attend their solemn crown wearings, deliberated with them on the affairs of the Reich and the locality, presided over pleas, granted privileges and made war against peace breakers at home and on enemies abroad.

The royal revenues came from the king's demesne lands and from his share of the tributes that Poles, Czechs, heathen Slavs and Danes had to pay whenever he could enforce his claims of overlordship. The king's demesne was his working capital. He and his household lived on its produce during their wanderings through the Reich, and it also served to provide for his family, to found churches and to reward faithful services done to him, especially in war. To swell the hosts vassals had to be enfeoffed, and alienations were inevitable. The Salians, though they inherited the remains of Ottonian wealth as imperial demesne, brought little of their own to make up for its diminution. Already the last Saxon, Henry II (1002–24) and after him Conrad II therefore took to enfeoffing vassals with lands commandeered from the monasteries. But the beneficiaries often enough were already powerful and wealthy men in their own right, so that no class of freeborn mounted warriors, linked permanently with the crown, sprang from the loyalties and rewards of one or two reigns. In any case the lion's share of grants went to the German church.

The German Church.—From the Carolingians the German kings inherited their one and only institution of central government: the royal chapel, with the chancery that does not seem to have been distinct from it. Service there became a recognized avenue of promotion to the episcopate for high-born clerks. In the 11th century bishops and abbots conducted the affairs of the Reich much more than the lay lords, even in war. They were its habitual diplomats and ambassadors. Unlike Henry I, Otto I and his successors sought to free the prelates from all forms of subjection to the dukes. The king appointed them, and to him alone, as to one sent by God, they owed obedience. Thus there arose besides the loose association of stems in the German kingdom a more compact and uniform body with a far greater vested interest in the Reich: the German church. By ancient Germanic custom, moreover, the founder of a church did not lose his estate in the endowment that he had made; he remained its proprietor and protecting lord. The bishoprics, it is true, and certain ancient abbeys such as St. Gallen, Reichenau, Fulda and Hersfeld did not belong to the king; they were members of the kingdom but under his guardianship. The greater churches therefore had to serve the rulers with mounted men, money and free quarters. Gifts of royal demesne to found or to enrich bishoprics and convents were not really alienations but pious reinvestments, as long as the crown controlled the appointments of bishops and abbots. But the church did not merely receive grants of land, often waste, to settle, develop and make profitable. It was also given, as has been shown, powers of jurisdiction over its dependents. Nor did the kings stint the prelates in other regalian rights, such as mints, markets and tolls. These grants broke up counties and to some extent even duchies, and that was their purpose: to disrupt the secular lord's jurisdictions which escaped royal control.

This policy of fastening the church, a universal institution, into the Reich with its well-defined frontiers is usually associated with the name of Otto I. But it gathered momentum only in the reigns of his successors. It reached a climax under Henry II (1002–24), the founder of the see of Bamberg in the upper Main valley; but Conrad II (1024–39), though less generous with his grants, and his son Henry III continued it. Bishops and abbots became the competitors of lay princes in the formation of territories, a rivalry which more than any other was the fuel and substance of the ceaseless feuds, the smouldering internal wars in all the regions of Germany for centuries. The welter and the confused mosaic of the political map of Germany until 1803 is the not so remote outcome of these 10th- and 11th-century grants and of the incompatible ambitions that they aroused.

Conquest of Italy and the Imperial Crown.—Otto I's marriage with Adelaide (Adelheid), daughter of Rudolph II of Burgundy, and the Italian rivalries between his brother Henry, duke of Bavaria, and his (Otto's) son Liudolf, duke of Swabia, drew him southward. After 951, expeditions into Italy were a matter for the whole Reich under the leadership of its ruler and not just an outlet for the ambitions of the south German tribes. For the Saxon military class too the south was more tempting than the primaeval forests and swamps beyond the Elbe. With superior forces at their back the German kings gained possession of the Lombard kingdom in Italy. There too their overlordship in the 10th and the 11th centuries came to rest on the bishoprics and a handful of great abbeys.

After his victory over the Magyars in 955, Otto I's hegemony in the west was indisputable. By the standards of one chronicler, the Saxon Widukind, he had become emperor already because he had subjected other peoples and enjoyed authority in more than one kingdom. But the right to confer the imperial crown, to raise a king to the higher rank of emperor, had fallen to the papacy, which had crowned Charlemagne and most of his successors. The Carolingian order in the west was still the model and something like a political ideal for all its ruling families in the 10th century. Otto had measured himself against the political tasks which had faced his East Frankish predecessors and more or less mastered them. To be like Charlemagne, therefore, and to clothe his newly won position in a traditional and time-honoured dignity he accepted the imperial crown and anointment from Pope John XII in Rome in 962. The substance of his empire was military power and success in war; but Christian and Roman ideas were woven round the Saxon's throne by the writers of his own and the next generation. Although the German kings as emperors did not give the law to the Roman church in matters of doctrine and ritual, they became its political masters for nearly a century. The imperial crown enhanced their standing even among the nobles and knights who followed them to Italy and can hardly have understood or wanted all its outlandish associations. Not only the king but also the German bishops and lay lords thus entered into a permanent connection with an empire won on the way to Rome and bestowed by the papacy.

Otto II (973–983) and above all Otto III (983–1002) were strongly drawn toward their new Mediterranean sphere of action but Henry II returned to a sober regime centred on Germany and contented himself with two brief Italian expeditions. Under Conrad II (1024–39), the first member of the Rhine Frankish house known as the Salians, the kingdom of Burgundy fell finally under the overlordship of the German crown and this tough and formidable emperor also renewed German authority in Italy. His son and successor Henry III (1039–56) treated the empire as a mission which imposed on him the tasks of reforming the papacy and of preaching peace to his lay vassals. Without possessing any very significant new resources of power he gave to his authority an exalted and strained theocratic complexion. Yet under him, the last German ruler to maintain his hegemony in western Europe, the popes themselves seemed to become mere imperial bishops. He deposed three of them, and four Germans held the Holy See at his command; but lay opposition to the emperor in Germany and criticism of his regime over the church were on the increase during the last years of his reign.

THE CONFLICT BETWEEN EMPIRE AND PAPACY, 1056–1125

More than any other feudal society in early mediaeval Europe, Germany was divided and torn by the revolutionary ideas and measures of the reformed papacy. From the pontificate of Leo IX onward—he was one of Henry III's nominees—the most determined and inspired spokesmen of ecclesiastical reform placed themselves at the service of the Holy See. Only a few years after Henry III's death (1056) they agitated against lay authority in the church, founded on proprietary rights. They regarded the laity as passive partakers of the sacraments and denied the supernatural status of kingship. Priests, including bishops and abbots, who accepted their dignities from lay lords and emperors at a price committed a sin, for these earthly powers could not rightly confer churches at all, nor could they own them. They believed moreover that thorough reforms could only be brought about by the exaltation of the papacy so that it commanded the obedience of all provincial metropolitans and was out of the emperor's and the local aristocracy's reach. The endless repetition of these teachings in brilliant pamphlets and at clerical synods spread agitation in Italy, Burgundy and Lotharingia, all parts of the empire. Their new program committed the leaders of the movement to a struggle for power, because it struck at the very roots of the regime to which the German church had grown accustomed and on which the German kings relied. The vast wealth that Henry IV's predecessors had showered on the bishoprics and abbeys would, if the new teaching prevailed, escape his control and remain at the free disposal of prelates whom he no longer appointed. Under Roman authority the churches were to be freed from most of the burdens of royal protection without losing any of its benefits. The most fiery spirits in Rome did not flinch from the consequences of their convictions. Their leader Hildebrand, later Pope Gregory VII (1073–85) was ready to risk a collision with the empire.

The Minority of Henry IV.—Henry IV (1056–1106) was six years old when his father died. The full impact of the Gregorian demands, coming shortly after a royal minority, a Saxon rising and a conspiracy of the south German princes has often been regarded as the most disastrous moment in Germany's history during the middle ages. In fact the German church proved thoroughly unreliable as an inner bastion of the empire even before Rome struck. Its leaders, Anno and Adalbert (*qq.v.*), archbishops of Cologne and of Hamburg-Bremen respectively, shamelessly exploited their hold over the young king by hunting for spoils out of the imperial demesne. When Gregory VII launched his decrees against simony and clerical marriage, humiliated the aristocratic episcopate by summonses to Rome and sentences of suspension and, in 1075, forbade rulers to invest bishops and abbots with their churches, the German hierarchy was demoralized and shaken. The prelates' return to their customary support of the crown was neither disinterested, nor wholehearted, nor unanimous.

Henry IV's minority also gave elbow room to the ambitions and hatreds of the lay magnates. His mother Agnes of Poitou's feeble regency faltered before the throng of princes who respected only authority and forces greater than their own. The ruling influence of the higher clergy at the court of Henry III and the renewed flow of grants to the church had estranged them from the empire. It is likely also that these eternally belligerent men were lagging behind the prelates in the development of their agrarian resources. The latter had a vested interest in peace and under royal protection improved and enlarged their estates by asserting enterprise and also by offering better terms to freemen in search of a lord. The bishops' market and toll privileges brought them revenues in money, which many of the lay princes lacked. So far, however, the princes' military power, their chief asset, had remained unchallenged. Now for the first time they had also to face rivals within their own sphere of action. Henry III and the young Henry IV began to rely on advisers and fighting men drawn from a lower tier of the social order, the poorer freeborn nobility of Swabia and above all the class of unfree knights, known as *ministeriales*. The latter had first become important as administrators and soldiers on the estates of the church early in the 11th century. Their status and that of their fiefs was fixed by seignorial ordinances, and they could be relied on and ordered about, unlike the free vassals of bishops and abbots. The Salian kings, beginning with Conrad II used ministeriales to administer their demesne, as household officers at court and as garrisons for their castles. They formed a small army which the crown could mobilize without having to appeal to the lay princes whose ill will and antipathy toward the government of the Reich grew apace with their exclusion from it.

The Saxon Rising.—Having come of age, the king used petty south German nobles and his ministeriales to recover some of the crownlands and rights which the lay princes and certain prelates had acquired during his minority, particularly in Saxony. Here, however, his recuperations went further and a great belt of lands from the northern slopes of the Harz mountains to the Thuringian forest was secured and fortified under the supervision of his knights to form a compact royal territory, where the king and his court could reside almost continuously. The south German magnates were thus kept at a distance when Henry and his advisers struck at the neighbouring Saxon princes, especially Otto of Nordheim and the Billung family.

The storm broke in 1073. A group of Saxon nobles and prelates and the free peasantry of Eastphalia who had to bear the brunt of labour and carrying services in the building of the royal strongholds revolted against the regime of Henry's Frankish and Swabian servants. To overcome this startling combination and to save his fortresses, the king needed the military strength of the south German princes Rudolph of Rheinfelden, duke of Swabia, Welf IV, duke (as Welf I) of Bavaria, and Berchtold of Zähringen, duke of Carinthia. Suspicious and hostile at heart, they took the field for him only when the Eastphalian peasantry committed outrages which shocked even their leaders. Their forces enabled Henry to defeat the Saxon tribal rebellion near Langensalza in June 1075. But when the life and death struggle with Rome opened only half a year later, the south German malcontents deserted Henry and, together with the Saxons and a handful of bishops, entered into an alliance with Gregory VII. Few of them at this time were converted to papal reform doctrines, but Gregory's daring measures against the king gave them a chance to come to terms with one another and to justify a general revolt. For on Feb. 22, 1076, the pope had absolved all men from their oaths to Henry and solemnly excommunicated him. In October his legates met the German lords at Tribur to decide on the future of the king, whom his last adherents now abandoned. Although Henry had to be absolved by Gregory at Canossa in Jan. 1077, the princes two months later nonetheless elected Rudolph of Rheinfelden to rule in his place.

The Civil War.—The war which now broke out lasted for almost 20 years. A majority of the bishops, most of Rhenish Franconia (the Salian homeland) and some important Bavarian and Swabian vassals sided with Henry. He thus held a central position dividing his south German from his Saxon enemies, who could not unite long enough to destroy him. With the death of Rudolph of Rheinfelden (1080) and the retreat in 1089 of another antiking, Hermann of Salm, the war in Germany degenerated into a number of local conflicts for the possession of bishoprics and abbeys. It almost died down in 1098, when the south German adherents of the papacy came to terms with Henry for the time being, but without recognizing his antipope Clement III. Throughout these years the crown, the churches and the lay lords had to enfeoff more and more *ministeriales* in order to raise mounted warriors for their forces. Though this and frequent devastations strained the fortunes of many nobles, they knew how to recoup themselves by extorting more fiefs out of neighbouring bishoprics and abbeys. The divided German church thus bore the brunt of the costs of civil war and needed peace almost at any price. Henry, since 1080 once again a vulnerable excommunicate, could not protect it.

Henry V and the Concordat.—The Salian dynasty and the rights it fought for were saved because Henry IV's son and heir himself seized the leadership of a last and pitiless rising against his father (1105). This cold-blooded manoeuvre enabled Henry V (1106–25) to continue the struggle for the crown's prerogative over the empire's churches against the inexorable demands of the papacy. The conflict now shrank into a legalistic dispute over the right to invest bishops and abbots with their dignities and the secular possessions attached to them (see INVESTITURE). In the course of it the princes became the arbiters and held the balance between their overlord and the pope. In 1122, acting as intermediaries and on behalf of the Reich, they forced the temporary concessions known as the Concordat of Worms out of the Holy See and its German spokesman, Archbishop Adalbert of Mainz (1109–37), the bitter personal enemy of Henry V and the territorial rival of the Hohenstaufen sons of Henry's sister Agnes. But by then they had for the most part defeated efforts to restore royal rights in Saxony and to stem the swollen jurisdictions and territorial powers of the aristocracy elsewhere.

Germany after the Conflict.—When Henry V, the last Salian, died childless in 1125, Germany was no longer and had for some time ceased to be the most effective political force in Europe. The brilliant conquest states of the Normans in England and in Sicily and the patient, step-by-step labours of the French monarchy were achieving forms of government and concentrations of military and economic strength which the older and larger empire lacked. The papacy had dimmed its prestige, and Rome now became the true home of universalistic interests. When Pope Urban II preached the first crusade in 1095, Henry IV, cut off and surrounded by enemies, lived obscurely in a comer of northern Italy. The Holy See by its great appeal to the militant lay nobility of western Europe thus won the initiative over the empire. At this critical moment the Reich also lost control in the Italian bishoprics and towns just when their trade was finding dazzling new openings through the Latin conquests on the Levantine seaboard. Germany thus did not even benefit indirectly from the crusaders' triumphs although some of their leaders, *e.g.*, Godfrey of Bouillon and Robert II of Flanders, were vassals of the emperor. The civil wars renewed for a time the relative isolation of the southern and central German regions.

Internally the crown had saved something of the indispensable means of government in the control over the church, but it was a bare minimum and its future was problematic. The ecclesiastical princes henceforth held only their temporalities as imperial fiefs, for which they owed personal and material services. As feudatories of the empire they came to represent the same interests toward it as did the lay princes; at least their sense of a special obligation tended to weaken. The king's jurisdiction continued to exist side by side and in competition with that of the local powers. The great tribal duchies survived as areas of separate customary law. Each developed differently, and the crown could not impose its rights on all alike or change the existing social order. The most tenacious defenders of this legal autonomy had been the Saxons; but in Swabia, where distinct territorial lordships grew fast, it prevailed also. The Gregorian reform movement therefore aggravated the age-old contradictions in Germany's early mediaeval constitution. But its monastic culture and its intellectual interests were anything but barren. Both sides fought with new literary weapons to work on public opinion in cathedrals and cloisters and —who knows?—perhaps also in the castles of the lay aristocracy. In their hard-hitting polemical writings they attempted to expound the fundamental theological, historical and canonistic truths of their cause. The agitation did something to disturb the cultural self-sufficiency of the German laity. It drove many of the south German nobles to maintain direct connections with the Holy See and, whether they wanted it or not, they had to fall in with the aspirations of the religious leaders. The reform movement of the 11th and 12th centuries, one might almost say, very nearly completed the conversion of Germany which had begun five centuries before.

GERMANY AND THE HOHENSTAUFEN, 1125–1250

Dynastic Competition, 1125–52.—The nearest kinsmen of Henry V were his Hohenstaufen nephews, Frederick, duke of Swabia (1105–47), and his younger brother Conrad, the sons of Henry V's sister Agnes and Frederick, the first Hohenstaufen duke of Swabia. Some form of election had always been necessary to succeed to the crown but before the great civil war nearness to the royal blood had been honoured whenever a dynasty failed in the direct line. By 1125, however, the princes, guided by Archbishop Adalbert of Mainz, no longer respected blood right. Affinity with Henry V was no recommendation to them, and hereditary succession seemed to lower their authority in the government of the Reich. Instead of Frederick they chose Lothair of Supplinburg (1125–37), duke of Saxony, who, like the Hohenstaufen, had risen by a lucky marriage and a successful career of continuous fighting into the first rank of dynasts but, unlike them, had served the cause of the Saxon opposition to the Salians. With the enormous Nordheim and Brunonian inheritance and half that of the Billungs behind him, he could humble the Hohenstaufen brothers (1134) after marrying his only daughter and heiress to a Welf, Henry the Proud (*q.v.*). The Welfs, already dukes of Bavaria and possessors of vast demesnes, countships and ecclesiastical advocacies were even without this dazzling alliance somewhat better off than their Hohenstaufen rivals. In 1137, however, the fears of the church and a few princes turned against them. Instead of Henry the Proud, who now held the duchies of Saxony and Bavaria and the Mathildine lands in Italy, they chose Conrad (1138–52), Lothair's unsuccessful Hohenstaufen opponent.

The battle against the Welfs, which Conrad III put foremost on his political program, was abandoned with his death in 1152 when an election once again decided the succession and the political situation in Germany for the next 30 years. The princes then chose Frederick I Barbarossa (1152–90), the son of Conrad's elder brother Frederick and the Welf princess Judith, who agreed to share power in Germany with his Welf cousin, Henry the Lion. The price of his election was dualism. In 1156 the duchy of Bavaria, which Conrad had tried to wrest from the Welfs, was restored to Henry, already undisputed duke of Saxony. The Babenberg margrave of Austria, his rival, had to be compensated with a charter which raised his margraviate into a duchy and gave him judicial suzerainty over an even wider area. Taken out of the Lion's duchy, it was to be held as an imperial fief which might descend both to sons and daughters. A perpetual principality, it served as a model for the aspirations of many other lay princes.

Colonization of the East.—The history of Germany in the 12th and 13th centuries is one of ceaseless expansion. A conquering and colonizing movement burst across the river frontiers into the swamps and forests from Holsatia to Silesia and suffocated the Slav tribes between the Elbe and the Oder. Every force in German society took part: the princes, the prelates, new religious orders, knights, townsmen and peasant settlers. Agrarian conditions in the older lands of Germanic occupation seem to have favoured large-scale emigration. With a rising population, there was much experience in drainage and wood-clearing but a diminishing fund of spare land to be attacked in the west. Excessive subdivision of holdings impoverished tenants and did not suit the interests of their lords. Sometimes also seignorial oppression is said to have driven peasants to desert their masters' estates. They certainly found a better return for their labour in the colonial area: personal freedom, secure and hereditary leasehold tenures at moderate rents and in many places quittance from services and the jurisdiction of the seignorial advocate. The colonists brought with them a disciplined routine of husbandry, an efficient plow and orderly methods in siting and laying out their villages. Very soon even the Slav rulers of Bohemia and Silesia competed for immigrants. First and foremost, however, the Saxon and Thuringian marcher princes sought to attract settlers for the lands that they had conquered and the towns that they founded to open up communications and trade routes. The older regions of the Reich moreover had not only peasants but also men of the knightly class to spare—soldiers who needed fiefs and lordships to uphold their rank. Both could be gained beyond the Elbe under the leadership of successful princes. The Germanized east thus became the home of fair-sized principalities in the 13th century, while all along the Rhine valley the rights of government were scattered over smaller and less compact territories. The Ascanian dynasty for instance, which under Albert the Bear (*q.v.;* 1134–70) began to advance into Brandenburg, by 1250 not only ruled over a broad belt of land up to the Oder river but had already established itself on the eastern banks ready for further advances. Further south the Wettin (*q.v.*) margraves of Meissen busied themselves with settlements and town foundations in Lusatia.

For a time Henry the Lion, as duke of Saxony (1142–80), overshadowed all these rising powers, and the Welf profited as much by the ruthless use of his resources against weaker competitors as by his own efforts in Mecklenburg. As his protection was alone worth having in northeastern Germany, the newly established Baltic bishoprics were at his mercy and he alone could attract the traders of Gotland to frequent the young port town of Lübeck, which he extorted from one of his vassals in 1158.

The Reich too possessed demesnes in the east, notably the Egerland, Vogtland and the land of Pleissen in the Thuringian march. The Hohenstaufen kings therefore took some part in opening up these regions. They too founded towns and monasteries on their thickly wooded lands and established their *ministeriales* as burgraves and advocates over them. But in this as in many other things they only competed with the princes. They did not and could not control the eastward movement as a whole.

Hohenstaufen Policy in Italy.—It was different with the other great field of German expansion in the 12th century, Lombardy and central Italy. Here the emperors and their military following alone counted, and the rural population of Germany had no direct interest in the wars waged to recover and exploit ancient regalian rights over the growing Lombard city communes. The connection between the German crown, the empire and dominion over Italy has indeed been regarded as a disaster for Germany and the ever increasing concern of the Hohenstaufen dynasty with the south as its most tragic phase. But although Frederick Barbarossa's policy was opportunistic he had really very little choice. Having bought off the Welfs and reconciled other great families with yet more concessions and lastly endowed his own nephew, Conrad III's son Frederick, with Hohenstaufen demesnes in Swabia, he had to try to mobilize their good will for the empire while it lasted. He now aimed at setting up a regime of imperial officials and captains who were to exact dues and to control jurisdiction which the communes had usurped from the failing grasp of their bishops. The Germans in Italy did not bring valuable accomplishments to poor and savage tribesmen, but they attacked economically advanced and better developed communities to which they had nothing to offer in return for the rights and taxes they demanded. Military power was their chief asset in Lombardy and they used it ruthlessly.

For the Hohenstaufen *ministeriales* the rule of their masters in northern and central Italy was a career. They could be deployed continuously and became therefore the backbone of the imperial occupation. A handful of minor dynasts also served Barbarossa for many years in the powerful and profitable commands that he established. The German bishops and certain abbots still had to supply men and money and some of them, for instance Rainald of Dassel (1159–67) and Philip of Heinsberg (1167–91), archbishops of Cologne who as arch-chancellors for Italy had a vested interest, threw themselves wholeheartedly into the war. But the support of the lay princes was fitful and sporadic. Even at critical moments they could not be counted on unless they individually agreed to serve or to send their much-needed contingents for a season. The refusal of the greatest of them, Henry the Lion, in 1176 brought defeat at the battle of Legnano and in the long run spoiled many years' efforts in Lombardy.

Fall of Henry the Lion and the Estate of Princes.—Forced to retreat before the Lombard league in 1177 Barbarossa cooled toward his Welf cousin, whom he could justly blame for some of his setbacks. Dualism in Germany had outlived its purpose. Hitherto the enemies of Henry, the princes, bishops and magnates of Saxony, had been unable to gain a hearing against him at the emperor's court days. By 1178, however, the emperor was ready to help them. Outlawed (1180), beaten in the field and deserted by his vassals, the Welf had to surrender and go into exile in 1182. His duchies and fiefs, all but his houselands, were forfeited to the Reich.

His fall left a throng of middling princes face to face with an emperor whose prestige, despite reverses, stood high and whose resources had greatly increased since he began to reign. They were nonetheless the chief and ultimate gainers by the events of 1180. The final judgment by which Henry the Lion then lost his honours was not founded on folklaw but on feudal custom. The princes who condemned him regarded themselves as the first feudatories of the empire, and they also decided on the redistribution of his possessions among themselves. During the 12th century the stem duchies of the Ottonian period finally disintegrated. Within their ancient boundaries not only bishops but also lay lords succeeded in eluding the authority of the dukes. In their large immunities they themselves wielded stem-ducal powers. To enforce the imperial peace laws became both their ambition and their justification. Everywhere the greater lay dynasties and even some bishops tried to acquire a ducal or an equivalent title which would enable them to consolidate their scattered jurisdictions and if possible force lesser free lords to attend their pleas. These highest dynasts had interests in common, and they closed their ranks not only against threats from above but also against fellow nobles who had been less successful in amassing wealth, counties and advocacies and who did not possess the superior jurisdiction of a duke, a margrave, a count palatine or a landgrave. They and they alone were now called princes of the empire. To lend a certain cohesion to their varied rights they were willing to surrender their houselands to the Reich and receive them back again as a princely fief. For the emperor it was theoretically an advantage that men so powerful in their own right should owe their chief dignity and most valued privileges to his grant. It opened the possibility of escheats, for in feudal custom the rules of inheritance were stricter than in stem law. But in Germany the political misfortunes of rulers brought it about that by and large ancient caste feeling and notions of inalienable right conquered the principles of feudal law. By 1216 it was established that the emperor could not abolish principalities, nor could he create princes at random.

The "heirs" of Henry the Lion had to fight a ceaseless battle to establish and maintain themselves. In Bavaria the Wittelsbachs (*q.v.*) had received the vacant duchy but they were not recognized as superiors by the dukes of Styria or by the dukes of Andechs-Meran. In Saxony the archbishop of Cologne was enfeoffed with Henry the Lion's ducal office and all his rights in Westphalia, while an Ascanian prince, Bernard of Weimar, received the eastern half of his duchy. Neither he nor the archbishop, however, could make much out of their dukedoms, except in those regions where they already had lands and local jurisdictions. All over the Reich these and regalian rights, such as mints, fairs, tolls and the right of granting safe-conducts, were the substance of princely power, and to possess them as widely as possible became the first goal of the abler bishops and lay lords.

New Conflict with the Papacy, **1159–1215.**—The attempt to establish a direct imperial regime in Italy antagonized the papacy once again and led to a new struggle with Rome, the ally of the Lombard Communes. Political and territorial rather than ecclesiastical interests were at stake in this quarrel; but the popes could only fight it as heads of the universal church defending its liberty against a race of persecutors and had to employ their characteristic weapons, excommunication, propaganda and intrigue. Nonetheless the German bishops stood by Barbarossa and for the most part followed him in maintaining a prolonged schism against Pope Alexander III (1159–81). Unsuccessful in Lombardy, the centre of Hohenstaufen ambitions after 1177 shifted to Tuscany, Spoleto and the Romagna. This redoubled the fears and the resentment of the popes. particularly when Frederick's son and chosen successor, Henry VI (1190–97), became after 1189 the legitimate claimant to the Sicilian kingdom through his wife Constance, the sole surviving heiress. With their backs to the wall the popes had to make what use they could out of any opposition to the Hohenstaufen. Their chance came in 1197 when Henry VI died prematurely, leaving a three-year-old son, Frederick, to succeed him. To escape the chaos of a minority regime, the bulk of the German princes and bishops elected the boy's uncle, Philip of Swabia (1198–1208); but an opposition faction in the lower Rhenish region, led by the archbishop of Cologne and financed by Richard I of England. raised an antiking in Otto IV (1198–1215), a son of Henry the Lion. Pope Innocent III (1198–1216) had to enlarge on his rights over imperial coronations and become a partisan in the German electoral feud if he wished to defend his recuperations in Italy against Hohenstaufen claims. Territorial interests in the Romagna tempted the papacy to exploit the weaknesses of the empire's constitution, the uncertainties of electoral custom and the lack of strict legal norms in Germany. In the course of the war for the crown much hard-won demesne and many useful rights over the church had to be sacrificed by the rivals to bribe their supporters.

Territorial Rivalries and the Empire, **1215–50.**—Frederick II (1215–50) entered Germany to regain his own against Otto IV in 1211. Despite promises to divide his inheritance, he kept the kingdom of Sicily and the empire together and thus he also shouldered the inevitable life and death struggle with the papacy. The Hohenstaufen demesne in Swabia, Franconia and Alsace and on the middle Rhine was still very considerable, and Frederick even recovered certain fiefs and advocacies which had been lost during the recent civil wars. Their administration was improved, and they provided valuable forces for his Italian wars. The great peace legislation of 1235 moreover showed that the emperor had not become a mere competitor in the race for territorial gain. But, except for brief intervals the princes and bishops were left free to fight for the future of their lands against one another and against the intractable lesser dynasts who refused to accept their domination. The great charters which Frederick II had to grant, first to the ecclesiastical princes (1220) and later to all territorial lords (1232) gave them written guarantees against the activities of royal demesne officials and limited the development of imperial towns at the expense of episcopal territories. But they were not always observed, and until 1250 the crown remained formidable in southern Germany, despite the antikings Henry Raspe (1246–47), landgrave of Thuringia, and William, count of Holland (1247), whom the papacy caused to be elected by the Rhenish archbishops in Germany.

The Reich after the Hohenstaufen Catastrophe.—Frederick II died in 1250 in the midst of his struggle against Pope Innocent IV (1243–54). His son Conrad IV (1250–54) left the north in 1251 to fight for his father's Italian possessions. The antiking William of Holland (1247–1256) was thus without a rival in an indifferent Germany which had lost interest in its rulers. But the princes were not ready to become the sole residuary legatees of imperial authority. The bishops' cities and the towns, many of them founded on royal demesne could not be absorbed. Their economic power challenged the age-old aristocratic order in German society. Deprived of royal protection they banded together to defend their autonomy. Within the nobility moreover each rank tended to acquire some of the personal rights of its betters. The princes could not mediatize the free lords and counts or turn their vassalage into effective subordination. The Hohenstaufen breakdown after 1250 left a gap in Swabia which no rising territorial power was able to fill. Countless petty lords and imperial *ministeriales* of the southwest succeeded in holding their seignories as immediate vassals of the Reich. Their independent territories often survived for centuries. The *ministeriales* elsewhere too ceased to be the dependable servants they once had been. Many free nobles voluntarily joined their ranks, and the knights thus assimilated the rights of the free aristocracy. They became the governing class of the territorial principalities, the standing councillors of their masters whose household offices and local justice they monopolized and held in fee for many generations. Without the consent of this territorial nobility the princes could neither tax nor legislate. Even the less important *ministeriales,* who only administered manors for their lords, entrenched themselves as hereditary bailiffs who kept surplus produce for themselves and usurped seignorial dues, so that it paid the owners to commute the labour services of their villeins into money rents and to lease out those portions of the demesne which the unfree peasants had cultivated ior them. Even then, however, the hereditary officials could not be easily dislodged. Lastly the ambitions of the princes themselves did not aim above the patrimonial policies of the past. They were acquisitive, it is true, and attempted to build up their territories as best they could by usurpation, inheritance, marriage treaties and escheats. They also tried where possible to administer their lands with officials whom they could depose at will. Yet they did this not to found sovereign states, but chiefly to provide for their families. Again and again they divided their dominions among sons who in turn founded cadet lines and set them up on a fraction of the principality.

By 1250 there was thus no really effective political authority left in Germany. The prince-bishoprics had become fiercely contested prizes between neighbouring dynasties, often enough vassals of the see. But constant feuds, disorder and insecurity did not by any means frustrate the immense energies of the Germans in the 13th century. Eastward expansion continued under the leadership of the princes and, above all, of the knights of the Teutonic order. Their advance into Prussia went hand in hand with the opening up of the Baltic by the merchants of Liibeck. It is possible that three centuries of complete security from foreign invasion made it unnecessary for the German aristocracy to learn the virtues of political self-discipline and subordination; but it would be a great mistake if Hohenstaufen Germany were to be judged solely by its failure to achieve political and administrative unity.

(K. J. L.)

RISE OF THE HABSBURGS

The period from the death of Conrad IV to the election of Rudolph of Habsburg in 1273 is generally called the Great Interregnum. It was used by the princes to increase their authority, although Richard, earl of Cornwall, who was crowned in 1257, enjoyed some authority in the Rhineland, thanks to his wealth, until his death in 1272. The interregnum established the electors, who from now on possessed vested interest in the maintenance of the imperial title.

Until this time the territories of a prince were rarely divided among his descendants, the reason being that, although the private fiefs of the nobles were hereditary, their offices—margraviate, countship and the like—were in theory at the disposal of the king. There was now a tendency to set this principle aside. Otto II, duke of Bavaria, a member of the Wittelsbach family, had in 1214 become by marriage ruler of the Rhenish Palatinate. For two years after his death these extensive lands were ruled in common by his two sons; but in 12jj a formal division took place and the territory of the Wittelsbachs was divided into the duchies of Upper Bavaria and Lower Bavaria (in the next generation the Palatinate was in turn detached from the Upper Bavarian branch of the family). About the same time the small duchy of Saxony was divided into two duchies, those of Wittenberg and Lauenburg.

The end of the interregnum was brought about by the pope, who realized the necessity for some power which could protect the church in Germany. In Sept. 1273, at the instigation of Pope Gregory X, the electors raised to the throne a Swabian noble, Rudolph, count of Habsburg. The situation on the eastern border was critical, because of the aggressive policy of Ottakar II, king of Bohemia (*q.v.*). The victory won by Rudolph I over Ottakar at Durnkrut (Aug. 1278) saved eastern Germany from disintegration. By the annexation of all Ottakar's possessions except Bohemia. Rudolph became one of the chief territorial princes in the empire. His policy of territorial aggrandizement was justified by the condition of the German kingdom, the ruler of which had little strength save that which he derived from his hereditary lands. Four years after the fall of Ottakar. Rudolph obtained from the princes a reluctant assent to the granting of Austria, Styria and Carniola to his own sons, Rudolph and Albert. In 1286 Carinthia was given to Meinhard, count of Tirol, on condition that when his male line became extinct it should pass to the Habsburgs. *(See* AUSTRIA, EMPIRE OF.)

On Rudolph's death the electors, fearing the new power which he had founded, passed over his son Albert and elected Adolph, count of Nassau (July 1291). Like his predecessor, Adolph wished to secure an extensive territory for his family. Meissen, which he claimed as a vacant fief of the empire, and Thuringia, which he bought from the landgrave Albert II, seemed to offer a favourable field for this undertaking, and he spent a large part of his short reign in a futile attempt to carry out his plan. Naturally he sought to isolate Albert of Habsburg, who was treating with Philip IV of France, and this led to an alliance with Edward I of England. But many of the princes were disgusted with him, and at Frankfurt in June 1298 he was declared deposed. He resisted the sentence, but Albert of Habsburg, who had been chosen his successor, marched against him, and in July 1298, at Gollheim near Worms, Adolph was defeated and killed.

After Adolph's death Albert was crowned at Aachen in Aug. 1298. As his father had done, the new king Albert I made it the principal object of his reign to increase the power of his house, but he failed in his attempt to add Bohemia and Thuringia to the hereditary lands of the Habsburgs, and he was equally unsuccessful in his endeavour to seize the countries of Holland and Zealand as vacant fiefs of the empire. He recovered some of the lost crown-lands, however, and sought to abolish unauthorized tolls on the Rhine; he encouraged the towns and took measures to repress private war; he befriended the serfs and protected the persecuted Jews. His greatest danger came from a league which was formed against him in 1300 by the four Rhenish electors, who disliked his pro-French policy and resented his action with regard to the tolls. Albert, however, supported by the towns, was victorious; and the electors soon made their peace.

The Luxembourg Dynasty and the **Wittelsbachs.**—After Albert's murder in May 1308, Henry, count of Luxembourg, a brother of Baldwin, archbishop of Trier (1307–54), became king as Henry VII. Since 1273 the material conditions of Germany had improved because the Habsburg kings had confined their activities to north of the Alps; but in 1308 as in 1291 the electors preferred a weak ruler. Henry was an ideologue, who felt himself obliged to restore imperial rule in Italy; but he did not lack shrewdness. as witness his seizure of Bohemia for his son John in 1310. At the end of 1310 he crossed the Mont Cenis into Italy, but died there (Aug. 1313) when superficially success seemed within his grasp. Dante (cf. especially Paradiso, xxx, 137–139, 142–144) conferred on him a reputation in excess of his ability.

After a year's delay there was a double election to the empire when the larger party chose Louis of Wittelsbach, duke of Upper Bavaria, and the smaller chose Frederick, duke of Austria, the son of Albert I. After a war of eight years, Frederick was defeated at Miihldorf in Sept. 1322. The success of Louis IV was to some extent due to the imperial cities which supported him from the first; but he was perhaps still more indebted for his victory to the outbreak of war between the Swiss and the Habsburgs; the position of the Habsburg family had been sensibly weakened by the defeat of Frederick's brother Leopold of Austria at Morgarten in 1315. Northern Germany, where emperors were usually ignored, had been unconcerned in the struggle, which was an episode in the feud between the landed powers of Wittelsbach and Habsburg that lasted to the 17th century. Until the battle of Miihldorf Pope John XXII was ostensibly neutral, but the appointment by Louis of an imperial vicar in Lombardy in 1323 caused him to arraign and presently to excommunicate him. (The nature of the struggle is described in the article PAPACY.) Louis cleverly insisted that the vote of the electors sufficed to make a German king and that the approval of the papacy was not essential. Thus he retained the support of most electors until 1346. In a diet at Frankfurt (1338) the papacy was declared excluded from any share in the choice of an emperor. The higher clergy and princes were alarmed at papal aggression; but there was no national opposition to the pope. Foreign scholars, William of Occam, Marsilius of Padua, John of Jandun and the Spiritual Franciscans were more valuable to Louis than his own countrymen. He added Brandenburg, Tirol, Holland and Hainault to the lands of his family, which however soon proved incapable of keeping them. The death of Louis (Oct. 1347) forestalled civil war with Charles of Luxembourg, king of Bohemia, a papal candidate accepted by four electors in 1346.

Charles IV, who has an important place in the history of Bohemia (*q.v.*), was crowned in 1349 amid the visitation of the Black Death, which in Germany led to attacks on the Jews exceeding in violence similar attacks elsewhere. In the Golden Bull (*q.v.;* 13j5–56) Charles, now emperor, gave the empire an electoral college and a law of succession. For several generations the princes had regarded themselves as a caste rather than as territorial rulers, and their lands were subdivided to support all the sons of a family. By asserting the indivisibility of electoral lands Charles encouraged reconsolidation. The cities, despite the prohibition of the Golden Bull, formed new associations for mutual defense or strengthened those which already existed. The Hanseatic league carried on a successful war with Valdemar VI of Denmark, while it extended its commerce. In 1376 some Swabian towns formed a league which in spite of the imperial prohibition soon became powerful in southwestern Germany and defeated the forces of the count of Wiirttemberg at Reutlingen in May 1377 (see SWABIAN LEAGUE). Meanwhile the emperor who, unlike his predecessor, avoided conflict with either the papacy or the princes was steadily increasing the power of his house chiefly at the expense of the Wittelsbachs and Habsburgs. When he died in Nov. 1378, he wore the crowns of the empire, of Germany, of Bohemia, of Lombardy and of Burgundy; he had added lower Lusatia and parts of Silesia to Bohemia; he had secured the mark of Brandenburg for his son Wenceslaus in 1373; and he had bought part of the upper Palatinate. Learned and systematic, he was responsible for the foundation (1347–48) of Prague university, an international but also a German seat of learning. By his reform of the imperial chancery he created a court and a centre of scholastic jurisprudence, which for the next 150 years was to exert an influence over Germany out of proportion to the power of the crown.

Such was the ascendancy of Charles IV, that his son Wenceslaus succeeded him peacefully in 1378, although for 200 years no son had followed his father on the throne unchallenged. For several years Wenceslaus proved a successful king of Bohemia; but by 1385 anarchy aggravated by the schism in the church prevailed in Germany. The Swabian league allied itself with the Swiss cantons: and, though only the Swiss were victorious in the field, it became impossible to prevent the towns from receiving external burghers, *Pfahlbürger,* as a means of extending municipal interests in the countryside and of undermining the jurisdiction of neighbouring lords. The chief sufferers were the knights holding their fiefs of the empire; except in parts of southern Germany where their confederation, the Shield of St. George, successfully bargained with princes and towns, these knights became a distressed class prone to lawlessness. Intellectual development suffered little, and the foundation of universities was even promoted by the schism, which cut off Germany from France; *e.g.,* Vienna (1383, second foundation), Heidelberg (1385), Cologne (1388), Erfurt (1392, second foundation) and, after the expulsion of Germans from Prague by the Czech Hussites, Leipzig (1409). In 1400 the Rhenish electors set up the able Rupert of Wittelsbach, the elector Palatine, as a rival king. But Rupert had no large patrimony to sustain his dignity and, intervening in Italy (1401), was defeated by the Visconti and their mercenaries; he died in 1410 having failed to establish himself.

In defense of order Germany was compelled to rely on local organs of government. One of these, Fehmic court (*q.v.*) or Verne, which spread from Westphalia, had a brief period of general usefulness before its venality led to its repression (after 1450). Elsewhere the estates in a particular area, assembled in a Landtag, would by means of a *Landfrieden* restrain private wars when they became intolerable. Disintegration had reached its extreme, and although national unity was farther than ever from realization, the 15th century witnessed a slow consolidation of the territories ruled by princely dynasties. The estates, normally composed of nobility, towns and clergy, played their part in effecting unity on a local scale and preventing it on a national scale. At the same time as the Hohenzollern margrave and elector Albert Achilles was enacting the *Dispositio Achillea* (1473) to introduce primogeniture into Brandenburg, the estates of Württemberg were participating in the reunion of territories formerly partitioned among members of the reigning house. As feudal revenues declined, the princes were driven to depend on grants from the estates of their territories, and in 1438 those of Saxony gained an exclusive right to impose taxation. The local estates throughout Germany wrecked the national taxation on which all schemes for the reform of the empire hung; and those of Bavaria. Saxony and Austria removed foreigners (*e.g.,* Styrians in Austria) from the administration. The economy and civilization of Germany were sustained by the towns, and the stand of Nuremberg against Albert Achilles did much to save the independence of imperial cities; but the majority of towns were submitting to the government of princes, frequently, as in Brunswick and in Berlin, to the advantage of both sides. Meanwhile technical discoveries and improvements were transforming society. These included not only printing and the glazing of stoneware but also advances in metallurgy and mining, as well as the instrument manufacture of Nuremberg without which the Portuguese voyages of discovery could hardly have been made. A wave of piety swept Germany in the 15th century but ecclesiastical conditions were uneven and mainly unsatisfactory. A large number of monasteries were reformed. In the north the Augustinian congregation of Windesheim was the chief agency, in the south the Benedictines of Melk. Notwithstanding the efforts of the cardinals John Carvajal and Nicolaus Cusanus (legate 1451–52) the reform of the church, such as it was, owed most to the participation of the princes.

Sigismund, a brother of Wenceslaus, mas elected king in 1410. He gained standing for himself and for the empire by his part in the Council of Constance (1414–17); but he proved unable to defend Germany against the Hussites (*q.v.*) or to recoter Bohemia. He was mainly preoccupied in Hungary. Bohemia recognized him after negotiation with the Council of Basle in 1435. From 1434 to his death in Dec. 1437 he concerned himself with imperial reform; and his proposals for the division of the country into circumscriptions and for the regulation of currency and justice set the program for many schemes until Maximilian's time.

The Habsburgs Established.—In March 1438 the electors chose a Habsburg as king, in the hope that he would defend the eastern frontier. Albert II (*i.e.,* Albert V of Habsburg) was universally respected but died after a single campaign against the Turks in Oct. 1439.

Frederick, duke of Styria, the senior Habsburg prince, was elected as Frederick III in Feb. 1440. His reign was a series. of crises for Germany and particularly for the Habsburg lands. From 1438 to 1448 the electors preserved neutrality in the rivalry between the papacy and the Council of Basle. The Habsburg territories were jeopardized by the counts of Cilli until 1457 (when Ulrich of Cilli was murdered) and then by Frederick's brother Albert VI of Habsburg until 1463. Peasant revolts in the southeast and among the lesser nobility the feud of the Baumgartens were acute examples of social troubles besetting all Europe at this time. Frederick failed to acquire Milan in 1447 but secured for his family the succession to the Burgundian Netherlands in 1477. (C. A. J. A.)

Maximilian I.—Maximilian, Frederick's son, became king of the Romans, or German king, in 1486. He had exceptional advantages. He was heir to the extensive Austrian lands and as the widowed husband of Charles the Bold's daughter Mary he administered the Netherlands. Although he soon gave up these provinces to his son Philip, the fact that they were in the possession of his family added to his influence, and this was further increased when Philip married Joanna, the heiress of the Spanish kingdoms. When Maximilian ascended the imperial throne in 1493, the empire exercised in the affairs of Europe an authority which had not belonged to it for centuries.

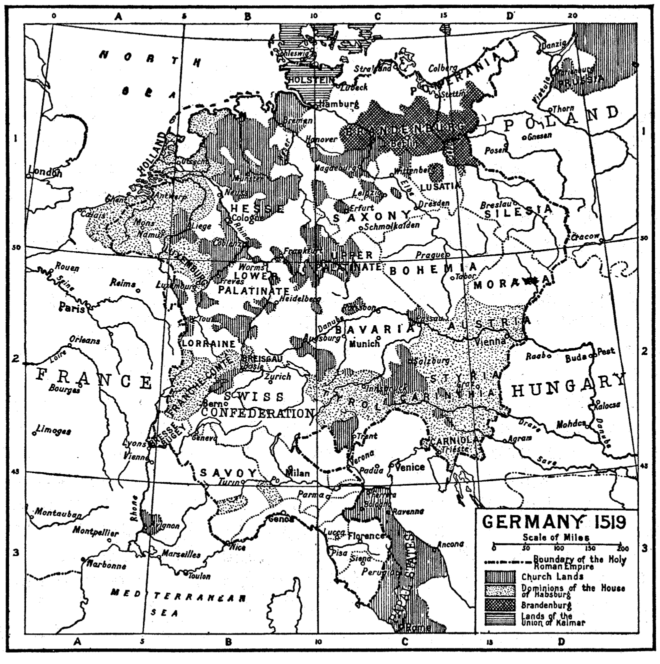
The reign of Maximilian I is important in many mays. The emperor himself is an interesting figure, erratic, ambitious, intelligent and fully aware of the contrast between his imperial position and his actual resources. His reign coincided with a strong movement among the princes for constitutional reform, led from within the electoral college by Bertold, archbishop of Mainz. Maximilian, in fact, was the first emperor to be confronted with a constitutional program. Naturally he had no sympathy with the limitation of imperial authority implied by the plan proposed by Bertold and his adherents. Nevertheless the changes which were made in his time had great influence on the later imperial constitution (see EMPIRE; DIET; IMPERIAL CHAMBER), and in a sense the modern history of the empire begins with him. In the history of Germany his importance lies in his resistance to the French claim to the provinces which had formed part of the Burgundian dominion. In this he was only carrying out his father's dynastic policy, and he had little support from other German princes. Few at the time realized that the integrity of Germany was at stake in the struggle which Maximilian maintained with very slender resources.

In many respects the reign of Maximilian must be regarded as the end of the middle ages. The feudal relation between the king and the princes and between the princes and their vassals had become purely nominal. No real control was exerted by the crown over the heads of the various states, and, now that war was carried on mainly by mercenary troops, the nobles did not hold their lands on condition of military service. The princes were now sovereigns, not merely feudal lords. By the growth of the cities in social, if not in political, importance the products of labour were more and more widely diffused; and it was easier than at any previous time for the nation to be moved by common ideas and impulses. Many causes contributed to effect a radical change in the point of view from which the world was regarded; and the strongest of all mediaeval relations, that of the nation to the church, was about to pass through the fiery trial of the Reformation. This vast movement in the later years of lllaximilian severed the mediaeval from the modern world.

The seeds of the Reformation were sown during the time of the great conflict between the papacy and the empire. During the struggle of the emperor Louis IV with the popes of his day the feeling revived with fresh intensity. At the same time the spiritual teaching of the mystics awakened in many minds an aspiration nhich the church, in its corrupt state, could not satisfy, and which was in any case unfavourable to an external aurhority. The Hussite movement further weakened the spell of the church. Still more powerful, because affecting a more important class, was the influence of the Renaissance, which toward the end of the 15th century passed from Italy to the universities of Germany. The men of the new learning did not sever themselves from Christianity, but they became indifferent to it; its conceptions seemed to them dim and faded, while there was a constantly increasing charm in literature, in philosophy and in art. No kind of effort was made by the church to prepare for the storm. The popular feeling for the first time found expression when Martin Luther, on All Saints' day 1517, nailed to a church door in Wittenberg the theses in which he contested the doctrine which lay at the root of the scandalous traffic in indulgences carried on in the Pope's name by Johann Tetzel and his like. This episode, derided at first at Rome as the act of an obscure Augustinian friar intent on scoring a point in a scholastic disputation, was in reality an event of vast significance, for it brought to the front as the exponent of the national sentiment one of the mightiest spirits whom Germany has produced. Under the influence of Luther's strong personality the most active and progressive elements of the nation were soon in more or less open antagonism to the papacy. (X.)

CHARLES V AND THE REFORMATION

The Accession of Charles V.—Maximilian died in Jan. 1519. After a long contest for the succession between his grandson, Charles I of Spain, and Francis I of France, Charles was elected in June 1520 and in the following October was crowned at Aachen as the emperor Charles V. The religious conflict had reached a critical stage. the bull of excommunication against Luther having just been published in Germany. Some of the reformers cherished a hope that the new emperor's policy might be to act as a mediator for peace, not unfavourable to their leader. But though Charles showed later that he would not hesitate to oppose the Pope in the sphere of politics, he held that he owed him entire allegiance in that of faith, and the protection of the church had always been regarded as a chief function of the emperors. Moreover the peoples under his direct sway were adherents of the old faith. He was king of Spain, Naples, Sicily and Sardinia, lord of the Netherlands, the county of Burgundy and the Austrian arch-



duchies and of the new lands beyond the Atlantic—by far the most important ruler of his time. He hoped to add north Italy to his dominions, and this was another motive for standing well with the Holy See. It was not surprising therefore that at the diet of Worms, in Jan. 1521, he issued the edict drawn up by Cardinal Aleandro denouncing the reformer. This was accepted by the diet and Luther was placed under the ban of the empire.

At his election Charles had been required to accept a *Wahlkapitulation* (electoral agreement) embodying the conditions on which he was to receive the crown—a precedent followed at subsequent elections. This was confirmed by the diet. Charles, regarded as a foreigner by the princes, undertook to respect the freedom of Germany, use the German language and convene the diets on German soil. He was not to bring foreign troops into Germany or place German troops under foreign command. An administrative council, the *Reichsregiment* (state board of control), was to be set up, and after some debate between Charles and the princes it was settled that it should consist of 22 members with a president nominated by the sovereign. It was to govern Germany in his absence; at other times its functions would be only advisory. There was an undertaking to aid the emperor by raising and paying an army. In April 1521 Charles invested his brother Ferdinand (afterward emperor) with the Austrian archduchies and then left Germany to deal with disturbances in Spain and renew his struggle with Francis I.

The Civil Wars.—Serious trouble arose in his absence. The *Ritterschaft*, the knighthood of the empire, was a discontented class which had suffered by the substitution of Roman law for the old feudal law under which they were tenants in chief of the crown. They had now no share in government, and the suppression of private wars had deprived them of active employment. Two of their leaders, Ulrich von Hutten and Franz von Sickingen, had become supporters of Luther, hoping the coming changes in Germany would improve their position. Hutten held that there could be no reform in church and state while the country was divided into a number of small princedoms, and he planned a revolution to be effected with the help of Sickingen, who had got together a small army, with which in Aug. 1522, he besieged Trier, the city of a prince archbishop and elector of the empire. The place made a good defense, and on the approach of an army levied by the princes the siege was abandoned. The revolt ended with the defeat and death of Sickingen at Landstuhl in May 1523. Hutten, broken in health, took refuge in Switzerland, where he died a few weeks later. Luther and his friends had stood apart from the movement though the knights had proclaimed the freedom of Germany from papal influence as one of their aims.

A more serious revolt was the rising in south and central Germany known as the Peasants' War (*Bauernkrieg*). The small farmers and peasants had real grievances, partly the outcome of changing economic conditions but largely of the grasping policy of the princes and great landowners. Like the knights, they had lost many of their traditional feudal privileges by the introduction of the new system of Roman law. In many districts there were obstacles to migration and resettlement which led to their small holdings being subdivided till, with an increasing population, they became too small to support a peasant family. Since 1461 there had been a recurrence of minor local outbreaks. The first movements of a rising on a wide scale took place in 1522 while the revolt of the knights was still in progress. As in former movements the standard of revolt was the *Bundschuh*, a peasant's clog upon a pole. As the rising spread, many knights and adventurers joined the peasants, and they also found friends among the poorer workers of the towns. A new feature of the revolt was that the rebels put forward a religious as well as a social program, one of their claims being that each village should elect its pastor. There were appeals also to scriptural prophecies interpreted to predict the coming of a new era of freedom and prosperity. Some of the lords granted the more moderate claims of the peasants, among these peace makers being the elector Palatine, the bishops of Bamberg and Speyer and the abbots of Fulda and Hersfeld. Luther wrote a pamphlet warning the princes that their oppression had caused the rising and that the reasonable claims of the peasants should be granted, but telling the peasants that their grievances did not justify their violence and that they should negotiate for peace. Meanwhile the rising spread along the Rhine and across the Main into Thuringia. It was not till the summer of 1525 that the war ended and ended in disaster for the rebels. After their first successes they had indulged in reckless outrages on life and property, and the princes, when their forces got the upper hand, wreaked a ferocious vengeance on them. Luther encouraged these reprisals in a pamphlet "On the Murderous Peasant Hordes," urging that the rebels deserved no mercy.

Rival Forces in the Diets.—During the civil wars the *Reichsregiment* had proved an inefficient organ of government, and it was soon to disappear. Meeting at Nuremberg in 1522, it had voted supplies for defense against the Turks, but many of the cities resisted its levy of taxes, and on an appeal to Charles its scheme was vetoed. It had left to a group of princes the suppression of the revolts. It had declined to enforce the edict of Worms, and a new meeting of the diet only ventured to direct that it should be enforced "if possible." The party of the reformers was gaining ground and had the support of several of the princes. Much church property was secularized, monasteries were suppressed and the Lutheran service was introduced into many churches. A notable event of 1525 was the action of Albert of Hohenzollern, grand master of the Teutonic order, who, supported by most of its knights, declared for Luther, secularized the property of the order and made himself the personal ruler of its territory between Poland and the Baltic—a first step toward the building up of the future Prussian kingdom. All over Germany men mere falling into line on one side or the other of the religious conflict. Charles vetoed a proposal for a national assembly to decide the questions at issue. The Catholics under the archduke Ferdinand and Cardinal Campeggio met at Regensburg to concert measures against Lutheranism, while on the other side assemblies at Speyer and Ulm declared their intention of forwarding the teaching of the new doctrines. In 1525 the Catholic princes formed a defensive league at Dessau, and the reformer princes took a similar step next year at Gotha.

In the diet that met at Speyer in June 1526 the reformers were the stronger party. A message from Charles in Spain, calling on the diet to forbid innovations and enforce the edict of Worms, was rejected on the ground that when the emperor wrote it three months earlier, he and the Pope were at peace but were now at war. The diet decreed that pending a national council each prince should regulate the religious affairs of his own dominions. After this wherever the reformers were in power—notably in Saxony, Brandenburg, Hesse and the Palatinate, in Strasbourg, Nuremberg, Ulm and Augsburg—the religious changes nent forward. But when the diet met again three years later at Speyer under the presidency of the archduke Ferdinand, the Catholic party was stronger, and a message from Charles required the repeal of the decree of 1526. But the Catholics were anxious for a truce, and with the approval of the reformer and theologian Philipp Melanchthon (*q.v.*), who was also striving for peace, secured the adoption of a decree that until a council met, the reformers should abstain from further changes, but that in their states the Catholic minority should have freedom to practise their religion. Philip of Hesse with four other princes and the delegates of several cities protested against any limitation of their powers and declared their resolve to disobey the decree. Melanchthon wrote of this rejection of the *modus vivendi* as "a terrible affair." The protest was the origin of the new name of "Protestant," soon applied to and accepted by the reformers.

Charles's Intervention.—Charles V, having this year made peace with the Pope and Francis I, was crowned by Clement VII at Bologna in Feb. 1530, and then went to Germany to make a personal effort to settle its troubles. The Protestant forces were now divided by the conflict between the Lutherans and the followers of the Swiss reformer Zwingli, whose influence extended to the south German cities. In June 1530 the diet was convoked at Augsburg. By the emperor's invitation, as a basis for discussing a religious peace the Lutherans presented a statement of their position, drawn up by Melanchthon, its articles accentuating points of agreement with the Catholics and dealing cautiously, and even vaguely, with points of controversy. It is known as the Confession of Augsburg and forms still the confession of faith of the Lutheran Evangelical Church. It led to long debates which ended, as was to be expected, in failure to effect an agreement. Four of the Zwinglian cities at once protested against it. Numbers of the Lutherans themselves denounced its guarded statements. A conference bet een Catholic and Lutheran theologians only accentuated points of vital difference. Several of the Lutheran princes and their friends left Augsburg. In November the diet ended with a decree issued by Charles giving the Lutherans till the following April to reconsider their position, calling for submission to a settlement, leaving it to the imperial courts to insist on the restoration of confiscated church property and referring to the hope of a final peace being effected by a general council.

In Jan. 1531 at Cologne Charles secured the election of his brother, the archduke Ferdinand, to the dignity of king of the Romans, which implied succession to the empire. Meanwhile Ferdinand would act as his representative in Germany instead of the discredited *Reichsregiment*. In April the Lutheran leaders formed at Schmalkalden in Hesse the defensive alliance known as the League of Smalkald, which was joined by 9 princes and 11 cities. It entered into relations with Denmark, the Zwinglians of Switzerland and the emperor's rival Francis I. Tension with France and the Turkish peril made the emperor hesitate to go to extremes. The Turkish danger was serious. The Turks had conquered Serbia and overrun Hungary, and only an outbreak of pestilence in their army had saved Vienna. Early in 1532 the emperor convoked a diet at Regensburg. The Lutherans absented themselves, and though the Catholics voted supplies for the Turkish war, they opposed the emperor's policy of concessions to their opponents. Charles then entered into direct negotiations with the Protestant princes, which resulted in July in the peace of Nuremberg, granting temporary toleration to the Lutherans, which was renewed in the following years. His reward was immediate and substantial. His subjects vied with each other in hurrying soldiers to his standard and the Turkish army was soon in full retreat.

Protestant Progress and Divisions.—Protestantism now made considerable progress especially in Anhalt and Pomerania, and, thanks chiefly to the energy of Philip of Hesse and the support of Francis I, the Lutheran claimant to Wiirttemberg, Ulrich, was forcibly restored to his duchy. (*See* WÜRTTEMBERG.) Ferdinand found himself obliged to recognize the restoration and to promise that he would stop all proceedings of the imperial courts against the members of the Smalkald league. Other events were less favourable to the supporters of the new religion. The mad outbreak of the fanatical Anabaptists at Münster, though suppressed, caused widespread alarm, and there was an abortive attempt at a revolution by the extremists at Liibeck. A renewal of the war between the empire and France in 1536 was followed by an enlargement of the League of Smalkald and its prolongation for ten years. Among its new members was Christian III of Denmark. About the same time Martin Bucer arranged the friendly agreement between the Lutherans and Zwinglians, known as the concord of Wittenberg (May 1536). Thus strengthened the Protestant princes declared against the proposed general council at Mantua. In June 1538 the Catholic princes formed a new defensive alliance, the League of Nuremberg, but though he had made a truce with France in this same month Charles was more conciliatory toward the Protestant princes than some of his supporters, and in April 1539 he came to terms with them, without however granting all their demands. This year the Lutheran Henry succeeded his Catholic brother George as duke of Saxony. Ducal and electoral Saxony were thus won to the Protestant party and, with its gains under the elector Joachim II in Brandenburg, it was now practically dominant throughout north Germany.

In 1542 Charles was again involved in war with both France and Turkey, and the League of Smalkald took advantage of his troubles to expel its opponent Henry of Brunswick-Wolfenbiittel from his duchy and establish Protestantism there. The citizens of Regensburg declared for Lutheranism, and Hermann von Wied, prince archbishop of Cologne, and William, duke of Gelderland, announced their secession from Rome. The Protestants were now at the height of their power, but their ascendancy was soon to be destroyed more by their own division and the folly and imprudence of their leaders than by the skill and valour of their foes. The unity and power of the League of Smalkald was undermined by dissensions between John Frederick, the ruler of electoral Saxony, and Maurice, who had succeeded Henry in ducal Saxony; and the bigamy of Philip of Hesse, carried through under a dispensation signed by Luther and several of his colleagues, made Philip many enemies and endangered his legal status, so that in June 1541 he saved himself by coming to terms with the emperor. Thus the league lost its most important leader. In 1543 it looked on helplessly while Charles crushed William of Gelderland and added his duchies to the lands of the Habsburgs. Charles, however, hesitated to make a general attack on the Protestants and, in accordance with the promises made in 1539 at Frankfurt, arranged conferences between the two religious parties which, however, gave no result. The diets held at Regensburg and Nuremberg failed to give any solution of the religious question, and made grudging votes for the war; but at the diet of Speyer in 1544 lavish promises to the Protestants obtained supplies with which a new army was placed in the field. In September of that year Charles concluded the treaty of Crépy with Francis I and had his hands free to deal with the affairs of Germany.

Charles was influenced by political even more than religious considerations. He regarded Protestantism as a movement that had divided and disorganized Germany, and endangered both the system of the empire and the supremacy of the Habsburgs. He now meant to break up the league and at the same time to use his influence for the convocation of a general council, which would deal with the abuses of discipline that had weakened the Catholic Church. Pope Paul III, not without hesitation, summoned the council which met at Trent in Dec. 1545, and Charles prepared for war. He made peace with Turkey and secured the neutrality of Bavaria and the support of Maurice of Saxony. He detached from the league those who were too timid or too lacking in zeal to face a conflict. Meanwhile its members were divided in policy, and neglected war preparations in the hope that another religious truce would be patched up. Luther, lamenting in his last days the Protestant divisions, died at Eisleben on Feb. 18, 1546. It was not until the diet met at Regensburg in June that a group of the Protestant princes, headed by Philip of Hesse and John Frederick, the ruler of electoral Saxony, realized the peril and at last began preparations for defense. In July they were placed under the ban of the empire and war began in the south. Charles had brought reinforcements from Italy and the Netherlands. Several cities, with Ulrich of Württemberg and the elector Palatine, submitted to him. The army of the league was forced northward from Saxony along the Elbe valley. At Mdhlberg on April 24, 1547, Charles forced the crossing of the Elbe with hardly a show of resistance, and scattered his opponents. John Frederick was taken prisoner and Philip of Hesse soon after surrendered. The Saxon electorate was added to Maurice's duchy as a reward; more than one of the Lutheran princes hastened to court the conqueror's good will; and Charles met the diet at Augsburg in Sept. 1547 confident in his power to remodel German affairs.

But his overconfidence led to mistakes of policy. The princes evaded his chief demands by prolonged debate, and were soon encouraged by news that he was quarrelling with the Pope over the proposed removal of the council from Trent (in the empire) to Bologna (in the papal states). Charles imagined he could settle the religious question himself. He proposed the acceptance of a compromise set forth in a decree known as the Interim, as it was to be in force till the decisions of the council were known. His critics, both Protestant and Catholic, spoke of it as "the Interim religion." Only a minority of both parties were ready to accept it. He did not satisfy either earnest Lutherans or orthodox Catholics by slurring over points of difference in vague formulas.

Maurice of Saxony prepared to change sides once more. He built up a secret alliance with several of the Lutheran princes and obtained promises of help from Henry II of France, with whom a secret treaty was signed in Jan. 1552. Charles was off his guard when the storm suddenly burst in March. Henry II invaded western Germany, declaring he came as the defender of German freedom. Maurice seized Augsburg and with his friends marched on Innsbruck, where the emperor was residing. Charles fled across the Brenner, and in May negotiations were opened, and by July the peace of Passau was arranged. Charles set at liberty John Frederick and Philip of Hesse and agreed that the Lutherans should have full religious liberty.

Maurice then went to help Ferdinand against the Turks, but his ally, Henry II of France, continued the war against Germany. He had seized Metz, and Charles failed in an attempt to recover it. Another of Maurice's allies, Albert of Brandenburg, after living on the country in Franconia, was for a while with the emperor's army fighting against France and then resumed his bandit raids, which became such a terror that a league of the princes, formed by Maurice, united to drive him out of Germany. Maurice lost his life in this campaign.

The Peace of Augsburg.—In Feb. 1555 the diet met at Augsburg to settle a final peace on the general basis of the treaty of Passau. Ferdinand presided for his brother. It was agreed that Catholics and Lutherans should be placed on an equal footing in the empire and that the Lutherans were to retain all the church property they had held at the date of the peace of Passau. But the Calvinists were excluded by both parties from the settlement, and the peace of Augsburg did not really establish either religious freedom or individual toleration. The principle of state supremacy —*cuius* regio eius religio—was accepted.

The treaty was published in Sept. 1555. Charles had left the settlement entirely to his brother. His health was failing, he was tired of the troubled affairs of Germany, and anxious chiefly to consolidate his Spanish dominions in the hands of his son Philip (then the husband of Mary Tudor). He abdicated, in Jan. 1556, entrusting Spain, the Netherlands and his overseas empire to Philip, while Ferdinand took over the conduct of German affairs though it was not until after the death of Charles (1558) that he was formally installed as emperor.

The Counter Reformation.— During his short reign Ferdinand I devoted himself to enforcing the peace of Augsburg. War with the Turks went on till 1562, and he had to deal with local troubles in Hungary, Bohemia and north Germany. Efforts were made, with no result, to compose the growing differences among the Protestants. In his Catholic dominions he supported the reforms decreed at Trent in matters of ecclesiastical discipline. The Catholics were now gaining ground thanks largely to the reforms in clerical training ordered by the council, and the missionary and educational work of the Jesuits. Before Ferdinand died in July 1564 the Counter Reformation had begun. Some changes had been introduced in the empire. Lutherans now sat among the judges in the imperial courts; and the Aulic council or *Hofrat* established by Maximilian I for the Austrian lands extended its authority over the empire and was known as the Reichshofrat.

Ferdinand's son and successor, Maxirnilian II (1564–76), was a man of tolerant views and had even been at one time suspected of an inclination to Lutheranism. He secured his election by a declaration of fidelity to the old faith, but for a while cherished optimistic but misleading dreams of effecting a peaceful religious reunion in Germany. His first diet at Augsburg in 1566 gave no encouragement to these hopes. The Catholics stood firmly for the decrees of Trent, and the Protestants gave new proof of their divisions by an attempt to exclude the Calvinist elector Palatine, Frederick III, from the advantages of the peace of Augsburg. This led Frederick and the Calvinists into closer relations with France and the Dutch Netherlands, while the Lutherans, now led by Augustus of Saxony, courted the friendship of the emperor. But even they were divided, while the Catholics were still gaining ground. Albert III of Bavaria boasted that without force or strife most of his people had been won to the Catholic cause. The emperor now abandoned his reunion projects and was for a while occupied with a Turkish campaign. The new diet held at Speyer in 1570 was chiefly engaged in debates on the abuses resulting from the enlistment of Germans by foreign agents as mercenaries, but nothing practical was done. It is to Maximilian's credit that he tried to mediate between his cousin Philip II and the rebellious Netherlands. He was engaged in negotiations with a Polish party, which wished to elect him king of Poland, when he died in Oct. 1576.

He was succeeded by his son Rudolph II (1576–1612). The drift of events during his long reign can be explained by noting as the chief factors the growing strength of the Catholics, not only in the Habsburg territories but also in south Germany and wide tracts of the Rhineland and Westphalia; the efforts of the Protestant leaders, now no longer prominent divines but politicians and princes, to obviate the divisions that weakened them by sinking sectarian differences in a common alliance against the house of Habsburg, which they regarded as the chief protector of the Counter Reformation; and, finally, the formation of opposing Catholic and Protestant leagues—the prelude to the Thirty Years' War. The first effort at a Protestant union was made in the very month of Rudolph's accession (Oct. 1576), when Augustus of Saxony drew up a moderately worded Lutheran profession of faith, the *Formula Concordiae*, which was accepted by a large number of princes and cities; but an influential minority refused it, and it only accentuated existing divisions. In the pears that followed the Catholics secured not a few successes. An immigration of refugees from the Netherlands into northwest Germany led to troubles, and the local Catholic government was driven from Aachen in 1581. The *Reichshofrat* declared the movement a rebellion, but it was not till 1598 that Protestant worship was abolished at Aachen and the Catholic government restored. At Cologne in 1582 the prince archbishop, Gebhard Truchsess von Waldburg, became a Lutheran, married and declared his intention of keeping both his see and its territory. He was placed under the ban of the empire and numbers of his subjects took up arms against him, aided by troops from Bavaria. This local conflict. the War of Cologne, lasted for nearly five years. The Protestant princes stood neutral except John Casimir, a zealous Calvinist with some military experience, who was acting as regent of the Palatinate in the minority of his nephew Frederick IV. He gave some help to Gebhard, who was finally driven from his see and took refuge at Strasbourg, where he instigated an unsuccessful rebellion. Meanwhile the Catholics succeeded in establishing their faith in several of the dioceses they had lost.

The Strengthening of the Parties.——After the death of Augustus of Saxony there was another brief alliance of the Protestant princes, under the leadership of his successor Christian I and of John Casimir. An opposition party was organized in the diet, but with little practical result, and the deaths of the two leaders in 1591–92 put an end to the alliance between Lutherans and Calvinists for a time. But in the diets held at Regensburg in 1593 the Protestant princes drew together. Under the leadership of Christian I of Anhalt they put forward demands for new concessions and tried to hinder or delay the payment of subsidies for a new war with Turkey. In 1598 they advanced a theory that in the diet the decisions of a majority did not bind the minority, and in the diet of 1603 they asserted the same position, protested against various decisions of the *Reichshofrat* and finally withdrew from the diet in a body. The war with Turkey lasted from 1593 to 1606, when peace was negotiated not by the emperor but by his brother Matthias, who, because Rudolph was intermittently mad, had been declared head of the house of Habsburg. Rudolph resented this indignity and his relations with his brother were strained till his death in Jan. 1612.

During the last years of his reign the leader of the Catholic party in Germany was Maximilian, the duke of Bavaria. In 1607 he was given an imperial mandate to deal with a religious riot in the free city of Donauworth and, after suppressing it, retained the city under his government. Alarmed by this arbitrary act, the Protestant princes formed in 1608 the Evangelical union, and in response the Catholics, led by Maximilian, united in a similar confederation, afterward known as the Catholic league. As the union was headed by the Calvinist elector Palatine, Frederick IV, many of the Lutherans were slack in supporting it, but it became very important by an alliance with Henry IV of France, who was ready to profit by German quarrels and was interfering in a disputed succession to the duchies of Cleve and Jülich. War between the two confederations on this question seemed imminent, but after the murder of Henry IV in May 1610 the union did not venture to fight.

Rudolph II was succeeded by his brother Matthias (1612–19). He had no children, and the Habsburgs selected as his heir tne Habsburg archduke Ferdinand of Styria. During the brief reign of Matthias the union and the league jealously watched each other. It was a time of dangerous tension. Matthias died in March 1619, and in the following August Ferdinand of Styria obtained the imperial crown as Ferdinand II (1619–37). He had already practically eradicated Protestantism in his archduchy, and was determined to secure the triumph of his church in the empire.

The Thirty Years' War **(1618–48).**—On his accession Ferdinand found himself faced with troubles in his hereditary dominions and a serious crisis in Bohemia, the conflict which was the first phase of the Thirty Years' War. Its beginning is usually dated from the revolt of the Protestant nobles in Bohemia in 1618. Since the days of Huss there had been a strong party in the kingdom opposed both to Rome and Vienna. When Ferdinand's accession was announced, the Bohemian diet refused to acknowledge him and elected as their king the elector Palatine, Frederick V, a son-in-law of James I of England. Ferdinand, on both dynastic and religious grounds, was determined to subdue the Bohemians. At first troubles in his other hereditary states made it difficult to take decisive action. But Spain promised help by invading the Palatinate and early in 1620 it was arranged that Maximilian of Bavaria should send the army of the league under Johann Tzerclaes, Count of Tilly, to assist the emperor. Frederick received little help from the Protestant princes, most of the Lutherans disliking the alliance with a Calvinist leader. He had hoped for English support, but James I went no further than allowing volunteers under Sir Horace Vere to take part in defending the Palatinate. Tilly marched into Bohemia and on Nov. 8, 1620, routed Frederick's army in the decisive battle of the Weissenberg (the White Mountain) near Prague. Frederick fled only to find Ambrose Spinola's Spanish veterans and a Bavarian force overrunning the Palatinate, so that he was obliged to leave Germany. His hereditary lands were declared forfeit and handed over to Maximilian. The war died down into mere desultory fighting against Frederick's only remaining adherents, Christian of Brunswick and Count Ernst von Mansfeld.

The war blazed up again on a larger scale in 1625. The emperor's successes and the rising power of Maximilian of Bavaria alarmed the Lutheran princes, and a new Protestant combination was formed, of which the leading member was Christian IV of Denmark, who as duke of Holstein was a prince of the empire. Two confederate armies were soon in the field, the princes accepting the leadership of King Christian and Mansfeld. Unwilling to depend entirely on Maximilian and the league and unable to raise a large force of his own. Ferdinand accepted the offer of the celebrated Albrecht von Wallenstein to raise, equip and maintain in the field at his own cost an army of 20,000 men, mostly veteran troops, on condition that he should command them and have a free hand. He was a wealthy Czech noble, who had seen service in the Turkish wars and had a real military genius with the mentality of a soldier of fortune. A Catholic, at least by profession, and serving the Catholic emperor, his levies were made up of a mixture of Catholics, Protestants and all kinds of. adventurers ready to fight under any successful leader. He meant to pay and supply his army by levying contributions on the country in which it operated. As the war went on, many of the armies in the field were not unlike Wallenstein's. In April 1626 with his hard-fighting mercenaries he defeated Mansfeld at Dessau, and in August Tilly with the army of the league defeated Christian of Denmark at Lutter. The victors united their armies and invaded Denmark. Wallenstein now formed in union with the Spaniards an ambitious scheme for cutting off the supplies of the Netherlands and controlling those of north Germany by seizing the North sea and Baltic ports. He was only partly successful, and after five months' siege had to abandon the attempt to seize Stralsund. But Denmark was at the mercy of the imperialists and in May 1629 had to conclude the peace of Liibeck.

Intoxicated by success, Ferdinand had only two months before issued the ill-advised "edict of restitution," ordering the restoration of all ecclesiastical lands taken over by the Protestants since the peace of Passau in 1552. This stirred up widespread opposition. While it was still being debated, Maximilian and the other members of the Catholic league united in demanding the dismissal of Wallenstein, now duke of Friedland, governor of the conquered territories of Mecklenburg and Pomerania, and rightly suspected of dangerous personal ambitions. Ferdinand had to yield just when new dangers were arising. In the summer of 1630 Gustavus Adolphus of Sweden declared himself the champion of the Protestant cause in Germany, and established himself with a strong force in Pomerania. How political rather than religious motives were now influencing events is shown by the fact that Cardinal Richelieu promised him subsidies from France for the support of the war.

Gustavus, probably the ablest soldier of his day, had already extended the Swedish power to several of the Baltic lands, and at first the Protestant princes were slow in uniting with him, suspecting that his real object was further Swedish conquests on the Baltic shores. But they soon welcomed his aid. He pushed forward to the Elbe gathering strength with success. He captured Frankfurt-on-Oder, added the Saxon army to his own and defeated Tilly and the main army of the league at Breitenfeld near Leipzig in Sept. 1631. Then, a hile the Saxons conquered Silesia and invaded Bohemia, Gustavus marched triumphantly through central Germany and established his headquarters at Mainz. In April 1632 Tilly met Gustavus on the Lech in an attempt to stop him from penetrating into Bavaria. The army of the league was defeated, however, Tilly was fatally wounded, and Gustavus occupied Augsburg and Munich. Ferdinand now appealed to Wallenstein to take command again. Wallenstein only consented on condition that he was given control of all the imperial forces and the right of making treaties and granting pardons. He then drove the Saxons out of Bohemia and repulsed an attack made by Gustavus on the entrenched camp near Nuremberg, but was defeated by the Swedes at Lutzen (Nov. 16, 1632). It was a costly victory, for Gustavus was killed leading a cavalry charge. The crown passed to his daughter Christina and under the government of the chancellor Axel Oxenstjerna the Swedes continued the war.

In April 1633 at Heilbronn the Swedes and their German allies agreed that the military command should be divided betaeen Bernhard of Saxe-Weimar and the Swedish general Gustaf Horn. France was still supplying money to the allies. The war went on in the Rhine and Danube valleys, the Swedes entering Alsace and Bernhard capturing Regensburg. Wallenstein showed no longer his former vigorous leadership. There was enough reason for dissatisfaction to evoke a movement for his dismissal. Ferdinand yielded and in Jan. 1634 declared Wallenstein deposed from command. Wallenstein tried to retain control of his army, but next month, as a result of a conspiracy among his officers, he was assassinated.

Commanded now by the archduke Ferdinand, king of Hungary (later the emperor Ferdinand 111), the imperialists began a successful campaign by recapturing Regensburg and Donauworth and then, aided by Spanish troops, won a complete victory over the Swedes and their allies at Nordlingen (Sept. 1634). The fortunes of the confederates were at a low ebb, but France presently came to their aid. Richelieu signed an alliance with Sweden at Compiègne in April 1635, and the following month France declared war and put its armies in motion. But by this time there was a movement for peace in Germany. Men of all classes were tired of the long conflict, in which they saw their country wasted and ruined by contending armies which levied contributions on city, town and countryside and, whether they were friends or foes, left a trail of misery in their track. John George I, the Lutheran elector of Saxony, took the lead in the movement and despite Swedish opposition signed in May 1635 the treaty of Prague aith the emperor. The vexed question of the ecclesiastical lands was settled by the agreement that land should remain for 40 years in the possession of those who held it on Nov. 12, 1627; during this period amicable arrangements might be made. The elector agreed to help the emperor to recover territories occupied by the Swedes and to place the Saxon army at his disposal, receiving in return a small increase of his own dominions. The elector of Brandenburg, George William, Eberhard III of Wurttemberg and several of the cities soon adhered to the treaty.

In this last phase the war became a struggle between the Bourbon and the Habsburg interests. The Swedes won some successes in north Germany but after France had come in, the important field of operations was in the west and south. The French armies on one side drove the Spaniards back in Flanders and on the other crossed the Rhine and, under the prince of Condé and the vicomte de Turenne with some help from Bernhard and the Swedish general Karl Wrangel, penetrated far into south Germany. (On Bernhard's death in 1639 his army was taken over and paid by the French.)

The Treaty of **Westphalia.**—While these operations were in progress, preliminary negotiations for a general peace had already begun at Hamburg and Cologne before the death of the emperor Ferdinand II in 1637. But it was not till Dec. 1641 that under his successor, Ferdinand III, a treaty was signed at Hamburg, by which it was agreed that peace conferences should meet at Munster and Osnabruck in March 1642; the emperor treated with France at the former and with Sweden at the latter. The Catholic princes of the empire were to be represented at Munster and the Protestants at Osnabrück. The conferences did not actually begin till 1645, when George William, the elector of Brandenburg, had made and John George, the elector of Saxony, was about to make, a truce with Sweden. In three years many controversial questions were settled, with much diplomatic playing for advantages, but at last in Oct. 1648 the peace of Westphalia (*q.v.*) was signed, ending the Thirty Years' War.

France gained possession of the three bishoprics — Metz, Verdun and Toul, with the Austrian territory in Alsace. Sweden was granted western Pomerania, Stettin, Verden and Bremen, and in virtue of this cession became a member of the empire. Hanover, Brandenburg and Saxony received some increase of territory, and the Rhenish Palatinate was divided between the electoral house and Bavaria. Switzerland and Holland, long actually independent, were formally recognized as independent nations. The German states of the empire were accorded a measure of independence by the recognition of the right to make alliances even with foreign powers, with the nominal proviso that these should not be injurious to the emperor or the empire. The princes were to regulate the religious affairs of their territories, and though there was a stipulation for individual religious freedom, in practice for long after in many states those who did not belong to the officially established religion were under some disabilities. To the imperial diet was left the settlement of treaties and laws affecting all Germany. By a compromise 1624 was fixed as the date for settling the question of the ecclesiastical lands; all lands secularized before that date were to remain secular. This left to the Catholics recent gains in the Habsburg territories. The general effect of the treaty was to relax the connection between the Habsburg and the other German lands. The empire survived, but there was a foreshadowing of the future change when the Habsburg emperor at Vienna would be no longer emperor of a Holy Roman empire, but emperor of Austria. But for another century and a half he was to represent the dignified tradition of some of the greatest memories of European history. **(A. H. A.)**

DECAY OF THE EMPIRE

Social and Economic Conditions after **1648.—The** condition of Germany after the conclusion of the peace of Westphalia was indeed tragic. The population had decreased in the course of the Thirty Years' War from about 30,000,000 to 20,000,000; the greatest decrease was shown in the rural population on whom the hardships of the war fell the most heavily, causing country people to migrate in large numbers to the cities. Many villages were totally degerted, and the old conditions were not completely restored until the middle of the 18th century.

Agriculture was almost at a standstill; large numbers of the land workers had been killed, or enrolled as mercenaries in the armies; stock had been destroyed and houses burned to the ground. Without capital or credit the peasants were reduced to utter dependence upon the great nobles and landowners who only furnished them with the money to rebuild their houses and replenish their stock on extremely hard terms. Everywhere their dues were increased and their rights of tenure diminished. A peasant without capital could not hope to improve the state of his holding. In consequence of the depopulation of the land the demand for agricultural produce had decreased, prices of livestock and grain had fallen and the area of land under cultivation had steadily diminished.

These conditions also affected the great landowners. In order to maintain their estates they were forced to raise mortgages on their properties at a high rate of interest. If, in spite of this, the nobility succeeded for the most part in maintaining their properties, it was chiefly due to the administrations of the different states, who came to their help by declaring moratoriums or by remitting interest. By the establishment of a *Fidei-kommiss* the aristocracy sought to keep their landed property; the same object prompted the prohibition of the sale of noble estates to townsmen which survived in many cases until the beginning of the 19th century. The great landlords were seldom in a position to carry out any agricultural development, and it was only gradually that a certain number of them, at the instigation of the ruling princes, began to cultivate the potato, which had been newly imported from America, and other foodcrops and to plant fruit trees and tobacco.

Industry and commerce had been equally ruined by the wars. The disorganization of industry had favoured the import of foreign goods, and the lack of purchasing power and skilled labour made recovery difficult. The country was flooded with French and English goods through the agency of the Dutch merchants. The once flourishing German trade had almost entirely ceased; the south German linen and cloth industry decreased, and the quality too deteriorated. Official regulations were of little avail, and it was only the immigration of the French Huguenots in the second half of the 17th century that gave new life to German industry. The ancient organizations of the handicraft workers, the guilds, had become rigidly occupational associations, and bad trading conditions and want of capital hindered the introduction of the factory system which was already developing widely throughout western Europe. German trade suffered especially from the fact that the mouths of the great German rivers were in foreign hands; the Dutch held the mouth of the Rhine; the Swedes and Danes the Weser, Elbe and Oder. This meant that German participation in world commerce was very restricted; German merchants were confined to internal trade and were often only agents for foreign investors.

Germany had been a wealthy country in the second half of the 16th century, but now money was scarce and furniture, art treasures and other valuables had been looted in large quantities by foreign armies: The crushing levies which the towns had to pay to preserve themselves from the hand of the invader had brought them to the verge of ruin. The mineral wealth, which had formerly been an important source of German prosperity, especially the silver mines, was partly exhausted and had partly diminished in value through the growing imports of precious metal from America. This loss of national wealth could only be replaced in the course of centuries. Intellectual life had also suffered severely, for hard conditions had made material interests and the struggle for daily bread predominant.

Political Organization in the 17th Century.—The political life of Germany was in a no less deplorable state. The imperial authority had become utterly powerless, lacked an administrative system and was possessed of only a very limited revenue. When the peace of Westphalia gave to the individual states the right to form associations among themselves or with foreign powers in so far as such alliances were not directed against the emperor and the empire, the emperor was reduced in fact to the position of president of an aristocratic republic. He was unable to make laws or levy taxes without the consent of the *Reichstag,* which from 1663 was to be permanently established at Regensburg. It was composed of representatives of all the immediate estates and was divided into the three chambers—electoral princes, princes and cities. The first chamber consisted of representatives of the eight electors of the empire—the archbishops of Mainz, Cologne and Trier, the king of Bohemia, the dukes of Saxony and Bavaria, the margrave of Brandenburg and the count Palatine of the Rhine; in 1693 a ninth was added, the elector of Hanover. The second chamber was composed of representatives of all the greater princes while the lesser counts and lords were combined in separate bodies each possessing a single vote. The third chamber consisted of the representatives of the immediate cities; their right to a casting vote when the other two houses disagreed was however disputed, and they were virtually condemned to insignificance. The working of this assembly was made very difficult by the fact that the representatives of the different estates had to obtain the consent of their principals on every vote. As communications were difficult and slow, the proceedings were often dragged out interminably, and it became excessively difficult to obtain consistent decisions.

Besides the *Reichstag* there existed a further general imperial organization, the *Reichskammergericht,* the supreme judicial body of the empire. It met first at Speyer and later at Wetzlar and was financed by the estates. Its effectiveness was seriously impaired, however, because the greater principalities were exempt by special imperial privileges from its jurisdiction. In addition the emperor maintained a separate *Reickshofgericht* at Vienna which was in perpetual conflict over questions of competence with the *Reichskammergericht.* Moreover, as the procedure was very complicated, the hearing of processes was almost incredibly prolix. and at times a decision was never reached. An inquiry held in 1772 revealed that no less than 61,233 suits were still awaiting judgment by the *Reichskammergericht.*

The empire possessed no army or police force and was unable to take precautions to safeguard its territory, to preserve law and order among its citizens or to protect the interests and lives of its subjects abroad. When the empire went to war each estate had to furnish a stated quantity of troops and ordnance. The amount was recorded in a register. When the numerous small contingents did assemble at the appointed date and place, which rarely happened, the troops were variously armed and for the most part were made up of raw levies. The organization of larger forces was difficult because no estate would permit its soldiers to be placed under foreign command. When it is also remembered that the troops were never trained together, it is easy to understand that an imperial army composed in such a manner rarely possessed any real military effectiveness. There existed no regular taxation, and the necessary duties were collected on the basis of a register in which each constituent estate of the empire was assessed at a definite rate. These amounts, however, were regularly diminished because the different estates protested that their ability to pay was rated too highly; and payment into the imperial treasury was very irregular. It can therefore be said with truth that after the peace of Westphalia the empire was a conception that ceased to have real meaning in Germany, for administrative measures were carried out not by the empire but by the individual territories that had grown up within it and had practically attained to the status of independent states. The number of these states was extraordinarily large, and has been estimated at about 1,800 including some amazing examples. The smallest territories were the dominions of the knights of the empire, numbering some 1,475. These were nearly all situated in southwest Germany, and their joint population amounted to about 500,000. Each individual territory averaged about 300 inhabitants. These territories, therefore, were no more thdn properties which, since their owners were free knights of the empire, were not under the dominion of a prince, but directly dependent on the emperor and the empire. In this instance the capacities of landowner and sovereign lord were united in the same person, who administered the law and exercised police rights over his little territory. These knights of the empire were unrepresented in the *Reichstag.*

Then there were 51 free imperial cities with a total population estimated at about 750,000. Included in their number were certain of the more important ancient commercial towns such as Hamburg, Bremen, Nuremberg, Augsburg, Ulm, Strasbourg and Frankfurt-on-Main but the vast majority were small and insignificant country towns of 2,000 to 3,000 inhabitants in southwest Germany which had had the good fortune, like the knights, to be protected by their ancient privileges from coming under the rule of a prince. For the most part these towns and cities were governed by a small number of patrician families who monopolized all positions of influence and profit and often gained a reputation for devoting the revenue of the tonn more to their own special interests than to those of the citizens at large. With certain exceptions, these towns were little animated by civic spirit and the desire for economic progress. Moreover they were overshadowed by the capitals rising round the residences of the princes although these had not the advantages enjoyed by the free cities.

The 63 ecclesiastical principalities (archbishoprics. bishoprics, abbacies) with their population of about 3,000,000 had special characteristics. Here the supreme lord was a bishop or abbot elected by the cathedral chapter with whom he shared the administration of the district. The chapter was almost entirely composed of the nobility of the neighbourhood, since these religious foundations and orders afforded the nobles a convenient opportunity of providing for their younger sons in a manner befitting their rank. For the most part the administration was bad, and it was not until the 18th century that a few of the ecclesiastical princes were sufficiently enlightened to introduce important reforms. Many bishops used their high position to further the interests of their families by making over to them ecclesiastical estates and by filling the chapters mith their relatives.

The temporal principalities and countships numbered between 170 and 200; the number varied because the estates were often divided among different lines of the same family, and many principalities united by inheritance under one prince. A patriarchal form of government characterized the smaller principalities, in nhich the prince was personally acquainted with most of his subjects, concerned himself in their family affairs and expected them to take a similar lively interest in the joys and sorrows of his own family. Nearly all these lesser princes maintained a magnificent court and employed a number of officials out of all proportion to the size of their principalities; they were especially inventive in introducing fresh methods of taxation by which they sought to obtain the money for the upkeep of their courts. A true political life was naturally impossible in all these miniature states and was only to be found in the few larger principalities. Of these, the greatest was in the possession of the house of Habsburg which ruled over a vast territory in southeast Germany composed of the kingdom of Bohemia, Austria, Styria, Carinthia, Carniola and Tirol and in addition a number of scattered possessions in southern Swabia stretching to the banks of the Rhine. These territories could not be regarded as constituting a single state, for from time to time they were divided among various branches of the ruling house, and it was only in 166j after the failure of the Tirolese line that Leopold I finally united all the possessions of the Habsburgs. The individual states, however, kept their own administration and diets, and the central authority for the whole territory, which Maximilian I had begun to establish, was still very unwieldy and exercised little control.

Next in importance came the territories of the house of Hohenzollern. The margrave of Brandenburg had inherited in the 18th century the district of East Prussia which had hitherto owed allegiance to Poland. At the same time he inherited from the last duke of Julich the district of Cleve in western Germany together with the countship of Mark and Ravensberg in Westphalia. After the death of the last Pomeranian duke, the treaty of Westphalia gave to the Hohenzollerns eastern Pomerania and, as compensation for western Pomerania. ceded to Sweden. the former bishoprics of Magdeburg, Halberstadt and Minden. The centre of their territory extended from the Elbe and the Harz mountains almost to the bank of the Vistula, while East Prussia (which was cut off from the central territory by Polish West Prussia) and their territories on the Rhine and in Westphalia formed districts loosely joined to the main body. The individual districts maintained substantial independence and did not look upon themselves as forming part of a single united territory, but rather as districts that had by chance come into the hands of the same ruler. After the Habsburgs and Hohenzollerns came the house of Wettin, which was divided into so many branches that the head of the house, the elector of Saxony, only ruled personally over a portion of its territories. The same was true of the house of Wittelsbach, of which the most powerful member was the elector of Bavaria, ruling over the largest and most compact territory, whereas the widely scattered lands in the Palatine were divided among numerous cadet branches of the family. In northwestern Germany the leading role fell to the house of Welf, whose lands in Hanover and Brunswick were shared among innumerable members of the family, The other important territories were the duchy of Württemberg and the margraviate of Baden in the south and the lands of the house of Hesse in central Germany. In these greater states there existed estates in which the landowning aristocracy exerted the predominant influence, but in which the civil population of the towns was also represented. These diets claimed that no new legislation could be enacted, no fresh taxation introduced, and no burden of loans laid upon the state without their consent. While the princes endeavoured to reduce the old-established power of the estates, they did not dare to suppress it outright. With the assistance of their paid officials and the support of the standing armies which had been maintained in all the greater states since the Thirty Years' War, the princes succeeded in the course of the 17th and 18th centuries in increasing their power until in fact they became absolute rulers; while the rights of the estates dwindled away more and more.

Administration and justice were far better in these greater states than in the smaller territories, and by developing the police system the princes ensured peace and order within their states. Political life in Germany was confined to these larger states. The only question was whether they would not gradually become wholly independent, and thus destroy the last traces of that national alliance of all the Germanic peoples that still existed in the old imperial state union (*Reichsverband*). In that event, Germany would have been divided into a number of independent states, each of which would have pursued its own special interest, and one could then have spoken of a German nation only in so far as the inhabitants of the different states possessed in common a similar language and certain common elements of intellectual culture. Such a collapse of the empire could only be avoided either by strengthening the power of the empire to such a degree that the central authority could bring the individual territories into submission, or by one of these territories becoming so strong that the remainder would be forced to submit to its leadership.

Ferdinand 111.—The sovereign princes of the German states were not sufficiently gifted to construct a real government in the midst of the difficulties then prevailing in Germany. Ferdinand III (1637–57) had been brought up in a strictly religious atmosphere and was dominated by his confessors. He had never given evidence of any special qualities. His eldest son, Ferdinand, who during his father's lifetime had been chosen as his successor by the imperial electors, died before him in 1654 and notwithstanding all his endeavours, the emperor was unable before his own death to bring about the election of his younger son, Leopold, as king of the Romans. Hence, when the emperor died in 1657 an interregnum followed that lasted for almost a year. until finally the electoral princes united to elect Leopold (Aug. 18, 1658) ; he was, however, compelled to sign a capitulation by which the imperial rights were still further reduced.

Leopold I and the French **Wars.**—Leopold, who until 1705 was to be the head of the German peoples, was 18 years old at the time of his election. He had originally been destined for the church; he was a thorough theologian, and a pious and bigoted churchman. Very reluctantly he abandoned his religious life in order to assume the duties of a temporal ruler. He invariably regarded the promotion of the interests of the Catholic Church as his first duty, while those of the house of Habsburg and of his Austrian territories had for him a quite secondary importance. He had little sympathy for the empire and its needs. Under the influence of his Spanish mother, Maria Anna, his education had been entirely Spanish, and in his immediate circle Spanish alone was spoken. Though kindly. well-intentioned. benevolent, and even weak by nature, Leopold was pitiless and unyielding in all matters involving either interest of the church or his own sovereign rights. His firm conviction that he was an instrument and agent for the execution of the divine will endowed him with an almost unshakable spiritual equanimity. Although he was not a man of action, Eeopold was exceedingly tenacious in maintaining his own point of view and in guarding his own interests.

In the first decade after the peace of Westphalia, the primary concern of all the estates was the maintenance of peace. As the war between France and Spain lasted until 1659, and as grave issues were arising in north and east, Germany could easily have been involved again in a general war. As no one believed in the ability of the emperor to safeguard the empire from this danger, there grew up a network of alliances between the different estates for mutual defense. The elector John Philip of Mainz succeeded in uniting the most important Catholic and Protestant princes in a great defensive alliance. The Confederation of the Rhine was signed on Aug. 16, 1658, for three years and had for its object the full execution of the peace of Westphalia, the prevention of foreign wars and the defense of its own territories. But in fact this alliance, which the emperor regarded as directed against his authority, very soon became largely dependent on France. It was frequently renewed and lasted until 1667.

During the first Northern War (1656–60), the emperor, in the Catholic interests, supported the Catholic king of Poland, John Casimir, and the elector of Brandenburg, Frederick William, who at the outset supported Sweden, later entered into an understanding with Poland and the emperor. These wars, however, were waged for the most part outside the territory of the empire, and Germany was far more deeply disturbed by the course of events on its western frontier.

Since 1661 Louis XIV had personally governed France, and in accordance with the traditional French policy which had been built up under Richelieu and Mazarin, he sought to advance the French frontier to the Rhine and to include Belgium within the French kingdom. Belgium and the Franche-Comte still belonged to Spain, and hence Louis's policy led in 1668 to a renewal of war between France and Spain. The intervention of England, Holland and Sweden brought the war to a conclusion after a few months by a peace which Spain purchased at the cost of the surrender of certain fortresses in southern Belgium. As Louis XIV was unable to dissolve this triple alliance, he endeavoured by means of a sudden invasion to crush Holland and succeeded in getting the archbishop of Cologne, the elector Palatine and the bishop of Miinster to allow the passage of his armies through their territories. The neighbouring states, which feared that they would be involved in the war, witnessed these intrigues with great disfavour and invoked the assistance of the emperor and the empire. As, moreover, Louis XIV had, without any legal grounds, driven the duke of Lorraine, Charles IV, who was a prince of the empire, out of his duchy, the empire had good cause to intervene.

But Leopold still hesitated to take any action against Louis XIV. In view of the anticipated extinction of the Spanish branch of the Habsburgs, his main policy mas to unite the Spanish monarchy with his own territories. This policy depended for its success upon the acquiescence of the French king, and since Louis was clever enough to dangle before the emperor the hope that France would help him to fulfil his desires, Leopold did not feel himself at liberty to oppose Louis in his schemes. Hence the Dutch found their sole support in the elector of Brandenburg, Frederick William, who had grown up in Holland and whose first wife had been a princess of Orange. By cutting the dykes and flooding the country the Dutch were able with great difficulty to avert the French attack in 1672. At the urgent request of the estates, Leopold determined to send an army under Raimondo, count of Montecucculi, for the defense of the imperial frontier on the Rhine, but with instructions to maintain the defensive. The empire declared war on France at the same time as Spain. The war mas chiefly waged in Belgium and on the Rhine. Louis XIV allied himself with Sweden, which at his request invaded Brandenburg from Pomerania in order to restrain the elector Frederick William, who was participating in person in the war against France. At the same time Louis XIV entered into relations with Poland and Turkey, and with Hungary which was discontented with the Habsburg rule. The emperor then found himself threatened in the rear. By his victory at Fehrbellin on June 28. 1675, Frederick William of Brandenburg drove the Swedes out of his territory and occupied nearly the whole of Swedish Pomerania. The French on the other hand were for the most part victorious in Belgium and on the Rhine. As the war dragged on without any definite decision being reached, Louis was able to induce first Holland and then Spain to conclude a separate peace. When the emperor saw that he could no longer hope to obtain any success by carrying on the war, he concluded the peace of Nijmegen with France in Feb. 1679. The greater part of Alsace and Lorraine, as well as the former Austrian territory of Breisgau, remained in French possession. The elector of Brandenburg. who was required by the peace to give up all his acquisitions in Pomerania, was unwilling to subscribe to such terms and for a short time carried on alone a forlorn fight. In the following year, however, he too was compelled to conclude peace.

In consequence of these events, Louis XIV became convinced that the weakness of the empire was such that he could encroach upon its territory with impunity. He established in the French law courts in Metz, Breisach and Besançon so-called chambers of reunion (*Reunionskammern*) for the purpose of determining what lands had at any former time belonged to the districts which had now been ceded to him. As the result of these investigations he declared that the countship of Mömpelgard, the whole of Alsace and certain districts in the Palatine and Trier belonged by right to France; and he sent his armies to occupy these districts. The imperial city of Strasbourg, which was included in these districts, was on Sept. 28, 1681, forcibly seized and at once erected into a powerful French fortress. The emperor and the *Reichstag* contented themselves with ineffectual protests against these acts of violence.

That the emperor did nothing to safeguard the integrity of the empire at this crisis is partly accounted for by the fact that his own immediate territories were menaced by many grave dangers. The Turks in Hungary were planning a desperate attack on Austria, and in the spring of 1683 appeared with a powerful army before the walls of Vienna. But Riidiger, count of Starhemberg, managed to defend the city until the arrival of an army under John Sobieski of Poland and the electors Maximilian Emmanuel of Bavaria and John George III of Saxony, which defeated the Turks and freed Vienna.

When Louis XIV, on grounds that had no legal justification whatever, sought to bring the Palatinate within his grasp, claiming it as the inheritance of Elizabeth Charlotte, the wife of his younger brother, Philip, duke of Orléans, war once more broke out in the west. The French armies invaded the Palatinate, and the emperor resumed the war in alliance with Holland and England. This new war lasted for nine years, inflicted severe losses on the French, but did not result in any decisive victory. Once more Louis was able to sow dissension among his enemies and to isolate Germany, and the emperor was forced to conclude the peace of Ryswick in 1697, with but small gain to himseif. Louis abandoned his claim to the Palatinate and the districts outside Alsace that had been declared to have once formed part of it. Further he had to restore his duchy to the duke of Lorraine, but he retained the whole of Alsace and also Strasbourg.

The **Conquest** of Hungary.—Meanwhile the war between the emperor and the Turks continued in the east; two-thirds of Hungary remained in Turkish hands. Prince Eugene of Savoy, one of the greatest generals of the age, was appointed to command the Austrian army and defeated the Turks in a decisive victory at Zenta (Aug. 29, 1697). Prince Eugene invaded Serbia and Bosnia and forced the Turks to conclude the peace of Carlowitz on Jan. 26, 1699, by which the entire kingdom of Hungary, with the exception of the Banat of Temesvar, was restored to the emperor. It was the conquest of Hungary that paced the way to the later Habsburg monarchy and its position as a great power.

The Spanish Partition Treaties.—Shortly after this the last Habsburg to occupy the Spanish throne, Charles II of Spain, died (Nov. 1, 1700). The question of succession, which had already occupied the European diplomats for decades, had now to be settled. The emperor Leopold's mother and his first wife had been Spanish princesses, and at the time of his marriage it had been expressly agreed that, in event of the failure of a male heir to the Spanish house, his children should be regarded as the heirs. But Louis XIV was also the son and husband of Spanish princesses. On marrying into the house of France. indeed, it had been stipulated that they should renounce all their rights to the Spanish inheritance. Louis. however, declared that this renunciation was invalid because the promised dowries of the princesses had never been paid in full. Louis had endeavoured to come to an agreement with Leopold about the partition of the Spanish dominions, but without definite result. These projects for a partition had aroused great uneasiness in Spain, and Charles II determined to make a will. By his first marriage with the princess Margaret Theresa, Leopold had only one daughter, who was married to the elector Maximilian Emmanuel of Bavaria; the only child of this marriage, the crown prince Joseph Ferdinand, then six years of age, was designated in 1698 by Charles II heir to all his possessions, but the young prince died in the following year. Then Charles II under pressure from the French party at the Spanish court was persuaded shortly before his death to draw up a second will in which he named as his sole heir Philip. duke of Anjou, a grandson of Louis XIV and Maria Theresa of Spain, who was then 17. Acting on this last will, Louis XIV despatched his armies into Spain as soon as he learned of Charles's death and sent his grandson to Madrid where, under the title of Philip V, he assumed the reins of government. (See also SPAIN.)

The War of the Spanish Succession (**1701–14**).—It remained to be seen, however, whether the success of this sudden and violent measure would be lasting. First there was the danger that the emperor would refuse to recognize the Validity of Charles's wiil and attempt, if necessary, to support his own claim by force of arms. Further, the interests of the other European states were deeply involved in this question. England and Holland, old enemies of Louis XIV. had as little desire as the emperor to see the great Spanish kingdom, with Belgium, Naples, Sicily, Milan and the rich Spanish possessions overseas, pass into the hands of the French king, whose power was already a sufficient menace to them. William 111 of Orange, stadholder of the Netherlands and since 1689 also king of England, believed that this must be prevented in the interests of both the countries over which he ruled. He was the first to stress the theory of a European balance of power and was the soul of the Grand Alliance concluded in the fall of 1701, between the emperor, England and Holland. Among his supporters Louis XIV reckoned-Hungary. which was anxious to throw off Austrian domination, the English supporters of James II, who had been dethroned in 1688, and a number of German princes, chief of whom was the elector of Bavaria. Louis possessed a seasoned army led by skilled generals and already held the greater part of the lands in dispute. It is true that his finances were in a bad state because the frequent wars of these latter pears and the extravagance of his court had involved him in heavy debt. Among the allies there existed points of disagreement especially after the death of William III (1702) when the close relationship maintained between England and Holland was dissolved and opposition to the war gained strength in England. But they had at the head of their armies two generals of outstanding military ability, Prince Eugene and the duke of Marlborough, whose harmonious co-operation was rarely broken by differences of opinion. In the first years of the war the advantage lay with France. Its position was such that it was able to strike a deadly blow at Austria by a concerted attack from the Rhine and Italy. This danger was averted by the union of Prince Eugene and Marlborough and the allied armies won a decisive victory at Blenheim on Aug. 13, 1704. The French general Camille Tallard was taken prisoner and the French army forced to retreat across the Rhine. Bavaria, whose elector was allied with Louis XIV, was occupied by the imperial troops and the elector Maximilian Emmanuel was forced to fly to Brussels. On May 5, 1705, the emperor Leopold died and was succeeded by his eldest son, Joseph I, then 27 years old. His arrogant bearing aroused great resentment in Germany and impeded the prosecution of the war.

Meanwhile a fleet of the maritime powers attacked Spain. The younger brother of the emperor Joseph, the archduke Charles, who was the imperial claimant to the Spanish throne, accompanied this fleet, which seized Gibraltar, sailed along the east coast of Spain and effected a landing at Barcelona. Catalonia rose in support of the archduke and by the summer of 1706 Charles was able to enter Madrid. In that year Marlborough gained a great victory over the French at the battle of Ramillies (May 23), and occupied almost the whole of Belgium. Eugene took command of the allied forces in Italy, and by his victory at 'Turin (Sept. 7) relieved the army, which had been surrounded, of the duke of Savoy and drove the French out of Italy. A year later Eugene occupied the kingdom of Naples.

The French, after failing in a renewed attempt to cross the Rhine into Swabia, concentrated their main military strength in the Netherlands. Eugene hastened thither with the imperial troops and again joined forces with Marlborough. After their victory at Oudenarde (June 11, 1708) the allies captured Lille. Louis XIV expressed his readiness to renounce on behalf of his grandson all claims to the Spanish throne and to agree to a restoration of the Franco-German frontier on the line laid down in the peace of Westphalia in 1648. This meant restoring Strasbourg. The allies, however, thought that he was only playing for time and demanded that he should place his troops at their disposal to help in the expulsion of his grandson from Spain. When he refused to do this, they broke off negotiations.

Once more the allies were victorious at Malplaquet (Sept. 11, 1709) and captured the fortress of Mons. Louis again sued for peace and now declared his willingness to concede to Germany his acquisitions in Alsace and the three bishoprics, Metz, Toul and Verdun. He further offered to pay a sum of money to be used in driving his grandson out of Spain. Intoxicated by victory the allies stood firmly by their former demands, and negotiations once more broke down.

A change now occurred in the general political situation which threatened to rob the allies of all the fruits of their victories. In England the Tories, who were opposed to the war, came into power and entered into negotiations with France for a separate peace. The other allies, too, were disturbed by the death of the emperor Joseph I (April 11, 1711), for as he left no son, his younger brother Charles was elected emperor. If Spain, Austria and the empire were all to be united under one ruler there was danger that such a disproportionate concentration of power under the house of Habsburg would threaten the European balance of power more seriously than the establishment of a second French dynasty in Spain. Neither England nor Holland nor Savoy felt disposed to prosecute the war for such an object; a peace congress assembled at Gtrecht in 1712 and the chief treaties were signed on April 11, 1713. The emperor was awarded only a portion of Lombardy and the Neapolitan mainland; no mention was made of a restoration of the old Franco-German frontier. Meanwhile the emperor and the Reichstag were still fighting, but when Landau and Freiburg-im-Breisgau had been captured by the French, they were forced in the treaties of Rastatt and Baden (March 7 and September 7, 1714) to assent to the terms of the peace of Utrecht. The frontiers of the German empire remained as laid down in the treaty of Ryswick (1697). The prospect of winning back the old German territories in the southwest, which a few years before had seemed so near realization, now completely disappeared. Moreover the emperor was forced to agree that the elector of Bavaria should recover his territories. Thus the War of the Spanish Succession had overthrown the supremacy enjoyed by France in Europe in the early years of Louis XIV's reign without yielding any profit to Germany. (See also SPANISH SUCCESSION, WAR OF THE; UTRECHT, TREATY OF.)

The Northern War.—At the same time another long-standing quarrel came to a head in the north and the east. The accession to the Swedish throne of the young king Charles XII (1697) gave Sweden's enemies a chance to unite in an attempt to oust it from the position of power in which it had been placed during the Thirty Years' War by Gustavus Adolphus. In 1697 the elector Frederick Augustus I of Saxony, after conversion to Catholicism, was elected king of Poland. In alliance with Denmark and the Russian tsar Peter the Great, he began a war in the summer of 1700 which was to last more than 20 years. By the spring of 1706, Charles was in possession of the greater part of Poland and the capital, Warsaw, and in agreement with a section of the Polish nobility had set up Stanislaus Leszczynski as king in opposition to Frederick Augustus. But Charles conceived the plan of overthrowing his chief enemy by seizing his German lands, and so rendering it impossible for him to receive money and reinforcements from Germany. To effect his purpose, he marched through Silesia toward Saxony, occupied a great part of the elector's domains and established his headquarters during the winter of 1706–07 in Altranstadt near Leipzig. But the peace which he compelled Augustus to sign and in which the latter renounced his claim to the Polish throne did not long remain in force. In the meanwhile Peter the Great had organized an efficient army with which he threatened to occupy Poland. Charles marched to oppose him and was completely defeated at Poltava (1709) and forced to take refuge in Turkish territory. The Swedes were driven from Poland, and their allied enemies invaded Swedish territory on all sides. The elector of Brandenburg who, with the emperor's consent, had assumed the title of king in Prussia in 1701, also took part in this attack upon his old enemy. The Swedish possessions in Germany, Pomerania, Bremen and Verden were seized, and when Charles returned from Turkey, he found himself powerless to give a more favourable turn to the war.

After Charles had been shot at Halden on the Norwegian frontier, the conclusion of peace was possible. Sweden was forced to surrender Bremen and Verden to Hanover and western Pomerania south of the Peene to Prussia. Of greater importance for future relations of Germany and Russia was that Estonia, Livonia and Ingermanland fell into the hands of the tsar, giving Russia a firm foothold on the shores of the Baltic and thereby a position that became more and more threatening to Germany. The Northern War made an end to Sweden as a great power although it retained the German districts of New Pomerania and Riigen until they were joined to Prussia in 1815.

Charles VI and the Pragmatic Sanction. — From his earliest youth the emperor Charles VI (1711–40) had been regarded by the emperor Leopold as the future king of Spain and he had been brought up in the spirit of Spanish Jesuitism. Throughout his life his dearest wish was to secure as large a share as possible of the Spanish possessions for the house of Habsburg, and Austrian policy became more and more obviously inspired by the desire to govern Italy and extend the Habsburg rule to the lower reaches of the Danube. The emperor had little sympathy with the interests of the rest of Germany which lay, above all, in safeguarding its western and northeastern frontiers. He exercised but limited influence in the empire and the individual states were practically independent. There was no common political history in Germany at this period though Germany's destiny as a whole was deeply influenced in the following decades by international affairs.

The lack of a male heir was the source of much anxiety to the emperor. He devoted his energies to assuring the succession to his eldest daughter, Maria Theresa, and as his action was contrary to the provisions of earlier compacts between the members of the house of Habsburg, which gave the precedence to the daughters of his eldest brother, he spared no trouble to ensure that after his death his wishes respecting the succession would be carried out. These wishes he embodied in a special law, the Pragmatic Sanction, for which he secured the approval of the diets in all the territories of his empire. (*See* AUSTRIA, EMPIRE OF.)

Charles did not consider this sufficient security in itself against the probable attempts on the part of the other heirs to secure the throne; he sought to have it recognized by the great powers and approved by the *Reichstag.* The approval of the *Reichstag* was especially difficult to obtain because two of the most important princes in Germany, the future electors Frederick Augustus II of Saxony and Charles Albert of Bavaria, had, in 1719 and 1722 respectively, married his brother's daughters and so had an immediate personal interest in frustrating the execution of the emperor's wishes. In these circumstances, the emperor was particularly anxious to secure the consent of the king of Prussia to his plan. Frederick William I of Prussia was quite willing to fall in with the emperor's wishes but demanded in return his assistance in prosecuting his claim to a part of the inheritance of the duties of Jiilich and Berg in the lower Rhine. The emperor appeared to assent to his wish and so secured the consent of Prussia to the Pragmatic Sanction by the treaty of Berlin (Dec. 23, 1728). But since it soon appeared that the emperor had made contrary promises to the rival claimants, the courts of Vienna and Berlin became estranged and Frederick William allied himself with the emperor's enemies.

War of the Polish Succession **(1733–35).**—In 1733 Augustus II of Poland (that is, Frederick Augustus I of Saxony) died. While Austria and Russia declared themselves in favour of the succession of his son Augustus III (who also followed his father as elector of Saxony), a number of Polish nobles, who were in relations with France, chose Augustus II's former opponent, Stanislaus Leszczynski, whose daughter was married to the young French king, Louis XV. Out of this quarrel arose the War of the Polish Succession (*q.v.*) which was chiefly fought in Italy and the upper Rhineland and which ended unfavourably for Austria; the emperor was forced in the peace of Vienna (1738) definitely to abandon Sicily and Naples which were placed under the rule of one of the Spanish princes, Don Carlos, though the duchy of Parma was ceded to Austria. Of special significance to Germany was the consent of the emperor to the cession of Lorraine. This duchy which had long been in the possession of France was made over to Stanislaus Leszczynski, as compensation for his abandonment of all claim to the Polish crown. After his death Lorraine was to be restored to France. The reigning duke of Lorraine, Francis Stephen, who was married to Maria Theresa, was compensated for the loss of his ancestral inheritance by the grand duchy of Tuscany. France, in return, recognized the Pragmatic Sanction with the important reservation that it only did so in so far as it did not conflict with established third party rights.

In the evening of his days the emperor found himself once more called upon to engage in war with Turkey — a war that ended disastrously for him. By the peace of Belgrade (1739), he was forced to restore a great part of the conquests made for him by Prince Eugene in the war of 1715–18, and a frontier was laid down for Serbia and Walachia that was to remain essentially the same until the outbreak of World War I.

Maria Theresa's Accession. — When the emperor Charles VI died on Oct. 24, 1740, his daughter Maria Theresa at once assumed the reins of government in the countries belonging to the house of Habsburg. The electors Frederick Augustus II of Saxony (Augustus III of Poland) and Charles Albert of Bavaria protested against her accession and were supported by France, which desired to see a partition of the Austrian territories; a still more pressing danger threatened Maria Theresa when the new Prussian king joined her opponents. Frederick William I of Prussia had died a few months before the emperor and his son Frederick II the Great thought that by virtue of certain old family compacts he could lay claim to a part of Silesia, namely the duchies of Liegnitz, Brieg, Wohlau and Jagemdorf. These claims had never been recognized by Austria, nor had they ever been completely settled. At one time, indeed, compensation had been offered but no final agreement was reached on the matter. Frederick now claimed the cession of a portion of Silesia and in return promised Maria Theresa his aid against her enemies. When she rejected his proposal, Frederick determined to occupy the disputed lands by force.

War of the Austrian Succession **(1740–48).**—In Dec. 1740 Frederick crossed the Silesian frontier, advanced as far as Breslau and defeated an advancing Austrian army near Mollwitz on April 10, 1741. As at the same time the Bavarians, supported by a French army, invaded Austria, advanced as far as Linz and even seized Prague with the help of the Saxons, Maria Theresa found herself in an extremely critical situation. Finally the German electors, under French and Prussian influence, did not elect as emperor her husband, Francis Stephen, but the elector Charles Albert of Bavaria (Jan. 24, 1742). He assumed the name of Charles VII, but throughout his three years' reign (1742–45) he never received full recognition in Germany nor succeeded in setting up a working government. When Frederick invaded Moravia in 1742, after he had secured possession of all Silesia and defeated an Austrian army at Chotusitz, Maria Theresa thought it prudent to open negotiations. Her troops had regained Linz and even invaded Bavaria, but she thought a complete victory over her other enemies impossible so long as the Prussian army threatened her flank. Frederick expressed his readiness to conclude a separate peace. England, also at war with France over colonial questions, acted as intermediary and thus the peace of Breslau (June 11, 1742) was concluded. Austria ceded the greater part of Silesia along with the countship of Glatz to Prussia and retained only the principalities of Troppau and Teschen. In return Frederick promised his neutrality. The first Silesian War, which ended with this peace, established the military reputation of Frederick the Great. It was the first armed contest between the two greatest German states that had developed out of the old empire, states which had long regarded each other with distrust and jealousy.

After the withdrawal of Prussia the struggle for the inheritance of Charles VI continued until the Austrian army captured Prague, freed Bohemia from the invaders and even captured Munich, the capital of the Bavarian pretender, Charles VII. England had also despatched an army to the continent, led by George II in person, which, after a victory at Dettingen in the summer of 1743, advanced from Hanover as far as the Rhine. The Austrians, under the leadership of Prince Charles of Lorraine, were advancing from southern Germany with the intention of crossing the Rhine, when Frederick decided to intervene again in the war. He feared that Maria Theresa, after a complete victory over her other enemies (as now seemed possible), would attempt to wrest Silesia back from him. Having signed a new alliance with France, Frederick invaded Bohemia and advanced by forced marches by way of Prague to Budweis. But as the expected simultaneous advance of the French army did not take place, he found himself forced to retire to Silesia before the oncoming Austrians. During the winter Charles VII died (Jan. 20, 1745), and his son, the elector Maximilian Joseph, at once made peace with Maria Theresa. He received back his ancestral domains in return for the renunciation of all his claims to the Austrian throne as grandson of the emperor Joseph I. As the elector Frederick Augustus II of Saxony had already abandoned his claims and made peace with Austria, and as the French were fully occupied with the campaign in Belgium, Frederick found himself alone opposed to the main force of Austria. Strengthened by Saxon troops, the Austrians attacked Silesia in the s- mmer of 1745, but were defeated near Hohenfriedberg on June 4. Once more Frederick was able to invade Bohemia, and by the end of the year a great part of Saxony was in his possession. On Dec. 1j his chief general, Leopold of Anhalt-Dessau, won a fresh victory over the Austrians and Saxons at Kesselsdorf, near Dresden.

The majority of the electors had in the meantime at Frankfurt-on-Main elected Francis Stephen of Lorraine as emperor. As Francis I he was nominal head of the German empire from 1745 to 176j. Maria Theresa, who perceived from the events of the last few years that it would not be so easy to retake Silesia and who laid great stress on the recognition of her husband as emperor by Frederick, signified her willingness to reopen negotiations. On Dec. 25, 1745, the second Silesian War was brought to a close by the peace of Dresden, by which Frederick retained Silesia and recognized Francis I as emperor.

The War of the Austrian Succession lasted for yet another three years and was chiefly fought in Belgium. Because the French victories on land were more than offset by the English victories at sea, each of the contestants began to doubt the possibility of a decisive victory, and the dispute was finally settled by the peace of Aix-la-Chapelle (1748) which recognized Maria Theresa as sole heiress of her father and gave certain frontier districts in Lombardy to Savoy and the duchy of Parma to prince Philip of Spain.

The Seven Years' War, 1756–63.—Although peace was thus outwardly restored, the tension between Austria and Prussia remained, since Maria Theresa had never abandoned her hopes of regaining Silesia at the first favourable opportunity. Her hopes were shared by her chief minister, the prince von Kaunitz-Rietburg, who looked upon Prussia as the natural enemy of Austria. Neither party, however, wished to resume the contest without the help of powerful allies. Kaunitz had already established relations with Russia, and his special concern was to induce France to lend support to his schemes. This was an especially difficult task because for a century and a half France had been accustomed to regard Austria as its particular foe. At the same time the French viewed the growing power of Prussia with dislike and feared that French influence in western Germany would be prejudiced. Frederick, for his part, was convinced that he would again be called upon to defend Silesia from an Austrian attack. Since he was himself allied with France, whereas in earlier wars England had supported Austria, he was anxious to separate England from Austria without imperilling his good relations with France. At this time English policy was governed by growing colonial rivalry with France, especially in America. In the autumn of 1755 French and British settlers in North America had already come to blows. It was obvious that the mother countries would also become involved in the conflict. As it was feared in England that in such an event France would attack Hanover, and since Austria showed itself unwilling to undertake the protection of Hanover against a French attack, the English government sought a promise of help in such a situation from Prussia. Since it was to be a purely defensive agreement, Frederick considered that he could enter into it without breaking faith with France. On Jan. 16, 1756, Frederick concluded with England the Convention of Westminster the main stipulations of which were that Prussia should help England in the event of an attack on Hanover and that England should support Frederick in the event of an attack on Silesia. When the news of this treaty reached Paris, it was regarded as a defection on the part of Frederick; and on May 1, 1756, at Versailles, the French concluded the defensive alliance with Austria for which Kaunitz had so long laboured but which might never have materialized without the Anglo-Prussian agreement.

While Kaunitz with the zealous support of Russia set to work in Paris to turn this defensive alliance into an offensive one, *i.e.,* to secure the consent of France to the complete destruction and partition of Prussia, Frederick the Great learned of the conclusion of the Versailles treaty. As at the same moment he received intelligence that Russia was arming on his eastern frontier, and from intercepted letters perceived that an attack on Prussia by Austria, Russia and France was being planned for the following spring, Frederick determined to anticipate the plans of his enemies before their negotiations had been completed. Austria having collected a great military force in Bohemia, Frederick inquired of Maria Theresa whether her military preparations were directed against Prussia and whether she would be ready to give him her assurance that in this and the following year no attack would be made upon him. On receiving an evasive answer he gave the order to his troops to cross the Saxon frontier.

Thus began the Seven Years' War (*q.v.*), in which Frederick the Great fought against Austria, France, Russia, Saxony and Sweden. His sole ally was England-Hanover, whose support consisted mainly in a subsidy of 4,000,000 talers a year. It was only his pre-eminent generalship and his resolute determination, even in the most difficult circumstances, to lose everything rather than to consent to any diminution of his state that made it possible for him to survive these perilous years.

During the autumn of 1756 Frederick occupied Saxony and after he had first defeated a relieving Austrian army at Lobositz compelled the Saxon army to surrender at Pirna. In the following year he invdded Bohemia, defeated the Austrians near Prague and invested the Bohemian capital. When, however, he sought to turn back the advancing Austrian army under Leopold, count von Daun, he was himself heavily defeated at Kolin on June 18, 1757, and forced to withdraw from Bohemia. At the same time Russian troops invaded East Prussia, the French attacked Hanover, and the English army that was stationed there to protect the country was put out of action. Hanover was occupied by the French. A second French army, in conjunction with an imperial army, advanced from Thuringia upon Berlin. Frederick immediately attacked this army and won a brilliant victory at Rossbach on Nov. 5. As the Austrians had in the meantime invaded Silesia and seized Breslau, Frederick hastened thither and by his victory at Leuthen (Dec. 5) recaptured the capital of Silesia.

The following year saw a dangerous attack by the Russians, who occupied Konigsberg. The Austrians advanced in the southnest to join them and besieged Kustrin. Frederick, who had again attempted an attack on Moravia, was forced by this to return in order to avert this pressing danger and to prevent a junction of the enemy armies. He defeated the Russians at Zorndorf on Aug. 25, although himself sustaining very heavy losses. The Russian forces now retreated into Pomerania and besieged Kolberg. The Austrians, however, had entered Lusatia and in an attempt to expel them Frederick was defeated by Daun at Hochkirch, near Bautzen, on Oct. 14. Notwithstanding this defeat Frederick was able, on the whole, to maintain himself in Silesia and Saxony, while in the west Ferdinand of Brunswick, who commanded the English and Prussian forces, held the line of the Rhine.

The year 1759 brought Frederick to the verge of irretrievable disaster. While the French advanced in the west as far as the Weser, Frederick, who this time had been unable to prevent a junction of the Austrian and Russian armies, was heavily defeated by them at Kunersdorf on Aug. 12. His army seemed to be well-nigh exterminated. Frederick himself almost despaired, and it was only his opponents' failure to use their victory that gave him time to collect his troops again. He was, indeed, unable to prevent the imperial army from entering Dresden and occupying a part of Saxony. But having failed to overpower Frederick completely his enemies began to weaken in their attack. The illness of the empress Elizabeth hindered the operations of the Russians since it was a matter of common knowledge that the sympathies of the heir-apparent were with Frederick. Although a Russian advance guard did on one occasion (Oct. 1760) reach Berlin, Frederick was able more or less to retain possession of his kingdom. But in 1761 the Austrians captured Schweidnitz and the Russians Kolberg, and it became daily more difficult for Frederick to obtain reinforcements and money with which to pursue the war. After the fall of Pitt's ministry, the English government began to negotiate for peace with France and English financial support was no longer forthcoming. No decisive change in the situation took place until the death of Elizabeth of Russia on Jan. 5, 1762. The new tsar, Peter III, immediately made peace with Frederick and entered into an alliance with him. Although he was murdered a few months later, his successor Catherine II the Great was also of the opinion that neither a strengthening of Austria nor the destruction of Prussia would serve the true interests of Russia. She withdrew her military support from Frederick but she did not renew the alliance with Austria. Since the conclusion of peace with England, France had lost all interest in the war with Prussia and had withdrawn French troops across the Rhine. Hence Maria Theresa found herself deprived of all hope of a decisive victory and was compelled to enter into negotiations for peace. Peace was signed at Hubertusburg on Feb. 15, 1763. Frederick evacuated Saxony but retained Silesia. Both parties renounced all claims to a war indemnity.

The importance of the Seven Years' War in the history of Germany lies in the failure of Austria's attempt to destroy Prussia before Prussian power was consolidated. But the hostility between the two greatest German states continued to exist and to influence powerfully the whole future political development of Germany.

Joseph II.—The emperor Francis I died (1765) soon after the conclusion of peace, and was succeeded by his son Joseph II (1765–90) who was appointed co-regent in the Austrian possessions by Maria Theresa. As long as his mother was alive, however, he exercised a very limited influence upon internal Austrian policy. His ambition therefore led him to invest the imperial position with new significance, to reform the *Reichshofrat* and the *Reichskammergericht,* and to restore many imperial rights that had fallen into disuse. He was steeped in the ideas of the *Aufklärung* and endeavoured to introduce them into public life. But although he was a man of quick perception, Joseph was a doctrinaire rather than a man of action, and he was too ready to seek to enforce his ideas without regard to circumstances. Frederick the Great said of him that he invariably took the second step before he had taken the first; and from the beginning his projects aroused the deep distrust of the German princes. Another principal concern of the emperor Joseph was the wish to secure some compensation for the loss of Silesia and indeed to extend the frontiers of his realm on all sides. This was first evident when Polish affairs called for interference on the part of the neighbouring powers.

First Partition of Poland.—When Augustus III died in 1763 he was succeeded on the throne of Poland by a king of Polish birth, Stanislaus Poniatowski. He had many enemies in Poland, however, and the Russian empress, Catherine II, sought to use these internal disputes to make herself mistress of the whole of Poland. This policy closely affected the interests of the neighbouring German states, and especially Austria and Prussia. Although Frederick the Great believed it impossible to check the expansion of Russian influence in Poland, he hoped that at least Austria and Prussia might obtain a share in the spoil. When the emperor Joseph in the course of a personal visit to Frederick at Neisse in 1769 expressed his desire for an understanding with his former enemy, a concerted action on the part of Austria and Prussia in the Polish question seemed to be possible. Joseph II devoted all his energy to the task of bringing this about, despite the disapproval of Maria Theresa, and even took the initiative of occupying Szepes.

His action was followed by the first partition of Poland by the treaty of Aug. 5, 1772. Russia received all the land lying to the east of the Dvina and Dnieper; Austria received Galicia and Lodomeria; while Prussia was given the Polish province of West Prussia, with the exception of Danzig and Thorn, the bishopric of Ermland and the district of the Netze. Though Prussia's share was the smallest, it was of very great importance in that it established the territorial unity between East Prussia and the main body of the kingdom. The knights of the Teutonic Order had indeed held West Prussia as well as East Prussia from 1308 to 1466, but under the Treaty of Thorn it had been reunited with the Polish kingdom as the province of Pomorze.

War of the Bavarian Succession.—Joseph II had designs on Germany also. In 1777 the elector Maximilian Joseph of Bavaria died, and with him the Bavarian branch of the Wittelsbachs came to an end. According to the principles of the German law of inheritance. Bavaria fell to the head of the younger branch of the Wittelsbach house, Charles Theodore, the elector Palatine. The emperor, who maintained that he himself had claims on Bavaria, succeeded in persuading the elector Palatine to make a treaty by which Charles Theodore, in return for the emperor's recognition of his rights to the remainder of Bavaria, ceded to the emperor the district of Lower Bavaria. The remaining German princes, especially Frederick the Great, saw a menace to themselves in this extension of the Habsburg power. The emperor's action seemed especially questionable because his claim was entirely unfounded; moreover, the childless Charles Theodore's heir, Charles of Zweibriicken, had protested to the Reichstag against the injury done to his rights. When the emperor sought to extend his claim to include Upper Bavaria and proposed to compensate the elector Palatine with the scattered Austrian possessions in Swabia and the Upper Rhineland, Charles of Zweibriicken again protested to the *Reichstag.* Frederick the Great promised his protection to Charles of Zweibriicken and, after he had assured himself of the co-operation of the elector of Saxony, Frederick Augustus III, invaded Bohemia in June 1778. The War of the Bavarian Succession came to an end without a decisive battle. The empress Maria Theresa, who from the beginning had disapproved of her son's actions, at once initiated negotiations with Frederick that led to the peace of Teschen (May 13, 1779). Austria received only a small district in Bavaria, the so-called Innviertel, and renounced all claims to the Bavarian inheritance.

The *League* of Princes.—Empress Maria Theresa died on Nov. 29, 1780. Joseph II now became sole ruler in Austria, Bohemia and Hungary. While he sought by far-reaching laws to transform these states into a more centralized state under German rule, to free the peasants and to reduce the influence of the church, he pursued his old schemes in foreign policy. He purchased the support of the empress of Russia by promising to help her to realize her eastern policy, and he resumed afresh his negotiations with the elector Palatine, Charles Theodore, for the cession of the whole of Bavaria to Austria. This time he offered him in compensation Belgium and the title of king of Burgundy. Charles Theodore was not unwilling to accept the offer; but once again Charles of Zweibrucken raised objections and called upon Frederick the Great for aid. Frederick seized the opportunity to put into execution a long-cherished plan. He had had sufficient experience of the unreliability of foreign alliances, and he now thought to raise the status of Prussia by an alliance with the more powerful German princes. As these all felt themselves thieatened by the emperor's action, Frederick found them more sympathetic to his idea than previously. On July 23, 1785 the League of German Princes was concluded among Prussia, Saxony and Hanover, to which were later added Saxe-Weimar, Saxe-Gotha, Palatinate-Zweibriicken, Brunswick. Baden, Hesse-Cassel, Anhalt, Ansbach, Mecklenburg, the electorate of Mainz and some other smaller states. The preservation of the integrity of the imperial constitution was the aim and object of this league. When the emperor saw that the majority of the German princes had united to oppose his projects, he was obliged to abandon them.

The League of German Princes was an important forerunner of later events since this was the first occasion on which the majority of the German states allied themselves under the leadership of Prussia and in opposition to Austria; yet it was not regarded by Frederick the Great and most of its members as a permanent institution. It mas called into being by Joseph II's projects for adding to his possessions and lost its significance with the complete abandonment of those projects by Joseph's successors. Of all its members only Charles Augustus of Saxe-Weimar sought to give it a more far-reaching character. He thought to endow the league with a permanent constitution and to establish a common legal, financial and customs administration, supported by a joint army. The league would then have taken the place in German political life of the old empire now crumbling into ruins. His plans, however, awakened no response in the other members.

The establishment of the League of Princes was the last political act of Frederick the Great. He died at Sans Souci on Aug. 17, 1786, lonely as he had lived, feared and admired by his contemporaries but not loved. The emperor Joseph II in the last years of his reign threw himself into vast undertakings in the east. The war against Turkey, into which he entered in alliance with Russia, ended disastrously for Austria and was threatening to involve the empire in a European war when Joseph died, on Feb. 20, 1790. As his successor the electors chose his younger brother, Leopold II grand duke of Tuscany, who ruled for only two years. A peaceable, prudent and farsighted man, Leopold at once sought to restore peace in the east, to bring about friendly relations with Prussia, to overcome the mistrust aroused in the German princes by the adventurous schemes of his brother and to quiet the disorder that had arisen within his dominions in consequence of the hasty reforms introduced by Joseph II.

THE FRENCH REVOLUTIONARY AND NAPOLEONIC PERIOD

The French Revolution. — After the outbreak of the French Revolution, the ideas of liberty, equality and fraternity became popular among the educated classes in Germany. The proceedings of the first French National Assembly were regarded as an attempt to put into practice in political life the great principles of reason; but public opinion was sobered and disillusioned when the Reign of Terror followed, which seemed to suggest that complete anarchy and insecurity of life and property were the immediate and the inevitable consequences of revolution. As yet the lower classes were not sufficiently independent to take a lively interest in these questions. Only in the Rhineland, which was soon afterward invaded by the French, was there any real agitation.

There was at first friction between the new rulers in France and the neighbouring German princes when the National Assembly wished to put the decree abolishing feudal rights into practice in Alsace, where many German princes had extensive estates. The princes called on the emperor and the empire for help against the execution of the French law. But the far-seeing, prudent emperor Leopold had little desire to be involved for such a cause in a war with France. Day by day the bands of French émigrés seeking refuge in Germany grew in number. They found asylum at the courts of the Rhineland princes, who permitted them to enlist and arm volunteers. The French saw in this a threat to their territory and demanded the disbandment of these troops. But even this dispute would not have led to an outbreak of war if it had not been that the course taken by the revolution and the attempted flight of Louis XVI in 1791 placed the lives of the French royal house in danger. Queen Marie Antoinette was the sister of the emperor, and she had long entreated him to support her and her husband; but Leopold considered that this would only be possible if concerted action were taken by all the great European powers. He invited the sovereigns of Europe in a circular note of July 6, 1791, to make common cause with him on behalf of the French king and queen. His proposal was energetically supported by Frederick William II of Prussia, who met Leopold at Pillnitz (Aug. 25–27), to discuss what further measures should be taken. The representatives of the French émigrés and especially the count of Artois, the youngest brother of Louis XVI, came to Pillnitz to solicit help. They were informed that only if the non-German powers also promised their support could the German states contemplate taking measures which would give the king complete freedom to decide whether to accept the new constitution. When, however, the National Assembly, after it had completed the drafting of the constitution, gave the king more liberty and when he accepted the constitution without any outward signs of intimidation, Leopold declared in a circular note of Nov. 12, addressed to all the great powers, that he considered the king's acceptance to have been a voluntary act and that the necessity for intervention by the great powers no longer existed.

Meanwhile the earlier Declaration of Pillnitz had become known in France through émigrés and had there aroused fierce resentment. In consequence of the threatening speeches delivered in the Legislative Assembly and the growing influence of extreme elements, the emperor found it necessary again to contemplate the assembling of a European congress. After he had concluded a defensive alliance with the king of Prussia for the maintenance of the integrity of their respective dominions, Leopold despatched a sharply worded note to the French government in which he announced that the growing disorder in France and the steadily increasing influence of the war party compelled him to take defensive precautions on the frontiers of the empire. The Girondists who had now taken complete control of the government demanded that he should cease all military preparations immediately and abandon explicitly the European congress. But when this reply reached Vienna, Leopold had just died (March 1, 1792). His son, Francis II, at once returned the answer that he could not grant either request until the complaints of the Alsatian princes had been settled and a government had been set up in France able and willing to carry out treaty obligations. On receipt of this reply the French government declared war on April 20.

War with France. — It is therefore not true to say that Prussia and Austria united to make war for the purpose of crushing revolutionary ideas; on the contrary, they desired to avoid war, while the Girondists in Paris were loudly demanding it. Obviously, when such a war once broke out, it would of necessity be a war for the principles of government and the enforcement of the ideas prevailing in the age of absolutism against the new ideas born of the revolution.

The Austro-Prussian campaign against France did not begin until the autumn of 1792. From the very outset its progress was' crippled by the fear that Catherine II of Russia would seize the opportunity presented by the preoccupation of the allies in France to annex the whole of Poland. The chief command was entrusted to the duke of Brunswick, who increased the resentment of the French by issuing a menacing manifesto to his armies. Since the French troops were ill equipped and badly led, the German armies succeeded in capturing Verdun and advancing as far as the passes of the Argonne. But here the duke of Brunswick delayed his attack so long that the French were able to bring up reinforcements for the defense of the passes. The bombardment of the Heights of Valmy (Sept. 20) had no decisive result. Brunswick did not dare to attempt a general assault or to advance any further since his line of retreat might be threatened. Since moreover differences of opinion had meanwhile arisen between the Austrian and Prussian commanders and news had arrived that a Russian army had, in fact, marched into Poland, Frederick William II, who was present with the army, decided to order a retreat. The allies' attack on France was thus frustrated. As Goethe rightly observed on the day of the battle, Valmy marked the beginning of a new epoch.

While it was yet winter the French took the offensive and occupied Speyer, Worms and Mainz, but failed to obtain more than a temporary grip upon Frankfurt-on-Main. Wherever the French troops came, they set up Jacobin clubs and sought to win over the population to revolutionary ideas. In this they were at first partially successful; but it was soon clear that the Paris government was more concerned with plundering the financial resources of the occupied districts than with their liberation. As soon as the inhabitants realized this, public opinion turned against the French. The threatening advance of the French on the Rhine again forced the two German powers to take vigorous steps. During 1793 the French were again driven out of Belgium, the greater part of which they had occupied. Mainz was recaptured and the German troops entered Alsace. It was not until the following year that the French were able by their victory at Fleurus to reconquer Belgium, to regain possession of Alsace and to advance on the lower Rhine as far as Aachen and Cologne. They were able to do this chiefly because Prussia had virtually retired from the war because Polish affairs demanded its whole attention. (See also FRENCH REVOLUTIONARY WARS.)

Second and Third Partitions of Poland.—In the autumn of 1792 negotiations mere initiated between Russia and Prussia for a new partition of Poland. On Jan. 23, 1793, a treaty mas signed by which Prussia obtained Danzig, Thorn, Posen and nearly all Great Poland, while Russia received Minsk, Pinsk and the frontier on the Zbrucz. Austria was merely promised assistance in reconquering Belgium. The emperor felt that he had been cheated, and his distrust of Prussia steadily increased from that time. Of the former Polish kingdom only a small and unimportant part remained in existence. The opposition displayed by the Poles to the occupation of the partitioned districts was forcibly crushed by Russia and Prussia. Both these states henceforth believed that the only security against a repetition of such occurrences lay in a complete partition of Poland. But this time Austria had to be given a share of the plunder, and after lengthy negotiations the third partition treaty was signed in Aug. 1795. Prussia got the Polish capital Warsaw with the district up to the Bug and Memel; Austria got Cracow, Siedlce and Chelm, and Russia got all eastern Poland together with Courland. The treaty was immediately put into force, and the old Polish kingdom was erased from the map of Europe without any attempt to consult the wishes of the inhabitants. The partition was a simple act of violence characteristic of the *Kabinettspolitik* of the 18th century.

Basle, Campo Formio and *Lunéville.*—Shortly before this Frederick William of Prussia had signed at Basle (April 5, 1795) a separate peace with France in order to leave himself free to deal with affairs in the east. By this treaty the left bank of the Rhine was given over to France, while Frederick William reserved the right to demand in compensation for Prussia's possessions that Germany north of a line drawn from the Rhine to Silesia should be declared neutral; French troops were not to enter this area, and in return I'russia promised to use its influence to prevent the north German princes from supporting the emperor against France. Thus Prussia once more resumed the anti-Austrian policy which it had for some years abandoned to make common cause with Austria against France.

Austria continued to carry on the war with the financial support of England for a further two years until it was compelled, as a result of Napoleon's masterly Italian campaign, to conclude the' peace of Campo Formio (Oct. 1797). The emperor was forced to surrender Lombardy and Belgium to France and received in return Venetia, Istria and Dalmatia. He was also forced to agree to the cession of the left bank of the Rhine to France. The German princes who suffered a loss of territory in consequence of this cession were to be compensated on the German right bank of the Rhine, and their claims were to be dealt with individually by a congress which was to meet at Rastatt.

This congress met but before it had completed its labours war had broken out anew. On the death of Catherine II (1796) her son Paul I had succeeded to the Russian throne; he was a bitter enemy of the revolution. Since Austria, too, was eager to throw off the hard terms of the treaty of Campo Formio, the English minister, William Pitt, was able to build up a new alliance against France. Napoleon had embarked on his expedition to Egypt, and the moment therefore seemed specially favourable for a renewal of the war. Under the leadership of the Russian general Alexander Suvorov the allied army drove the French out of Italy in 1799, but an attempt to expel them from Switzerland miscarried. Before Suvorov had arrived with Russian reinforcements the Austrian army had been defeated near Zurich. The French were also victorious over the English troops in the Netherlands, and when Napoleon returned from Egypt in the autumn of 1799 and took over the supreme command, the French armies again resumed the offensive. By their victory at Marengo (June 14, 1800) they won back Italy. They also advanced victoriously into southern Germany. Under these circumstances the allies decided to treat for peace with Napoleon, who had in the meantime become head of the French republic as first consul. By the peace of Lunéville (Feb. 9, 1801) the cession of the left bank of the Rhine to France was confirmed. Peace between France and England was signed in the following year at Amiens.

Napoleon and the Confederation of the **Rhine.**—Negotiations now began in Germany for the compensation of the German princes uho had incurred losses on the left bank of the Rhine. The *Reichstag* appointed a special commission for this purpose, but the settlement really lay in the hands of the great powers, especially France. Napoleon came to an understanding with Russia and Prussia to divide up the ecclesiastical states and the majority of the imperial cities among the injured princes. Bavaria, Württemberg, Baden and Hesse were won over by promises of especially large compensation; finally Austria was drawn in since, although it was reluctant to assent to such a great diminution in the Catholic elements in the Reichsfag, it gave up its opposition as unavailing. On Feb. 25, 1803, the results of the negotiations were embodied in the final decision of the commission: 112 states were apportioned, out of which in the first place certain foreign princes who had sustained losses elsewhere had to be compensated. Thus the hereditary stadholder of the Netherlands, who had been driven from his dominions, was given the abbacy of Fulda and certain adjoining districts; the duke of Modena the Breisgau; and the grand duke of Tuscany the archbishopric of Salzburg. Prussia was indemnified by the bishoprics of Miinster, Paderborn and Hildesheim in addition to Erfurt and a number of imperial cities in central Germany; Bavaria received the bishoprics of R'iirzburg, Bamberg, Augsburg and Freising with a number of south German imperial cities; Wurttemberg, Baden, Hanover and Oldenburg were similarly greatly increased in area. The map of Germany was entirely altered by these political changes which marked only the beginning of a transformation that was to be carried still further three years later.

Meanwhile war had again broken out between France and England. Russia and Austria made common cause with England; Prussia remained neutral. Napoleon's great victory at Austerlitz on Dec. 2, 1805, decided the war in his favour. The tsar withdrew to Russia, and Prussia, which in consequence of a violation of its territory by French troops was on the point of declaring mar on France, again entered into an understanding with Napoleon. Austria, however, was forced to sign the unfavourable peace of Pressburg on Dec. 26, 1805, to surrender Venetia to the kingdom of Italy recently founded by Napoleon, Tirol to Bavaria, and its remaining Swabian lands to Württemberg and Baden. As compensation, it received only the archbishopric of Salzburg, its former possessor, the grand duke of Tuscany, being compensated by

Wiirzburg. The emperor was also forced to recognize the elevation of Bavaria and Wurttemberg to the status of kingdoms. Napoleon set up in the Rhineland a new grand duchy of Berg for his brother-in-law Marshal Joachim Murat.

Kapoleon now resolved to unite the states that he had created or enlarged in a permanent confederation. and on July 12, 1806, he founded the Confederation of the Rhine which included Bavaria, Wurttemberg, Baden, Hesse-Darmstadt, Nassau and Berg as well as some small states. The territories of the counts and knights of the empire (*Reichsgrafen* and Reichsritter) which lay between these states were divided up among them and the rulers of the different states therefore feared that Napoleon's defeat would involve them in the loss of all that they had gained. The states of the Confederation of the Rhine remained independent in internal administration, but could not pursue an independent foreign policy and were required to place their troops at any time at the disposal of Napoleon, who had been nominated the official protector of the confederation. The members of the confederation informed the emperor and the Reichstag that they regarded themselves as having ceased to be members of the empire, and that this had ceased to exist (Aug. 1, 1806). The emperor therefore laid aside the German imperial crown on Aug. 6, having already assumed the title of emperor of Austria in 1804. The old German empire, in existence for almost 1,000 years, wholly disappeared, and the complete independence of the individual states that had grown up on its territory was legally recognized. Germany became a geographical expression, and lacked any political unity.

Prussia's Collapse and Resurgence, –Napoleon now thought that his day of reckoning with Prussia had tome. Thanks to his too cautious and wavering policy, Frederick William III found himself without support before the might of the French emperor. Frederick William was able to conclude a defensive alliance with Russia, when Napoleon's threatening speeches left no doubt as to his intentions, but, except for Russia, Prussia had as supporters only electoral Saxony and certain small north German states. When Kapoleon occupied certain Prussian districts on the Rhine in order to hand them over to the grand duchy of Berg and when he demanded that Prussia should recognize as valid this act of violence and completely disarm, Frederick William replied with an ultimatum in which he required Kapoleon to evacuate southern Germany. As Napoleon naturally refused to comply with this demand, war broke out between France and Prussia in Oct. 1806.

The defeat sustained by the Prussian armies at Jena and Auerstadt on Oct. 14 decided the fate of the Prussian kingdom. Napoleon entered Berlin in triumph and Frederick William was compelled to flee to Konigsberg. The whole of northern Germany was occupied by the French, and only a few Prussian fortresses put up a successful resistance. (See NAPOLEONIC CAMPAIGNS.) The elector of Saxony made peace with Napoleon and entered the Confederation of the Rhine in return for the conferment of the royal title. If the tsar had not at this moment come to its aid, Prussia would have been wholly destroyed. The bloody contests on the battlefields of West and East Prussia during the early months of 1807 failed to bring about a decisive victory, and Napoleon therefore entered into the peace negotiations with the tsar that resulted in the peace of Tilsit (July 7, 1807). Although Prussia continued to exist as a kingdom, it was forced to cede its entire possessions west of the Elbe in addition to the greater part of its acquisitions in the last partition of Poland. A vast war indemnity was demanded, and until it had been paid in full Prussia was required to consent to the occupation of its most important fortresses by French troops and had to undertake not to maintain an army of more than 42,000 men. Out of the territory between the Elbe and the Weser ceded by Prussia Napoleon created the kingdom of Westphalia, with which he incorporated the territory of the elector of Hesse-Cassel who had been dispossessed. He made his own brother Jerome king.

French rule in Germany brought about, directly or indirectly, important changes. In the states belonging to the Confederation of the Rhine a French administrative system and code of laws was directly imposed. In Prussia the changes came from within, though there too they were conceived and carried through by a few men with power and were not the outcome of a popular movement.

Stein and *Hardenberg*.—The chief force behind the Prussian reforms was Heinrich, baron vom und zum Stein (*q.v.*). Stein had pressed for alterations in the government before 1806 but without success. After the disastrous defeat at Jena, however, Frederick William perceived that desperate measures were needed and he appointed Stein as his leading minister, partly at the suggestion of Napoleon, ironically enough, though Stein was strongly anti-French and aimed at creating a strong Prussia which should repel the French invader and become the nucleus of a free and united Germany.

Stein came to power on Oct. 4, 1807; in Dec. 1808 he was forced to flee the country. In his single year of office, however, he produced domestic reforms which might have given Prussia a new life if they had not been allowed to disappear later under Junker pressure. The system whereby power was divided between the ministers of state and the cabinet, a body of the king's private advisers, was abolished; instead the chief ministers were themselves to offer advice and were to be the administrative heads of the various departments of state. Towns were freed from the jurisdiction of men appointed by the crown and were made instead self-governing. a reform which was to have been extended later to country districts, where government was in the hands of the Junker manorial courts. As well as making these administrative changes Stein struck at the caste system which ran through and through Prussian society. He placed himself behind the land reforms already recommended by the Immediate commission, which had been appointed by the king, and on Oct. 9, 1807, five days after he took office, he declared the Edict of Emancipation abolishing serfdom in Prussia. The laws whereby land could not pass from one class of owner to another were annulled; the Junkers were now permitted to sell their land, and the middle classes, which had the money to cultivate it, could buy it. Further, by the same edict, all the regulations confining particular occupations to particular classes were abolished. Meanwhile Gerhard von Scharnhorst (*q.v.*) was making changes in the army, trying to create a national rather than a purely professional force, and Stein supported these reforms also. Unfortunately an intercepted letter showed Napoleon where Stein's policy was designed to lead: an imperial decree was issued against him on Dec. 6, 1808, and he fled to Bohemia. His place was taken by Karl, prince von Hardenberg (*q.v.*). Hardenberg had been associated with Stein and pursued a similar policy of reform but with less force.

The War **of** Liberation — While the attention of Napoleon was fully engaged in Spain, Austria made another attempt in 1809 to regain its old position. As Russia refused its aid and Prussia after its defeat was unable to help, the war once more ended in the total defeat of Austria (Wagram, July 6, 1809). The peace of Vienna (Oct. 14) deprived Austria of Salzburg, Galicia and Istria. Napoleon erected a grand duchy of Warsaw out of the Polish lands formerly taken by Austria and Prussia and made the king of Saxony grand duke, while Dalmatia (already ceded by the treaty of Pressburg) and Istria were united to France under the name of the Illyrian provinces.

Although he was victor in this war, Kapoleon saw with anxiety the excitement these events aroused in the whole of Germany. Bodies of volunteers were formed in various districts to offer their assistance to Austria — such as those organized by Ferdinand von Schill and Frederick William of Brunsmick. Despite the fact that these movements met with no success, Napoleon deemed it necessary to unite the north of Germany still more closely with France, and in 1810, with the exception of Holland, he annexed all the German districts lying northwest of a line drawn from Cologne to Lubeck and formed them into *départements* after the French model. He had now attained the zenith of his power, and his marriage with the daughter of the emperor Francis had brought his dynasty within the circle of the ancient ruling houses of Europe. But a change came over the scene with his Russian campaign in 1812, in which the French army was almost entirely destroyed, a miserable remnant alone surviving to reach Germany in the winter.

It was only natural that Germany should seek to make use of

Napoleon's heavy defeat to shake off his rule; but there was wanting a single directing will in a country that was governed in part by princes who were vassals of France and in part occupied by French garrisons. The population of north Germany, where the rule of the foreigner had been felt most oppressively, was filled with a wild hatred against the French; in the south, where native princes still ruled and no foreign troops or officials had penetrated, emotions were less violent. For the first time the educated classes in Germany learned to understand the importance of a national state in the common life of a people. The rulers of the greater states, however, still hesitated to come to a definite decision. The emperor Francis did not wish to fight against his son-in-law, and Frederick William III of Prussia feared that he might lose the rest of his kingdom if the new war should prove unsuccessful. Only when the Russians seemed determined to pursue their fight with Napoleon on German soil were the German princes forced to decide on which side they would fight. At Napoleon's bidding, Austria and Prussia had been forced to send reinforcements to help him against Russia. The commander of the Prussian contingent, Count Yorck von Wartenburg, acting on his own responsibility, concluded a treaty of neutrality with the commander of the Russian forces opposing him. But it was only under pressure from the emperor Alexander of Russia that Frederick William finally decided to address from Breslau the "Appeal to my People" (*Aufruf an mein Volk*) in which he declared war against France. This proclamation gave the signal for a general rising in northern Germany against Napoleon. Volunteers enthusiastically rushed to arms and the Russian and Prussian troops advanced to the Saxon frontier. Austria remained neutral.

Napoleon hastened to the defense of his German allies, defeated the Russians and Prussians at Lutzen and Bautzen and forced them to retreat to Silesia. Feeling himself unable to prosecute the campaign to a final victory Napoleon concluded an armistice during which peace negotiations were opened at Prague through the intermediary of Austria. Napoleon, however, was unwilling to surrender any of his conquests and after much hesitation the emperor Francis finally made common cause with the allies and declared war on France on Aug. 12, 1813. Since England was giving financial support to the allies, and the Spaniards in conjunction with an English army were advancing from the south against France, Napoleon found himself opposed by almost the whole of Europe. After many changes of fortune, the campaign in Germany finally ended in the defeat of Napoleon at the Battle of Leipzig (Oct. 16–19, 1813). The French army had to retreat over the Rhine, the allied forces following them slowly; on New Year's Eve 1814 they crossed the Rhine and advanced into northern France. By the end of March 1814 the allies were in possession of Paris. Napoleon was compelled to abdicate his throne and appeal to the mercy of his enemies. He was banished to the island of Elba. The house of Bourbon was restored to power and, by the first treaty of Paris, France was forced to abandon all the conquests it had made since 1792. (See also NAPOLEONIC CAMPAIGNS.)

Reconstruction: the Congress of Vienna.—With the removal of French rule the difficult question of Germany's future organization arose. Austrian policy, now inspired by Prince Metternich, aimed at preventing Prussia from becoming too powerful and tried to draw to itself the German princes who had been allied with Napoleon. The emperor Francis signed the treaty of Ried with the king of Bavaria by which Maximilian was assured of full sovereign rights in his former dominions, and similar treaties were concluded with Wiirttemberg, Baden and the other states in the former Confederation of the Rhine. Thus it was no longer possible to regard these states as captured districts to be divided up among the victors. In northern Germany Hanover, whose ruler was the king of England, also remained intact. Moreover it seemed unjust to exclude from their territories the princes whom Napoleon had exiled while preserving the vassal states which he had created. Under these circumstances it became excessively difficult to find a means of giving expression to the political unity of Germany.

At the Congress of Vienna, which sat from Sept. 1814 to June 1815, the German question was one of the most difficult problems considered. Finally it was agreed that Austria should recover Tirol, Vorarlberg, Salzburg and the district of the Inn from Bavaria, Venetia and Lombardy in the south and also Dalmatia and the rest of France's Illyrian provinces. Austria kept most of Galicia. Belgium and the remaining scattered Austrian possessions in Swabia were given up. Thus Austria withdrew from western Germany, and the task of safeguarding the western frontier was passed on to Prussia, which was given a large area in the Rhineland and Westphalia, lands that on the east of the Rhine had belonged to members of the Confederation of the Rhine and on the west had formed part of Napoleonic France. These lands were entirely separate from Prussia's other possessions and a corridor joining them was refused. But the other powers, and especially England, hoped that Prussia would now provide a bulwark against possible French aggression and would be a safeguard to the new kingdom of the Netherlands. Prussia also received the Swedish province of Pomerania and about two-fifths—less than it had hoped—of Saxony; the Saxon king, Frederick Augustus I, had now to pay the penalty for having remained loyal to Napoleon to the last. Of its Polish lands Prussia kept only Posen, Danzig and what it had gained in 1772. The rest of Poland, apart from Galicia and from Cracow, which was made a free city, went to Russia, though it was promised a constitution. In compensation for the territory now handed back to Austria, Bavaria was given Wurzburg and the Palatinate lands on the left bank of the Rhine, together with the south German districts of Ansbach and Bayreuth, which were renounced by Prussia. Hanover gave up Lauenburg to Prussia, but was enlarged by East Friesland, Hildesheim, Goslar and some smaller lands.

After the settlement there remained in Germany 39 different states, of which four were the free cities of Hamburg, Bremen, Lubeck and Frankfurt; the rest had monarchical constitutions. The idea of restoring the empire was abandoned and the 39 states formed a union whose constitution was laid down in the Federal act of June 8, 1815. (E. BRA.; X.)

THE GERMAN CONFEDERATION, 1815–1866

The 1815 Settlement.—The Napoleonic Wars had broken the old political structure of Germany. At the same time the administrative changes brought about by the French and the patriotic emotions of the war of 1813 had led many Germans to demand a measure of German unity, and also constitutional reforms in the individual states. The history of the next 50 years in Germany showed the difficulty of reconciling these two demands and determined the form that German unification was to take.

The establishment of the German confederation at the Congress of Vienna satisfied neither the demand for German unity nor the demand for constitutional reform. The sovereign independence of the middle states—Bavaria, Hanover, Wiirttemberg, Baden and Saxony—was confirmed, and their rulers were reluctant to give up their new power to any central body. In the circumstances, the German confederation set up in June 1815 left few powers to the federal diet established at Frankfurt-on-Main. The federal diet was a meeting of plenipotentiaries and not a legislative assembly able to make decisions directly binding on individual citizens. It consisted of representatives of 39 sovereigns, some of whom ruled over territory not included in the confederation; for much of Austria and the Polish provinces of Prussia were excluded; the king of Hanover was also king of England; the duke of Holstein and Lauenburg was king of Denmark; and the duke of Luxembourg was king of the Netherlands. The Austrian representative acted as president of the diet. The individual states retained full sovereignty over their internal affairs. Even the establishment of a supreme court of justice for the confederation proved impossible. As any change in the confederation's basic principles could only be effected by a unanimous vote, an extension of its competence was practically impossible. The avowed purpose of the confederation was "to uphold the external and internal security of Germany and the independence and integrity of the individual German states." During the following years it was to demonstrate its inability to do either.

The establishment of the confederation in this form was largely the work of Metternich, the Austrian chancellor, and it was his influence that predominated in Germany until 1848. The working of the confederation depended on agreement between the two German great powers, Prussia and Austria. During the reign of Frederick William III of Prussia this peaceful dualism worked successfully. Frederick William was a timid, sceptical, unimaginative man with an unremitting dislike of liberalism, and he was quite ready to follow Metternich's lead both within the German confederation and by opposing domestic reforms in Prussia. Under his influence the changes introduced by Stein and Hardenberg in the stress of defeat before 1813 were never completed, although Hardenberg remained chancellor until his death in 1822. The promises that Frederick William had made in May 1815 of a representative assembly remained unfulfilled until 1847, and a long struggle was carried on in the new Prussian provinces of west Germany in an attempt to remove the French influence on the administrative and judicial systems.

Metternich hoped to use both the German confederation and the Holy alliance (*q.v.*) of Prussia, Austria and Russia (1815) as a means of fighting revolution wherever it might threaten. In a series of congresses between 1818 and 1823 (Aix-la-Chapelle, Troppau, Laibach, Verona) he tried to establish the principle that the great powers had the right to intervene to suppress revolution elsewhere; *e.g.*, in Spain and Italy. This policy was only partially successful since England refused to associate itself with it. Inside Germany. however, Metternich with Prussian support was able to use the federal diet to pursue the same ends. Some of the middle and smaller states, notably Baden and Wiirttemberg, had adopted constitutions based on representative assemblies and liberals in the other states were demanding similar measures. In the universities the student associations (Burschenschaften) were agitating for German unity, while papers like Joseph von Görres' Rheinische *Merkur* expressed liberal discontent with the settlement of 1815. In Oct. 1817 these sentiments found expression in a great gathering at the Wartburg in commemoration both of Luther's tercentenary and of the fourth anniversary of the battle of Leipzig. Within two years, however, Metternich found the excuse he needed for attacking the whole of this liberal and national movement. On March 23, 1819, August von Kotzebue, a writer of no great importance and a propagandist in Russian pay, was murdered by a student named Karl Sand. who had been associated with one of the most radical of the student organizations, the Unbedingten, led by Karl Follen. Metternich at once summoned a conference, which met at Carlsbad in August and was attended by representatives of most of the German princes. A series of decrees (the Carlsbad decrees) was drawn up and passed by the federal diet in September. The governments of the German states undertook to introduce press censorship, to remove university teachers suspected of subversive doctrines, to forbid the Burschenschaften and to establish a central commission to investigate the revolutionary movement.

The Carlsbad decrees began a decade of reaction when it seemed that Metternich had succeeded in halting the demand for national unity and constitutional change. The decrees were executed with various degrees of severity in the different states, for some, such as Baden, had a genuine constitutional life, others, such as the two Mecklenburg duchies, had preserved an almost mediaeval feudal system, while in Brunswick, Hesse-Cassel and others the most capricious and unenlightened despotism prevailed. In Prussia the most prominent of the leaders of the national and liberal movement were arrested or driven into exile.

The Zollverein. — Yet the political inactivity of the 1820s was accompanied by economic developments of the greatest importance. The end of the war had brought serious economic difficulties in most of the countries of Europe, and not least in Germany. Other countries were imposing tariffs that excluded German corn; British manufactured goods were flooding the German market. All over Germany there was an agitation for some measure that would remove the differences of tariffs, currencies, weights and measures and general economic policy between the individual German states. The economist Friedrich List led the movement in southern and western Germany, but efforts at action through the federal diet were unsuccessful. Similarly, negotiations between the governments of the southern states broke down because of particularist feeling and jealousy. By 1825 the initiative in forming a customs union lay with the one state prepared to take it — Prussia.

In June 1816 all internal customs barriers inside Prussia had been abolished and in 1818 the tariff was revised and a moderate protectionist system was introduced. Both these measures aimed at restoring order in the state's finances and at the integration of the newly won provinces into the Prussian state. From 1819 onward the independent enclaves of Schwarzburg, Anhalt and Saxe-Weimar, which were surrounded by Prussian territory, interrupting communications and serving as centres for smuggling, were absorbed into the Prussian economic sphere, so that by 1829 a large part of north Germany was included within a single customs system. In 1825 a new Prussian finance minister, Friedrich von Motz, began to extend this area. On Jan. 11, 1828, Hesse-Darmstadt adhered to the Prussian system, and by May 1829 agreement had been reached with Bavaria, whose new king, Louis I, was anxious for a customs union, and whose government had already succeeded in coming to an agreement with the neighbouring states of south Germany. The remaining states were rapidly forced in their own interests to join, and neither the attempt made in Sept. 1828 to form a mid-German commercial union (Mitteldeutscher *Handel*sverein), nor the effort to secure economic co-operation between Hanover, Oldenburg, Brunswick and Hesse-Cassel (treaty of Einbeck, March 1830) was long successful. By Jan. 1, 1834, a customs union (Zollverein) was in being including all the states of Germany except Austria and the states of the northeast, Hanover, Brunswick, Oldenburg and the Hansa cities. An attempt by the latter to form a rival union, the Steuerverein, did not long survive in the face of the changing economic situation and the attractions of membership of the Zollverein; Brunswick agreed to join in 1844, Hanover in 1851 and Oldenburg in 1852; only the great ports of Hamburg and Bremen remained outside until after the foundation of the empire. The Zollverein was a triumph for the Prussian officials who planned it. The inadequacy of the machinery of the federal diet had been demonstrated, and a step had been taken in the substitution of Prussian for Austrian leadership in Germany, since Austria was excluded from the Zollverein and the economic developments that resulted from it. Above all, a fresh impetus was given to trade and industry all over Germany, preparing the way for the great developments of the German economic system after 1850.

The Liberal Movement. — The prevailing political conditions in Germany prevented many attempts to follow the example of the French Revolution of July 1830. The particularly arbitrary rulers of Hesse-Cassel and Brunswick were deposed, and there were minor revolutionary outbreaks elsewhere. On May 27, 1832, a demonstration (similar to the 1817 Wartburg demonstration) was held at Hambach in favour of the liberal and national cause. Its sole effect was to enable Metternich to persuade the members of the confederation again to declare their support for conservative principles and to agree on further measures of repression. (The Six Articles, June 1832.)

Nevertheless, the death of the emperor Francis I in 1835 and the accession of his feeble-minded son Ferdinand began to weaken Metternich's influence inside the Austrian government. At the same time new movements in Germany began to make themselves felt. In spite of the ban imposed in 1835 on the writings of Heinrich Heine and the other writers of the Young Germany movement, in spite of the suspension of seven Göttingen professors in 1837 by the new king of Hanover, Ernest Augustus (the former duke of Cumberland, who succeeded to the throne when the crowns of England and Hanover became separated on the death of William IV), the movement for national unity and constitutional government continued to gather strength. An opportunity for demonstrating this national feeling occurred in 1841, when an international crisis gave rise to rumours of a possible French attack on Germany; it was at this time that "The Watch on the Rhine" (the title of a song written in 1840 by Max Schneckenburger) first became a national slogan.

Moreover the accession in June 1840 of a new king of Prussia, Frederick William IV, aroused hopes that Prussia might take the lead both in constitutional reform and in national unification.

These hopes were to be disappointed. The new king had, it is true, a romantic feeling for a common German past, its traditions and monuments, but this included a respect for the house of Habsburg as the traditional imperial dynasty in Germany so that he was unwilling to break the peaceful dualism that had been established in 1815. He had been brought up on the ideas of the conservative political philosophers of the romantic age, and he looked back to an idealized mediaeval state very unlike the system of government at which the liberals were aiming. Nevertheless his imagination, eloquence and enthusiasm, coupled with such measures as a relaxation of the censorship and the rehabilitation of some of those teachers and writers who had suffered for their liberal views, meant that in Prussia political activity of all kinds began to revive. New leaders of the liberal movement were emerging from the new industrial and commercial middle class of the Rhineland, men such as Ludolf Camphausen, David Hansemann, or Gustav von Mevissen, and they joined with the liberals in other parts of the kingdom in pressing for the fulfilment of Frederick William III's promise of a representative assembly, given in 1815 and not kept in his lifetime. After long hesitations and delays the king eventually summoned in Feb. 1847 an assembly composed of representatives of the diets of the various Prussian provinces, and this united diet met April 11, 1847. It soon became clear, however, that Frederick William's conception of a mediaeval system of estates (Stiindesstaat) grouped together under a king whose position derived from divine right was incompatible with the beliefs of even the mildest of liberals, and in June 1847 the diet was prorogued.

In most of the other states of Germany there were similar movements although their nature depended on the prevailing political conditions, which differed widely between the various states. In the towns artisans and apprentices were anxious to be rid of the last mediaeval restrictions on their professional freedom; in the country the peasants in south and west Germany and the German provinces of Austria wanted to be freed from their remaining feudal obligations. The intellectual classes — lawyers, professors, students — wanted freedom of speech, trial by jury and a representative system of government as well as the satisfaction of their desires for a German national state. In Austria the non-German nationalities were stirring, while the diets of the German provinces, especially that of Lower Austria, were voicing liberal demands. Liberal leaders in the individual states of Germany were beginning to meet one another and to draw up common programs expressing their liberal and national aims.

The Year of Revolution. — It only needed the example of the Paris revolution of Feb. 1848 to bring these discontents in Germany to a head. Within a few weeks the governments in most of the middle and small states had yielded to popular agitation, promised a constitution and appointed liberal ministers. In Bavaria, where dislike of the king's favourite, Lola Montez, had confused the political situation, Louis I was forced to abdicate in favour of his son Maximilian on March 20. The revolution scored equally easy and surprising successes in Vienna and Berlin. On March 13 Metternich was forced to resign and then went into exile; the emperor promised a constitution, and a national guard was formed. At the same time the non-German nationalities in the empire were demanding autonomy and constitutional government. On March 18, encouraged by the events in Vienna, the inhabitants of Berlin, not content with the promises the king had already made of summoning the united diet again, started riots in the streets. The king, with characteristic impetuosity, issued a long-winded sentimental proclamation "to my dear Berliners" and later even consented to salute the corpses of those killed in the street fighting. On March 19 on his orders the troops were withdrawn from the city although they could easily have suppressed the disturbances. A constituent assembly was summoned, and a ministry headed by the Rhenish liberals Camphausen and Hansemann was appointed.

These easy revolutionary successes in the individual states were accompanied by plans for establishing a measure of national unity. On March 5 a meeting of the leading academic liberals at Heidelberg had declared in favour of a national representative assembly, while the Hessian statesman Heinrich, Freiherr von Gagern sent his brother Maximilian on a mission to the courts of Germany to try and secure common action. These efforts were overtaken by the revolutions in Berlin and Vienna. The initiative now lay with the liberals rather than with the princes. The Austrian government was distracted by the national revolt in Hungary and by the revolution in Milan and the war with the kingdom of Sardinia for the possession of Lombardy. In Prussia Frederick William appeared to be prepared to co-operate in the work of German unification and declared on March 21 that henceforth Prussia would merge itself in Germany.

The Frankfurt Parliament. — A preliminary parliament met in Frankfurt at the instigation of the liberal leaders who had assembled at Heidelberg early in the month, and it established a committee of 50 to prepare for the election of a national assembly. The elections were duly held though the electoral laws and methods varied considerably from state to state, and on May 18 the national assembly met in the Paulskirche in Frankfurt. The success of the moderate liberals in the elections to the diets of the individual states and in the electrons to the Frankfurt parliament, together with the defeat of a radical rising in southwest Germany in April, led liberals all over Germany to hope that a constitution for a united Germany might emerge without difficulty.

The Frankfurt national assembly devoted a great deal of its time to the discussion of general principles and of the basic human rights it was necessary to guarantee in the new united Germany. But it also had to decide on immediate practical problems, such as the nature of the executive power and Germany's territorial extent. As a temporary answer to the first problem the archduke John, an uncle of the emperor Ferdinand and the most liberal-minded member of the Habsburg family, was appointed regent on June 29, and a government was formed under Charles, prince of Leiningen, the halt-brother of Queen Victoria. Yet it soon became clear that the executive appointed by the Frankfurt parliament had no power except such as was granted to it by the governments of the individual states. The Frankfurt parliament took over the conduct of a war with Denmark about the duchies of Schleswig and Holstein. Frederick VII of Denmark wished to separate Holstein from the German confederation and treat both duchies like the other provinces of the Danish kingdom. (See SCHLESWIG-HOLSTEIN QUESTION.) The war had broken out in April and was being waged by Prussian troops under a Prussian commander in chief, Friedrich, count von Wrangel. The Prussian government alone decided when the war should end and signed the peace of Malmo on Aug. 26. The war had been the object of great national enthusiasm, and Prussia's decision to end it (because the king was losing interest in liberal causes and feared international complications) became a source of such dissatisfaction at Frankfurt that Leiningen was forced to resign on Sept. 5, 1848. He was succeeded by Anton von Schmerling, a moderate liberal from Austria, who held office until December when he was succeeded by Heinrich von Gagern.

The Counterrevolution. — In September and October, during the political crisis caused by the end of the war with Denmark, revolutionary outbreaks by radical republicans in Frankfurt itself and in the southwest of Germany had to be suppressed. These risings were defeated only with the help of Prussian and Austrian troops. In October a similar revolt in Vienna was also suppressed and the city was bombarded by Alfred, prince von Windischgratz. By the end of the year the counterrevolution had triumphed in both Austria and Prussia. The emperor Ferdinand abdicated in favour of his 18-year-old nephew, Francis Joseph, on Dec. 2, and the new Austrian minister, Felix, prince zu Schwarzenberg, was prepared to reassert the authority of the central imperial government both inside the empire and in the rest of Germany. In Prussia, too, Frederick William IV had lost all the sympathy with the liberals he had shown in the spring and was relying increasingly on extreme conservative advisers. On Dec. 5 the Prussian national assembly was dissolved and a new constitution issued by royal proclamation. A new ministry with conservative sympathies had already been formed in October under Friedrich Wilhelm, count of Brandenburg. Although it contained certain concessions to the liberals, these were largely undone in the subsequent months when the old restricted franchise was restored.

The re-establishment of conservative governments in the two great states of Germany was inevitably reflected in the discussions of the Frankfurt parliament about the nature of the sovereign power in Germany and its territorial extent. By the end of 1848 the national assembly had completed its discussions about the basic rights to be included in the constitution, and in Jan. 1849 the proposed constitution was circulated to the individual states for their comments without any decision having been taken about the person or nature of the central executive. The second reading was concluded and the constitution adopted on March 27. The final decision was that the executive power should be in the hands of a hereditary emperor, although to obtain this the radicals had to be soothed with the promise of universal suffrage. The next stage was to elect an emperor.

Meanwhile, the territorial extent of the new Germany had been partially decided by the proclamation of a new Austrian constitution on March 4. By this, the Austrian empire was treated as a single whole, and it was made clear that either the whole empire or none of it would have to enter the new Germany. This was a blow to all those south German and Austrian liberals who had hoped for a "great German" settlement that would include at least the German provinces of Austria and meant that the initiative passed to those who believed in a "little German" settlement under Prussian leadership. Accordingly, when the election of an emperor took place in the national assembly on March 28, 290 votes were cast for Frederick William against 248 abstentions. On April 3 the king received a deputation headed by Eduard Simson, the president of the assembly, which came to offer him the crown. The offer was refused. Frederick William was too deeply conservative to receive a German imperial crown from any hands except those of the other German princes. On April 21, in spite of last-minute efforts by Camphausen and the governments of some of the smaller states, the king formally declared that Prussia could not accept the proposed constitution.

Without the support of either Prussia or Austria the Frankfurt parliament could not now survive. By May Gagern's ministry had broken up and the majority of the deputies were ordered home by the governments of their respective states. The rump that remained was forced to move to Stuttgart and was finally dispersed on June 18 by William I of Württemberg. In May and June final risings by the left in Baden and Saxony were suppressed with the help of Prussian troops. The revolutions were over.

The Prussian Union Project. — With the failure of the Frankfurt assembly to achieve German unification the opportunity for action passed back to the two great powers, Prussia and Austria. In the spring of 1849 Frederick William IV was listening to the advice of Gen. Joseph Maria von Radowitz. Radowitz was a Catholic conservative who believed that if Germany was to be saved from revolution, some concessions must be made to the social and national demands of the liberals. He devised a plan for setting Prussia at the head of a union of the states of north and central Germany that should be linked with the existing German confederation. On May 26, 1849, an "Alliance of the Three Kings" was concluded between Prussia, Hanover and Saxony to further the project, and in June a congress was held at Gotha attended by some of the former members of the Frankfurt assembly — moderate liberals willing to accept Prussian leadership in a little Germany — who gave Radowitz' plan somewhat reluctant support. In spite of opposition from many of the Prussian nobility, who suspected what they held to be Radowitz' leanings toward liberalism, it was agreed that a conference should meet at Erfurt in March 1850 to discuss a new constitution for Germany.

Meanwhile, Austria too had embarked on a positive policy. The king of Sardinia, Charles Albert, had been finally and decisively defeated at the battle of Novara in March 1849. The Hungarian revolt had been crushed with Russian assistance, and the Hungarian forces had capitulated at Világos on Aug. 13, 1849. The national movement in Bohemia had already been put down in June 1848. The danger of the disintegration of the Habsburg empire had gone, and Schwarzenberg was determined to follow up his attempt to consolidate and centralize the monarchy by a reassertion of Austria's predominance in Germany. He was aided in this task by Karl Ludwig, Freiherr von Bruck, his minister of commerce, who had a grand design of uniting the whole of central Europe into a single economic sphere of 70,000,000 inhabitants, a scheme which some of the liberals in south Germany were prepared to support. By the end of 1849 Austrian diplomacy had succeeded in drawing many of the small and middle states away from Prussia; Saxony and Hanover withdrew from the union project before the Erfurt congress assembled. Meanwhile Austria had announced its support for an alternative plan of constitutional amendment put forward by Brunswick, Hanover and Wurttemberg and, as the presiding power, had summoned a meeting of the federal diet for May 1850 to re-establish and revise the old federal constitution.

In spite of the relative failure of the Erfurt meeting, inevitable under these circumstances, Radowitz continued to work for the formation of the Prussian union. In the autumn of 1850 an internal conflict in Hesse-Cassel brought Prussian and Austrian troops face to face. The elector, Frederick William I, had appealed to the federal diet for support in his struggle with the liberals and on Oct. 31, 1850, Austrian and Bavarian troops entered Hessian territory in response to the elector's appeal; shortly afterward Prussian troops marched in to assert Prussia's right to defend the military roads that linked the parts of the Prussian kingdom lying on either side of Hessian territory. Radowitz urged the reluctant king to mobilize and prepare for war against Austria, and Brandenburg had been to Warsaw to try and gain the support of the tsar. But Nicholas I's sympathies were with Austria, and indeed most Prussian conservatives (Otto von Bismarck among them) were opposed to a breach between the two traditionally conservative powers in Germany. The influence of the conservatives prevailed, for Frederick William IV was reluctant to embark on a war between Germans and in any case was never capable of pursuing a consistent policy for long. Radowitz was obliged to resign on Nov. 3 and Brandenburg died suddenly on Nov. 6. A new ministry was formed under Otto, Freiherr von Manteuffel. The new government decided to negotiate with Austria, and with the encouragement of the tsar an agreement between the two governments was signed by Manteuffel and Schwarzenberg at Olmütz on Nov. 29. By this convention (long remembered by many of the Prussian supporters of Radowitz' policy as the "humiliation of Olmutz") Prussian troops were withdrawn from Hesse, and the question of the future constitution of Germany was referred to a conference which met at Dresden in Dec. 1850.

The Restoration of the Confederation. — At this conference which lasted until March 1851, Schwarzenberg was unable to secure for Austria the position in Germany for which he had hoped. Prussia, moreover, was able to win some support from the smaller states against the idea of a strong executive in Austrian hands. As a result, the only solution was a compromise that restored the old federal constitution of 1815 unchanged. It was as if the revolutions of 1848 had never been. Nor was Austria any more successful in using its political success at Olmutz to force its way into the *Zollverein;* the most it secured was a commercial treaty with Prussia in 1853. Schwarzenberg's plans for the establishment of Austrian political power in Germany, and Bruck's plans for an "empire of 70,000,000" in central Europe had both been disappointed. Thus the restoration of the position as it had been before 1848 pleased nobody and opened a period of political reaction and dull discontent. Many liberals went into exile (one, Carl Schurz, even became secretary of the interior in the United States), while those who remained behind began to realize that the unification of Germany could only come about by the action of those actually in possession of political power.

In Prussia, Austria and nearly all the smaller states every attempt was made to return to the constitutional position of the years before 1848. The Prussian constitution promulgated in Dec. 1848 was given its final form on Jan. 31, 1850; though it still made concessions to some liberal ideas, it was based on a restricted franchise by which two-thirds of the votes were held by those citizens whose taxes were rated in the two highest groups, while only one-third of the votes were held by the poorer people who made up the majority of the population. The Austrian constitution of 1849 was replaced by a patent of Dec. 1851 which imposed a centralized bureaucratic system of government on the whole empire. In 1855 this was followed by a doncordat with the pope, which restored the Roman Catholic Church to a position such as it had not enjoyed since before the reign of the emperor Joseph II. Yet the unimaginative bureaucracy that ruled in the largest states of the confederation and the general political stagnation were accompanied by considerable economic developments. Capital was being more widely invested; the railway network was being extended and the main railway system completed; coal production was rising, so that by 1860 Germany produced more coal than France and Belgium combined. At the same time the urban population, especially in Prussia, was increasing, so that a new industrial working class was coming into being, creating new problems with which economists such as Franz Hermann Schulze-Delitzsch, the founder of the co-operative movement in Germany, and agitators such as Ferdinand Lassalle were becoming concerned. (Lassalle began his agitation in 1861 and founded the Allgemeiner Deutscher Arbeiterverein in 1862.)

Moreover, events outside Germany made it increasingly clear that the restored machinery of the confederation was inadequate. The rise of Napoleon III and the re-emergence of France as a great military power, the Crimean War and the growth of the movement for Italian national unity all influenced developments inside Germany. In the Crimean War no common policy was followed by Austria and Prussia. Austria had hesitated between Russia and the west, but had by mobilization forced Russia to evacuate the principalities of Moldavia and Walachia. Prussia remained strictly neutral, although the opinion of the governing class was deeply divided and the king himself, as so often, unable to make *up* his mind. The situation of the confederation was even more serious in 1859 when Austria was involved in a war with France and Sardinia in defense of its possessions in north Italy. Francis Joseph appealed in vain to the Prussian government for support. The most that Prussia was prepared to do was to order a partial mobilization so as to enforce an armed mediation if necessary. After the Austrian defeat and the armistice of Villafranca (July 8, 1859), Francis Joseph publicly complained that he had been deserted by his natural allies. The period of peaceful dualism in the German confederation was clearly drawing to an end.

Plans for Reform.—The many projects for the reform of the confederation that were put forward after 1859—the attempts to overhaul the federal machinery or to restore co-operation between the two German great powers—were based on a deep division in the beliefs of Germans about the kind of united Germany they wished to see. The war of 1859 had given an opportunity for the expression of these different views. There were some who regarded Austria as taking the lead in a common German cause against the traditional enemy, France. Others regarded the Italian movement for national unity with sympathy and as an example which Germany must soon follow; to them Austria was a reactionary power hampering the free national development of Germany. The latter section of opinion began to find expression in a new political organization, the Nationalverein, founded in Sept. 1859. This body soon had branches in most of the states in north and central Germany and conducted a vigorous agitation for a united and liberal Germany from which Austria should be excluded. Its leaders, such as Rudolph von Bennigsen and Johann von Miquel, were to play important parts in the foundation and consolidation of the North German confederation and the empire after 1866. It was inevitable that such a project should look to the unification of Germany under the leadership of Prussia, yet the political situation in Prussia was such as to make it difficult for liberals to accept its leadership.

The "New Era" in *Prussia.*—In Sept. 1858 Frederick William IV, whose mind had been growing increasingly deranged, finally became incapable of carrying on the government and a regency was formed under his brother William, prince of Prussia (the future emperor William I). The regent had a personal dislike for his brother's ministers, and the Manteuffel government was replaced by one headed by Karl Anton, prince of Hohenzollern-Sigmaringen. Because the new government included one or two moderate liberals such as Rudolph von Auerswald, who had been a member of the liberal ministry of 1848, and because most of its members belonged to the group that had criticized Manteuffel in their journal, the Wochenblatt, the rival of the extreme conservative Kreuzzeitung, the new administration was hailed as inaugyrating a new era of liberal rule.

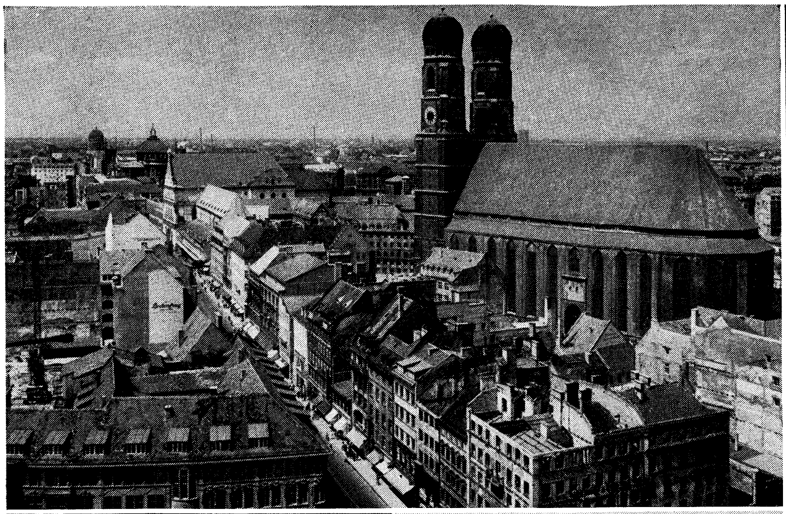
In fact, the regent had no intention of making concessions to the liberals. He was a simple, practical man whose main interest was in the army in which he had served since his early youth, and it was over the question of military reforms that he was to come into conflict with the liberal elements in the Prussian diet. The mobilization in the summer of 1859 had shown that the Prussian army needed overhauling and in Dec. 1859 the regent appointed the general Albrecht, count von Roon, war minister. Early in 1860 Roon brought his proposals for reform before the Prussian diet and asked for funds to put them into practice. The two points that aroused the most political discussion were a proposal to increase the active strength of the army by making every recruit serve a full three years, and a proposal to link the Landwehr, the reserve army, more closely with the regular army. It was the latter suggestion that especially aroused the anger of the liberals, for the Landwehr had been a preserve of the middle class and was connected with the ideals of a "people in arms" dating from the war of 1813. The liberal opposition to the military budget put an end to the idea of a new era in Prussia and involved the regent in increasing hostility to the liberals. For the year 1860 a compromise solution was found, and a military budget was voted so that Roon's reforms could be started; but the conflict was repeated the following year when the military budget was only passed by a small majority. In the autumn of 1861 a new party, the Deutsche Fortschrittspartei (the Progressive party) was formed by those liberals who saw the importance of retaining parliamentary control of finance and who wanted to unite Germany under the leadership of a liberal Prussia. In the elections of Dec. 1861 the new party had a considerable success, and in March 1862 the diet rejected the military budget. The diet was dissolved but in spite of attempts to influence the elections a new parliament was returned with a majority opposed to the military budget.

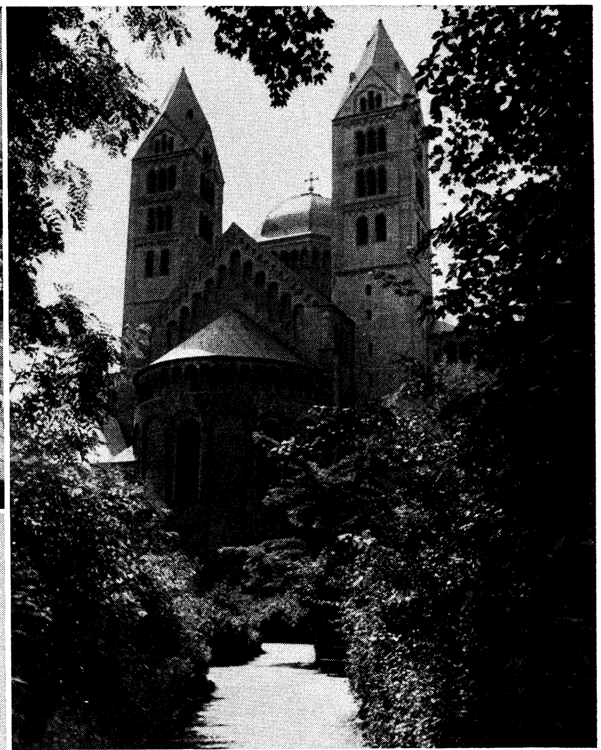
The king (the regent had succeeded to the throne on the death of Frederick William IV on Jan. 2, 1861) was unable to find a government that could resolve the conflict and win parliamentary support. The generals were talking of a coup d'état. Finally, on Sept. 18, 1862, Otto, count von Bismarck, was summoned from Paris, where he had recently become ambassador, and on Sept. 22, he agreed to become minister president of Prussia.

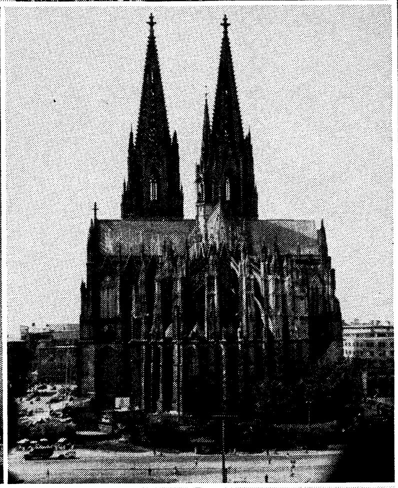
The Establishment of Bismarck.—It was only with reluctance that William had agreed to approach Bismarck. Bismarck had been closely associated with the extreme conservatives of the *Kreuzzeitung* group, with whom the king had broken in 1858, and his violent temperament and his ruthless methods made him a figure of alarm. He had served as Prussian representative with the federal diet from May 1851 to Jan. 1859, and then as ambassador in St. Petersburg until May 1862, when he was appointed to Paris. In his diplomatic career he had learned the necessity of making Prussian policy independent of that of Austria, and he was a firm believer in the necessity of friendship with Russia. He had used his influence in favour of neutrality during the Crimean War, and in Feb. 1863 he sent Gen. Gustav von Alvensleben to Russia to sign an agreement by which the Prussian government promised to help the Russians to suppress the revolt that had broken out in Russian Poland.

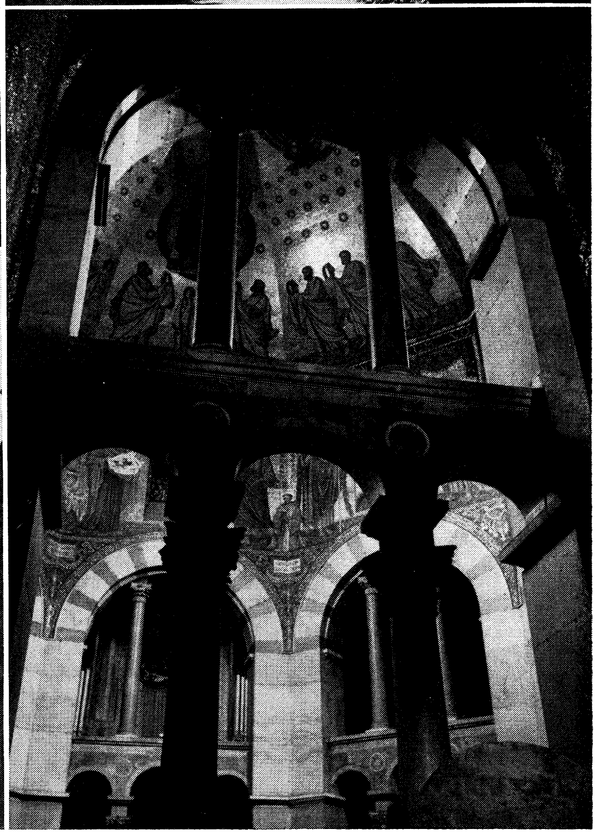
When Bismarck assumed office he not only had to solve the Prussian constitutional deadlock; he had also to decide on the policy Prussia should follow in the face of the various plans for reform of the confederation and the growing popular demand for national unity. For four years he solved the constitutional problem by governing without a budget. (Under article 109 of the constitution taxes continued to be levied until they were repealed, and the crown had considerable resources of its own—estates, forests, mines, etc.)

Austrian Plans for Reform.—The rifts in the federal system









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GERMAN CATHEDRALS

Top left: the Frauenkirche at Munich, built in the 15th century. Its two spires are among the most familiar landmarks of Munich

Top right: The cathedral at Speyer (capital of the Bavarian palatinate), founded in 1030; one of the best examples of Romanesque architecture in Germany

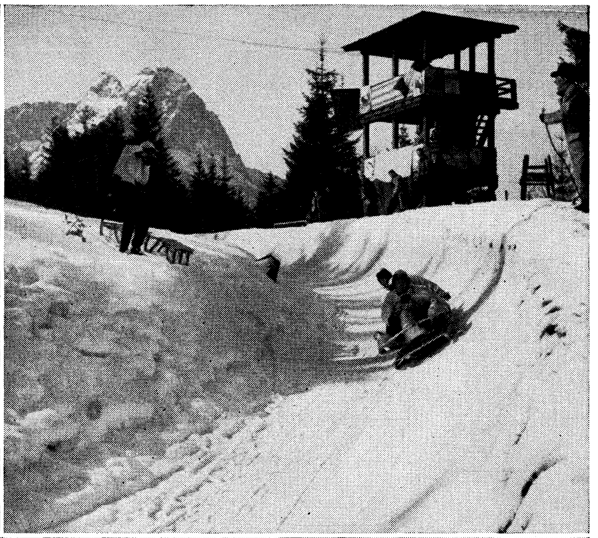
Centre left: The cathedral at Ulm, Wurttemberg, now a Protestant church, was begun in 1377 and completed in the 19th century. It is a distinguished example of the Gothic style in Germany. The modern spire, 528 ft. in height, is the highest in the world

Centre, second left: Cathedral in the heart of Cologne (Köln), parts of which were damaged by the heavy bombing during World War II

Bottom left: Cathedral at Aachen (Aix-la-Chapelle) begun under Charlemagne's auspices c. 790. The octagonal domed structure (centre) dates from that period. It was damaged by Norman raiders in 881 but was later restored on the original lines. The Gothic choir (left) was added in the 14th and early 15th centuries. The spire is modern and was damaged during World War II, as were the roofs of the chapel and baptistry

Bottom right: Interior of the cupola of the cathedral at Aachen, showing its gold and multicoloured mosaics and the pillars of the two-storied ambulatory

GERMANY



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YOUTH AND RECREATION IN GERMANY

Top left: View of a Munich beer hall shortly after World War I

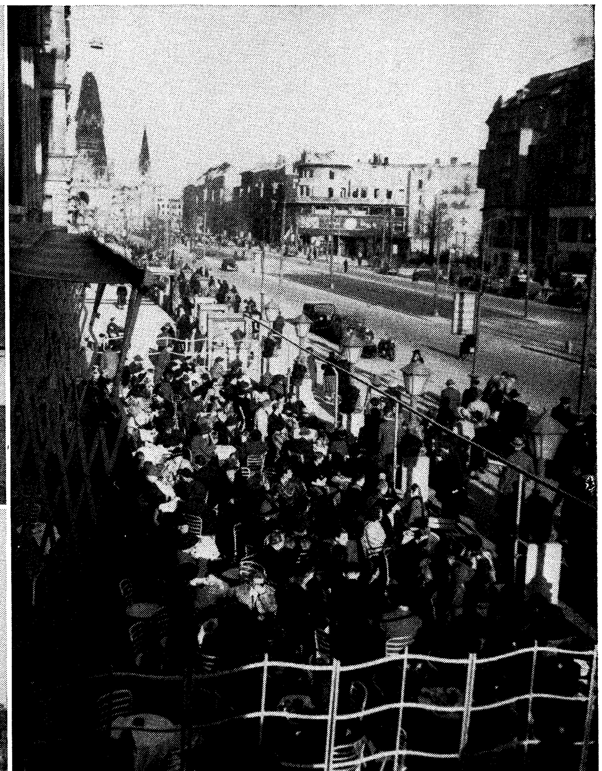
Top right: The Olympic bobsled run in Garmisch-Partenkirchen, southern Bavaria

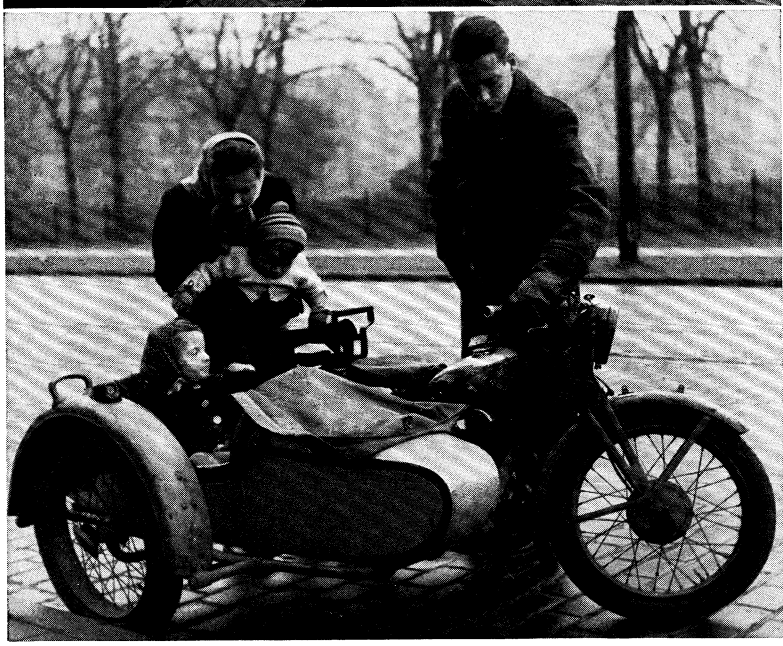
Centre left: Folk dancing at an International Youth camp at St. Goarshausen in the Rhine valley

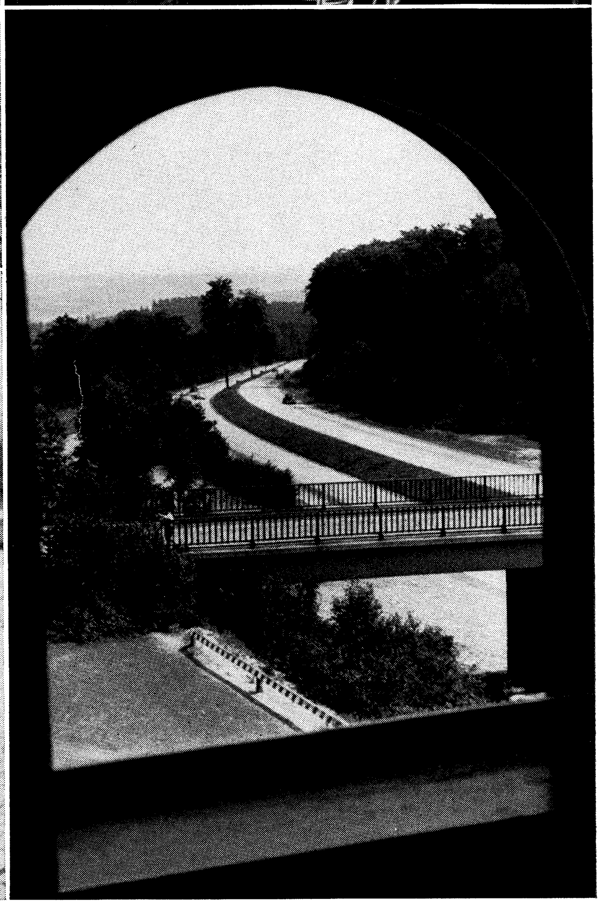
Centre right: Characteristic dance of peasants of the Bavarian mountains, in the costume of the region: the men in knee-length leather breeches with embroidered suspenders and girdles, and felt hats adorned with goat's beard or eagle's feather; the women in wide skirts and aprons and embroidered neck cloths

Bottom left: Five "Wandervogel" (wandering birds), a name popularly applied to young men and women of Germany, largely students, who travel on foot through the countryside and are known for their characteristic songs

Bottom right: Children's procession during a performance of the "Kinderzeche," a historic play given annually in Dinkelsbuehl to commemorate liberation of the village during the Thirty Years War







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SOME FEATURES OF INTEREST IN GERMANY

Top left: The Nuremberg stadium, scene of mass political gatherings during the nazi regime

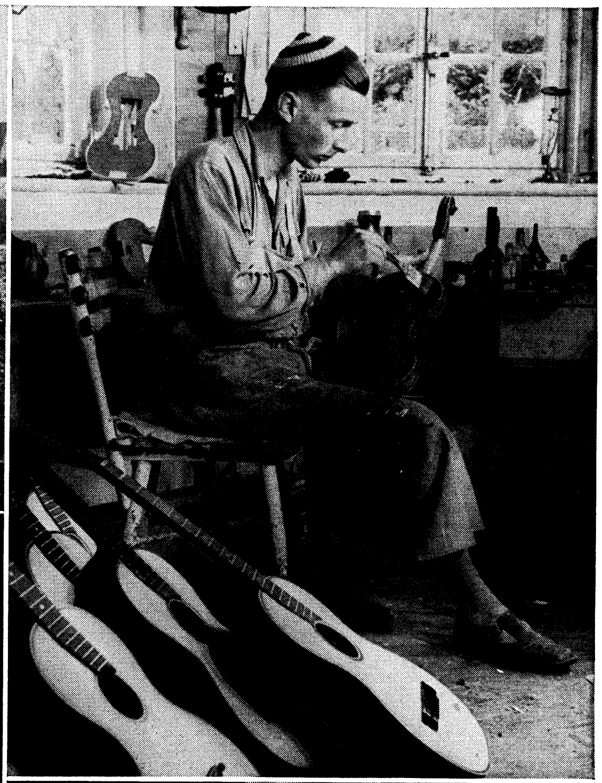
Top right: Outdoor cafe on the Kurfuerstendamm, one of the principal streets of Berlin

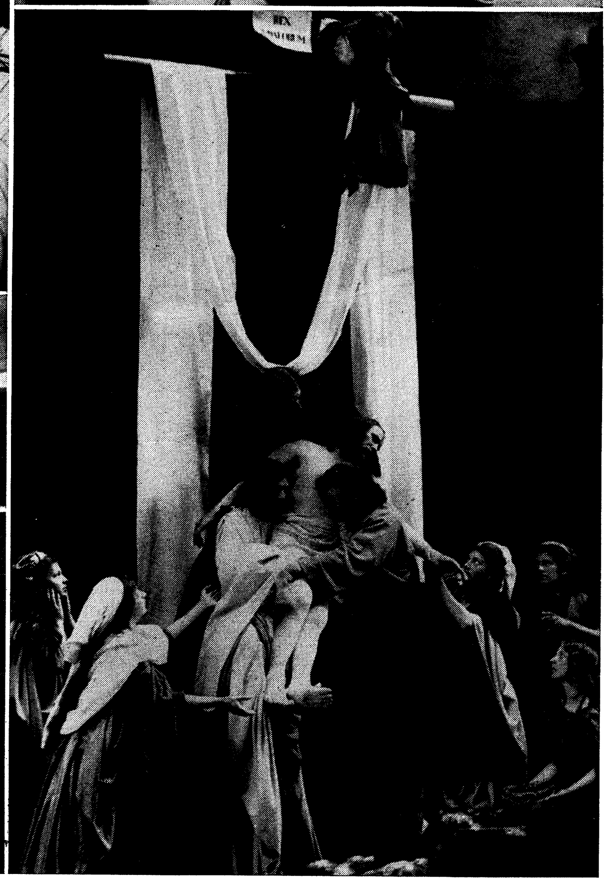
Centre left: The harbour at Hamburg

Bottom left: The motorcycle is popular among German families of moderate income, serving them in lieu of automobiles

Bottom right: One of the German autobahns built as military highways by the nazis and a boon to motorists after World War II

GERMANY





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SOME GERMAN ARTS AND HANDICRAFTS

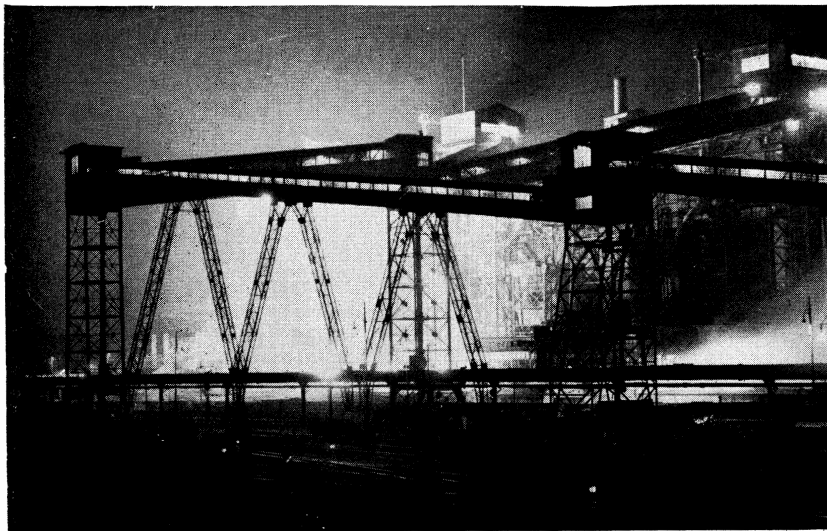
Top left: German farmer plowing with a team of oxen in the rich Saar district

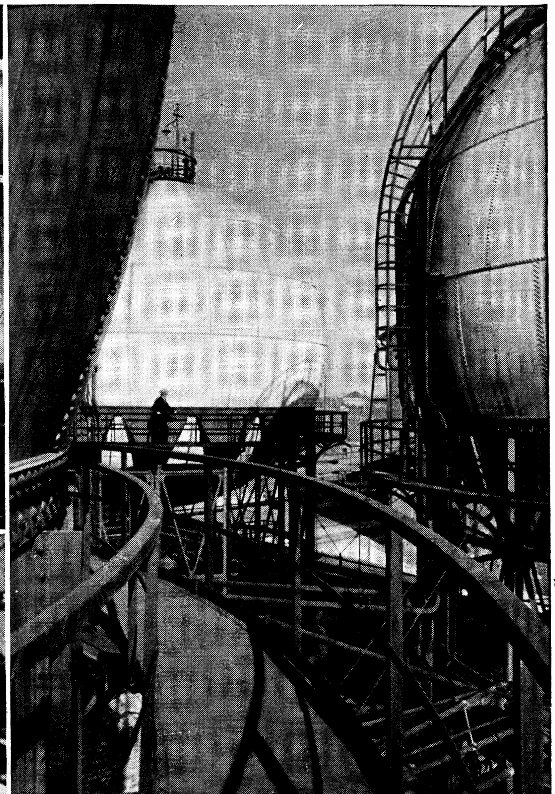
Top right: Violinmaker lacquering a finished violin In a shop in Mittenwald, southern Bavaria, where he acquired traditions of workmanship begun in the 17th century

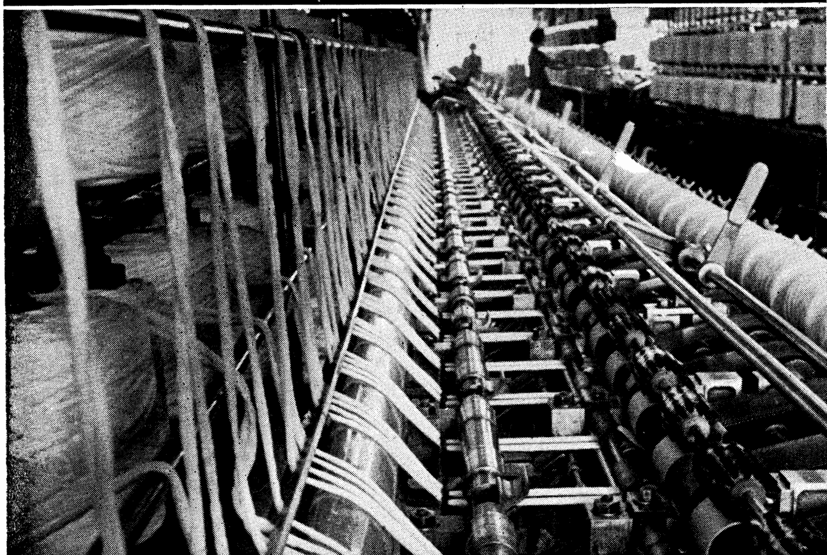
Centre left: Glass blower doing preliminary work on Christmas tree ornaments

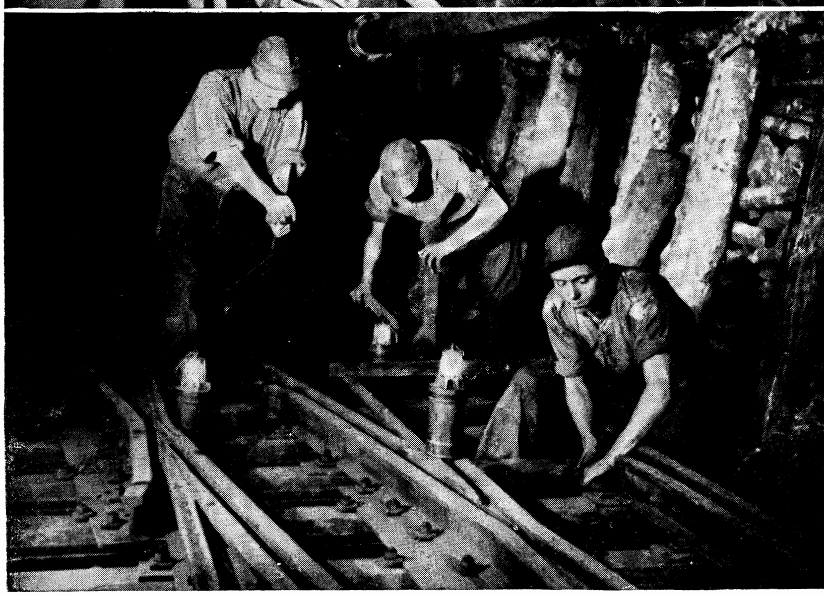
Bottom left: Examples of some of the beautiful wood-carving found in houses built by wealthy Hanseatic merchants of Bremen in the 14th century

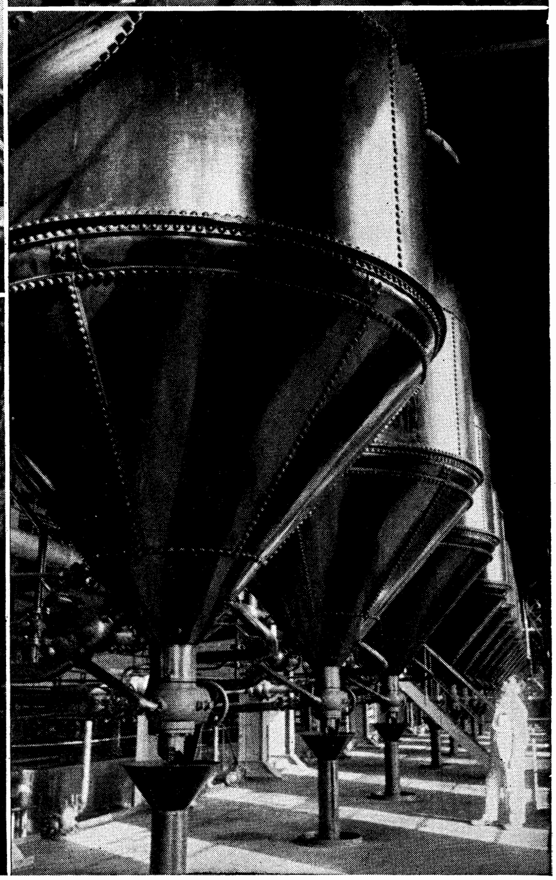
Bottom right: Scene from the Passion play at Oberammergau, a modern survival of the miracle plays of mediaeval times; only natives of the village may act in the play











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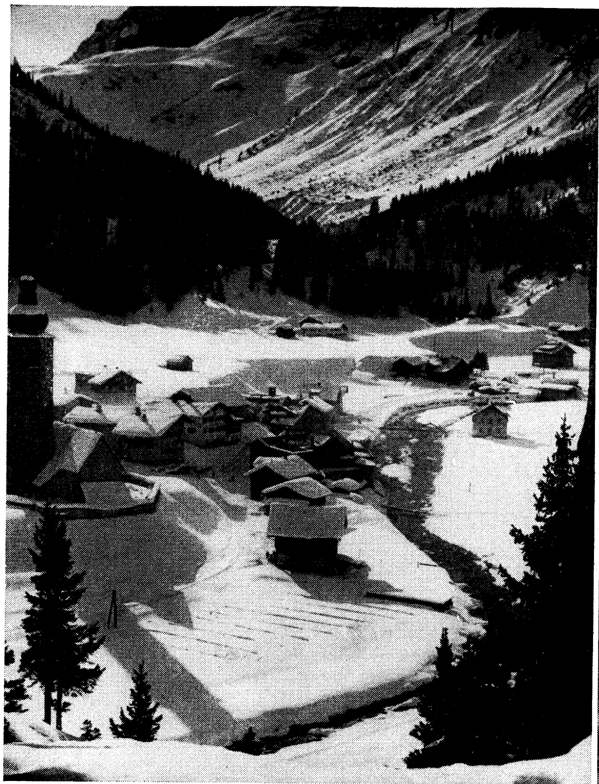
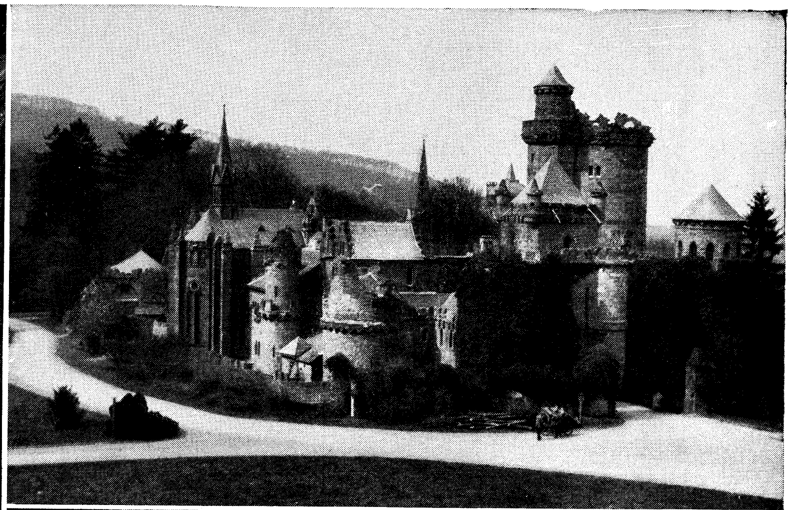
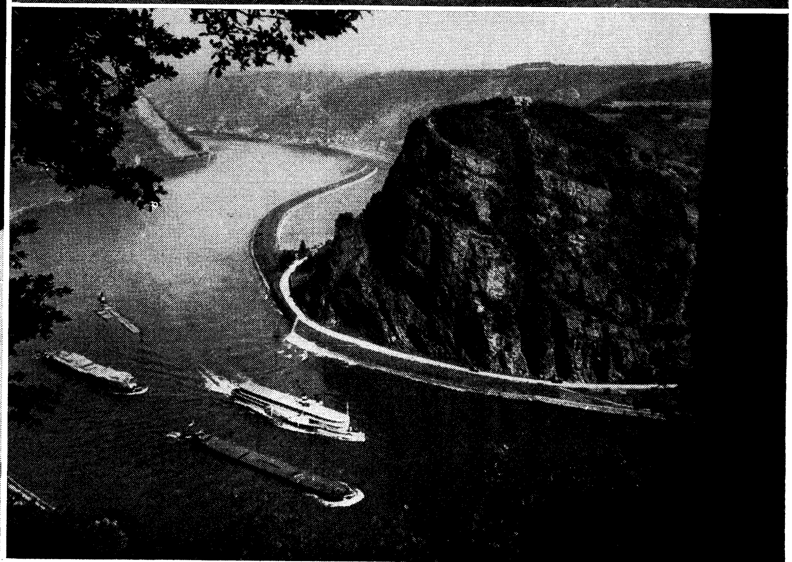
LARGE INDUSTRIAL PLANTS AND EQUIPMENT IN GERMANY

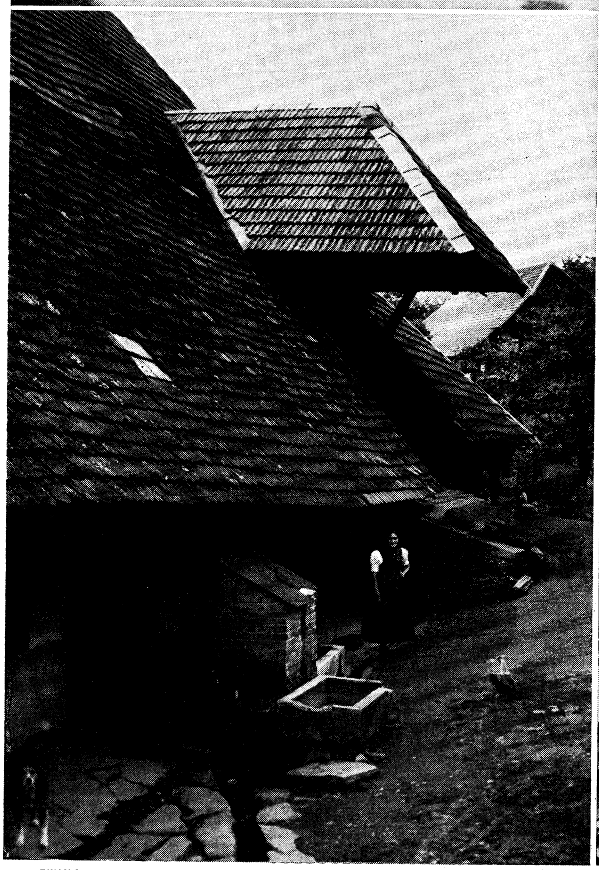
Top left: Night view of steel works in the Ruhr valley
Top right: Tanks of by-product ammonia water at a German plant manufacturing artificial fertilizer
Centre left: Interior of a large German textile mill
Bottom left: Apprentice miners laying tracks for mine lorries in a Ruhr coal mine
Bottom right: Petroleum refinery equipment in Hamburg

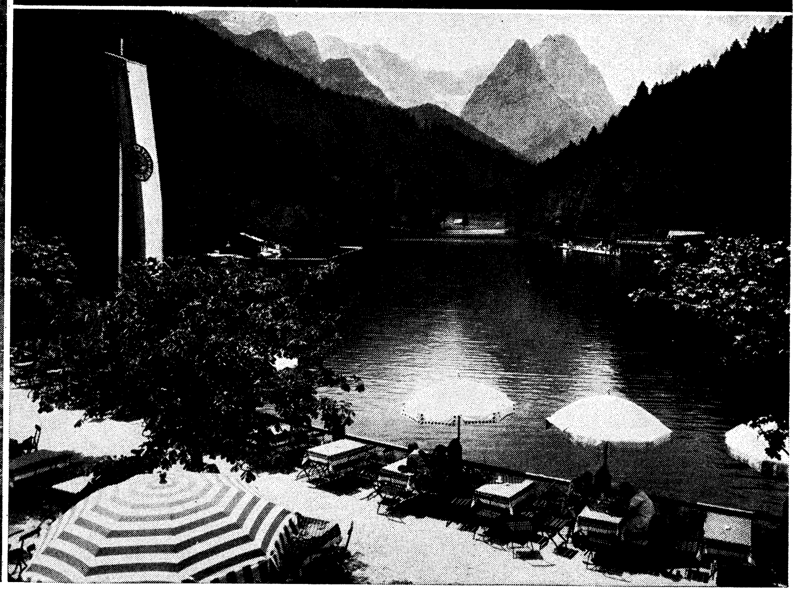
GERMANY











EWING GALLOWAY

THE GERMAN COUNTRYSIDE

Top left: A mountain village on the Lech river, southern Germany
Top right: Lion's castle near Cassel, Hesse-Nassau, built in the 15th century
Centre right: The Lorelei, a rock in the Rhine near St. Goar. Its hazardous position gave rise to the many legends concerning the Lorelei maiden who lived on the rock and lured navigators to destruction with her singing

Bottom left: Farmhouse in the Schwarzwald (Black Forest), one of the loveliest wooded areas in Germany. The wide, overhanging roof of shingles or thatch is common there as the winters are long and snowy
Bottom right: The Risser-See at Garmisch-Partenkirchen, a resort town in upper Bavaria noted for both summer and winter sports

revealed by the war of 1859 caused several plans of reform to be put forward. The minister president of Saxony, Friedrich Ferdinand, count von Beust, and the Bavarian minister, Ludwig von der Pfordten, tried to revive the idea of a triple division of power in Germany, in which the middle and small states would play a role equal to that of Austria and Prussia. The suspicions felt by the middle states for each other prevented these plans from coming to anything. At the same time the Austrian government was taking the initiative both in constitutional change inside the empire and by attempting to reform the German confederation. The failure of the war of 1859 had obliged Francis Joseph to reform his methods of government. The first attempt in the October diploma (Oct. 20, 1860) was an attempt to establish a quasi-federal system based on the conservative landlords in the historic provinces. It soon failed and the patent of Feb. 26, 1861, restored a centralized form of government with a central parliament whose members were elected indirectly by the provincial diets. (See AUSTRIA. EMPIRE OF.) To Germans; if not to the other peoples of the empire, the February patent could be represented as a step in a liberal direction. Many liberals in south Germany still had the hope that Germany might be united under Austrian leadership and be a greater Germany that included the Germans inside the Austrian empire. In Oct. 1862 the Reformverein was founded in Munich to promote these aims. Its most important member was Julius Fröbel, a former member of the left in the Frankfurt assembly, who had taken part in the rising in Vienna in Oct. 1848. Now, however, he was reconciled with the Austrian government and even exercised an influence on some members of it; for while Johann, Count Rechberg-Rothenloven, the foreign minister, was a disciple of Metternich and believed in a peaceful dual control of Germany by Prussia and Austria, Anton von Schmerling, the minister of the interior, believed in the formation of a greater Germany under Austrian leadership.

In the summer of 1863 the emperor Francis Joseph took the initiative and summoned a congress of the German princes to meet at Frankfurt-on-Main on Aug. 18. Early in August the emperor met the king of Prussia at Gastein and invited him to attend, but without success. When the princes met, amid considerable enthusiasm in south and west Germany. another attempt was made to persuade the king of Prussia to come and the king of Saxony was sent to make a personal appeal. However, Bismarck with some difficulty succeeded in persuading William to stay away. This absence prevented the congress of princes from having any serious significance and made its discussions on reform of the confederation purely academic. The Austrian plan, by which the confederation was to be headed by a directory of five advised by an assembly of delegates from the individual states, was only to come into effect if Prussia agreed. But Bismarck put forward, on Sept. 15, an alternative plan including the alternation of the presidency between Austria and Prussia, a Prussian right of veto against any declaration of mar if federal territory was not attacked (*i.e.,* Prussia would not defend Austria's Italian dominions) and the creation of "a true national representation based on the direct participation of the whole nation." Although the liberals were still too suspicious of Prussia's conservative internal policy to give Bismarck's proposals a warm welcome, the Austrians had lost their initiative and the next move lay with Prussia.

Schleswig-Holstein. — It was the revival of the Schleswig-Holstein question (*q.v.*) that presented the confederation with its next crisis. After the Prusso-Danish war of 1848 the constitutional position of those two duchies had become a matter of international concern. The London protocol of May 8, 1852, had ruled that if Frederick VII of Denmark died without male heirs and the throne of Denmark passed to the line of Holstein-Glucksburg, the new king should also inherit the duchies of Schleswig, Holstein and Lauenburg. It was provided, however, that the duchies should be governed autonomously and not fully incorporated in Denmark. Holstein remained as before within the German confederation. At the same time Christian, duke of Augustenburg, the other claimant for the succession in the duchies, renounced his claims. The federal diet had, however, become increasingly anxious because the king of Denmark was not fulfilling his obligations and was asserting that the Danish constitution was valid in Holstein. In March 1863 the king of Denmark had issued a royal patent that applied the Danish constitution to Schleswig and left the position of Holstein unsettled. This move aroused great popular disapproval in Germany because it appeared to separate Schleswig from Holstein definitively, dividing territory that all German liberals regarded as German. On Oct. 1, 1863, the federal diet decided on action against Denmark.

The situation was complicated still further on Nov. 15 by the death of King Frederick VII, so that the question of succession to the duchies was added to that of their constitutional position. Christian of Glücksburg ascended the throne of Denmark as Christian IX and at once declared himself duke of Schleswig, Holstein and Lauenburg. At the same time Frederick of Augustenburg announced that he did not recognize his father's renunciation of his claims to the duchies and declared himself duke. His claim was widely supported inside Germany, for he was believed to have liberal leanings, and it was hoped that he would enable the duchies to be incorporated in the confederation. While the federal diet was supporting Frederick of Augustenburg's claims and sending federal troops into Holstein (Dec. 1863), Bismarck was acting with Austria independently of the confederation. He was anxious about international complications, and he was still in conflict with the Prussian diet; he was therefore careful to associate Austria with every step he took, a course which Rechberg, the Austrian foreign minister, was very ready to support. An Austro-Prussian alliance was signed on Jan. 16, 1864. An ultimatum presented to the Danes on Jan. 16 was rejected, and on Feb. 1 Austrian and Prussian troops invaded Schleswig under the command of Friedrich von Wrangel.

The German forces stormed the fortifications of Dueppel on April 18 as a preparation for crossing to the islands of Als and Fyn. Meanwhile the great powers were asked by the Danish government to mediate, and a conference was held in London from April 25 to June 25, accompanied by an armistice. The conference failed to reach an agreed solution since the Danes refused to accept either the Austrian suggestion that the. duchies should be linked to the Danish crown purely by a personal union or the suggestion that they should form a separate state under Frederick of Augustenburg. Hostilities were resumed and the Prussians were successful in landing on Als on June 29. The Danes, all hopes of British assistance having vanished, sued for peace, and an armistice was signed, which took effect on July 20. Preliminaries of peace were signed in August and the peace treaty was formally signed in Vienna on Oct. 30, 1864. Denmark gave up all rights to the duchies and they were handed over to Austrian and Prussian occupation.

The question at once arose of how the duchies should now be administered. The bulk of German opinion still supported the claims of Frederick of Augustenburg. Austria had little direct interest in the territories but hoped to be able to use them as a bargaining point that would make Prussia agree to support Austria if its Italian possessions were again threatened and might possibly even make Prussia cede some territory in Silesia. Bismarck, on the other hand, had already determined that the duchies should come under Prussian control. His position in Prussia had been strengthened by the successful war. The conservatives were given fresh confidence in him by the triumphs of the Prussian army and he had demonstrated his independence of the diet by fighting a war for which it had not voted any credits. King William and the emperor Francis Joseph met at Schonbrunn in Aug. 1864, and their ministers worked out a scheme for a joint occupation and administration of the duchies. The other members of the German confederation were still hoping for the establishment of Frederick of Augustenburg, but these hopes were rendered vain by Bismarck's hostility to him and the refusal of Prussia to allow the other states to participate in the occupation of the duchies. (The Saxon troops, the last to leave, departed from Holstein in Dec. 1864.) At the same time the Prussians were beginning to make use of their position in the duchies, and in March 1865 the Prussian naval base was moved from Danzig to Kiel.

The Convention of **Gastein.**—By May 1865, differences of policy between Austria and Prussia were becoming acute. Bismarck had stated in Feb. 1865 that he was only prepared to recognize Frederick of Augustenburg as duke if Frederick mere prepared to give Prussia control of the economic and military life of the duchies. These conditions were unacceptable both to Austria and to the federal diet, which continued to recognize Frederick's claims. On May 29, 1865, a Prussian crown council discussed the means by which the duchies might be annexed, but no firm decision was taken. Bismarck does not seem to have been ready for war, and in Aug. 1865 the king of Prussia and the emperor of Austria met at Gastein where a convention about the duchies was signed on Aug. 14. The Convention of Gastein laid down that Austria should administer Holstein and Prussia Schleswig. The port of Kiel and the fortress of Rendsburg came under Prussian control, nominally in the name of the confederation. In fact the other members of the confederation were not consulted, and the convention not only put an end to Frederick of Augustenburg's chances, but also made it harder afterward for Austria to claim to be the champion of the federal constitution against Prussia, Bisma ck himself regarded the convention as a "papering over of the cracks" and not as a lasting settlement. However, before a final breach with Austria he needed to ensure that Prussia would not be faced with a hostile coalition of foreign powers; he also needed a measure of popular support both in Prussia and in the other states of the confederation. A conversation with Napoleon III at Biarritz on Oct. 11, 1865, did not make France's intentions any clearer. Then, on Feb. 28, 1866, a Prussian crown council decided to strengthen Prussia's position decisively by offering an alliance to Italy, which was signed on April 8. Italy undertook to support Prussia against Austria on the understanding that the treaty would lapse if there were no war within three months.

Austro-Prussian Diplomatic Struggle.— Bismarck also surprised everyone on April 9, 1866, by proposing at a special meeting of the federal diet that a German parliament should be elected by universal suffrage and should meet to discuss constitutional reform of the confederation. This offer of universal suffrage, which was an attempt to gain popular support, was only partly successful in winning the liberals, but it showed that reform of the federal constitution was Prussia's aim and not just the annexation of Schleswig and Holstein. During the next two months, too, Bismarck was in touch with the leaders of the Nationalverein in the other states of north Germany, among them Bennigsen and Miquel in Hanover, in the hope of winning their support. They at least were prepared to support a policy of neutrality in an Austro-Prussian war and declared their belief in this policy at a liberal meeting at Frankfurt on May 20. Bismarck was not successful in eliminating the constitutional crisis in Prussia at this stage. Although after the success of the war with Denmark some of the Prussian liberals were prepared to vote Bismarck an indemnity for the period during which he had governed without a budget, the king was opposed to any such compromise and a suggestion made by Karl Twesten at the end of May 1866 for a solution of the conflict had to be refused.

The Austrians saw the Prussian preparations with alarm and began to strengthen their military forces in Bohemia. Alexander, Count Mensdorff-Pouilly, Rechberg's successor as foreign minister, was anxious for a peaceful solution, but other members of the Austrian administration were anxious to assert Austria's rights against Prussia by war if necessary, notably Ludwig, Freiherr von Biegeleben, the head of the German department in the Austrian foreign office. Austria's finances were in a bad state. The cost of the mobilization during the Crimean War in 1854–55 and of the war with Italy in 1859 had left its credit weak and it had been persistently excluded from the *Zollverein.* In 1862 a commercial treaty between Prussia and France gave France the most-favoured-nation treatment hitherto accorded to Austria under the treaty of 1853, and the *Zollverein* had been renewed in 1863 without Austria on the basis of the acceptance of the French treaty by the other members.

Nor did Austria succeed in welding the middle and small states of Germany into a solid anti-Prussian bloc. The two most important, Bavaria and Saxony, had ministers who still believed that the middle states could play a role of their own independently of Prussia and Austria. Moreover, Louis II of Bavaria was a neurotic young man who gave little of his time to the affairs of state. Many of the small states of central and north Germany had been forced by their geographical position to sign military agreements with Prussia and the most that they could hope for in an Austro-Prussian struggle was neutrality. Hanover and Hesse-Cassel had rulers ready to support Austria but the liberals in both states wanted at least neutrality even when they did not actively desire a Prussian victory.

On April 21, 1866, the emperor Francis Joseph ordered the mobilization of Austria's southern army under the archduke Albert, and the army of the north under Ludwig von Benedek was mobilized between April 27 and May 5. Prussian mobilization was complete by May 8. Last minute attempts at mediation mere unsuccessful. Napoleon III proposed a European congress (May 24) but, although Bismarck was ready to accept, the Austrians were prepared to do so only if the congress did not discuss any territorial increases for any of the participating states, and the proposal was dropped. Inside Germany an attempt was made by Anton von Gablenz, brother of the Austrian governor of Holstein, to mediate, but equally without success. By May 28 his proposals had been put aside. At the last minute Napoleon concluded a secret treaty with Austria by which in return for French neutrality Napoleon was, if Austria won, to receive Venetia, which was then to be handed over to Italy, while Austria was to receive compensation in Germany.

Austro-Prussian War.—Early in June Austria summoned the diet of Holstein to meet on the eleventh of the month and this step was immediately denounced by Prussia as a breach of the Gastein and other earlier agreements. Prussian troops entered Holstein on June 7. The last meeting of the federal diet took place on June 14, and at it Austria moved that troops of the confederation should be mobilized against Prussia. Bismarck denounced this step as unconstitutional and said that he would regard any states that voted for the Austrian proposal as being in a state of war with Prussia. Bavaria introduced a motion calling for the mobilization of contingents other than those of Austria and Prussia. This was carried by nine votes to six, Luxembourg, the Mecklenburg duchies and three groups of the smallest states of the north and centre voting against. The Prussian representative then left.

Prussian troops crossed the frontiers of Hanover, Saxony and Hesse-Cassel on the night of June 1j–16. One army marched through Hanover toward the Main river; on June 29 the Hanoverian army was forced to capitulate after the battle of Langensalza. The Prussian army captured the king of Hanover and the elector of Hesse, crossed the Main and entered Bavaria.

In the south the Italians had engaged the Austrians but were defeated on land at Custozza (June 24) and at sea in a battle off Lissa (July 25). The main theatre of war, however, was Bohemia, where a Prussian force advanced from Saxony and Silesia in accordance with the plan of Helmuth von Moltke. On July 3 Benedek's position at Sadowa (Koniggratz) was attacked by two Prussian armies, and they were joined by the third under the crown prince of Prussia at a critical moment. The Austrian army was utterly defeated.

King William and the generals would have liked to march on Vienna, but they were restrained by Bismarck supported by the crown prince. Rejecting an offer of mediation by Napoleon III, Bismarck began negotiations with the Austrians, and a preliminary peace was signed at Nikolsburg (Mikulov) on July 26 and embodied in the final peace of Prague on Aug. 23. The Austro-Italian peace treaty was signed on Oct. 3. Treaties with the southern states were negotiated during the same period. The terms were extremely mild. Austria paid an indemnity and surrendered Venetia to Italy but lost no other territory. Bavaria, Saxony, Wiirttemberg, Baden and Hesse-Darmstadt paid indemnities but remained intact. Prussia annexed Schleswig-Holstein, Hanover, Hesse-Cassel and Frankfurt-on-Main. The southern states agreed that their armies should come under Prussian command in the event of war. The states north of the Main, together with the kingdom of Saxony, joined a new North German confederation under Prussian leadership. The old confederation was at an end; Austria had been finally excluded from Germany.

(J. B. Jl.)

THE GERMAN EMPIRE

The Compromise of the Prussian Liberals.—The peace of Prague cleared the way for a settlement both in Prussia and in the wider affairs of Germany. The Prussian parliament had been dissolved at the beginning of the war, and new elections were held on the day of the battle of Sadowa. The liberals had a reduced majority and they were now split in their attitude to Bismarck; his success had shaken their liberal principles. The moderates broke away from the Progressives to form the National Liberal party, a party in which liberalism was subordinated to nationalism. Bismarck. on his side, made a conciliatory gesture by asking for an act of indemnity for the unconstitutional collection of taxes since the beginning of the parliamentary struggle in 1862. This act mas passed on Sept. 3, 1866, by 230 votes to 75. It was a decisive step in German history. The Prussian liberals, hitherto genuine opponents of Bismarck, dropped their insistence on parliamentary so ereignty in exchange for the prospect of German unity and for an assurance that united Germany would be administered in a "liberal" spirit. Instead of a struggle for power there was henceforth compromise. The capitalist middle classes ceased to demand control of the state; the crown and the Junker governing class conducted the state in a way which suited middle-class needs and outlook. Since the middle classes ceased to be liberals. the Prussian Junkers had to become "Germans." Neither side kept its bargain fully, and there were renewed alarms of cqnstitutional struggle throughout the period of the empire. But the decision of Sept. 3, 1866, was not undone; Germany did not become a constitutional monarchy of the western type.

The North German Confederation.—With the defeat of Austria Prussia was now the sole power in Germany. Bismarck was limited only by the promise given to Napoleon III that the states south of the Main should have "an internationally independent existence." All Germany north of the Main had been virtually conquered by Prussia, but Bismarck was anxious to conciliate south German opinion. Besides he dreaded the radical nature of a unitary German state. Therefore he tried to change as little as possible. and the North German federation which he created in 1867 had curious echoes of the despised German confederation which had vanished in 1866. Indeed Bismarck still thought of German unification as primarily an affair of foreign policy, *i.e.,* to represent a united power abroad. For him the only difference with 'the period before the war of 1866 was that, instead of being balanced by Austria, Prussia now dominated, hut since this domination was exercised in the interests of conservatism he expected little change. The federal constitution which he hastily drafted early in 1867 was not a sham. It contained genuine federal guarantees for the individual states. Nevertheless it was a pretense in that the reality on which it rested was not federal. A federation must be an association of states more or less equal in power; in the North German federation Prussia eclipsed the others so decisively that Prussian will was always sure to prevail.

The federal constitution was adopted by the North German *Reichstag* on April 17, 1867. Four years later it became almost mithout change the constitution of the German empire. Two principles were balanced against each other—the sovereignty of the German states and the national unity of the German people. In constitutional theory the first carried the day. The *Bundesrat* (federal council), its members nominated by the state governments, initiated laws. conducted the federal government and could alter the constitution by a two-thirds majority. (Prussia, which had 17 members out of 43, could thus veto any constitutional change.) The king of Prussia, as president of the confederation, nominated the chancellor who was to carry out federal affairs under the direction of the *Bundesvat.* The *Reichstag,* on the other hand, elected by direct universal suffrage, was strictly limited to legislative activities; there was no provision by which it could interfere with the activities of the federal government. Even its control of finance was limited to an approval of expenditure, other than that permanently authorized by the constitution (court expenses, chancellor's salary, etc.); and since the member states were to supplement the regular federal revenue by "matricular" contributions, the *Reichstag* did not possess the usual parliamentary sanction of being able to cut off the government's income. Yet despite these provisions the *Bundesrat* soon lost all importance and the German government became in as much need of a parliamentary majority as though Germany were a thoroughly liberal state. For, despite Bismarck's efforts to conceal the reality, the German states were without significance and the German people were conscious of their national unity. The federal element counted for more in the sphere of administration where there was a real division of duties. The federal authority controlled foreign affairs, the army and economic affairs, and there was to be a single judicial system and a single legal code. The states conducted ordinary administration and remained in control of educational and religious matters.

The war of 1866 had destroyed the *Zollverein.* In July 1867 Bismarck offered to all German states a new customs union on condition that they accepted a customs parliament. As this parliament was to consist of the members of the North German *Reichstag* with members from southern Germany added, this was a way of smuggling in German unity by a side door. Thus the line of the Main was weakened, though not removed, within a year of its establishment as an international boundary. The North German federation was regarded by many, including Bismarck, as a halfway house to German unification which would stand for a long time; Bismarck even thought that his life's work was accomplished. Indeed between 1867 and 1870 the movement for German unity lost ground in southern Germany. Early in 1870 the pro-Prussian government of Chlodwig, prince of Hohenlohe-Schillingsfürst in Bavaria was replaced by a clericalist government under Otto Camillus Hugo, count von Bray-Steinburg, and this government pushed ahead with plans for a separate South German confederation, predominantly Roman Catholic and under the protection of France and Austria. This underlined the precariousness of the existing situation, and the deciding question between 1867 and 1870 was not German opinion, but whether France and Austria would come together in order to oppose Bismarck's policy or even to undo his mork.

Tension with France.—The first alarm came in 1867 when Napoleon III raised the question of Luxembourg. This had been a member of the old confederation and a Prussian garrison still remained there. Napoleon III proposed to buy the grand duchy from its ruler, the king of Holland. There was an outcry in Germany and questions in the *Reichstag.* Bismarck held that no essentially German issue was at stake and probably held too that Prussia was not ready for a new war. But Napoleon had bungled the affair; other European powers protested. After a conference in London, Luxembourg became an independent neutral state with its fortifications dismantled. Thereafter Napoleon sought more actively for an alliance with Austria but without effect. The Austrian government would not risk a new defeat and its real interest in the French alliance was to resist Russia in the near east —a concern far removed from Napoleon's preoccupation with Germany and the Rhine.

Early in 1870 Bismarck made a move against France which has been variously interpreted; he hinted unofficially to the provisional rulers of Spain that they should offer the throne to Leopold, prince von Hohenzollern-Sigmaringen, a member of the Roman Catholic branch of the Hohenzollern family. It has often been argued that Bismarck gave this advice in order to provoke France into war, and that he was driven to provoke war by the trend of opinion hostile to Prussia in southern Germany. It seems more likely that he was concerned with establishing a friendly ruler in Spain and thus weakening still further Napoleon's project of an anti-Prussian coalition. At all events he could never have foreseen the folly of the French government which deliberately forced a crisis when it had already received satisfaction. Bismarck's intention had been to present the French with a *fait accompli.* They were to know nothing until Prince Leopold was actually elected. But by a confusion typically Spanish the *Cortes* had adjourned before Leopold s answer of acceptance arrived and the French government had to be told on July 3 why the *Cortes* was being recalled. There were wild protests in Paris and an immediate demand that Leopold be ordered to withdraw. On July 12 Prince Karl Anton renounced the Spanish candidature on behalf of his son. This was not enough for the French government; it insisted that King William. as head of the Hohenzollern family, should promise that the candidature be never renewed. This demand was presented to the king at Ems by Vincent Benedetti, the French ambassador, on July 13. Though the king refused to give a promise, he dismissed Benedetti in a friendly enough way. But when the account, given in the "Ems telegram" reached Bismarck, he shortened it in such a way as to imply that the French ambassador had been insulted. This version provoked a French declaration of war on July 1;. But though the Ems telegram gave the occasion for war, the cause of it was to be found in the French determination to check Prussia's greatness and to restore the fading glory of the empire by a renewal of prestige in foreign policy.

The **Franco-German** War. — Though the war was perhaps not planned by Bismarck, it was certainly not unwelcome to him. It solved at a stroke the problem of south Germany, since all the south German states at once acknowledged their treaty of alliance with Prussia and placed their troops under William's command. Austria dared not join France, Russia was won to benevolent neutrality by Bismarck's support of Russian designs in the Black sea, and Great Britain cared only for the neutrality of Belgium. The French had supposed that they would take the offensive. Instead, after a trivial victory at Saarbriicken, the French armies under Patrice de MacMahon were defeated on the frontiers at Wörth and Wissembourg (Aug. 4 and 6). One French army under Achille François Bazaine was driven into Metz and failed to break out in the two fierce battles of Mars-la-Tour and Gravelotte (Aug. 16 and 18). The main French army under MacMahon at first retreated and then attempted to pass the flank of the German forces in order to relieve Metz. This army was surrounded at Sedan and on Sept. 2 forced to surrender. That brought the overthrow of Napoleon and the establishment of a provisional government in Paris. The new government was resolved not to surrender any French territory, and the war was therefore continued. Metz surrendered in September. Strasbourg in October. The German armies were then free to press the siege of Paris throughout the winter. Though the French, under the inspiration of Léon Gambetta, made an amazing recovery, they were unable to relieve Paris which was compelled to capitulate on Jan. 28, 1871. An armistice was then concluded and a French national assembly elected which had to authorize the conclusion of peace. Preliminary terms were agreed to by Jules Favre on Feb. 26, and the final peace treaty was signed at Frankfurt-on-Main on May 10. France had to cede Alsace and most of Lorraine including Metz, its capital. Bismarck had not intended to make such extensive demands and was overborne by the German generals. On their prompting he also demanded Belfort, but abandoned this demand in exchange for a victory march by the German army through the streets of Paris. France had also to pay an indemnity of 5,000,000,000 fr., and the Germans remained in occupation of part of France until the indemnity was paid. *(See* also FRANCO-GERMAN WAR.)

The Making of **the** Empire. — During the war, negotiations were pushed on for the uniting of all Germany outside Austria. In September a conference of Prussia, Bavaria and Wurttemberg met at hfunich to discuss the terms of unification. Bray, the Bavarian prime minister, held out against any real union and demanded special treatment for Bavaria. Bismarck turned his flank by securing the incorporation of Baden in the North German confederation. Bavaria and Württemberg then negotiated separate treaties of union, which were concluded at the end of November. Some Bavarian wishes were fulfilled. Bavaria and Württemberg kept their own postal and telegraph services and were able to levy taxes on beer and brandy; Bavaria further kept its own army in peacetime. As a particularly meaningless concession, a committee of the ***Bundesrat*** under Bavarian chairmanship was to advise the chancellor on questions of foreign policy; the advice was seldom sought and never taken.

There remained the question of a name for the new state. Bismarck wished to revive the title of German emperor, a proposal most unwelcome to William. It was equally unwelcome to Louis II of Bavaria, the one important German sovereign. With great adroitness Bismarck manoeuvred one against the other and actually induced Louis to press the imperial title on William. The proposal mas seconded by the other German princes and supported by the North German *Reichstag;* the leader of the *Reichstag* deputation was Eduard Simson, who had offered the imperial throne to Frederick William IV in 1849 on behalf of the Frankfurt assembly. William could hold out no longer; he was proclaimed German emperor at Versailles on Jan. 18, 1871.

The remaining formalities were few. A *Reiclzstag* was elected from all Germany, and this *Reichstag* accepted the constitution of 1867, with the concessions to Bavaria, as the imperial constitution on April 14, 1871. The new Reich consisted of 4 kingdoms, 5 grand duchies, 13 duchies and principalities and 3 free cities (Hamburg, Lubeck and Bremen). Alsace-Lorraine was treated as a conquered province. It was made a *Reichsland* and ruled by an imperial governor or *Statthalter*. In theory this was a temporary settlement, but Alsace-Lorraine never developed the German loyalty which would have qualified it for autonomy. The constitution left open the great question of the powers of the *Reiclzstag* over the executive, a question never settled in the 40 years of the empire. The question was symbolized in two forms: the position of the imperial chancellor and the method of authorizing expenditure on the army. The chancellor was defined as "responsible" but it was not stated to whom; Bismarck contended that he was responsible to the emperor, while the politicians tried to insist that he was responsible to the *Reiclzstag.* As to military credits, Bismarck tried to include the sums necessary for an army of 400,000 men as a permanent grant in the constitution, and thus exempt from parliamentary criticism or control. He failed to carry this and had to agree to a compromise, the *Septennat,* by which military credits mere voted for seven years — hence the political crises which occurred every seven years (1879, 1886, 1893) when artificial alarm had to be created in order to renew the army grant.

Bismarck's Liberal Period and the **Kulturkampf.**—Bismarck had been on bad terms with the Prussian Junkers or conservatives ever since 1866, and the estrangement was completed by the creation of the empire. Only a small group, the Reichspartei, composed mainly of officials, remained loyal to him. On the other hand, the National Liberals were more enthusiastic for Bismarck than ever before, and from 1871 to 1879 they formed almost a government party. Bismarck discussed proposals for legislation with their leader, Rudolph von Bennigsen, and the National Liberals supported his general conduct of policy. Moreover, in the first years, the National Liberals managed to win more votes than any other single party despite universal suffrage; only in 1879 did it become clear that a purely middle-class party could not keep its hold on peasant and working-class voters. Thus the first period of the empire was the great age of liberal reform. Germany was given at a stroke uniform legal procedure, uniform coinage and uniform administration. An imperial bank was created, all restrictions on freedom of enterprise and freedom of movement were removed, and limited companies and trade combinations were allowed. Freedom of the press was secured in 1874. Work was begun on an imperial civil code, which finally extended to all Germany in 1900. Particularly important was the establishment of municipal autonomy in 1873; this freed the towns from the control of the *Landrat* (usually a large landowner) and thus cleared the way for the development. of local government in which Germany led the world.

Bismarck's alliance with the National Liberals naturally led him into conflict with the Roman Catholics, who made up more than a third of the population of the new empire. The conflict began after the Vatican council of 1870 had declared the infallibility of the pope. Some leading German Roman Catholics, known as Old Catholics, opposed these decrees; and the church demanded that the German states should dismiss all Old Catholic teachers. Thus a struggle began over the clerical control of education and soon turned into a general attack on the independence of the Roman Catholic Church. The conflict was also political. The German Roman Catholics were anti-Prussian both by tradition and by geography; they were at once particularist and greater German, in that they favoured both the small states and the German Austrians. As the struggle developed, the Roman Catholics organized their own political party, the Centre, and this party cut across class and state lines. The Centre was, in fact, the first mass party of imperial Germany, though, because of its confessional nature, it could never win a majority. But it was strong enough to menace the stability of Bismarck's political system.

The conflict with the Roman Church, the so-called *Kulturkampf,* was fought by Bismarck with all his usual exaggeration and violence. He abolished the special section in the Prussian ministry which dealt with Roman Catholic affairs, made marriage an exclusively civil proceeding and insisted on a state degree before a priest was appointed to a benefice. When the church excommunicated all Old Catholic teachers, Bismarck answered by expelling the Jesuits from Germany. The church only increased its resistance. The clergy refused to appear before the state courts or to pay the fines which were imposed. The archbishops of Posen and Cologne were imprisoned and the former deposed. These penal measures were expressed in the "May laws" which the Prussian *Landtag* passed in 1873, and were by further measures promoted by Adalbert Falk, the Prussian minister of cults, in 1874 and 1875. By then it was clear that Bismarck would not achieve victory. The Old Catholics carried no weight and even many Protestants, particularly among the Junkers, disliked this attack on religious teaching. Though Bismarck still allowed the struggle to continue, he put increasing responsibility on Falk and thus made it easy for himself to repudiate responsibility when the time came for a change of course. The conflict also served a purpose in foreign policy. It was a move against the Roman Catholic powers, France and Austria-Hungary, and a gesture in favour of Protestant England and Orthodox Russia. By 1877 the needs of Bismarck's foreign policy were changing. The danger of an ultramontane bloc had disappeared, if it had ever existed; and here too the way was open for a change of course.

The Breach with the National Liberals.—The first Bismarckian system broke down between 1877 and 1879. In 1877 Bismarck, still at odds with the Centre, offered to make Bennigsen, the leader of the National Liberals in the *Reichstag*, a Prussian minister. Bennigsen thought that this was the preliminary to a fully parliamentary ministry and insisted on bringing in two Liberal colleagues with him. Bismarck refused, and from that moment was determined on a reconciliation with the Conservatives and the Centre in order to escape from National Liberal control. He had also pressing financial motives for this breach. The revenues allotted to the empire by the constitution were from the first inadequate, and Bismarck disliked the dependence on contributions from the separate states which this involved. The National Liberals wished to create direct imperial taxation, in order to increase the power of the *Reichstag;* for the opposite reason Bismarck was set on indirect taxes. In 1873 he attempted to introduce a tobacco monopoly and was defeated by National Liberal opposition. A year or two later he had still more urgent reasons for action. Toward the end of the decade German agriculture faced the challenge of American wheat for the first time, and Bismarck was determined to protect German agriculture for reasons of social conservatism and also because he regarded the agricultural workers as the best element for the army in time of war. But it was not only agriculture that needed protection. German industry, too, was hard hit by the great economic crisis of 1873 and here, also, Bismarck was determined to protect a great iron and steel industry so as to ensure German strength in wartime. Thus every motive combined to thrust him over into a policy of protection—agricultural protection to satisfy the Junkers; industrial protection to satisfy the capitalists; and an escape from the interference of the *Reichstag* by the increase in customs dues.

The last of the old duties, inherited from the *Zollverein*, were repealed in 1877 and a new protective tariff was introduced in 1879. This tariff was opposed by the National Liberal party, which broke into two. One group, which retained the party name, hoped to renew the alliance with Bismarck; the other united with the Progressives or Radicals under Eugen Richter to form the German Independent party. In return Bismarck struck a bargain with the Centre. He agreed that the conflict with the Roman Church should be called off and that any increase in the customs yield beyond 130,000,000 Marks a year should be divided among the individual states—a striking illustration of the Centre's particularism. The new tariff was then passed on June 12, 1879, and Germany became a protectionist country.

Bismarck kept his bargain with the Centre. Falk resigned after being repudiated by Bismarck in the *Reichstag*. In 1880 Bismarck got power to suspend the May laws in individual cases and the secular examination for candidates to the priesthood was abolished. Pope Leo XIII, more conciliatory than his predecessor Pius IX, made Bismarck's task easy; he induced the two recalcitrant archbishops to resign. Peace was finally concluded in 1887. The peace was a compromise, not a defeat for Bismarck as sometimes suggested. The Roman Church preserved intact the education of priests for which it had been contending. In exchange the Roman Catholic party of the Centre accepted Bismarck's Reich and tacitly agreed to support his policy when confessional issues were not at stake. In fact the Centre became purely a party of tactics, once its religious concerns were secured.

The Social Democrats.—Bismarck always believed that every political system needed an enemy or whipping boy. The Centre had been the whipping boy of the liberal era; the Socialists were now chosen to take their place. Bismarck genuinely believed that the Social Democrats, as the followers of Karl Marx called themselves, represented a grave social peril; he took them as seriously as Metternich had taken the threat from "the revolution." In 1877 the Social Democrats won 12 seats at the general election. Bismarck then introduced exceptional legislation against them, but was thwarted by the National Liberal majority. An attempted assassination of the emperor on June 2, 1878, gave Bismarck the opportunity to dissolve the *Reichstag* and to win the election on the cry of "the social peril." The Liberals lost 42 seats, the Conservatives gained 37. The exceptional laws were then carried, on Oct. 19, 1878. The Social Democratic party was declared illegal and its press and its meetings were forbidden. In practice these laws amounted to little. Social Democrats were still candidates at elections and still sat in the *Reichstag;* their journals were easily smuggled in from Switzerland; and in all, between 1878 and 1890, only 1,500 persons were imprisoned. But as a political manoeuvre the attack on the Socialists served its turn. Bismarck secured a sound Conservative majority and in the anti-Socialist uproar no one noticed that the *Septennat* had slipped through almost without opposition early in 1879.

Bismarck's other weapon against the Social Democrats was his social policy. Bismarck had never shared the laissez-faire views of the Liberals and his breach with them freed his hands for measures of social security. The workers, too, were to be made to feel that they had a stake in the greatness of the German Reich. In 1881 he proposed a system of compulsory accident insurance, to be supported in part by subsidies from the Reich. This met with strong opposition from the Liberals, who in 1881 recovered in part from their defeat of 1878. It was not until March 1884 that Bismarck got his way. Later he instituted sickness insurance and a system of old age pensions, also subsidized by the Reich. Though the Social Democrats remained theoretically revolutionary, Bismarck's aim was, in the long run, achieved; the workers came to believe that they were benefiting, not from their own efforts, but from the paternal state.

Foreign and Colonial Policy.—The year 1879 also marked an epoch in Bismarck's foreign policy. Once the empire was founded, Bismarck's sole aim was peace and security. This aim never varied, though methods changed. In the first years of the Reich Bismarck had aimed at peace by avoiding foreign commitments and he stood resolutely aside during the great eastern crisis of 1875–78. Thereafter Bismarck came to see that he must take a more active line if Europe was to be kept at peace. On Oct. 7, 1879, he concluded a defensive alliance with Austria-Hungary against Russia; though this guaranteed Austria-Hungary's survival as a great power, it did not provide German support for its Balkan ambitions. Indeed Bismarck always advocated a partition of the Balkans between Austria-Hungary and Russia. The Austro-German alliance, far from estranging Russia, won it back to the side of peace and conservatism and the League of the Three Emperors (June 1881) was a revival, in more modern terms, of Metternich's Holy Alliance. But its precondition was that neither Russia nor Austria-Hungary should have Balkan ambitions, a condition almost impossible of fulfilment. To give Austria-Hungary greater security, Bismarck also concluded the triple alliance between Germany, Austria and Italy (May 20, 1882), by which Germany guaranteed Italy against France in exchange for Italian neutrality in the event of a war between Austria-Hungary and Russia. The triple alliance was not a vital part of Bismarck's diplomatic system; it seemed to become essential to Germany only when his successors failed to keep on good terms with Russia.

Bismarck's diplomacy became increasingly elaborate in method when a new eastern crisis arose over Bulgaria in 1885. His aim remained the same—to avoid being drawn into a war between Russia and Austria-Hungary and if possible therefore to prevent such a war. Since Russia and Austria-Hungary would not agree, each side had to be strengthened so as to maintain the balance between them. On the Russian side Bismarck concluded the Reinsurance treaty (June 18, 1887), promising Russia diplomatic support in Bulgaria and at the Straits and agreeing to stay neutral unless Russia attacked Austria-Hungary. On the other side Bismarck promoted the two Mediterranean agreements between Austria-Hungary, Great Britain and Italy (Feb. and Dec. 1887), which virtually created a triple entente opposed to Russia in the near east. These complicated arrangements subsequently led men of lesser understanding to accuse Bismarck of duplicity, but they served their purpose of averting a new Balkan war. Since Germany occupied the centre of Europe, its policy was bound to be two-faced.

Bismarck was long sternly opposed to German expansion overseas; he believed that Germany ran enough risks in Europe without also challenging the imperial interests of Great Britain and France. But when he had to choose between satisfying German national feeling by supporting German expansion in southeastern Europe and thus identifying himself with Austro-Hungarian ambitions or by launching colonies overseas, he chose the less provocative course. He had also a subsidiary motive in considerations of foreign policy. Between 1883 and 1885 he strove actively for a reconciliation with France, and he believed that this reconciliation would be easier if Germany were in conflict with Great Britain, France's colonial rival. Bismarck deliberately chose areas which were on the fringe of British colonial interests in the hope of provoking a violent British reaction; thus South-West Africa trampled on the toes of Cape colony, and New Guinea on the toes of Australia. His two tropical colonies, the Cameroons and East Africa, cut across the British plans that were just developing for a new empire in central Africa. The French, however, remained suspicious, and the colonial conflict with Great Britain failed to mature, for the British were too conciliatory. In 1885 Bismarck called off the conflict, especially as he needed British support for Austria-Hungary, and he would have been glad to get rid of the German colonies except for the pressure of imperialist feeling inside Germany. The German colonial empire was never a serious factor in German economic life; the colonies were an embarrassment, not a source of strength, and important only as an emotional outlet for the growing sense of German power. Though Bismarck had made the German empire in 1871 by evoking national feeling, he was anxious thereafter to arrest German expansion. His social and political conservatism made him dread a Germany that would dominate all Europe. Hence he sought to divert German nationalism into harmless channels. With this purpose, he took up the struggle with the Poles in eastern Germany. This struggle began in the days of the conflict with the Roman Church and was continued in 1886 by an economic war which sought to eliminate Polish landowners and to establish German colonists in the eastern marches. The conflict had the great advantage of being directed against a Slav people and yet being welcomed by Russia, itself in conflict with the Poles. For similar reasons, Bismarck exacerbated the conflict in the Reichsland, Alsace-Lorraine. This estranged even German liberals from France and made them tolerate Bismarck's policy of friendship with tsarist Russia. In essence, Bismarck wished to keep up hostility with France as being less risky for conservative Germany than a struggle for existence in eastern Europe.

This was well shown in the so-called war crisis of 1887. Bismarck had tried to win the general election of 1884 solely on the issue of colonies, but this cry had strengthened the left-wing parties, instead of the conservatives, who were opposed to colonial expansion. By 1887 the time for a new army grant was approaching; and Bismarck knew that he could not carry it through the existing Reichstag. Bismarck therefore deliberately raised the alarm of a French "revanche," and his manoeuvre was successful. The Reichstag threw out the army bill and was dissolved in Jan. 1887. Bismarck fought the election on the cry, "the fatherland in danger," and won a majority for his coalition of agrarian and industrial supporters. The reconstituted National Liberals, the party of capitalist interest, became the largest single party in the Reichstag for the last time (122 members). The Bismarckian coalition carried the army bill on March 11, 1887. It was Bismarck's last triumph.

The Fall of Bismarck.—Bismarck's impregnable position had a weak spot; he must be regarded by the emperor as indispensable. The old emperor, William I, remained faithful until his death on March 9, 1888; he never forgot that Bismarck had saved him from "liberalism" in 1862. Frederick III, his son and successor, was bound to Bismarck by memory of the triumphs of 1870. Liberal in phrase, he was at best National Liberal and, like the other National Liberals, would have made his peace with Bismarck in exchange for a few concessions. But he was already a dying man and his reign of 99 days ended on June 15, 1888. William II, third and last German emperor, had no memory of past dangers or past victories to bind him to Bismarck. He represented the new Germany which knew no moderation, the self-confident Germany which recognized no limits to German power. At the same time, he was impatient with Bismarck's social conservatism, which seemed to estrange the emperor from the mass of his subjects.

The dispute came to a head after the general election of 1890. Bismarck had failed to hit on a national cry and failed to carry the election. The Bismarckian coalition of Conservatives and National Liberals fell from 220 to 135; the Progressives, Centre and Social Democrats rose from 141 to 207. Bismarck wished to tear up the imperial constitution which he himself had made and to set up a naked military dictatorship. William II was determined to continue on the path of demagogy, appealing still more strongly to German national sentiment. There were, of course, also elements of personal conflict. Bismarck objected to the emperor's interference on questions of policy; William objected to Bismarck's attempts to manoeuvre with the party leaders, especially with Ludwig Windthorst, the leader of the Centre. But essentially it was a conflict between the old Junker Germany which tried to maintain moderation for reasons of conservatism and the new imperialist Germany which was without moderation. Once Bismarck had quarrelled with the emperor, he had no real support, for he had always fought the parties of the German masses. He tried without success to engineer a strike of Prussian ministers. Finally he was opposed even by the leaders of the army. On March 18, 1890, he was forced to resign.

Caprivi.—Bismarck's successor was Georg Leo von Caprivi, a military administrator who, despite his conservatism, accepted William II's policy of winning over the parties of the masses. Caprivi inaugurated the four years of the "new course," an attempt to follow a more democratic line without changing the social or economic foundations. Caprivi's first act was to refuse to renew the Reinsurance treaty with Russia, thus breaking the partnership between tsardom and the Junkers which had been the basis of Bismarck's policy. Caprivi promised German support for Austro-Hungarian plans in the Balkans, and he dreamed of bringing Great Britain as a fourth partner into the triple alliance. The symbol of this hope was the treaty of July 1, 1890, by which Germany received Heligoland in exchange for concessions to British interests in east Africa. In economic affairs Caprivi lowered the Bismarckian tariffs and looked forward to a free-trade era, in which German trade would expand overseas under the protection of the British navy.

Caprivi refused to renew the anti-Socialist laws and viewed without dismay the increase in the Socialist vote. He carried measures of social security and of factory inspection, which offended the great capitalists as much as his free-trade policy offended the agrarians. To please the Centre, Caprivi promoted an education bill, which gave the church control of religious instruction. This led to a revolt of Prussian ministers, headed by Miquel, now Prussian minister of finance and a former National Liberal. In the outcome the bill had to be withdrawn and the Centre party returned to opposition. At bottom Caprivi's problem was the same as Bismarck's, *i.e.,* how to carry the septennial army grant. But Caprivi meant to carry it with the support of the Centre and of the left-wing parties, the Progressives and the Socialists. It was symbolical of his demagogic policy that in 1892 he ceased to be Prussian prime minister; in theory the Prussian Junkers ceased to dominate the Reich. Caprivi introduced an increased army grant in the autumn of 1892; in view of his "liberal" foreign policy, he had to invoke the danger from Russia, not from France, and this led the conservative parties to oppose the bill. As the Centre also opposed it because of the education bill, it was rejected. Caprivi dissolved the *Reichstag* and tried the line of more social concession to please the Social Democrats and a reduction of the period of the army grant from seven to five years to please all the parties of the left. The Progressive party split, a majority supporting the army bill and being joined by some of the Centre party. The Cehtre members supported Caprivi purely as a matter of tactics; the Progressives supported him from the conviction that even radical Germans should favour war against Russia, a conviction shared by the Social Democrats. The split in the Progressive party was the end of German radicalism, an event as decisive as the split of the liberal ranks in 1866. Caprivi's anti-Russian line led even the Polish deputies to support the army bill, a unique event in the history of the Reich. With this miscellaneous support the army grant was renewed on July 13, 1893.

Caprivi, though a conservative, tried to behave as if Germany had passed through a liberal revolution. He played for the support of the parties of the left and, in political and economic matters alike, ignored the interests of the Junkers and of the great capitalists as though they no longer held the keys of power. He had claimed that this would lessen the appeal of the Social Democrats; instead they increased their representation to 44 in the general election of 1893. William II was now disillusioned with the policy of social concessions and began to advocate most of the violent measures that Bismarck had been dismissed for supporting in 1890. Moreover Botho, Graf zu Eulenburg, the Prussian prime minister, also advocated a revival of the anti-Socialist laws. Caprivi answered by proposing that the Prussian franchise should be revised in a democratic spirit. The struggle between Junker Prussia and democratic Germany, which Bismarck had avoided, seemed to be approaching; but democratic Germany was not fighting for itself. Its cause was merely being promoted by Caprivi, an enlightened general.

Caprivi's fall was hastened by the failure of his foreign policy. He had counted on winning Great Britain for the triple alliance but the British would not commit themselves. In June 1894 Caprivi's subordinates, Baron Adolf von Marschall von Bieberstein, the secretary of state, and Friedrich von Holstein, the real adviser on foreign policy, tried to blackmail Great Britain into friendship by joining with France to oppose British schemes in central Africa; this was the first open dispute with Great Britain since 1885. The British, far from being won over, were estranged and repudiated their earlier promises of support for Austria-Hungary. Germany had consequently to try to restore good relations with Russia. Thus foreign policy, too, dictated a return to conservatism. In Oct. 1894 William II "solved" the conflict between Caprivi and Eulenburg by abruptly dismissing both. There was neither anti-Socialist law nor revision of the Prussian franchise; merely a prolongation of the Bismarckian compromise or deadlock.

Hohenlohe.—Chlodwig, prince of Hohenlohe-Schillingsfürst, the new chancellor, had been prime minister of Bavaria before 1870 and subsequently Statthalter of Alsace-Lorraine. His greatest qualification was that he was 75; he was to revive the glories of the age of Bismarck without the personal difficulties of the great man's temper. Hohenlohe at first found it easy to get on good terms with the Conservatives. Moreover, his Bavarian experience had made him less hostile to the Centre than Bismarck had been, and he won the support of the Centre by agreeing to many of their confessional demands. In foreign policy Hohenlohe renewed German friendship with Russia, a task made easier by the shift of Russian interest to the far east. He refused to support Austria-Hungary in the Balkans and revived Bismarck's land legislation against the Poles. The Social Democrats were again treated as a subversive force but Hohenlohe made no serious effort to pass new anti-Socialist laws. In fact, his short period of effective rule, from 1894 to 1897, was an attempt to repeat the era of Bismarck without its troubles. Hohenlohe tried to behave like a good-tempered Bismarck, and William II modelled himself on his grandfather. The most striking event of this period was the flagrant dispute with Great Britain over the Boer republics which culminated in the Kruger telegram (Jan. 3, 1896) congratulating the president of the Transvaal on having defeated the Jameson raid. Like many of Bismarck's demonstrations in foreign policy, this was an attempt to satisfy German feeling by a display of power, proof that Germany now counted for something even in South Africa. The Kruger telegram did not affect British policy in South Africa, but it had a lasting effect on German feeling; it taught the Germans, for the first time, to regard the British as their principal rivals in imperial greatness.

Bülow and "World Policy".—Hohenlohe was too old to inaugurate a new policy or even to revive an old one; he could not even control the demagogic enthusiasms of William II. Philipp, Graf zu Eulenburg, the emperor's only personal friend, wished to bring his erratic behaviour under some control and in June 1897 persuaded him to appoint Bernhard von Bulow secretary of state. Bulow became at once the leading man, a position openly acknowledged on Oct. 17,1900, when he displaced Hohenlohe as chancellor. Bulow's task, in Eulenburg's words, was "to satisfy Germany without injuring the emperor"; in other words, to display imperial power without allowing William to make a fool of himself. In home affairs Bulow depended on Miquel, Prussian minister of finance since 1891 and vice-president of the Prussian ministry in 1898. Miquel was a former Radical, once a friend of Karl Marx, and now intent on reviving the partnership between Junker agrarianism and pan-German industrialism which had been broken in the days of Caprivi. All through the 1890s the Junkers had threatened to "bolt" as they did when they brought down Caprivi, thus displaying too openly the artificial Prussian control of the Reich which Bismarck had cloaked in national phrases. Miquel bought the Junkers anew for the Reich, not, as Bismarck had done, with arguments of high conservative principle, but literally by high tariffs on grain and by favouritism in fiscal policy. Tariffs on food were to make the Reich self-sufficient in time of war, and easy credits for the Junkers were to enable them to defend the "national" cause against Polish encroachments. Miquel's financial policy, culminating in the high and rigid tariff of 1902, made the Junkers economically dependent on the Reich. Though they' might still dislike the policy of limitless expansion, the mortgages which weighed on every estate east of the Elbe made them unwilling accomplices in pan-Germanism.

Bulow's own contribution was "world policy," the pursuit of grandeur abroad in order to stave off reform or conflict at home.

The new generation of Germans wished to experience anew the glories of the age of unification without its risks or dangers and such organizations as the Colonial society, the Navy league and the Pan-German league, existed more for the purpose of boasting than anything else. Nevertheless it was impossible to continue boasting without coming to believe that the boasts were true, and in time the demagogic organizations of imperialism took the government prisoner. There was some foundation for their boasts. Thanks to the iron and steel of the Ruhr, Germany had become the greatest industrial power of Europe, and there was nothing to stop its economic domination of the continent if it pursued a cautious foreign policy, relying on peaceful penetration, not on armed force. This was the justification for Bulow's policy of "the free hand," keeping Germany free from foreign alliances except its protectorate over Austria-Hungary. Even the Austro-German alliance seemed without risk, since Russia was now absorbed in the far east. Bulow's great object was to avoid being drawn into the far eastern conflict between Russia and Great Britain. He repeatedly rejected the British offers of an alliance, made most positively by Joseph Chamberlain in March 1898 and by Lord Lansdowne, British foreign secretary, in the spring of 1901. This British attempt is often treated as a turning point in the relations of the great powers, but this is to misunderstand its meaning. The British were concerned solely with China and were incapable of giving the Germans any support in Europe; the Germans were thus being asked to fight a war for existence against both Russia and France for the sake of British investments in the far east. Nor did the failure of the alliance negotiations lead to an estrangement between Great Britain and Germany. Bulow was as careful not to offend Great Britain in Africa as not to offend Russia in China. In Aug. 1898 he concluded an agreement with the British for a hypothetical partition of the Portuguese colonial empire and in exchange abandoned German patronage of the Boer republics. Moreover, during the South African War, official German policy remained strictly neutral, though public opinion in Germany (as elsewhere in Europe) was strongly on the side of the Boers.

Tirpitz **and** the **German** Navy.—Far more decisive in its effect on Anglo-German relations was the building of a great German navy, first sketched in the Navy law of 1898 and fully launched by the Navy law of 1900. The protagonist of this policy was Alfred von Tirpitz (*q.v.*), secretary of state for the navy since 1897. The essence of Tirpitz' naval policy was a great battle fleet, and he justified this by various strategical arguments. At times he spoke of a "risk theory," that Great Britain, on bad terms with Russia and France, would not risk a conflict with a German navy even smaller than its own; at others he envisaged a "decisive battle" with the British fleet. At bottom, Tirpitz, like the other supporters of the great navy, simply held that a great navy was essential to a great power; or, in the words of Theobald von Bethmann Hollweg, that it was necessary "for the general purposes of imperial greatness." Tirpitz insisted that the navy must be planned on a long-term basis, and the Navy law of 1900 laid down the lines on which the German navy should develop until 1917. This made it difficult or impossible to modify German building plans when the British later sought a naval agreement. Here again it would be a mistake to put too early a significance on the German navy. So long as the German plans were merely plans, they did not alarm British opinion much; the great naval scare only came after 1906 when the German navy seemed to be approaching British strength.

The naval projects played an essential part in German home policy, In 1897, when the plans were first drafted, German industry was going through a period of depression, and one object of the great navy was to provide a stable demand, at the taxpayer's expense, for German iron and steel. It was a concession to the German steel magnates which balanced Miquel's favouritism of the Junker landowners. But the navy had a wider appeal. Unlike the army, which retained its Prussian character, the navy was essentially German, an affair of the Reich. Even in 1848 the navy had been a proposal of the Radicals, and now Tirpitz' plans won the support of many liberals who would have opposed an anti-British policy on any other issue. Most striking of all, the Centre voted solidly for the second Navy law (1900) though it drew most of its support from peasants and artisans in areas far from the great ports. With this vote the Centre openly joined the government coalition. It tried to make one condition—that the navy should be paid for by direct taxation. This was the old demand that the Liberals had made in regard to the army. The Centre, too, was unsuccessful; the conservative agrarians had supported the navy only on condition that it should be financed by increases in the taxes on food or by an increase in the national debt. Direct imperial taxation was the vital issue on which the landed classes maintained a veto almost until the outbreak of World War I. In fact, the navy, like the army before it, was largely paid for by state borrowing. Thus inflationary finance, by which Germany conducted World War I, was the basis of the Reich's fiscal policy long before the outbreak of war. Implicit in it was the argument, based on the French indemnity of 1871, that the army and navy would in time pay for themselves by imposing terms of conquest on the other nations of Europe.

The First Moroccan Crisis, 1905–06.—The policy of "the free hand," which Bulow conducted on Holstein's advice, assumed that Great Britain, France and Russia would always remain on bad terms, because of their conflicts in Africa and the far east. So long as these conflicts continued, Germany could ignore such a triviality as Italy's reconciliation with France (1902), which Bulow dismissed as "a dance out of turn." German calculations were upset by the Anglo-Japanese alliance of 1902, which enabled the British to check the Russians in the far east without becoming involved themselves; this was shown in 1904 when the Russo-Japanese war broke out. The Germans would have welcomed a conflict between Russia and Great Britain, but they were far from being willing to join in the war on the Russian side. The most they were prepared to offer was an alliance with Russia which would become operative when the war in the far east was over. This offer was made in Nov. 1904 and repeated by William II in theatrical terms when he met Tsar Nicholas II at Bjorko in July 1905. The offer had no attractions for the Russians; once they had been defeated in the far east, their enemy would be Austria-Hungary not Great Britain. Bulow and Holstein, however, believed that the principal opposition to a "continental bloc" against Great Britain came from France. They therefore decided to use the opportunity of Russia's preoccupation in the far east to force France into dependence on Germany, the more so as the Anglo-French entente (April 8, 1904) had been concluded without enquiring into Germany's position. The result was the first Moroccan crisis.

On March 31, 1905, William II landed at Tangier and announced German support for Moorish independence. The French sought to negotiate. They were answered by a German demand for the resignation of Théophile Delcassé, French foreign minister, and faced, as they supposed, by a threat of war, gave way. Delcassé resigned and on the same day William II created Bulow a prince. This was the reward for success on a Bismarckian scale. But thereafter things went wrong for Germany. Holstein had launched the Moroccan crisis in the old style of cabinet diplomacy without making any attempt to prepare German opinion, which was indifferent to Moorish affairs. The French received strong diplomatic support from the British, including even military conversations against a possible German aggression, and recovered their nerve. At the conference of Algeciras (January–April 1906) the Germans were compelled to acquiesce in French predominance in Morocco and to content themselves with a shadow recognition of its independence. Holstein resigned in protest against this compromise and the German foreign ministry was left without any guiding intelligence until Alfred von Kiderlen-Wachter became secretary of state in 1909. The crisis had been the first for almost 20 years; and it had ended in failure for Germany. The Bismarckian system had been accepted by Germans because it had offered them success abroad; now this capital of success had been exhausted. The German government would either have to make political concessions at home or seek success abroad by more violent means.

The Bulow Bloc.—In 1906 it still seemed possible that Germany might follow the path of liberal reform. Until 1906 Bülow had controlled the *Reichstag* by a coalition of Conservatives and the Centre. This coalition was held together by concessions to the agrarian interest of the one and the confessional interest of the other. In 1906 the Centre put their price too high: they demanded a large share of government appointments for Roman Catholic officials and special privileges for Roman Catholic missionaries in the German colonies. When these terms were refused, they voted against the military grants for suppressing a native revolt in South-West Africa (Oct. 1906). Since the colonies were a popular, even a Radical cause, Bülow seized the opportunity to break with the Centre and organized instead a coalition between the Conservatives and the non-Socialist parties of the left; even the Progressives, who had held out against the go ernment until now, joined the Bülow bloc. Bulow believed that this coalition, in which the left predominated, would also enable him to solve the financial problem; he would be able to carry direct taxation over Conservative opposition. The bloc was successful at the general election of 1907, principally at the expense of the Social Democrats. Bulow now followed a progressive policy in colonial administration and revived the struggle against the Poles which had always been a popular cause. But he was still the prisoner of the Conservatives; he failed to reform the Prussian franchise, and he was unable to introduce direct taxation.

The logical consequence of the swing toward liberalism in home affairs should have been a *rapprochement* with England and an estrangement from Russia, as in the days of Caprivi. Bulow certainly attempted to improve relations with Great Britain, but his hands were tied by Tirpitz' naval plans, which after the development of the dreadnought or all-big-gun ship reached their most dangerous point. In fact Anglo-German relations took a sharp turn for the worse in 1908 and reached a crisis in March 1909, with the great naval scare in Great Britain. In order to get a yearly program of six dreadnoughts against Germany's four, Reginald McKenna, the first lord of the admiralty, had exaggerated Germany's building rate. This frightened the public into demanding more than McKenna himself wanted and "we want eight and we won't wait" became the slogan. On the other hand Bülow certainly accomplished the estrangement from Russia. In Oct. 1908 Russia and Austria-Hungary fell out over the Balkans, when Austria-Hungary annexed Bosnia and Hercegovina. Despite the criticism expressed by William II, the German government decided to support Austria-Hungary unreservedly and in March 1909 settled the crisis by a virtual ultimatum to Russia. The Bismarckian attitude of indifference in Balkan affairs was decisively abandoned, and later attempts to return to it proved ineffectual. Yet Bulow condemned his own policy when he said on his resignation, "No more Bosnias."

The high-water mark of Bülow's pose as a liberal statesman came in the autumn of 1908. In the "liberal" atmosphere of the Bulow bloc it became fashionable to blame William II for the erratic course of German policy and for all the failures of the preceding years. Criticism of the emperor became stronger in 1907 when Eulenburg, his only personal friend, was driven from public life by charges of immorality. In Oct. 1908 the English *Daily Telegraph* published an interview with William II on Anglo-German relations. This interview, in the usual rhapsodical style of imperial utterances, naïvely expressed the bewilderment which most Germans felt at the British resentment against German "world policy." Ordinarily it would have passed unnoticed; in the autumn of 1908, with isolation abroad and liberal stirrings at home, it became the locus of every German discontent. William II had in fact submitted the interview to the German foreign ministry before passing it for publication but Bülow made out that he had been too busy to read it. While ostensibly accepting responsibility, he encouraged the uproar in the *Reichstag* (Nov. 10–12) and public opinion was satisfied only when Bulow announced that in future William II would "respect his constitutional obligations." This seemed a great victory for liberal principles and for Bulow personally. He seemed to have broken the imperial authority which had been too much for Bismarck. But this was true only if Bülow remained in control of the *Reichstag* and that soon escaped him. The Conservatives resented Bülow's quarrel with Russia at the time of the Bosnian crisis (October 1908–March 1909); they resented still more his proposal to introduce succession duties on landed estates. They returned to their alliance with the Centre and defeated the succession duties by a narrow majority. Bülow wished to dissolve the *Reichstag;* but this made him again dependent on the emperor, and William II eagerly seized the chance to dismiss him on June 14, 1909. This ended the Indian summer of liberalism in Germany. Bülow was the last effective chancellor. After him Germany was administered, not governed, as Metternich's Austria had been in its days of decay.

Bethmann Hollweg.—Theobald von Bethmann Hollweg, the new chancellor, was a perfect symbol of the decline in the authority of the Reich. He had no experience either in politics or foreign affairs; he was content to administer. Cultured and honest, he ran over with good intentions, and his high character often put William II and even the *Reichstag* on their best behaviour. But he had no sense of power; he put forward sensible proposals and when these were defeated acquiesced in the wild policy of his opponents. This was early shown in his negotiations with Great Britain over the limitation of naval armaments. In March 1909, during the naval scare in Great Britain, the effect of an agreement would have been enormous on British opinion. Bethmann saw this clearly and tried to negotiate but he was resisted by Tirpitz, overruled by the emperor and gave way without protest. Again Bethmann was led by Kiderlen, his secretary of state, into a second conflict with France over Morocco (July–November 1911).

The Second Moroccan Crisis, 1911.—Kiderlen's object was to restore good relations with France but, with German heavy-handedness, he chose the way of threats and bullying. A German warship, the "Panther," was sent to the Moorish port of Agadir in order to stake out a claim against the French; and Kiderlen demanded the French Congo as compensation for surrendering German rights in Morocco which did not exist. Pan-German feeling was aroused and Kiderlen received more support in Germany than he had bargained for. Against his will he had to create a war crisis, and in this war crisis Germany was defeated by Anglo-French resolution. The Agadir affair ended with a settlement in which Germany received only a fragment of the French Congo. In the ensuing *Reichstag* debate Bethmann and Kiderlen were furiously attacked for their timidity, attacks openly patronized by the crown prince. Bethmann would not make a frank defense of his pacific policy, yet mas resolved against a policy of violence. Hence, as usual, he fell back on a policy of routine.

In the two and a half years between the Agadir crisis and the outbreak of World War I, Bethmann made sincere, though ineffectual, attempts to lessen the tension in international relations. He tried vainly to take advantage of Lord Haldane's visit to Berlin (Feb. 1912) to improve Anglo-German relations, an attempt once more wrecked by Tirpitz' refusal to restrict his naval plans. Again, Bethmann worked with Sir Edward Grey to limit the Balkan Wars and successfully prevented their turning into a conflict between Russia and Austria-Hungary. Finally he negotiated with the British agreements settling the Baghdad railway and devising a new hypothetical partition of the Portuguese empire. These seemed signs of a policy of appeasement. But Bethmann was the prisoner both of German opinion and of the great general staff. He was engaged in postponing a European war, not in preventing one, and even the improved relations with Great Britain aimed only at detaching the British from France and Russia so that Germany would have more chance of winning a continental war.

In home affairs also Bethmann was content to leave things at a standstill. He never found a government coalition to replace the Bülow bloc and therefore ran the *Reichstag* without a secure majority. His solution for every problem was to do nothing. Thus, in order not to annoy the Poles he did not enforce Bülow's anti-Polish laws; but in order not to annoy national feeling he did not repeal them. The general election of 1912 returned the Social Democrats as the largest single party. Bethmann did not attempt to renew Bismarck's battle against the Social Democrats. On the other hand he did not bring them over to the government side, As usual he made gestures without action. He consulted the Social Democratic leaders, but did not act on their advice.

He promised a reform of the Prussian franchise, but did nothing to redeem his promise. Bethmann's helpless position was clearly shown in Nov. 1913. The officers of the garrison at Saverne (Zabern) in Alsace provoked quarrels with the townspeople and arrested some of them in defiance of the law. Bethmann thought the military authorities in the wrong, but, as usual, thought it his duty to defend them. The *Reichstag* revolted, and Bethmann was censured by a vote of 293 to 54. It was a vote without a sequel. Bethmann did not resign; the military authorities were not punished; and the "progressive" *Reichstag,* which had condemned the military, voted an enormous capital levy for the further increase and equipment of the army. Thus, to the end, the German people tried to combine the rule of law at home and the rule of German military power abroad. It was certainly a great achievement that Germany remained a *Rechtsstaat* (a state of law) throughout the period of the empire; but it was an achievement that had to be paid for by the other peoples of Europe.

Outbreak of World War I.—The diplomatic crisis of July 1914 was not, like the two Moroccan crises, a manufacture of the German foreign office. There is little or no evidence that the Germans deliberately planned war in the summer of 1914; the strongest argument against this view is that there was probably no one in the government capable of planning anything. The crisis caught the German government unawares; but there could be no doubt of its response. The question which Bismarck had evaded had now to be answered. Was Germany to abandon or to extend the advance into southeastern Europe that had been proceeding for centuries? The survival of Austria-Hungary was at stake, and Germany had either to fight a war for the mastery of all Europe or to abandon even central and southeastern Europe to independent national states. Confronted as they were by such a crisis, the only dispute among Germans—between Bethmann and the general staff or between the German and Austro-Hungarian foreign offices—was tactical: whether Aug. 1914 was the best moment to fight the inevitable war for European hegemony. Bethmann, as usual. opposed but acquiesced and finished up even by defending the German march through Belgium which he knew to be indefensible and which brought Great Britain into the war.

The outbreak of war accomplished something which social concessions had failed to do; it brought the Social Democrats over to support of the imperial government. The German Socialists had always been the leading spokesmen in the Socialist International of the general strike against war. When it came to the point, they were won over by the argument that Germany mas being attacked by tsarist Russia (the old Radical cry of 1848). At the meeting of Socialist members. a minority opposed the war; but when the *Reichstag* met, the entire Socialist party voted for war credits, in the name of party unity. The Socialists went further. They joined the other parties in declaring *Burgfrieden,* a civil truce, by which they agreed to criticize neither each other nor the government. In other countries at war, the party politicians formed a coalition or otherwise established control over the government. In Germany the members of the *Reichstag* abdicated to the imperial government, though it remained unchanged and beyond its control. No wonder that William II declared, "There are no more parties; I see only Germans." This was, of course, an exaggeration. The Social Democrats had always some doubts about supporting the war without reserve, and they had to devise increasingly elaborate arguments in order to satisfy their consciences. In the autumn of 1914, after the battle of Tannenberg, it became obvious that Russia was not a menace to Germany. The Social Democrats then made out that Germany was becoming a Socialist country under the pressure of war and that they were fighting a war of defense against "entente capitalism."

For Germany, as for other belligerent countries, World War I fell into two distinct phases: the first, old-style conventional war which lasted until 1916; the second. a war of desperate expedients when both sides fought a struggle for existence. The German war plan was a plan for a short war. France was to be overrun within six weeks, Russia within six months; Great Britain mould be excluded from Europe. This plan met disaster at the battle of the Marne (Sept. 1914). The Germans missed the capture of Paris on which they had pinned their hopes; lines of trenches stretched to the French coast, and the Germans were left in occupation of Belgium and of northern France. Yet at the same moment the defeat of the Russians at Tannenberg gave Germany the security which was its ostensible war aim and at any time between Sept. 1914 and the summer of 1917 the Germans could have had peace on the basis of the *status* quo. Such a peace, horn-ever, was impossible for Germany. It mould have destroyed the prestige of the German armies; it would have arrested the expansion of German industry; above all, it would have led to a political revolution at home. The Bismarckian compromise between the demands of the middle classes and those of the Junkers had been created by him in order to restrain German ambitions and to make a moderate policy possible; now the Germans had to wage a mar of conquest and to abandon all moderation in order to preserve the Bismarckian compromise.

The defeat at the Marne brought a change in the high command. Helmuth von Moltke, nephew of the great commander of 1866 and 1870, disappeared and was succeeded by Erich von Falkenhayn, an organizer rather than a strategist. He determined to stand on the defensive in the west, while breaking Germany's enemies in the east. This plan was, in its limited aim, successful. Anglo-French offensives on the western front achieved nothing. Meanwhile the Russians were driven out of Galicia, and the way was prepared for the conquest of Poland. In the autumn of 1915 Serbia was overrun, and with the entry of Bulgaria into the war the Central Powers had a secure land route to Turkey and beyond it to the Persian gulf. Turkish efforts to threaten the Suez canal failed but this was more than offset by the Allied failure to break through the Dardanelles. The Allies had counted on great advantage from bringing Italy into the war (May 1915); but their hopes were disappointed. The Italian armies were no more than a match for the Austro-Hungarian army; and in any case they had to attack on a very narrow front where no decisive victory could be obtained.

In home affairs the second year of the war saw the first effort to mobilize German resources for a serious war. No preparations had been made for this, and the inspiration of the program came from Walther Rathenau, a businessman who convinced Bethmann and the high command of the need for an economic plan in the winter of 1914. It may be said without exaggeration that Rathenau alone made it possible for Germany to wage war for four years. Politically, too, the second year of the war saw the beginning of an effort to think in war terms. The conquest of Belgium shifted Germany's interests, as it were, west. Throughout the war Germans of every party, including the Social Democrats, made the annexation of Belgium, in whole or in part, or at least German control of Belgium, an essential condition of peace. This was sometimes justified by strategic arguments, disguised as the need for security, sometimes by arguments of economic union. The basic fact was that German plans of conquest had moved to the west and for a simple reason: Germany had become the greatest industrial power. The plans for extending German territory in the Baltic—the only plans with which the Prussian Junkers sympathized—were plans for the benefit of landowners; the plans for controlling southeastern Europe! also of long standing, were the plans of German traders; both were eclipsed by the ambition of the German magnates of the Ruhr to control the industrial resources of Belgium and of northeastern France. Against these plans, there was a stirring of German liberal sentiment, some of it roused merely by the hope that Germany might make peace with the entente if it demanded less territory in western Europe or was even content with territory in the east. But there was also a movement among a minority of the Social Democrats against a war of conquest, and soon against any war at all. In Dec. 1914 Karl Liebknecht, a left-wing Socialist, first voted against the war credits; in 191j some Social Democrats began to move against their party and to form an "independent" group, largely pacifist in tone.

In 1916 Falkenhayn, still without a constructive strategy, attempted to "bleed the French white" by the prolonged battle of Verdun (Feb. 21–June) which exhausted the Germans alinost as much as it did the French. At the same time an attempt to break British naval power by direct assault failed at the battle of Jutland

(May 31, 1916), the only serious engagement fought by the German High Seas fleet in the course of the war. It became clear that new men and new methods were necessary if Germany was to continue the war. The first decisive change came on Aug. 29,1916, when William II dismissed Falkenhayn and appointed Paul von Hindenburg chief of staff with Erich Ludendorff as his quartermaster general. Hindenburg, an elderly general who had achieved a spurious fame as the victor of Tannenberg, was merely a symbol of German resolve. Ludendorff, however, was a man who combined strategic daring with political ambition. He was determined to win the war and in order to do it intended to establish the authority of the high command over the civil government of the Reich.

The Political Crisis of 1916–17.—The appointment of Hindenburg and Ludendorff ushered in the political crisis of the German empire. Until then a semblance of Bismarck's constitution had been maintained. The high command had confined itself to military affairs, and Bethmann had still conducted policy. In Oct. 1916 the *Reichstag* gave the signal for ending this system when it passed a motion, proposed by the Centre, that it had confidence in Bethmann, so long as he possessed the confidence of the high command. Bethmann was at this time attempting to get tsarist Russia out of the war and to prevent the United States from entering it. The resolution of the *Reichstag* made it impossible for him to resist the policy of the high command. In Nov. 1916 Ludendorff cut across Bethmann's negotiations with Russia by insisting on the proclamation of an independent kingdom of Poland; this effectively estranged the Russians without bringing any serious Polish recruitment to the armies of the Central Powers. On Feb. 1, 1917, a crown council resolved, again against Bethmann's opinion, on unrestricted submarine warfare, in order to answer the British blockade by bringing Great Britain to its knees. Though this campaign had some success, it had the much graver failure that it brought the United States into the war.

The spring of 1917 saw an explosion of war weariness in Germany. Ludendorff had taken over a difficult strategic situation and he had to plan for a defensive war, with dispiriting results, for the whole of 1917. The first Russian revolution (March 1917) encouraged left-wing sentiment in Germany, and on April 7 Bethmann once more promised a democratic reform of the Prussian franchise, though as usual the promise was not carried out. In July there folloned mutinies in the German navy which was confined to its base at Kiel. Hitherto the attacks on the war had come from the Independent Social Democrats and from the Spartacists. as the revolutionary followers of Liebknecht were coming to be called. But in the spring of 1917 Matthias Erzberger, leader of the Centre, visited Gen. Max Hoffmann, who had succeeded Ludendorff on the eastern front, and learned from him that the war mas lost. Erzberger returned to Berlin, determined to secure for the Centre the position of leading anti-war party; after all it was the only party that could survive any change of regime. On July 6 he launched an attack on Bethmann accusing him of advocating a policy of conquest and demanding the enunciation of defensive peace terms. Ludendorff had long regarded Bethmann as weak and too pacific but he none the less welcomed this attack by Erzberger as a way of getting a chancellor more to his taste. Thus Erzberger and the high command worked hand-in-hand, though for exactly opposite ends. The politicians meant to get rid of Bethmann with Ludendorff's assistance, and then to control Ludendorff by calling in Bulow as chancellor. For Bulow, as a result of his clash with the conservatives in 1909, had an undeserved reputation as a liberal. His parting words to the conservatives had been: "We shall meet again at Philippi." Both Bulow and the *Reichstag* politicians thought that Philippi had now come. This grotesque scheme failed at the first hurdle. William II, with the humiliation of the *Daily Telegraph* affair still rankling, refused to hear Bulow's name mentioned, and Ludendorff then nominated out of hand Georg Michaelis, an unknown official who had acted competently as Prussian food controller. Thus ended the great crisis that was to give Germany parliamentary government with the backing of the high command.

The *Reichstag* had to be given some satisfaction. Having failed to make a chancellor, the politicians were allowed to make **a** policy. The "peace resolution" of July 19 was a string of innocuous phrases, expressing Germany's will to peace, but without a clear renunciation of indemnities or annexations. Most of the politicians who supported it, including Erzberger himself, were still in favour of annexing Belgium and part of northeastern France. The peace resolution was, at best, a gesture of good will in answer to Pres. Woodrow Wilson's advocacy of the Fourteen Points. Later in the year the *Reichstag* received a further acknowledgment from the high command. Ludendorff admitted that Michaelis had proved incompetent as chancellor and ordered him out of office (Nov. 2, 1917). Georg, count von Hertling, his successor, was 75 years of age and had been prime minister of Bavaria. Appointed principally to please the Centre, he was the only Roman Catholic to be chancellor of Bismarck's empire. As a further innocuous concession, Friedrich von Payer, leader of the Progressives, became vice-chancellor. Neither Hertling nor Payer had any influence on policy, which was determined by the high command. Only Richard von Kuhlmann, the secretary of state, tried to assert some civilian control but he too was ordered out of office by the high command when he ventured to suggest in the *Reichstag* that a peace based on complete victory was no longer possible.

Last Year of the Empire.—Bismarck's Reich was to have a last year of illusory success before defeat. In 1917 Ludendorff met and routed the Allied offensives on the western front. More important, the Russian forces on the eastern front fell to pieces, particularly after the failure of Alexander Kerensky's offensive (July 1917) and the Bolshevik revolution in Nov. 1917. The Bolsheviks believed that they could cause revolution also among the German workers by offering a peace "without indemnities or annexations." Hence they negotiated with the German high command at Brest-Litovsk. The Bolshevik calculation proved false. Though Germany was swept by a wave of strikes in Jan. 1918, these sprang simply from grievances against the hard domestic conditions, and in any case they collapsed without producing any political result. The German working class, through the mouths of the Social Democrats, had announced that they were fighting a war of defense against tsardom; but they continued to fight when tsardom had disappeared. On March 3, 1918, the Bolsheviks had to sign the peace treaty of Brest-Litovsk. by which Russia lost 56,000,000 inhabitants, 79% of its iron and 89% of its coal production. This annexionist treaty was not opposed by the parties that had voted for the "peace resolution." The Centre and the Progressives voted for the treaty, the bulk of the Social Democrats abstained and only the Independent minority of Social Democrats voted against. When it came to the treaty of Bucharest with Rumania (May 7, 1918), which made Germany the economic master of the country, the majority of the Social Democrats actually voted for the treaty. Thus, for a few brief months, Germany achieved the dream of *Mitteleuropa,* with all Europe east of the Rhine under its economic domination.

The decisive battle had, however, still to be fought in the west. On March 21, 1918, Ludendorff launched the "emperor's battle" (much against the emperor's wish). On April 9 he won a battle against the British and at the end of May against the French. Decision eluded him. On July 18 the French struck back, and on Aug. 8—the black day of the German army—the British broke through. Ludendorff remained confident that he could fight a defensive war. At the end of September Bulgaria collapsed and the collapse of Austria-Hungary was near. On Sept. 29 Ludendorff lost his nerve and declared that an immediate armistice was necessary. Further, to make the approach to the Allies easy, he ordered that Germany should become a constitutional monarchy overnight. Max, prince of Baden, who had long enjoyed a happy reputation as a liberal and an international conciliator, became chancellor (Oct. 3). The same day the political leaders were told by Ludendorff's representatives that the war had been lost. Ludendorff had never studied the Fourteen Points; and when he understood their impiications he wished to continue the war. He was overruled and resigned on Oct. 26. Hindenburg remained at the head of the general staff with Wilhelm Groener as quartermaster general.

The Revolution.— The change to constitutional monarchy had been carried through peacefully, at the order of the high command. At the end of October the *Reichstag* resolved that the chancellor must henceforth possess the confidence of the *Reichstag* and this resolution was approved by the emperor. But the German people were now growing impatient. On Nov. 3 mutiny broke out in the fleet at Kiel and revolt soon spread to Berlin. On Nov. 9 Liebknecht, the Spartacist leader, prepared to proclaim a Soviet republic. Prince Max's cabinet tried to counter this by proclaiming the abdication of the emperor. When this failed, Philipp Scheidemann, one of the two Social Democrats in the cabinet, proclaimed the republic in order to anticipate Liebknecht, much to the fury of Friedrich Ebert, his colleague. Prince Max handed over his office to Ebert, who thus became for 24 hours the last imperial chancellor. Meanwhile at Spa, the seat of the high command, where William II had taken refuge, the emperor tried to defend his position. He was told by Wilhelm Groener that the army would not support him and on Nov. 9 fled to Holland. Thus the Social Democrats and the high command, much against their will, combined to create the German republic. On Nov. 10 the workers' and soldiers' councils of Berlin, which had been set up in imitation of the Russian soviets, gave a revolutionary blessing to Ebert's regime; it was more important for him that the high command blessed it at the same time. *(See* also WORLD WAR I.) It remained to establish a government for the state.

Ebert, last imperial chancellor, became chairman of the Council of Peoples' Commissars, a body dominated by Majority Socialists who were opposed to revolution. His first act was to strike a bargain with the high command; Hindenburg would retain his command, and Ebert would resist the revolution. This had already lost its mass appeal with the signature of the armistice (Nov. 11). On Dec. 19 Ebert persuaded the Congress of Soldiers' and Workers' Councils to fix elections for the constituent assembly for Jan. 19, 1919. On Dec. 23 revolutionary sailors answered by occupying the chancellery and taking Ebert prisoner. He was rescued on Dec. 24 by troops from the Potsdam garrison. On Dec. 29 the three Independent Socialists resigned from the government in protest against Ebert's counterrevolutionary policy; this left him with a free hand. Gustav Noske, another Majority Socialist, organized a volunteer corps with which to defeat the revolution. He said: "Someone must play the bloodhound; I am not afraid of the responsibility."

On Jan. 4, 1919, Robert Emil Eichhorn, an Independent Socialist and police president of Berlin was dismissed. Mass demonstrations of protest followed, but the government was not overthrown. On Jan. 11 Noske's Volunteers entered Berlin. Heavy street fighting took place, which ended with Noske's victory on Jan. 15. The same evening the two Spartacist leaders Karl Liebknecht and Rosa Luxemburg were arrested and murdered by Volunteer officers. Elections for the national assembly were duly held on Jan. 19. The social revolution had been defeated and the way was clear for a democratic republic to preserve the economic order and the military values of imperial Germany. Ebert and Hindenburg, the two presidents of the Weimar republic, were also the partners who brought it into existence. (A. J. P. T.)

THE GERMAN REPUBLIC

The Weimar Constitution.— The national assembly met at Weimar on Feb. 6, 1919, and listened to an opening speech by Friedrich Ebert in which he underlined the breach with the past and urged the Allies not to cripple the young republic by the demands imposed on it. On Feb. 11 the assembly elected Ebert as president of the Reich, and on the following day Philipp Scheidemann formed a ministry which contained representatives of the Centre and of the Democrats, besides members of Scheidemann's own party, the Social Democrats. This was the so-called Weimar coalition.

The principal task of the assembly was to provide a new constitution for Germany. After several months' discussion, this was promulgated on Aug. 11, 1919. The government's draft mas drawn up by Hugo Preuss, one of the leaders of the Democratic party. Preuss, however, was not able to secure the unitary Reich he favoured, in which Prussia would have been broken up and the old states (*Länder*) abolished in favour of a new division of the country by provinces. The republic, like the empire it replaced, was to have a federal basis. The powers of the Reich, however, were considerably strengthened and it was now given overriding control of all taxation. National laws were to be superior to the laws of the states, and the Reich government was given the power to supervise their enforcement by the local authorities. Under the republic there were 17 *Lander* in all, ranging from Prussia with a population (in 1925) of 38,000,000 and Bavaria with 7,000,000 to Schaumburg-Lippe with 48,000. The only new *Land* was that of Thuringia. formed in 1919 from the amalgamation of seven small principalities.

The *Lander* continued to be represented in the *Reichsrat,* which replaced the imperial *Bundesrat,* but the new chamber's powers were much reduced and it took a subordinate place under the *Reichstag,* to which alone the government mas made responsible. All men and women over the age of 20 were to have the right to vote for the *Reichstag,* and the elections were to be conducted on the basis of proportional representation. Under this system no party ever succeeded in securing a clear majority and the governments of the republic from beginning to end were coalitions. Proportional representation had the further consequences of excluding independent members, encouraging the formation of numerous political parties and increasing the power of the party machines. In addition to the democratic franchise, provision was also made for popular initiative in legislation and for a referendum.

As a counterweight to the *Reichstag,* Preuss persuaded the assembly to endow the president as the chief executive with strong powers. He was to be elected independently of the *Reichstag* by the nation itself, was to hold office for seven years and was to be eligible for re-election. He mas given the power to make alliances and treaties; he was the supreme commander of the armed forces, with the right to appoint and remove all officers; he could dissolve the *Reichstag* and submit any law it had enacted to a referendum. Finally, under the famous article 48, he had the right to suspend the civil liberties guaranteed by the constitution in case of emergency and to take any measures required to restore public safety and order, if necessary with the help of the armed forces. These provisions reflect the insecurity, bordering on civil war, with which Germany was faced at the time; they were to prove of great importance in the final stages of the history of the Weimar republic. Under the president, political responsibility was to rest with the chancellor. The government was made dependent upon the confidence of a majority of the *Reichstag;* with the withdrawal of this confidence the government had to resign.

The Weimar constitution has been subjected to considerable criticism, notably for the system of proportional representation which it introduced and the large powers it conferred on the president. For the first time in German history, however, it provided a firm foundation for democratic development. The fact that within 14 years this ended in a dictatorship was due far more to the course of events and to the character of social forces in Germany than to constitutional defects.

The German Reich, as it was re-established in 1919, was a democratic but not a socialist republic. A number of measures for the socialization of certain parts of the national economy (*e.g.,* the coal, electrical and potash industries) were introduced but proved ineffectual. German industry continued to be marked by cartels and other combines of a monopolistic character, control of nhich was increasingly concentrated in the hands of a small number of men. The fact that, after the hopes aroused in 1918–19, no far-reaching plan for securing public control over industry or for breaking up the big landed estates was carried through had two consequences. Although the German working class undoubtedly improved its political and economic status under the republic, a considerable section was embittered by the failure to effect a drastic reform of the social and economic system. This was to provide the left-wing opposition (the Independent Socialists and the Communists) with strong working-class support which weakened both the Social Democratic party and the republic. Secondly, economic power was left in the hands of classes who were either irreconcilable opponents of the republic from the beginning, or equivocal supporters with a preference for authoritarian forms of government.

The position of the trade unions, the eight-hour day and the right of collective bargaining were safeguarded under the republic, but the attempt to extend democracy to the industrial sphere met with powerful opposition from the industrialists. A system of works councils set up early in 1920 enabled the workers in each factory to elect representatives to share in the control of management. This experiment, however, soon disappointed the hopes entertained of it, largely because of the stubborn resistance of the employers. The attempt to establish an economic parliament (Reichswirtschaftsrat), with equal representation for employers and workers proved equally disappointing.

The Treaty **of Versailles.**—Apart from drafting the constitution, the urgent task for the assembly and the new government was to conclude peace. The government's instructions to the German peace delegation which went to Versailles at the end of April 1919 show how wide was the gap between German and Allied opinion. In German eyes the break with the past was complete, and the Wilsonian program of self-determination and equality of rights as set out in the Fourteen Points was binding on both sides. The fact that the Allied powers refused to permit negotiations and the character of the terms presented on May 7 provoked bitter indignation throughout all classes in Germany.

Germany was called on to cede Alsace-Lorraine to France; Upper Silesia, most of Poznan and the so-called West Prussia to Poland; north Schleswig to Denmark, and three small frontier districts to Belgium. Danzig was to become a free city, independent of Germany; East Prussia was separated from the rest of the Reich by Polish Pomorze, and Memel was handed over to Lithuania. In Europe alone (without counting the German colonies, all of which had to be handed over to the Allies) Germany lost about 27,188 sq.mi. of territory, with a total population of over 7,000,000. The union of Austria with the Reich, which was desired by both countries, would have compensated for these losses, but was expressly forbidden by the treaty.

The left bank of the Rhine was to be occupied by Allied troops from 5 to 15 years to ensure the execution of the treaty's terms. The left bank, and the right bank to a depth of 50 km., were to be permanently demilitarized. In addition to the big industrial area of Upper Silesia which was to go to Poland, Germany was to lose the rich coal fields of the Saar for 15 years. At the end of this period a plebiscite was to be held. Until then the Saar was to be governed by the League of Nations and its coal mines by France.

The Allies could not agree on a figure for reparations. A decision was deferred until 1921, but the Germans were to make a provisional payment of 20,000,000,000 M. in gold as well as deliveries in kind. Prewar commercial agreements with foreign countries were cancelled; German foreign financial holdings were confiscated and the German merchant marine reduced to less than one-tenth of its prewar size. At the same time the Allies were to enjoy most-favoured-nation rights in the German market for five years.

Measures for the demilitarization of Germany accompanied the territorial and economic demands. The German army was to be limited to 100,000 officers and men; conscription was forbidden; the German general staff was to be dissolved; great quantities of war material were to be handed over, and the future manufacture of munitions rigidly curtailed. German naval forces were to be reduced to a similar scale, while the possession of military aircraft was forbidden. Inter-Allied control commissions were set up with wide rights of supervision to make sure that the disarmament clauses were carried out. A list of those accused of violating the laws and customs of war was to be prepared, and those named were to be handed over to the Allies for trial. Finally, as justification for their claims to reparations, the Allies inserted the famous war-guilt clause, article 231:

> The Allied governments affirm and Germany accepts the responsibility of Germany and her allies for causing all the loss and damage to which the Allied governments and their nationals have been subjected as a consequence of the war imposed upon them by the aggression of Germany and her allies.

All the German parties united in a solemn protest against these terms when the national assembly met in Berlin in the middle of May. The Allies were declared to have flagrantly violated the principles of a just peace proclaimed by Wilson, while the belief that Germany had been tricked into signing the armistice was widespread. The only concession of importance the German delegation was able to secure was the promise of a plebiscite in Upper Silesia. In June the Allies presented an ultimatum, and the German government had to face the alternatives of signing the peace treaty or submitting to an invasion of their country. A strong section of opinion in the army and in the parties of the right was in favour of rejection, whatever the consequences. The Centre and the Social Democrats, although sharing the indignation at the terms proposed, believed that rejection would mean economic ruin and the possible dismemberment of the Reich. Scheidemann, who was personally opposed to acceptance, resigned when his cabinet was unable to agree, and his place as chancellor was taken by Gustav Bauer who formed an administration supported by the Social Democrats and the Centre, but without the Democrats, most of whom joined the Nationalists (Deutschnationale Volkspartei) and the People's party (Deutsche Volkspartei) in opposition. On June 23 a majority of the assembly, persuaded that there was no alternative, voted in favour of acceptance, and the treaty was signed at Versailles on June 28.

The Allies' insistence that the republic should accept a peace settlement universally regarded in Germany as unjust and humiliating contributed powerfully to weaken the new regime. The republic never succeeded in breaking its association with the capitulation of 1918 and the signature of the peace treaty in 1919. For neither of these could the republic's leaders justly be held responsible, but the legend that the German army had never been defeated but was stabbed in the back by the Republicans, the Socialists and the Jews, "the November criminals," was assiduously repeated by the enemies of the republic and, in the mood of resentment created by the treaty, was readily accepted by many Germans. The Republican leaders, to whose sense of responsibility the nation owed the preservation of its unity and the avoidance of far worse disasters in the critical year which followed the request for an armistice, had to endure a campaign of vilification which represented them as traitors to the fatherland. From the ill-omened circumstances of its birth the republic was never able to set itself free.

The Years **of** Crisis, 1920–23.—The Weimar coalition of Social Democrats, Centre and Democrats, which had been the basis of Scheidemann's ministry (February–June 1919) was re-established by Bauer when the Democrats joined his government in Oct. 1919 and maintained by Hermann Miiller (also a Social Democrat) when he took Bauer's place as chancellor at the end of March 1920. The elections of June 6, 1920, however, showed a marked swing against the parties most closely identified with the republic. The Social Democrats' vote fell from 11,509,100 to 6,104,400 and the Democrats' from 5,641,800 to 2,333,700. The Roman Catholic parties, that is the Centre and the Bavarian People's party, had common lists at the election of Jan. 19, 1919, when they collected 5,980,200 votes; on June 6, going to the polls separately, the Centre obtained 3,845,000 votes and the Bavarian party 1,238,600. The opposition parties, the Nationalists and the People's party on the right, the Independent Socialists on the left, all showed heavy gains. This marked the end of the period during which the Social Democrats had been the dominant party in the republic. At the end of June 1920 the Weimar coalition was replaced by a new combination under Konstantin Fehrenbach (Centre), representing the Centre, the Democrats and for the first time the People's party. The inclusion of the People's party, which had raised its votes at the elections from 1,345,600 to 3,919,400, was due to the willingness of its left wing, led by Gustav Stresemann, to co-operate in the development of the republic on the pattern of a bourgeois and capitalist democracy.

Fehrenbach's ministry lasted until May 1921, when it resigned over the issue of reparations and was replaced by a restored Weimar coalition (Social Democrats, Centre and Democrats) under Joseph Wirth (Centre). This remained in office until Nov. 1922.

Throughout the period German politics continued to be dominated by the legacy of the lost war. Relations with France remained bad. Even before the occupation of the Ruhr in 1923, the French twice marched troops into German cities on the grounds that Germany was not carrying out its obligations under the treaty. French attempts to develop a separatist movement in the Rhineland failed but strengthened German impressions of an inflexible hostility and determination to break up the Reich on the part of France.

The plebiscite held in Upper Silesia on March 20, 1921 resulted in a majority for remaining with Germany. Disregarding the treaty provisions for the partition of the area according to the wishes of the inhabitants expressed by communes, Germany claimed that the whole territory should remain German. The Poles retaliated by organizing an armed revolt and attempting a seizure by force. A division of opinion among the Allies. with France supporting the Poles, led to the dispute's being referred to the League of Nations. The league's award, published on Oct. 20, 1921, divided the province, giving two-thirds of the territory to Germany, but leaving the coal mines, the principal industrial areas and a considerable German minority on the Polish side of the frontier. The decision was hotly resented in Germany.

Shortly after the Silesian plebiscite, on April 27, 1921, the Allied reparation commission fixed the total to be paid by Germany at 132,000,000,000 gold Marks. Regarding this as far in excess of the country's capacity to pay, the Fehrenbach government at once resigned (May 4). The Allies retorted with an ultimatum calling on Germany to announce its unconditional acceptance of the figure within six days, under threat of the occupation of the Ruhr. The German leaders were faced with the same dilemma as in June 1919. The Nationalists again took the easy way out by demanding the rejection of the Allies' demand. The Social Democrats and the Centre, impressed by the danger of seeing more of Germany occupied and possibly separated from the Reich, were joined by the Democrats in a renewal of the Weimar coalition, and Wirth, the new chancellor, secured a reluctant vote from the Reichstag in favour of accepting. Once again the Republican parties had been saddled mith the responsibility for carrying out decisions forced on a resentful country by the Allies.

The German government, however, found it impossible to pay the sums required on time. The bad economic and financial situation in the country led to frequent delays, culminating in July 1922 with the request for a moratorium on cash payments until the end of 1924. This request brought to light a sharp divergence between the Allies which led the French to proceed to the occupation of the Ruhr in Jan. 1923 on the pretext of a technical default by Germany in its deliveries of timber.

The Rapallo Treaty.—One may of breaking the hostile ring with which the Germans felt themselves encircled was to make common cause with the other outcast among the European nations, the Soviet Union. This idea was attractive not only to many on the left, but to some on the right, who believed that another war with France was inevitable and were looking for allies. Economic negotiations with Russia in 1921 proved successful and support for a *rapprochement* between the two countries came from Gen. Hans von Seeckt, the commander in chief of the army. Wirth and his foreign minister, Walther Rathenau, were both disillusioned by the difficulties of trying to co-operate with the western powers and were won over to the easterners' point of view. On April 16, 1922, a treaty of friendship was signed between Germany and Russia at Rapallo, establishing normal relations between the two countries, waiving reparations claims by both sides and promising the expansion of Russo-German trade. The treaty was widely acclaimed in Germany as a sign of national independence. The French and British were surprised and angry. No counteraction was taken, but Rapallo no doubt helped to harden French opinion for the trial of strength of 1923. The most important practical consequence was the conclusion of secret agreements between the German and Russian armies, which alloned German officers and units to acquire experience with the Red army and provided opportunities for experiments with the design of forbidden weapons such as tanks and aircraft.

Political Disturbances at Home.—At home, the successive governments had to deal with a situation in which public order nas still insecurely established and the republican regime challenged from both right and left. A workers' rising led by Communists took place in the Ruhr in the spring of 1920, and there was fierce fighting with the army and with the volunteer Freikorps before it was suppressed at the beginning of April. When miners in the Mansfeld district of central Germany took up arms against the police in March 1921, the Communists called for a general strike without success; the miners' resistance was rapidly overcome and order restored.

There was still widespread fear of a German revolution on the model of Russia's. Against this the powerful and moderate Social Democratic party and the trade union movement proved an effective barrier. After the left ning of the Independent Socialists joined the Communists (Dec. 1920), the majority of the Independents drew closer to the Social Democrats and a union of the two parties was achieved in Sept. 1922.

The greater danger to the republic came from the right. As early as March 1920, a coup d'état was attempted by Gen. Walther von Lüttwitz, who commanded the troops in the Berlin area, and Wolfgang Kapp, an East Prussian official who had helped Tirpitz to found the wartime Fatherland Front. With the help of the Ehrhardt brigade, one of the Freikorps formations, they assumed power in Berlin for a few days, while President Ebert and the government withdrew to Dresden. The Kapp *Putsch* honever failed to receive the support anticipated from the army or from the parties of the right (who regarded it as premature), and it was met by the solid resistance of the working class organizations, led by the trade unions, which called a highly successful general strike and forced Lüttwitz and Kapp to abandon their attempt.

Inside the *Reichstag*, the Nationalists kept up an unrestrained campaign against the republic and its leaders. But even the Nationalists were not sufficiently extreme for groups like the German Racial Freedom party in the north or Adolf Hitler's National Socialists in Munich, which combined anti-Semitism and antisocialism with open demands for the overthrow of the republic and an inflammatory nationalism. Closely linked with these groups were semimilitary organizations under a variety of names, drawing their membership largely from ex-servicemen (many of whom had served in the Freikorps after the war), and in close touch with officers in the regular army who provided them with arms and looked upon them as a reserve for the day when they would rise to destroy the republic and avenge the defeat of 1918. From this underworld of conspiracy, which was a breeding ground of the Nazi movement, were recruited gangs like the notorious Organization *Consul* (founded by Capt. Hermann Ehrhardt), which carried out a series of political murders. Among their victims mere Matthias Erzberger (Aug. 29, 1921), one of the leaders of the Centre party, who had signed the armistice, and Rathenau (June 24, 1922), the brilliant Jew who became foreign minister and was assassinated in broad daylight in the centre of Berlin. One of the most disturbing features mas the marked leniency shown by the courts toward political terrorism when practised by the right,

The stronghold of these counterrevolutionary forces was Bavaria. The most powerful party in south Germany, the Catholic Bavarian People's party, made no secret of its antirepublican and particularist views or its sympathy with proposals to restore the Wittelsbach monarchy in Bavaria. Relations between the state government in Munich and the Reich government in Berlin were continually strained by the refusal of the Bavarian authorities to proceed against the extremist organizations which found shelter in their territory, including Hitler's National Socialists who throughout the 1920s were predominantly a Bavarian movement.

The *Ruhr* and *Inflation*.—During these immediate postwar years the value of the Mark steadily deteriorated. This was due to a number of factors, among them reparation payments, the flight of German capital abroad, the obstacles to the revival of German foreign trade and a consequent adverse balance of payments. Faced with budgetary deficits, the German government followed a practice already begun during the war, that of issuing more money to meet its expenses. The result was a runaway inflation more severe than in any other part of postwar Europe. This process was well under way in 1922, during which the value of the Mark in terms of the dollar (pre-1914 relation: $1 = 4.20 M.) fell from 162 M. to over 7,000 M. The culmination of the inflation, however, came in 1923, the year which also saw the climax in the protracted crisis of internal disorder and disunity.

The occupation of the Ruhr by French troops in Jan. 1923 soon led to what was virtually a state of undeclared war between the French and the Germans in the Rhineland. The government formed by Wilhelm Cuno (Centre, People's party and Democrats) which succeeded that of Wirth in Nov. 1922, ordered passive resistance to French and Belgian attempts to get the mines and factories working and a ban on all reparation deliveries. The occupation forces retorted with mass arrests, deportations and an economic blockade which cut off not only the Ruhr but the greater part of the occupied Rhineland from the rest of Germany. This was a most serious blow to the German economy in view of the economic dependence of the rest of the country on the west, especially after the loss of Upper Silesia. On the German side there was resort to sabotage and guerrilla warfare, and for a time the army high command believed that the situation in the Ruhr might lead to open war, a view which led them to encourage the clandestine recruitment of irregular forces to form a Black Reichswehr.

The blockade enforced by the French dislocated the whole economic life of the country and gave the final touch to the depreciation of the currency. The Mark fell to 160,000 to the dollar on July 1; 242,000,000 to the dollar on Oct. 1; and 4,200,000.000 000 to the dollar on Nov. 20, 1923. The price of a single copy of a newspaper, to take one instance, rose to 200,000,000,000 M. Barter replaced other commercial dealings, food riots broke out, and despair seized hold of large sections of the population. The heaviest losers were the middle classes and pensioners, who saw their savings completely wiped out; the drop in real wages however hit the working classes hard. On the other hand, many businessmen and industrialists made large profits and bought up bankrupt enterprises; speculation was rife, and everyone with debts to pay off, such as farmers and landowners with mortgages on their land, gained immensely.

Threats of Disintegration and *Civil War*.—The extremist parties hastened to exploit a situation which undermined the authority of the state and destroyed social cohesion. A separatist movement in the Rhineland was supported by the French; in Saxony and Thuringia the Communists joined the local Social Democrats in the *Land* governments with the intention of carrying out a seizure of power in the Reich (Oct. 1923) and in Hamburg a Communist-led rising occurred on Oct. 23. At the same time the *Land* government in Bavaria openly defied the orders of the Reich government in Berlin. A coup aimed at the restoration of the Wittelsbach monarchy and even at the separation of Bavaria from the Reich appeared imminent, while Hitler and the small National Socialist movement were active in urging the Munich authorities to stage a march on Berlin, in imitation of Benito blussolini's march on Rome the previous year, and to carry out a national revolution against the republic.

In August the Cuno government had been forced to resign in face of a Social Democratic demand for a stronger policy to save the country from the threat of civil war and disintegration. A new ministry was formed by Gustav Stresemann with the support of the People's party, the Centre, the Democrats and (until November) of the Social Democrats. The problems confronting them were overwhelming, but Stresemann proved equal to them. On Sept. 26 he announced the courageous decision to call off the campaign of passive resistance in the Rhineland. This exposed him to violent attacks from the right, but he held to his course ordering the immediate resumption of work in the occupied areas and the lifting of the ban on reparation deliveries. A state of emergency was declared under article 48 of the constitution; the army was used to suppress the danger of a Communist coup in Saxony and Thuringia, the Hamburg rising was put down by the police, and the Reich government threatened drastic action if the Bavarian authorities did not fall into line. In a last effort to force the hand of the Bavarian government, Hitler attempted to stage a Putsch in Munich on Nov. 8–9 without success; the Munich authorities were glad enough to suppress the Nazis and make their peace with Berlin.

Toward Stabilization.— Having mastered the threat of civil war, Stresemann turned to face the problem of the Mark. A new currency, the Rentenmark, was introduced on Nov. 20, 1923, in strictly limited quantities and cover provided by a mortgage on the entire industrial and agricultural resources of the country. The process of stabilization was painful but was pushed through with determination by Hjalmar Schacht, who was appointed currency commissioner on Nov. 12, 1923, and president of the Reichsbank on Dec. 22, 1923.

The drastic action taken by Stresemann to end the crisis proved successful, but his critics on the left and right combined to defeat a vote of confidence on Nov. 23, and he promptly resigned. He was succeeded by Wilhelm Marx (Centre), Stresemann himself retaining the key post of foreign minister. In Feb. 1924 Marx felt secure enough to end the state of emergency, and Stresemann began the negotiations with the Allies which led to the Dawes plan.

The Dawes Plan.—The Ruhr was still occupied by the French. and the question of reparations remained unsettled. Thanks to the efforts of the British and U.S. governments, however, a committee of experts, presided over by a U.S. financier, Charles G. Dawes, was appointed in Jan. 1924 to survey the problem and make recommendations. On April 9 they produced their report, known as the Dawes plan (see REPARATIONS) which was accepted by the Allies and by Germany on Aug. 16, 1924. No attempt was made to determine the total amount to be paid by Germany, but definite proposals were made for the resumption of payments on a scale beginning at 1,000,000,000 gold Marks in the first year and rising to 2,500,000,000 in 1928 and subsequent years. Detailed arrangements were made for raising and transferring these sums, under foreign supervision, while a foreign loan of 800,000,000 RM. was secured to help the German government.

These proposals led to further bitter attacks on Stresemann's foreign policy of "fulfilment" from the German right. But, despite the success of the extremist parties at elections held in May 1924, Marx succeeded in finding a majority for the legislation embodying the Dawes proposals, and in return Stresemann secured the withdrawal of the French troops from the Ruhr.

On Aug. 30, 1924, the Reichsbank was made independent of the government and introduced the new Reichsmark currency with the exchange rate of 1 RM. = 1,000,000,000,000 M.

The year 1925 saw further progress toward stabilization. In Feb. 1925 President Ebert died, and Field Marshal Paul von Hindenburg was elected in his place. The election of Hindenburg, a monarchist and the candidate of the right, was opposed by the republican parties of the Weimar coalition and aroused considerable concern abroad. But, to the general surprise, Hindenburg, by his loyalty to the constitution during his first five years of office, in fact strengthened the republic and did something to reconcile the more moderate members of the monarchist right to the regime.

Locarno Pact.—In foreign policy, helped by the more conciliatory attitude of Edouard Herriot and Aristide Briand in France, Stresemann followed the Dawes agreement by the conclusion of the treaties of Locarno (*q.v.*) on Oct. 16, 1925. By this, Germany reaffirmed its renunciation of Alsace-Lorraine and undertook not to attempt any alteration of its frontiers with France and Belgium by force. The inviolability of these frontiers was guaranteed by the signatory powers, which included Great Britain and Italy. The treaties of Locarno were followed by the Allies' evacuation of the first (Cologne) zone of the occupied Rhineland, a withdrawal completed on Jan. 30, 1926, and by Germany's entry into the League of Nations with a permanent seat on the council in Sept. 1926.

The Locarno pact was regarded with grave suspicion by the Russians who feared that Germany might join the western powers in an anti-Soviet bloc. To reassure them, Stresemann signed a new Russo-German treaty in Berlin on April 24, 1926, confirming and extending the friendly relations established at Rapallo. Unlike Stresemann's agreements with the western powers, the treaty of Berlin received the unanimous approval of the German parties, including those of the right. A series of commercial treaties, completed in these years, began to restore German foreign trade. At the end of Jan. 1927, the Allied military control commission was withdrawn and, urged on by Stresemann, the League of Nations began to examine the problem of general disarmament. When the Kellogg-Briand pact to outlaw war was proposed, the German foreign minister accepted an invitation to go to Paris for the ceremony of signature, and was warmly received in the French capital (Aug. 27, 1928). In the five years since the crisis of 1923 Germany had thus made considerable progress toward regaining a position in Europe corresponding to its size and importance. This was almost entirely due to Stresemann.

Following the Dawes plan and the treaties of Locarno, large foreign investments were made in Germany, mostly in the form of short-term loans. As a result, the period from 1925 to the end of 1928 was one of remarkable prosperity in Germany. Private industry, the states, the municipalities and the churches, as well as the Reich, used these foreign loans to finance lavish expenditure. German industry was re-equipped, large public works undertaken; production boomed, unemployment was low and wages high; reparation payments were promptly met.

Party Politics and the Elections of *1924 and* 1928.—Throughout the years from 1924 to 1928 Germany was governed by a succession of coalition cabinets based on the three bourgeois parties, the Centre, the Democrats and the People's party. From the end of 1923 to the end of 1924 the office of chancellor was held by Marx (Centre); from Jan. 1925 to May 1926 by Hans Luther, a former minister of finance; and from May 1926 to May 1928 again by Marx. Elections were held twice in 1924, on May 4 and on Dec. 7. On the first occasion, the effects of the crisis and inflation were reflected in the marked gains of the extremist parties: Nationalists from 4,249,100 (in 1920) to 5,696,500; the combined list of Nazis and other racist parties, 1,918,300; the Communists from 589,500 to 3,693,300. Democrats and the People's party lost heavily, but the Social Democrats and the Centre, supporting the republic, held their ground. In December the Nationalists registered further gains, obtaining 6,205,800 votes, but the Nazis and their allies lost 1,011,000 votes, and the Communists fell back to 2,709,100. The republican parties regained many of the votes they had lost: Social Democrats 7,881,000 instead of 6,008,900 (May 1924); Democrats 1,919,800 instead of 1,655,100; People's party 3,049,100 instead of 2,694,400; Centre 4,118,900 instead of 3,914,400.

Opposition, apart from that of the Communists and the extreme right, came principally from the Social Democrats and Nationalists. The Social Democrats supported Stresemann's foreign policy and were loyal to the republic, but opposed the social and economic policies of governments which in their opinion were too much under the influence of industrial and business circles and too lenient toward the antirepublican forces on the right. The Nationalists, violently critical of Stresemann's foreign policy, were sharply divided in their attitude to the republic; representatives of the more moderate section were brought into their cabinets by both Luther and Marx, but were forced out again by the opposition of the party's irreconcilables led by Alfred Hugenberg.

In 1926 the question of compensation for the deposed princely houses excited prolonged controversy. A bill to provide generous compensation was challenged by the Social Democrats and Communists, who demanded a plebiscite. Over 14,000,000 people voted in favour of expropriation without compensation, but this fell short of the majority required by the constitution and the compensation bill was passed by the Reichstag. Social Democratic criticism of the army administration and clandestine rearmament roused another storm in the same year. General von Seeckt, the commander in chief of the army was obliged to resign, but the independent position of the army in the state which Seeckt had re-established was not impaired, and President Hindenburg made it plain that he would use all his influence to prevent civilian interference. The following year, Marx's government was responsible for two of the major achievements of the Weimar republic in social legislation, a comprehensive scheme of unemployment insurance covering 16,000,000 people and the extension of state arbitration in labour disputes.

On May eo, 1928, the German people again went to the polls. The most striking feature of the results was the gain made by the Social Democrats who received 9,151,100 votes. The Communists also gained support, receiving 3,263,400. This swing to the left was emphasized by the loss of votes by all the other big parties, including the Nationalists, whose vote fell to 4,380,000, and by the N.S.D.A.P. (Nationalsozialistische Deutsche Arbeiterpartei)—the Nazis—who got no more than 809,800 votes. On June 28, 1928, Hermann Muller, a Social Democrat. formed a cabinet in which the People's party, the Democrats and the Centre joined; Stresemann remained at the foreign ministry.

The Young Plan.—The first tasks of the new government were to secure a definitive settlement of the reparation question and the complete evacuation of the Rhineland. The question the nation most wanted to see answered was one on which the Dawes plan had nothing to say: the total amount Germany had to pay in reparations and the length of time over which payment was to be spread. On Feb. 11, 1929, a new committee of experts under the chairmanship of another American, Owen D. Young, set to work to produce a final plan. This time, the Germans themselves were represented in the discussions. After months of difficult negotiations, an agreed report was produced on June 7. The plan was negotiated and accepted with certain modifications at the two Hague conferences (Aug. 1929 and Jan. 1930) and came into force on Sept. 1, 1930. Total reparations were fixed at 121,000,000,000 RM., to be paid in 59 annuities, the present value of which was 39,000,000,000 RM. The foreign controls over German economic life established by the Dames plan were abolished, and the Bank of International Settlement was set up to handle the financial problems involved in transferring these amounts.

Before the Young report was published the Nationalists had launched an even more violent campaign than at the time of the Dawes plan against accepting it. Under the leadership of Alfred Hugenberg they joined forces with the Nazis in organizing a plebiscite in favour of a bill refusing all further obligations to pay reparations and declaring the chancellor and his ministers to be punishable for treason if they accepted new financial commitments. It mas during this campaign that the Nazis, financed by the Nationalists and their friends among the industrialists, made their first appearance on the national political scene. The plebiscite, however, failed completely, and a revolt against Hugenberg's leadership led to a break away from the Nationalist party under Gottfried Treviranus. Stresemann had secured from the Allies, at the same time that he accepted the Young plan, a promise to evacuate the whole of the Rhineland by June 1930. This was a decisive argument and the bills embodying the Young legislation were passed by the Reichstag in March 1930. By then Stresemann himself was dead (Oct. 3, 1929), worn out by the double strain of negotiating with the Allies and defending his policy against the attacks made on it by the right in Germany. Stresemann was the outstanding political figure of the Weimar republic and one to whom the German nation owed a great debt. His place was taken by Julius Curtius and his policy continued by the Müller government.

The End of the Republic.—On assuming office, Müller had spoken optimistically of the future and declared that the foundations of the republic were now firmly laid. The nation however was still divided. There was a sharp conflict of class interest between capital and labour, while the hostility of the Communists and of the Nationalists and Nazis to the republican regime was unconcealed. These weaknesses were clearly revealed in the second great economic crisis which the republic had now to face.

The basis of German prosperity in the later 1920s was precarious. Germany's economic recovery was too dependent on foreign credits. When these dried up and the loans already made were called in, Germany was plunged into a slump which was more severe than that experienced by any other country. Signs of this were already apparent at the beginning of 1929. With the crash on the New York stock exchange in Oct. 1929 and the beginning of the world depression, conditions in Germany rapidly went from bad to worse. Unemployment figures shot up; foreign trade was drastically curtailed; wages fell and the number of bankruptcies increased daily. The effects of the slump were felt by all sections of the community, by the farmers as much as by the urban population, by the shopkeeping, professional and white-collar classes as much as by the industrial workers. Nor were these effects limited to the economic field and to the hardship and insecurity suffered by millions who only a few years before had experienced the rigours of the inflation. The depression had immediate repercussions in the political field, undermining the foundations of the republic and producing a notable increase in the support for the extremist parties both on the left and on the right. Within two years the Nazis shot up to the first and the Communists to the third place among the German parties. In 1933 Hitler told a Munich audience: "We are the result of the distress for which the others are responsible." The depression was the indispensable condition for the Nazis' rise to power.

The immediate consequence of the slump was the breakup of the coalition government under Müller. Sharp differences of opinion divided the parties on the share of the burden to be borne by the different classes they represented. The particular issue in dispute was a proposal to cut unemployment benefit payments. To this the Social Democrats were strongly opposed, and on March 27, 1930, the Muller cabinet resigned.

Briining and *Schleicher*.—The man selected by Hindenburg to form the next government was Heinrich Briining, a 46-year-old member of the Centre party who had not previously held high office. His first concern was to pass the budget, but he was unable to secure a majority in the Reichstag for his proposals. The conflict of sectional interests was sharpened by the deterioration in the country's economic situation. Briining's appeal to the Reichstag to rise above party differences and look at the problem from a national point of view was met by the rejection of an essential part of his fiscal program (July 16, 1930), the Social Democrats combining with the Communists, Nationalists and Nazis to make up the hostile majority. Faced with a parliamentary deadlock, Briining resorted to the use of the president's emergency powers under article 48 to put his program into effect by decree (July 16, 1930). Such a possibility had been envisaged at the time of Briining's appointment to the chancellorship by the small group of men round the president, prominent among whom was Gen. Kurt von Schleicher, head of the ministerial office in the ministry of defense, a man who exercised great influence behind the scenes and who was convinced that the crisis could not be overcome by the compromise measures of coalition government. It was Schleicher who had suggested Bruning to Hindenburg as chancellor, and Briining, although sincerely attached to parliamentary institutions. accepted the view that the economic situation called for the use of emergency methods. His action, which overrode the principle of ministerial responsibility, was promptly challenged by the Social Democrats who succeeded in defeating the chancellor for the second time in the Reichstag. Briining at once took up the challenge and ordered the dissolution of the chamber, fixing the elections for Sept. 14, 1930. Both at the time and subsequently, in the light of later events, Bruning's decision to resort to the methods of presidential government and to go over the head of the Reichstag has been the subject of much controversy.

The results of the elections, held in an atmosphere of public disorder for which the Nazis and Communists were chiefly responsible, mere disconcerting. Bruning's appeal from the Reichstag to the nation failed. The impact of the depression on German society was reflected in the sensational rise of the Nazi vote from 809.800 (1928) to 6,406,379 (or 18.3% of the total) and that of the Communists from 3,263,400 to 4,590,160 (13.1%). The Social Democrats remained the strongest party in the Reichsfag, obtaining 8,575.244 (24.5%) votes. The Centre party won 4,126,900 (11.8%) votes. Hitler's party, campaigning on a platform of violent nationalism, antidemocratic and anti-Semitic radicalism, overnight moved from the position of ninth to that of second party in the state. Hitler insisted that he meant to come to power by legal means, a plan from which he never diverged, but the methods of demagogic propaganda and organized violence with which his campaign had been conduct??, as well as the character of the brown-shirted Nazi storm troopers, were patently incompatible with the continuation of parliamentary democracy. In the circumstances of the early 1930s, however, this acted as an attraction for all those who for the most varied reasons were in revolt against the system by which Germany had been governed since the war and which Hitler violently denounced.

Despite the result of the elections, Briining decided to remain in office. He had to face the noisy opposition of the Nazis and the Communists who attacked his government as unconstitutional and proceeded to reduce parliamentary procedure to a prolonged brawl. The Social Democrats, however, alarmed at the threat to the republic from the rising power of the two extremist parties, rallied to the chancellor's support, although they were critical of the deflationary policy he was pursuing. This provided Briining with sufficient votes to defeat the frequent motions of no confidence, while he put his program into effect by presidential decree.

The measures introduced by the government failed to check the slump. In an effort to break through the economic barriers separating the nations, Curtius, the foreign minister, proposed an Austro-German customs union (March 24, 1931) which would have had the additional advantage of placating the large body of opinion in both countries in favour of the combination of the two German states. France and Italy were strongly opposed to such a move and forced the German government to abandon it (Sept. 1931), a further blow to Bruning's prestige.

In July 1931 a severe financial crisis led the big Darmstadt and National bank to close its doors, and in September the figure for registered unemployment reached 4,300,000. On Oct. 3 (after the withdrawal of the customs union proposal) Bruning used the occasion of Curtius' resignation to reconstruct his cabinet, assuming the office of foreign minister himself. His dour struggle to master the economic situation continued, and he displayed unusual courage and integrity in the way he stood up to criticism and unscrupulous opposition, but success still eluded him. In the early months of 1932 unemployment passed the 6,000,000 mark.

In these circumstances the prospect of a presidential election in 1932, when Hindenburg's term of office expired, was alarming. Briining sought the agreement of the party leaders to a prolongation of the president's term until the crisis was over. Thanks to the opposition of Hitler and Hugenberg, this proposal was rejected and on March 13 elections for the presidency were held, with Hitler and three other candidates competing against Hindenburg. The result was a triumph for the old field marshal, now 84, who polled 18,661,736 votes to Hitler's 11,328,571. A second election, on April 11, made necessary by Hindenburg's failure to secure an absolute majority by 0.4%, raised the field marshal's vote to 19,359,642 and Hitler's to 13,417,460. The chief reason for Hindenburg's success was the decision of all the republican parties, including the powerful Social Democratic party, to vote for him as the defender of the constitution against the extremists. This trust was soon to be disillusioned.

The political struggle in Prussia, the largest of the German *Länder* or states, was scarcely less important than that in the Reich. Since 1920, Prussia had been governed by a stable coalition of the Social Democrats and Centre under the leadership of two Social Democrats, Otto Braun and Karl Severing. The Prussian government was regarded as the principal bulwark of German democracy and as such was a special object of the extremists' hatred; in particular, they wished to get control of the Prussian police force out of the hands of Severing. At the state elections on April 24, 1932, the Nazis scored another big success, becoming with 162 seats out of a total of 428 the largest party in the Prussian *Landtag;* they were unable to form an administration themselves, but the Social Democrat-Centre coalition had been defeated and only remained in office as a caretaker ministry until the political deadlock could be resolved.

Brüning hoped to offset the unsuccessful record of his government at home with successes abroad. He sought to secure the abandonment of reparation payments in view of Germany's desperate economic situation and the recognition of Germany's right to equality of armaments in view of the Allies' failure to disarm. There was considerable support for the cancellation of reparations on the Allied side, but Bruning's hopes were dashed by the postponement of the proposed conference until June 1932. Although the disarmament conference opened in February, French opposition rapidly brought it to a standstill, and here too Brüning failed to achieve any success.

Meanwhile intrigue among the president's camarilla, in which Schleicher played a leading part, led Hindenburg to withdraw his confidence from Brüning (May 30, 1932). Dependent upon the president's willingness to continue to sign emergency decrees, Brüning had no option but to resign, an event which may be regarded as decisive for the fate of German democracy. Brüning's program had raised powerful enemies among the industrialists and Junker landowners, and Schleicher turned against his former nominee when he failed to produce the government of national unity which was Schleicher's political objective. Once Brüning had secured the re-election of the president, his usefulness in Schleicher's eyes had been exhausted.

Papen and Schleicher.—One of the last acts of Brüning's government had been to impose in April a ban on the Nazi SA. *(Sturmabteilungen)*. Schleicher secured Nazi tolerance for his new nominee, Franz von Papen, on condition that the ban should be lifted and new elections held at once. Papen, although nominally a member of the Centre, was repudiated by that party, which remained loyal to Brüning, and on June 2 formed a nonparty cabinet, known as the cabinet of barons from its high percentage of members of the aristocracy with right-wing views. Schleicher became minister of defense.

Papen's government was highly unpopular in the country, but he relied upon the support of the president (and of the army), and he was fortunate enough to secure the success in foreign policy denied to Brüning. At the Lausanne conference on July 9, 1932, reparations were virtually abolished in return for a payment of 3,000,000,000 RM. into a general fund for European reconstruction. On July 20, 1932, Papen turned out the Braun-Severing government in Prussia on the pretext that it was unable to maintain public order and appointed himself Reich commissioner for Prussia. The Social Democrats, hamstrung by the attacks of the Communists on them as traitors to the working class, allowed Papen's action to pass without effective challenge and failed to call a general strike.

Immediately afterward elections to the *Reichstag* were held (July 31, 1932) and resulted in a Nazi triumph, 13,732,777 (37.4%) votes and 230 in place of 107 seats in the *Reichstag*. The old middle class parties, the People's party and the Democrats (now reorganized as the Deutsche Staatspartei) were practically wiped out but the Centre actually increased its vote to 4,586,501 (12.2%) ; the Communists also increased their votes to 5,278,094 (14.3%); and the Social Democrats got 7,951,245 (24.3%) votes. Papen agreed with Schleicher that it was necessary to bring the Nazis in and to make them share the responsibility for governing the country, but he hoped by holding out to force Hitler to accept office on his and not Hitler's terms. When the *Reichstag* met in Sept. 1932, the Nazis succeeded in massing an overwhelming vote against Papen, but he promptly dissolved the chamber and fixed new elections for Nov. 6, governing in the meantime by emergency decree.

At the November elections the Nazis got 11,737,391 (33.2%) votes, losing ground to the extent of 1,995,386 votes, but Schleicher, alarmed at the prospect of the deadlock continuing and at the further increase in the Communist vote, 5,980,540 or 17%, forced Papen's resignation on the grounds that the army could not deal with a double threat of civil war from both the Nazis and the Communists and that Papen's attempt to beat Hitler down was only increasing the danger of such a situation. Schleicher then took office himself as chancellor (Dec. 3, 1932). Hindenburg, however, had been alienated by Schleicher's intrigues against Papen and when Schleicher in turn failed to win the support of the other parties or to bring the Nazis into his government, Hindenburg declined to give him the power to dissolve the *Reichstag*. In the meantime, Papen had made contact behind the scenes with Hitler and the Nationalists, and was able to offer the president the prospect of a coalition which had a chance of securing a majority in the chamber. Hitler was driven by the declining fortunes of the Nazi party to accept considerably less than the demands he had made earlier in 1932, but he secured the chancellorship for himself. Papen, for his part, was convinced that he had tied Hitler's hands by forcing him into a coalition in which the Nazi ministers were heavily outnumbered, and in which he himself became vice-chancellor as well as Reich commissioner for Prussia. On Jan. 30, 1933, the coalition assumed office, and Adolf Hitler became chancellor of Germany, legally and not by revolution.

THE THIRD REICH

The Nazi Revolution. — In the coalition cabinet the Nazis held only 3 out of 11 seats. They had Hitler as chancellor, Wilhelm Frick as Reich minister of the interior and Hermann Goring (who became Prussian minister of the interior) as a Reich minister without portfolio. The Nazis were thus heavily outnumbered, and none of the key ministries were in their hands. The ministry of economy and that of food and agriculture, both in the Reich and Prussia, were held by Hugenberg, the leader of the Nationalists; the foreign ministry by Konstantin von Neurath, a career diplomat of conservative views; the ministry of defense by Gen. Werner von Blomberg. As vice-chancellor, Papen claimed the right to be present on all occasions when the chancellor saw the president and as Reich commissioner for Prussia he controlled the principal administrative machine in Germany. In this way Papen believed that he had tied Hitler's hands and effectively blocked any threat of extremist action by the Nazis. He was to be rapidly disillusioned.

Hitler's first step was to persuade his colleagues in the cabinet to agree to new elections in order to provide a majority in the *Reichstag;* he overcame their doubts by a categorical promise that, whatever the results, no change would be made in the composition of the coalition. The elections were fixed for March 5, 1933, and the Nazis made full use of the power they now possessed over the apparatus of the state, including the radio, to launch a whirlwind campaign. Although the other parties were still allowed to function, their meetings were broken up, their speakers assaulted and their newspapers continually suppressed. Goring, in control of the Prussian police force, displayed great energy in carrying out a purge of the police which placed the force under Nazi control; in addition, he called up 50,000 auxiliary police, the majority of them SA. and SS. (*Schutzstaffeln*). The police were forbidden to interfere with the many acts of intimidation carried out by the SA. who were thereby given the "freedom of the streets" for which they had long clamoured.

On the night of Feb. 27 the *Reichstag* building was destroyed by fire. It appears to have been secretly set alight by a Nazi gang under the direction of Karl Ernst, leader of the Berlin SA. group; the blame however was laid on the Communists, and on the pretext of a Communist plot to seize power the constitutional guarantees of individual liberty were suspended and the Reich government given emergency powers. It was in this atmosphere of fear and insecurity that the elections were held a week later. The Nazis increased their share of the votes cast to 17,265,823 (43.9%). They failed however to secure the outright majority for which they had hoped, and both the Centre party and the Social Democrats held firm, the former getting 4,423,161 (10.9%) and the latter 7,176,505 (18.3%). Even the Communists lost only 1,135,161 votes and polled 4,845,379 (12.1%). It was only with the help of his Nationalist partners (3,132,595 votes or 8%) that Hitler secured a bare majority of 288 plus 52 seats in a house of 647 deputies.

Hitler's next step was to secure the passage of an enabling act which would give the government the power to issue decrees independently of the *Reichstag* and of the president. For this he required a two-thirds majority in the Reichstag. The 81 Communist deputies were either arrested or excluded; the support of the Kationalists and of the Centre party (73 seats) was obtained by assurances and promises, and the Social Democrats who alone opposed the bill (March 23) were outvoted by 441 to 94. The Enabling act remained the constitutional basis of Hitler's dictatorship. No new constitution was ever introduced to replace that of the Weimar republic, which was simply suspended; fresh laws were promulgated as they were required.

Armed with these overriding powers, which he had been careful to obtain without formally infringing on the principle of legality, Hitler proceeded to carry out a revolution with the authority of the state on his side. The guarantees to which Papen and Hugenberg had trusted proved of no avail, and the Nazis took over and remodelled one after another of the country's institutions.

A series of decrees culminating in the Law for the Reconstruction of the Reich (Jan. 30, 1934) abolished the Land diets, transferred the sovereign powers of the Lander to the Reich and subordinated their administrations to the authority of the central government. In May 1933 the trade unions organization was suppressed and the unions merged into a German labour front under Robert Ley. This was followed in the course of the summer by the suppression or "voluntary" dissolution of the other political parties, including the Nationalists. Hitler's partners in the coalition. On July 14, 1933, the Nazi party was formally declared to be the only political party in Germany.

Opposition to these measures in the cabinet crumpled before the wave of revolutionary violence which swept over the country. Papen was shorn of his authority as Reich commissioner for Prussia. being replaced by Goring. and was quite unable to withstand the unscrupulous methods employed by Hitler and his lieutenants. Hugenberg was unable to prevent the dissolution of his own party and was forced to resign at the end of June 1933. The Nazi group in the cabinet was strengthened by the inclusion of Josef Goebbels as minister of public enlightenment and propaganda (March 14, 1933), but in fact the cabinet had ceased to count, and all decisions were taken by the Nazi leaders on their own authority.

There was, however, a point beyond which the process of Gleichschaltung (co-ordination), the current euphemism for Nazi seizure of control, could not be carried without seriously endangering the efficiency of the state and of the German economy. This was a threat to which Hitler, now the head of the government as well as the leader of a party, could not remain indifferent. During the summer of 1933 Hitler began to call a halt and declared openly that the revolution could not become a permanent state of affairs. The plans of the radical wing of the party to replace the capitalist economy by some form of corporate organization under state control were abruptly repudiated. Hitler could not afford to quarrel with the big industrialists and financiers, and from June 28 Hugenberg's successor at the ministry of economy was Kurt Schmitt, director general of the biggest insurance company in Germany, while Schacht, the new president of the Reichsbank (appointed on March 16), set his face firmly against radical anti-capitalist experiments.

The Roehm *Affair*.—There was considerable opposition to Hitler's new policy of stabilization, both from the more radical section of the Nazi movement and from those who had been left out in the scramble for positions and wanted no end to the revolution until they had been provided for. This opposition found its focus in the SA. and its leader in the SA. chief of staff, Ernst Roehm, who openly expressed his dislike of any compromise with the "reactionaries." From the summer of 1933 to the summer of 1934 this question of the so-called "second revolution" formed the dominant issue in German politics.

During the first half of 1934 the conservative forces in Germany came to look more and more to the army with its particular claim to the loyalty of the president, the aged Hindenburg, to withstand the demands of Roehm and the Nazi radicals for a renewal of the revolutionary process. The army leaders were inflexibly opposed to Roehm's plans for the incorporation of the SA. in the army as the basis for the expansion of Germany's armed forces. Hitler for his part was anxious to avoid an open quarrel. He needed the help of the generals in carrying out the rearmament of Germany; he recognized the importance of the army leaders' benevolent neutrality in agreeing to his assumption of power in 1933; and he was anxious to secure their support for his succession to the presidency (which included the supreme command of the armed forces) when Hindenburg, now in his 87th year, should die. For these reasons he could not afford an open clash with the army which still remained the most powerful independent institution in Germany.

The crisis came to a head in June 1934 and was touched off by Papen, who on June 17 delivered a speech at the University of Marburg in which he gave expression to the anxieties of the whole nation. Hitler now knew that Hindenburg had only a few weeks to live, and on June 21 when he flew to see the president at his country home he was met with an uncompromising demand, presented by the minister of defense, General von Blomberg: either the government must bring about a relaxation of the state of tension or the president would declare martial law and hand over power to the army.

Roehm had powerful enemies inside the party, notably Göring and Heinrich Himmler, the Reichsfiihrer of the SS., the party corps *d'élite*. When Hitler reluctantly made up his mind to take action against Roehm and the SA. leadership, it was Goring and Himmler who carried out the preparations for the purge. On the pretext of an SA. plot for a coup d'état, Roehm and his chief lieutenants were seized on the week end of June 30, 1934, and executed without trial. The opportunity was also taken to settle other accounts which had no connection with the SA. or the "second revolution": among those murdered were the former chancellor General von Schleicher and the former Nazi leader Gregor Strasser. A month later, on Aug. 2, President Hindenburg died, and with the agreement of the army leaders Hitler was proclaimed as his successor. The office of president and supreme commander was merged with that of chancellor, and Hitler assumed the title of Fuhrer und Reichskanzler. On Aug. 19 a plebiscite confirmed his new office by 88.2% of 43,529,710 votes cast.,

The crisis of June 1934 was the turning point of the regime. Although the army leaders congratulated themselves on the outcome, it was Hitler who after a period of hesitation had triumphantly reasserted his authority. Forced to choose, he had struck at the radicals and repudiated the "second revolution" but in doing so had used methods which only underlined the radical and revolutionary character of the regime he had established.

The Totalitarian Police State.—The years between 1934 and World War II saw the steady elaboration of the power of the totalitarian police state. The principal instrument of control was the unified police, security and SS. organizations under the direction of Himmler and his chief lieutenant, Reinhard Heydrich. Neither opposition nor dissent was tolerated. Schools. universities, the press, the theatre and the arts were forced to follow the pattern of Nazi regimentation, and the most determined efforts were made to indoctrinate the younger generation with the Nazi ideology through the schools and such organizations as the Hitler Youth. The concordat which the Vatican signed with the new German government on July 8, 1933, did not protect the Catholic community in Germany from constant interference and persecution by the Nazi authorities. The refusal of the German Protestants to accept the authority of the Nazi-sponsored German Christian movement led to an equally bitter conflict between the Protestant churches and the state, in the course of which many Protestant pastors, including Martin Niemoller (July 1937) were arrested and ill-treated.

Treatment of Jews.—The regime showed particular vehemence toward the Jews who were singled out for attack from the first day of Hitler's chancellorship. A law of April 7, 1933, decreed the dismissal of the Jews from government service and the universities; they were also debarred from entering the professions. Under the Nuremberg laws of Sept. 15, 1935, marriages between Jews and persons of "German blood" were forbidden, and the Jews were virtually deprived of all rights. Their persecution reached its climax in the pogrom of Nov. 9–10, 1938, carried out under the direction of the SS. On one pretext or another the greater part of all Jewish property was confiscated, and the surviving Jews were restricted to a ghettolike existence until the war when they were systematically put to death in different extermination camps. Altogether, in German-occupied Europe, out of a total of about 8,300,000 Jews, 6,000,000 were so killed or died of starvation or disease.

Rearmament.—By an extensive program of expenditure on public works—afforestation, land improvement, road building, etc.—the Nazi government succeeded in reducing the number of registered unemployed from over 6,000,000 in Jan. 1933 to 2,600,000 in Dec. 1934. From 1935 onward rearmament on a massive scale rapidly changed the problem from one of mass unemployment to one of an acute labour shortage. This remarkable recovery however did not lead to any comparable rise in the standard of living, which was deliberately held down by wage and price stabilization in order to permit the diversion of the greatest possible proportion of the national resources to the creation of a powerful military force.

All other considerations were sacrificed to Hitler's demand for the rearmament of Germany at double the rate which the military and economic experts thought possible. In Sept. 1936 Hitler proclaimed a four-year plan and appointed Goring with plenipotentiary powers to remove the obstacles which were holding up rearmament. Schacht, who became minister of economic affairs on Aug. 2, 1934, and to whom Hitler owed the expert planning of the finances of German rearmament as well as the elaborate network of controls over German foreign trade, became more and more critical of the reckless way in which the arms program was being pushed through and on Nov. 26, 1937, resigned from his post as minister of economics. Although Schacht remained minister without portfolio at Hitler's insistence and until Jan. 20, 1939, president of the Reichsbank as well, from the end of 1937 Goring was able to carry out Hitler's economic plans in preparation for war without hindrance. Germany's expenditure on armaments is estimated at over 51,000,000,000 RM. in the six years before 1939, rising from under 2,000,000,000 RM. in 1933–34 to 10,000,000,000 RM. in 1936–37 and 16,000,000,000 in 1938–39.

Shortly after Schacht's final resignation, Hitler successfully reorganized the two principal institutions which had so far escaped the process of Gleichschaltung—the army and the foreign service. He used the pretext of Field Marshal von Blomberg's *mésalliance* and a trumped-up charge of homosexuality against Gen. Werner von Fritsch to secure the removal of the first as minister of defense and of the second as commander in chief of the German army. Thereupon he assumed Blomberg's office of commander in chief of the armed forces himself and abolished the ministry of defense, replacing it by a separate high command of the armed forces (*Oberkommando* der Wehrmacht, O.K.W.) which in fact acted as his personal staff. Sixteen of the senior generals were retired, others were transferred to different posts.

At the same time Neurath was relieved of his post as foreign minister and replaced by the subservient Joachim von Ribbentrop, while the three ambassadors in the key posts of Vienna (Papen), Rome (Christoph Hassell) and Tokyo (Herbert von Dirksen) were all recalled. Finally, the insignificant Walther Funk assumed office at the ministry of economics after it had been stripped of the independent powers exercised by Schacht. By these measures, carried out in Feb. 1938, Hitler removed the few checks which still remained upon his freedom of action, and the last occasion on which the German cabinet met during the Third Reich was to hear the *Führer's* announcement of the changes he had proposed. Henceforth until the end of the war, Hitler's arbitrary power over Germany was complete.

Hitler's **Talk** of Peace—From the time that he first went into politics Hitler had been an uncompromising nationalist, and from the time that he came to power his unswerving aim was to overthrow the peace settlement of 1919 and reverse the verdict of 1918 by establishing a German hegemony in Europe. For the first few years, however, these aim: had lo be disguised until German rearmament had made progress, and Hitler showed great skill in soothing the anxieties of the other powers by his constant talk of peace.

On Oct. 14, 1933, Germany withdrew from the League of Nations and the disarmament conference. This was represented as a protest against the hypocrisy of the victor nations in refusing to keep their promise to follow Germany's example after they had forced it to disarm. The nonaggression pact with Poland, signed on Jan. 26, 1934, was used by Hitler as further evidence of his eagerness for peace, and when a Nazi rising in Austria on July 25, 1934, failed to secure power, he was quick to repudiate his followers and send Papen to Vienna on a mission of conciliation.

With the reunion of the Saar with Germany, following the plebiscite of Jan. 13, 1935, which had shown a 90.36% vote in favour of a return to the Reich, Hitler declared that all causes of dispute between Germany and France had been removed and that he renounced any claim to Alsace-Lorraine. He evaded British and French schemes for a general European settlement, however, and on March 16, 1935, announced that Germany was reintroducing conscription with the aim of creating a peacetime army of 35 divisions. This open repudiation of the treaty of Versailles involved a considerable risk, but the gamble came off; the other powers contented themselves with protests, and Hitler was encouraged to take bigger risks in future.

During the next few years Hitler played with remarkable success upon the divisions between the other European powers. He persuaded the British to sign an Anglo-German naval treaty (June 18, 1935) which was much resented in France, and he soon became the principal beneficiary of the quarrel between Italy and the western powers over Abyssinia. The outbreak of the civil war in Spain in 1936 enabled him to establish close working relations with Mussolini (Oct. 20–24, 1936) and perpetuated the conflict between Italy on the one hand and Great Britain and France on the other. Using the Spanish civil war as his text Hitler now redoubled his propaganda campaign against the dangers of communism with very considerable success in dividing and confusing public opinion in the western countries.

The ratification of the Franco-Soviet treaty of mutual assistance of May 2, 1935, provided him with a convenient pretext for the denunciation of the Locarno pact and the remilitarization of the Rhineland (March 7, 1936). The fact that this second open breach of the Versailles treaty was allowed to pass without effective challenge not only increased Hitler's confidence but had immediate repercussions in the alignment of the smaller powers. The alliance system which the French had built up in eastern Europe after 1919 began to show signs of strain.

On Nov. 25, 1936, Ribbentrop concluded the anti-Comintern pact with Japan, which gave a strong fillip to Hitler's anti-Bolshevik propaganda campaign, and a year later (Nov. 6, 1937) he secured the adhesion of Italy to the pact after Mussolini's state visit to Germany in Sept. 1937. By the end of 1937 Hitler was ready to take the offensive in foreign policy. German rearmament had already made considerable progress; he was convinced that France and Britain would never fight; he had driven a powerful wedge between the Soviet Union and the western powers; and he had won Italy away from the Anglo-French camp to close co-operation with himself.

Peaceful Annexations.—Hitler's first objective was the annexation of Austria, which had been forbidden by the peace settlement of 1919. After the unsuccessful Putsch of 1934, Hitler for a time had to go carefully in his relations with the Austrian republic. Then closer co-operation with Mussolini, who had hitherto been the most determined opponent of an Anschluss, opened up new possibilities. On July 11, 1936, a so-called gentlemen's agreement was concluded between Germany and Austria which ostensibly placed German-Austrian relations on a firmer footing but was used by the German government as a means of exercising pressure on Kurt von Schuschnigg's government in Vienna. Hitler explicitly forbade the Austrian Nazis to attempt another rising. He sought to preserve the façade of legality while applying political pressure under the threat, but without the overt use, of force. In accordance with this policy, on Feb. 12, 1938, Schuschnigg, the Austrian chancellor, was bullied into accepting far-reaching demands during an interview with Hitler at

Berchtesgaden. Schuschnigg's subsequent decision to hold a plebiscite, however, forced Hitler to act quickly and on March 12, 1938, German troops occupied Austria, 24 hours before the plebiscite was due to be held.

Once again the other powers failed to do more than utter solemn protests, and Hitler rapidly turned toward his second objective, the disruption of the Czechoslovak republic, The pretext in this case was supplied by the demands of the Sudeten German minority in Czechoslovakia for greater autonomy. These demands were skilfully used by Hitler to create a situation in which Czechoslovakia's ally, France, and Great Britain brought heavy pressure to bear on the Prague government to make far-reaching concessions in order to avoid war. This situation culminated in Neville Chamberlain's direct intervention in Sept. 1938 to secure Czech acceptance of Hitler's ultimatum for the cession of the Sudetenland to Germany (Munich conference, Sept. 29–30, 1938). Hitler in fact aimed at far more than this, at the breakup of the Czechoslovak state, and soon came to look upon the Munich settlement as a mistaken concession which had balked him of his entry into Prague. His hostility toward the Czechs was unappeased, and in March 1939 he used the smouldering quarrel between the Slovaks and the Czechs to create a further crisis which served as his pretext for the occupation of the whole of Bohemia and Moravia (March 15). Before the end of the month he followed this by the delivery of an ultimatum to Lithuania (March 20) and secured the return of Memel to the Reich from which it had been separated in 1919.

Poland's Refusal.—Shortly after the Munich settlement, Ribbentrop had opened yet another claim by suggesting to Jozef Lipski, the Polish ambassador to Germany (Oct. 24, 1938), that Poland should agree to the return of the free city of Danzig to the Reich and the construction of a German extraterritorial road and railway across Polish Pomerania to link East Prussia with the rest of Germany. These demands mere renewed in sharper terms after Prague. They met with an uncompromising refusal from the Polish government. and on March 31 the British government, which had abandoned its policy of appeasement after the occupation of Bohemia-Moravia, announced its guarantee to Poland in the event of any act of aggression.

Hitler's immediate retort was to denounce on April 28 the German-Polish nonaggression pact of 1934 and the Anglo-German naval treaty of 1935. Thereafter he relapsed into silence, while keeping up the tension in Danzig and watching to see how the situation would develop. In May, the understanding with Mussolini was converted into an open treaty of alliance by the signature of the "pact of steel," but Hitler's attention was directed above all to Moscow where the British and French were negotiating with the Russians in an attempt to build up a common front of resistance to German aggression in eastern Europe. The difficulties encountered in these talks encouraged Hitler to make a secret counterproposal for a Soviet pact with Germany. After a period of manoeuvring for position on the Russian side, Stalin agreed to a visit by Ribbentrop and the Nazi-Soviet pact was signed in Moscow on the night of Aug. 23-24. To the public pact of nonaggression was appended a secret treaty dividing the whole of eastern Europe into spheres of influence and partitioning Poland along the line of the rivers Narew, Vistula and San.

Hitler was convinced that the signature of the Moscow pact would lead the British and French to withdraw their guarantees to Poland. When the British government replied with the signature of the pact of mutual assistance between Great Britain and Poland (Aug. 2j), Hitler postponed the attack on Poland, originally fixed for dawn on Aug. 26, and attempted to avert British intervention by further diplomatic negotiations. The British, however, refused to bring pressure to bear on the Poles to accept what they regarded as unreasonable conditions, and on Sept. 1 the German army invaded Poland. Two days later Britain and France, after delivering an ultimatum demanding the immediate withdrawal of the. invading forces, declared war on Germany.

WORLD WAR II

The Years of Easy Conquests.—Hitler began the war with the intention of waging a localized war against Poland and following this with the quick offer of a peace settlement. The campaign, however, only lasted 35 days, and the ease of his conquest tempted Hitler to take the initiative in extending the war to the west, against the advice of his generals. Bad weather alone prevented him from launching an attack on the Low Countries and France before the end of 1939.

During the course of the winter 1939–40, Adm. Erich Raeder, commander in chief of the navy, won over Hitler to the idea of occupying Norway and Denmark, partly to safeguard the vital iron-ore supply route from northern Sweden through Narvik, partly to guarantee the inviolability of the Baltic and partly to prevent the dispatch of British and French troops to the aid of Finland (then at war with the U.S.S.R.) through Norwegian ports. The operation was launched on April 9 and, despite the risks involved in the sea-borne expedition to Norway, proved highly successful without disturbing the main concentration of German forces for the attack in the west.

The invasion of the Netherlands, Belgium and France mas begun on May 10, 1940. Following a plan suggested by Gen. Erich von Manstein, Hitler ordered the German armoured forces to concentrate on breaking through the hilly and lightly defended central sector of the front where the Ardennes covered the French frontier. The success of this advance through Sedan to the Channel coast, which cut off the French and British troops fighting in Belgium, proved the key to victory. The Dutch and Belgian armies surrendered before the end of May, the British were driven into the sea at Dunkirk, and by the middle of June the French had requested an armistice.

Hitler had no plans at all for the next stage of the war. With Poland eliminated and Britain's last continental allies out of the war, he hoped that the British would now be prepared to negotiate a settlement. In order to make this easier, he restrained the territorial appetite of Mussolini (who entered the war on June 10, 1940) and offered relatively moderate armistice terms to France.

When the British showed no disposition to consider a compromise peace, Hitler ordered preparations to be made for the invasion of Britain. How far he seriously intended to embark on so difficult an undertaking has been questioned, but in any case the failure of the German air force to win air supremacy over the Channel and their defeat in the Battle of Britain meant that the essential preliminary conditions were lacking, and in Oct. 1940 Operation "Sea Lion" was postponed indefinitely.

Admiral Raeder and the German naval staff were anxious to persuade Hitler to make the main German effort in the Mediterranean area, which they regarded as the most vulnerable part of the British position. Hitler, however, although he attempted to bring both Spain and Vichy France as well as Italy into the war, was never ready to spare more than limited forces for operations in North Africa, the Mediterranean and the middle east. In the summer of 1940 he ordered plans to be made for an attack on the U.S.S.R., and it was increasingly toward the east that his attention was directed.

Hitler had never regarded the Nazi-Soviet pact as more than a temporary expedient and throughout 1940 he became more suspicious of Russian aims in eastern Europe. A visit to Berlin by V. M. Molotov, the Soviet foreign minister, in Nov. 1940 failed to remove the causes of friction. Russian economic collaboration had been of great value to Germany in reducing the pressure of the British blockade, and in the first half of 1941 the Soviet government showed a marked disposition to avoid a breach with Germany, if at all possible. Hitler, however, had long seen the direction of German expansion as lying in the east and to cover his own aggressive designs now rapidly convinced himself that Germany was threatened by Russian ambitions. On Dec. 18, 1940, he signed the directive for Operation "Barbarossa," the object of which was described as the crushing of Soviet Russia in a quick campaign, and preparations to this end went on steadily throughout the winter and spring of 1941.

At this point, Hitler's plans were complicated by the action of Mussolini in attacking Greece (Oct. 28, 1940). The effect of this was to open up a Balkan front, of which the British might take advantage, at a time when Hitler was most anxious to keep the whole of eastern Europe quiet until his preparations against the U.S.S.R. were complete. The situation was made worse by the total failure of the invasion of Greece and by the rapid retreat of the Italians in North Africa before Sir Archibald Wavell's advance (Dec. 1940). Hitler was obliged to come to the aid of his axis partner. He sent German reinforcements to North Africa (where Erwin Rommel succeeded in driving the British back in the spring of 1941), and he took steps in readiness for a German invasion of Greece. Hungary and Rumania had already been reduced to the status of German satellites and made no difficulties about the movement of German troops toward the Greek frontiers; nor did Bulgaria, where, after a sharp diplomatic contest with the Russians the Germans proceeded to occupy key positions throughout the country in March. The remaining Balkan country, Yugoslavia, was induced under pressure to accede to the tripartite pact in March 1941, but the Yugoslav government was overthrown by a palace revolution in the name of the young king Peter. Thereupon Hitler ordered drastic measures to make an example of Yugoslavia. In the course of April 1941 German forces invaded both Yugoslavia and Greece, the former operation being accompanied by brutal air attacks on the defenseless city of Belgrade. By the end of the month both countries had been occupied, and in the last half of May German parachute troops completed the Balkan campaign by the capture of Crete.

Invasion of the Soviet Union.—With the occupation of Crete and Rommel's success in driving back the British to the Egyptian frontier, Raeder and others urged that the situation was ripe for a decisive blow against the whole British position in the middle east. But Hitler was set upon attacking the U.S.S.R. and insisted that all other operations must be postponed until it had been defeated, a task which he confidently expected to accomplish within six or eight weeks.

The invasion began on June 22, 1941, and in the opening stages of the campaign the German army drove deep into Soviet territory. Despite imposing successes. however, the Germans failed to achieve a decisive victory and by dispersing his forces Hitler left the frontal assault on the Soviet armies defending Moscow until late in the year. At the beginning of Dec. 1941, the onset of the dreaded Russian winter and the unexpected Soviet counteroffensive faced the German high command with a major military crisis. This brought to a head the strained relations between Hitler and the army leaders. Since the reluctance of the high command to undertake offensive operations in the west in the winter of 1939-40, Hitler had become increasingly critical of the generals, and was less and less prepared to listen to their advice. In Dec. 1941 he dismissed Gen. Walther von Brauchitsch, the commander in chief of the German army, and assumed the direct command of the armies in the field himself. The fact that by drastic measures he succeeded in holding the Soviet attacks during the winter greatly increased his confidence in his own military genius. Henceforward he refused to listen to any views, or even information, which ran counter to his own conception of how the war should be conducted.

Germany Declares War on the United States.—The Japanese attack on Pearl Harbor in Dec. 1941 now extended the war to the whole world. Hitler promptly declared war on the United States, whose resources he underestimated as grossly as those of the U.S.S.R. He failed however to grasp the unity of the war or the importance of seapower and in his growing preoccupation with the eastern front neglected until too late the importance of the Atlantic and Mediterranean theatres.

It was not until 1942 that Karl Donitz (who succeeded Raeder as commander in chief of the navy in Jan. 1943) was able to persuade Hitler of the importance of the U-boat war. Great efforts were made to build up Germany's submarine forces in 1942 and 1943, and the U-boat attacks taxed the Allies' shipping resources to the limit, but by the middle of 1943 the British and Americans were on the way to establishing a superiority in methods of defense (both by air and sea) against which the German navy was unable to prevail. By the end of 1943 the Germans had lost the battle of the Atlantic, largely through Hitler's neglect of its possibilities at an earlier stage.

Hitler had shown an equal blindness to the importance of the Mediterranean theatre of operations. At the close of 1942, the advance of the British 8th army from the east and the joint Anglo-U.S. landings in northwest Africa were driving the German and Italian forces under Rommel into a trap. Hitler now hurriedly made available the reinforcements he had earlier refused, but without being able to halt the Allies' advance; the only result was to increase the size of the forces captured in Tunisia, where more than 250,000 German and Italian troops surrendered in May 1943.

Meanwhile, in the east, ignoring the warnings of his professional advisers, Hitler had embarked on still more ambitious operations for the campaign of 1942, aiming at the occupation of the Caucasus oil fields in the south and a drive to the Volga in the southeast. The invasion of the Caucasus fell short of its objective, while the drive to the Volga turned into a desperate contest for the city of Stalingrad, where Hitler's obstinate refusal to withdraw in time led to the encirclement and capitulation of the German armies under Field Marshal Friedrich von Paulus at the end of Jan. 1943.

The double defeat of Stalingrad and Tunisia represented the turning point of the war. By mid-1943, Hitler had lost the initiative and from that time the German forces everywhere stood on the defensive.

The Nazi Empire — At the height of his success, Hitler was the master of the greater part of the European continent. German rule in the east was extended to wide areas of the Baltic states, Byelorussia, the Ukraine and European Russia; Poland (part of which was annexed, the rest organized as the government-general) and the protectorate of Bohemia-Moravia; Serbia and Greece (where the occupation was shared with the Italians); and the nominally independent, satellite states of Slovakia, Croatia, Hungary, Rumania and Bulgaria. In the west, Norway, Denmark, the Netherlands, Belgium and France were all under German occupation, part of France from the summer of 1940 and the whole country from Nov. 1942.

German economic exploitation of these territories was ruthless. The needs of the native population were subordinated to the demands of the German economy, often at the cost of widespread hunger and shortages, while German industrial and business firms as well as officials made the most of the advantages the situation offered. In eastern Europe German policy treated the population not only as conquered peoples, but in accordance with Nazi teaching, as inferior races without rights, fit only to serve as slaves. Those classes of the population which on account of their education or position might be expected to provide leadership, together with the Jews and any who showed signs of resistance, were put to death. At Mauthausen, one of the extermination camps in Austria, close to 2,000,000 people, mostly Jews, were exterminated between 1941 and 1945; at Oswiecim (Auschwitz) in Poland, 2,500,000 were executed in the gas chambers, while another 500,000 died from starvation and disease. Frequent man hunts were carried out to round up labour for deportation to Germany; at the end of 1944, 4,795,000 foreign workers had been recruited in this way, the three largest groups being Russians (1,900,000), Poles (851,000) and French (764,000). Those from the east were treated entirely as slave labour and the conditions under which they lived were often appalling. Hitler's and Himmler's plans for the new order they meant to build in eastern Europe were only partially carried out, but those who lived under German rule in Poland and the occupied parts of the U.S.S.R. suffered great hardship and cruelty.

In certain parts of the occupied territories (especially where the terrain was favourable) the Germans encountered partisan movements; *e.g.,* in Yugoslavia, Poland and the U.S.S.R. In almost all there was some form of resistance movement, in Norway, France and Holland as well as in the east. The German measures for stamping out this opposition, including the shooting of hostages, were frequently marked by brutality and left bitter memories behind.

In Germany itself the impact of war was not sharply felt until

1942. Casualties in the early campaigns were comparatively light and not until the winter of 1941–42 in Russia did they reach the scale of World War I. The effects of the blockade were reduced by the plundering of the occupied countries.

Following the crisis of 1941–42 on the eastern front Hitler demanded total mobilization. Fritz Sauckel, the *Gauleiter* of Thuringia, was made plenipotentiary general for manpower and took over the recruitment of foreign labour, while Albert Speer was appointed to succeed Fritz Todt at minister of armaments. It was thanks to Speer that Hitler was able to continue the war for another three years. By a remarkable feat of organization and improvisation he succeeded in maintaining and even raising German war production despite the heavy Allied bombing of industry and communications. By 1944 he had 14,000,000 workers under his direction and was virtually the economic dictator of the country.

In the early stages of the war, Goring was the second man in Germany and was named by Hitler as his successor. But by 1942 Goring's star was waning and suffered total eclipse with the failure of the air force to check the Allied raids or make effective retaliation. His place was taken by Himmler who had built up his power as head of the unified police and security services in a police state. During the war Himmler extended the functions of the SS. until it became virtually a state within the state. Not only was Himmler put in charge of the resettlement of the occupied territories in the east, but in the *Waffen* (armed) SS. divisions, 500,000 strong by 1944, he created a rival army to the *Wehrmacht* which in Hitler's eyes was far more reliable than the regular army.

Hitler's own position remained unchallenged until his death, apart from the attempt on his life in July 1944 (see below). The cabinet never met after the beginning of 1938. Ministers were confined to the discharge of their departmental duties, while Hitler reserved to himself alone the right to decide policy. This was true of military as well as of political decisions. He abolished the post of minister of defense in 1938 and, by dividing responsibility between his staff as commander in chief of the armed forces (the O.K.W.) and his staff as commander in chief of the army, after Dec. 1941 (the O.K.H.), he succeeded in preventing the growth of an organization with the independent authority of the great general staff during World War I. He retained his hold on the loyalty of Speer, Himmler, Goring and the other Nazi leaders until the last days of his life, and the contest for power between them was aimed at securing his favour not at replacing him. Adolf Hitler was in fact as well as in name the dictator of Germany.

The Beginning of Defeat.—Gen. Franz von Halder, chief of staff to the commander in chief of the army from 1938 to 1942, later expressed the view that by the end of 1943 at the latest Germany's defeat was certain. The fact that the war continued for another 18 months, at terrible cost to Germany, was due to the refusal of Hitler to admit defeat and his determination to drag down Germany and half Europe with him rather than repeat the capitulation of 1918.

During the course of 1943 Mussolini mas overthrown, Anglo-U.S. forces invaded Italy, and the Russians began the series of massive attacks which were to carry them deep into central Europe. In Italy energetic counteraction enabled the Germans to take advantage of the Allies' delays and establish a winter line south of Rome, thus forcing the U.S. and British forces to fight their may up the peninsula. In Sept. 1943 Mussolini was rescued by SS. troops and established as head of the Italian social republic set up under German protection in northern Italy. In the east Hitler insisted that the German troops must defend everything they held and obstinately refused to allow the strategic withdrawal which his generals considered the better course. This did not prevent the Red army from clearing most of Soviet territory and crossing the Polish frontier in Feb. 1944 and the Rumanian in March. In the summer of 1944 the German front in Poland broke and the Russians pressed forward toward the frontiers of the Reich; on June 4 Rome was liberated and on June 6 the British and Americans made their landings in Normandy.

Since the beginning of 1942 the Allied air forces had steadily increased the weight of their bombing attacks on Germany. The first 1,000-bomber raid, on Cologne, took place on the night of May 30–31, 1942. In July 1943 Hamburg was devastated in a series of such raids, while between mid-Nov. 1943 and mid-Feb. 1944, the R.A.F. dropped 22,000 tons of high explosive on Berlin (qv.). In March, the U.S. army air force carried out its first day raids on the German capital. These combined attacks continued without respite for three years and did enormous damage to the towns and communications of Germany.

Hitler, who had made his headquarters since the summer of 1941 in a remote part of East Prussia, was now completely cyt off from the life of the nation he led. He refused to visit the bombed towns, was scarcely ever seen in public and spoke or broadcast only on rare occasions.

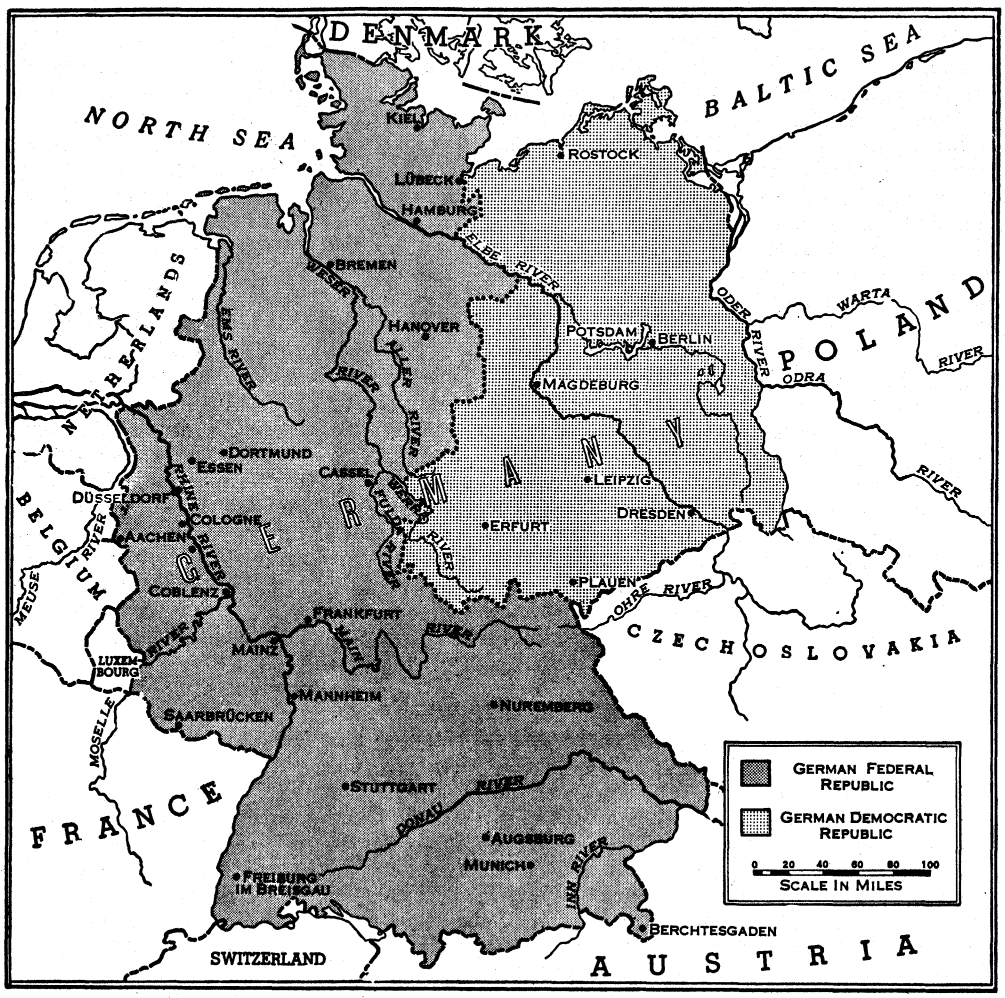
The **Plot** Against **Hitler.**—Realizing that Hitler's refusal to consider surrender would do irreparable harm to Germany, a group of German patriots had for some time been plotting to assassinate him. The German opposition was composed of a number of loosely connected groups, fluctuating in membership, with little common organization or common purpose other than their detestation of the Nazi regime. The two senior members, who had been engaged in conspiring to overthrow Hitler from before the war, were Gen. Ludwig Beck, chief of staff of the army until 1938, and Carl Goerdeler, a former *Oberbürgermeister* of Leipzig. The only institution in Germany able to stage a successful coup d'état was the army, and one of the principal centres of the plot was the *Abwehr* (the counterintelligence service of the armed forces). This was broken up by Himmler in the course of 1943 but was replaced by a small group in the command headquarters of the reserve army, whose outstanding personality was Col. Count Claus von Stauffenberg.

On July 20, 1944, Stauffenberg placed a bomb concealed in his' brief case under the table during a conference at Hitler's headquarters in East Prussia. By chance, however, Hitler, although injured, was not among those killed. The attempt of the conspirators to seize power in Berlin and bring the army over openly to their side failed, and both there and in Paris the coup was suppressed before the morning of July 21.

The End of the Third **Reich.**—From the summer of 1944 to the summer of 1945 the history of Germany is one of unrelieved disaster. By the end of 1944 the western Allies reached the Rhine, and six months' fighting in the west alone had cost the Germans 1,000,000 men killed, wounded and captured. The Russians swept through the Balkans and by Dec. 1944 were besieging Budapest and threatening East Pmssia. Nazi propaganda foretold a terrible fate for the German people if they failed to hold off the enemy, while extravagant hopes were placed in the secret weapons (guided missiles, jet planes and new U-boats) and in a split between the western powers and the U.S.S.R. By a last desperate effort a number of divisions and fresh supplies of equipment were gathered together in the closing months of 1944, but Hitler, ignoring the danger of a Soviet break-through in the east, persisted in gambling these resources on an attempt to disrupt the Allies' front in the west.

The Ardennes offensive of Dec. 1944, which fell far short of its objective, Antwerp, was the last offensive operation of which the German army proved capable. In Jan. 1945, the Russians launched an attack along the whole line from the Baltic to the Carpathians and broke into Germany from the east, while in March the British and Americans crossed the Rhine and poured in from the west. At Hitler's command Germany was turned into a battlefield in a senseless campaign which served no purpose except to delay the inevitable defeat by mortgaging the future of the nation.

Although there had been talk of a fight to the finish and the creation of a national redoubt in the mountainous country of Bavaria which was the birthplace of the Nazi party, Hitler finally refused to leave Berlin. In the last week of April he made preparations to commit suicide in the underground bunker of the Reich chancellery, while the Russians were fighting in the streets of Berlin. Among his last acts was to expel Goring and Himmler from the party and order their arrest on the suspicion that they were negotiating with the enemy. In the case of Himmler this was justified, although his efforts to reach a separate peace with the western powers through the representative of the Swedish Red



Cross, Count Folke Bernadotte, failed completely. In a political testament to the German nation, Hitler laid the blame for the disastrous war on others, principally on the Jews, and expressed neither regret nor remorse for what had happened. He appointed Admiral Donitz his successor as head of state and Goebbels as chancellor. In the early hours of April 29, he married his mistress, Eva Braun, and so far as is known shot himself on the afternoon of April 30. His body, together with that of his wife, is believed to have been burned in the chancellery garden. Goebbels committed suicide the following day and Himmler shortly afterward. Goring, Speer, Ribbentrop and most of the other Nazi leaders were captured and subsequently tried by the Allies as war criminals at Nuremberg. Only the fate of Martin Bormann, the head of the party chancery, who had acquired increasing influenre with Hitler in the last year of his life, remained uncertain.

The attempt of Admiral Dönitz to negotiate a surrender with the western powers proved unsuccessful. The Allies insisted upon an unconditional surrender and this was signed by Gen. Alfred Jodl and Adm. Hans von Friedeburg in the presence of representatives of the United States, Great Britain, the U.S.S.R. and France at Reims on May 7, 1945, to take effect midnight May 8–9.

GERMANY AFTER WORLD WAR II

With the unconditional surrender the German state ceased to exist and the responsibility for the government of the German people was assumed by the four occupying powers, the United States, Great Btitain, the U.S.S.R. and France. On June 5, the four powers announced that an Allied Control council, consisting of the four commanders in chief and their political advisers would be established in Berlin, and that the country west of the Oder-Neisse line would be divided into four zones of occupation (see *Population,* below). Berlin, although situated in the Soviet zone, was to be occupied by all four powers and to be governed by an inter-Allied authority or, in Russian, *Kommandatura.*

The Potsdam Agreement. — At the Potsdam conference (July 17–Aug. 2, 1945), attended by Joseph Stalin, Harry S. Truman, Winston Churchill and Clement Attlee (but not by a French representative), it was agreed, though a program of decentralization was to be carried out, not to partition Germany but to treat the country as a single economic unit with certain central administrative departments. Great Britain and the United States agreed to support at the peace settlement the Russian annexation of the northern half of East Prussia (including Konigsberg). The conference also agreed "pending the final delimitation of Poland's western frontier" to leave the territories east of the rivers Oder and Neisse (Pomerania, including Stettin and Swinemiinde; Silesia; and the southern part of East Prussia) under Polish administration, separating them from the Russian zone. The Poles proceeded to treat these territories as a permanent annexation. driving out the German population of several millions and bringing in Polish settlers. These changes in the east meant the loss of 23% of German territory as constituted by the treaty of Versailles.

The Allied plans for a common policy in Germany and for the treatment of the country as a single economic unit proved abortive. There were three principal reasons for this failure. The first was the opposition of the French, who had not been represented at Potsdam and who were determined, if possible, to prevent the reappearance of a unified German state by the partition of the Reich. The second was the growing divergence between the policies each of the powers followed in their own zones. The third and most important was the breakdown of the alliance between the United States and Great Britain on the one side and the U.S.S.R. on the other. Their differences covered the whole field of Allied policy, but so far as Germany was concerned, the most important issues were the functions and powers of the future German government, the economic unity of Germany, reparations, frontiers and the future of the Ruhr.

Prolonged negotiations between the four powers culminating in two meetings of the Council of Foreign Ministers during 1947 (Moscow, March–April; London, November–December) produced no agreement, and from 1948 the division of Germany by the "iron curtain" between the Soviet and western zones of occupation became the dominant fact in postwar development.

The Failure of Joint Allied Control. — The deadlock on the Allied Control council had already driven the British and U.S. authorities to act on their own initiative in dealing with the problems of their own zones of occupation. These were particularly severe in the British zone which contained the densely populated and heavily bombed industrial centres of the Rhineland, the Ruhr, Hanover and Hamburg.

The Allies undertook the occupation of Germany with the purpose of rooting out the Nazi regime and destroying once and for all the basis of German military power. Hence their original directives laid great stress on political and economic decentralization, disarmament, the arrest of war criminals, denazification, the dismantling of German war industries and reparations. They rapidly found themselves forced to deal with quite a different set of problems, the fundamental cause of which was not Germany's strength but its weakness. Characteristic of these problems were economic stagnation, the dislocation of communications, famine, a desperate shortage of housing. an unstable currency and rampant black market, the influx of millions of refugees expelled from Poland and the Czech Sudetenland, and the bewilderment and demoralization consequent to a lost war. Large-scale economic aid had to be given by the United States and Great Britain; in the first two and a half years even this did not prevent widespread hunger and suffering.

In 1946 the British accepted the offer of the U.S. government to merge their two zones for economic purposes and the bizone came into existence on Jan. 1, 1947. This development was bitterly attacked by the Russians and was disliked by the French who were still anxious to break up Germany and were occupied in detaching the Saar from the rest of their zone. The British and U.S. authorities had already handed over a great deal of administrative responsibility to the Germans and had set up state (Lander) governments. State parliaments (*Landtage*) were brought into being by elections in the U.S. zone at the end of June 1946, in the British in April 1947 and in the French in May 1947. The two largest parties to emerge in all three zones were the Christian Democratic Union (Christlich Demokratische Union, C.D.U.) and the Social Democratic party (Sozialdemokratische Partei Deutschlands, S.P.D.), the latter closely bound up with the revived trade union movement. In the bizone, on Jan. 1, 1947, a German economic council of 52 members elected by the Landtage assumed responsibility, under Allied supervision, for economic reconstruction.

Alongside this policy of rebuilding the German economy, and frequently (as in the case of dismantling) at variance with it, the Allies continued their measures to disarm Germany and reduce the industrial basis of its military power. This led to considerable confusion in Allied policy which already suffered from major differences between the western powers, *e.g.,* between the British Labour government and the United States over the socialization of the Ruhr industries; between the French and the other two western powers over the creation of centralized organs of administration and government. This confusion and the resulting sense of insecurity about the future added to German demoralization and apathy. Apart from the hardships of life in ruined and hungry towns, other factors weighed heavily upon the German population—the large numbers of prisoners of war still held abroad, especially in the U.S.S.R.; the difficulties of absorbing the refugees from the former eastern provinces; and the unbalanced division of the population between men and women (28,546,000 males to 35,952,000 females in the four zones, according to the census of Oct. 1946).

The turning point in the postwar history of Germany was the year 1948. The U.S. and British governments determined to press ahead with their plans for the reorganization of western Germany despite Soviet opposition and French reluctance. On Jan. 7, 1948, the powers and composition of the German Economic council for the bizone (meeting in Frankfurt) were changed to create the nucleus of a future German government. The Economic council was expanded from 52 to 104 members and a second chamber, a Landerrat consisting of two representatives from each state, was set up. To meet the objections of the French, a six-power conference was held in London, attended by representatives of the United States, Great Britain, France, Belgium, the Netheriands and Luxembourg. On June 7 this produced an agreed program for the future development of the three western zones. Its main features were: a constituent assembly and federal German government for all three zones (without the Saar, which at the end of 1947 became an autonomous territory economically attached to France); an Allied occupation statute governing relations between the Allies and the German authorities; an economic merger of the French with the British and U.S. zones; the establishment of an Allied Military Security board to enforce demilitarization; and an International Ruhr authority to control the coal and steel industries of the Ruhr basin.

The Russians, whose obstructive tactics had been responsible for the decision of the western powers to go ahead on their own initiative, reacted strongly to these developments. They attacked the new policy in western Germany, withdrew their representative from the Allied Control council (March 20) and began to place obstacles in the way of communications between western Germany and Berlin. Following the much-needed currency reform in the western zones (which the Russians had done everything possible to delay and which was put into operation on June 20) the Soviet authorities proceeded to enforce a blockade of the Allied garrisons in Berlin and of about 2,500,000 inhabitants of west Berlin, with the intention of driving out the western powers and securing control of the whole of the former capital. This blockade lasted from the summer of 1948 to the summer of 1949 and was accompanied by great hardship for the population of Berlin. The answer of the western powers was to institute a counterblockade of the Soviet zone and to organize the supply of Berlin by air. By Sept. 30, 1949, when the air lift ceased, 2,323,738 tons of food, fuel and raw materials had been brought into the beleaguered city in this way. Meanwhile the Allied governments refused to be diverted from the course on which they had embarked in western Germany and pressed ahead with the execution of the decisions made in the summer of 1948. On Sept. 1, a parliamentary council of 65 members, elected by the Landtage, met at Bonn under the chairmanship of Konrad Adenauer (C.D.U.) to draft a constitution. Pending a decision by a future German government on the question of public or private ownership, the coal, iron and steel industries of the Ruhr were placed in the hands of German trustees and an International Ruhr authority set up with powers to allocate supplies between internal and export needs, as well as to fix quotas, tariffs and prices. This plan, which made large concessions to the French point of view, was sharply criticized in Germany.

Following the Marshall offer of U.S. aid to Europe, further economic aid on a large scale (the European Recovery program) was made available to western Germany, and this, combined with the effects of the currency reform, led to a remarkable economic recovery. In the second half of 1948 industrial production rose from 45% to nearly 75% of the 1936 level, while steel production doubled during that year. The economic policy followed by the German authorities under the guidance of Ludwig Erhard was one of free competition and the removal of controls. This was criticized by the S.P.D. and the trade unions on the grounds that it led to a steep rise in prices and much hardship for the poorer classes of the community. The revival in German confidence, however, was marked.

In May 1949 the Russians, who had suffered a severe and unexpected setback with the success of the Allied air lift, finally agreed to lift the blockade of Berlin. The same month the western powers put into operation a new occupation statute for western Berlin which gave greater freedom and responsibility to the city administration under its lord mayor, Ernst Reuter (S.P.D.). After an uncertain period during which the Soviet authorities made further attempts to interfere with freedom of communication and the Allies continued the air lift, a tacit working agreement was reached which left Berlin divided into western and eastern sectors under separate administrations, but with the garrisons of the western powers still *in situ.*

A further meeting of the Council of Foreign Ministers held in Paris in May–June 1948 succeeded no more than earlier meetings in reaching agreement on a unified policy for the whole of Germany and the measures for the organization of separate west and east German states continued. On Jan. 17, 1949, an Allied Security board had been set up to supervise the demilitarization of Germany. Strong German protests continued to be made against the dismantling of German factories. A new program for demilitarization agreed on by the U.S., British and French foreign ministers in Washington in April made considerable concessions to the German attitude, but this did not stop the agitation, which led to a number of incidents with the British authorities in the course of the year. The three foreign ministers at their Washington meeting completed the arrangements for the merger of the French with the Anglo-American bizone and on April 10, 1949, published the promised occupation statute. This guaranteed full powers of self-government to the new west German state except for certain reserved subjects (see *Constitution,* below).

German Federal Republic. — With the occupation statute published, the parliamentary council at last concluded its discussions on the Basic law of the new state. It was passed by the council on May 8, 1949, by 53 votes to 12 and approved by the Allied military governors on May 12 with certain reservations, the most important of which was the exclusion of western Berlin as the proposed twelfth Land of the federation.

The constitution of the new German Federal Republic provided for a president and two chambers, the *Bundestag,* elected for four years, and the Bundesrat, representing the Lander governments. Considerably more freedom to manage their own affairs was left to the Lander than they had enjoyed under the Weimar constitution, but this did not satisfy the strongly particularist Bavarian *Landtag* which alone of the 11 Lander voted against ratification.

Elections for the *Bundestag* took place on Aug. 14. The two parties that stood for a rapid return to a free economy, the Christian Democrats and the Free Democrats (Freie Demokratische Partei, F.D.P.) secured 139 and 52 seats respectively, the S P.D., standing for a controlled economy and public ownership of heavy industry, 131 seats. When the parliament met at Bonn, the new capital, Theodor Heuss, the leader of the F.D.P., was elected federal president on Sept. 12 and Adenauer chancellor at the head of a right-wing coalition on Sept. 20. Kurt Schumacher became the leader of the large and critical S.P.D. opposition.

On Sept. 21 the occupation statute came into force, and the Allied military government disappeared in favour of the Allied high commission. On Oct. 11 the federal government was given permission to appoint its own delegate to the Organization for European Economic Cooperation in Paris, and on Nov. 24 the Allied high commission concluded a new agreement (the Petersberg agreement) with the chancellor. This covered further Allied concessions on dismantling and demilitarization; the right to build a German merchant marine; German membership in the Ruhr authority and in the Council of Europe; the right to re-establish consular and commercial relations abroad.

The new government faced severe internal problems, of which rising unemployment, the refugees from the eastern territories (between 16% and 18% of the total population of 47,612,200) and housing were the most pressing. Food and consumption goods were plentiful, but prices remained high and housing accommodation was desperately short. The S.P.D. attacked the economic policy of the government as responsible for the continuation of these conditions. Serious concern, with a widespread fear of war, was also felt throughout the country at the open hostility of the Soviet government and at the continued partition of Germany which, it was felt by many, was likely to be hardened by the policy of co-operation with the western powers on which Adenauer had embarked. On the other hand, the situation and prospects of the people of western Germany had changed out of all recognition since the immediate postwar years. and the new relationship with Germany's former enemies in the west which was beginning to take shape offered prospects for the future which would have appeared improbable on the morrow of unconditional surrender.

German Democratic Republic. — The Soviet zone of occupation, excluding Berlin, had a population of 17,313,734 in Oct. 1946. In April 1946 the Soviet military administration succeeded in bringing about a fusion of the Communists with the Social Democratic party in the Socialist Unity party (Sozialistische Einheitspartei Deutschlands or S.E.D.). The proposed alliance was rejected by the Social Democrats in the west under the leadership of Kurt Schumacher, but in eastern Germany Otto Grotewohl (joint chairman of the S.P.D. with Schumacher) agreed to join the veteran Communist Wilhelm Pieck in forming the new party, which rapidly became the main German agency used by the Soviet authorities to carry out their wishes. Other organizations used for the same purpose were the Free German Trade Union federation, the Farmers Co-operative organization and the Free German Youth.

In Oct. 1946 elections were held for the five Lander parliaments, and coalition governments between the S.E.D. and the two other principal parties, the Christian Democrats (C.D.U.) and the Liberal Democrats (Liberale Demokratische Partei, L.D.P.) were established. The eastern C.D.U. and the L.D.P. continued to be tolerated throughout the period, but only on conditions which made independent action impossible and subordinated them to the leadership of the privileged S.E.D. The Lander governments were balanced by a number of (German) central administrative departments which were directly responsible to the Soviet authorities. The Economic commission set up in 1947 and largely taking the place of the central administrative departments weighted the balance further in favour of central direction against the authority of the state governments and served, like the Economic council at Frankfurt, as the nucleus of a future central government.

Large-scale land reform affecting one-third of the total land area was carried out at the beginning of the occupation, close on 70% of the land being distributed for private ownership. No attempt however was made at that stage to introduce collectivization. A large number of industrial, commercial and financial undertakings were taken over by the state, and by 1948 it was estimated that 75% of the total industrial capacity of the zone was owned by the Economic commission and the Land governments.

Although much in eastern Germany recalled Soviet models, the Soviet zone in these years could not be accurately described as a Communist state. The first Soviet interest was to secure reparations, and everything else, including the interests of the German Communists, was subordinated to this purpose. Reparations were taken in three different ways: first, by dismantling and removing equipment; second, by taking from the current production of German undertakings on orders given by the powerful Soviet trading companies operating in the zone; third, by the direct transfer of German industrial property and land to Soviet corporations. The exact amount of reparations taken out of the zone has been much disputed; the order of magnitude is indicated by the fact that the Soviet corporations (representing only one category of reparation operations) accounted for one-quarter of the industrial production of the whole zone in 1947.

On Dec. 6–7, 1947, the S.E.D. convened in east Berlin a People's congress (Volkskongress) and a second one on March 17–18, 1948. The latter decided to set up a People's council (Volksrat) of 400 members to serve as a platform for the Soviet-directed agitation against the formation of a west German state. In the autumn of 1948 the People's council was set to work to draw up a constitution for a German Democratic Republic. A third People's congress of 1,525 members, "elected" on May 15–16, 1949, in the Soviet zone, adopted the constitution on May 30. The People's congress appointed a new People's council of 400 which was transformed on Oct. 7 into a provisional People's chamber (Volkskammer) for the new republic. A chamber of states (Landerkammer) was appointed three days later and on Oct. 11 the two chambers elected Wilhelm Pieck president of the republic. A government nominally a coalition but in fact dominated by the S.E.D. was established under the premiership of Otto Grotewohl. The Soviet military administration then formally handed over power to the new government, being replaced by a Soviet control commission, and the republic was recognized by the U.S.S.R. and other Soviet-dominated governments. In fact the firm hold of the Soviet authorities was not relaxed at all. The government and the S.E D. remained the instruments of Soviet policy. One of the first acts of the new government was dutifully to announce its acceptance of the loss of the eastern territories to the Poles. An agreement recognizing the Oder-Neisse line as the permanent frontier was signed on July 6, 1950. (A. Be.)

On May 16, 1950, Stalin announced a reduction in Soviet reparations demands. In a letter to Grotewohl he stated that by the end of 1950, eastern Germany would have paid about $3,658,000,000 toward the total Soviet demand of $10,000,000,000. In view of this, the Soviet government, in agreement with the Polish (entitled to 15% of the Soviet share), had decided to reduce the sum still due by 50%, that is, to $3,171,000,000 to be paid from current production over a period of 15 years.

At the same time the number of nationalized industries was extended. Of the 115 Soviet limited liability companies (*Sowjet*

Aktien Gesellschaften or S.A.G.) only 19 were handed back to the eastern German government.

During May 1952 the German Democratic Republic announced several measures which isolated it from the German Federal Republic. A police-guarded no man's land 3 mi. wide was created along the whole extent of the western frontier of the German Democratic Republic, Berlin remaining the only exception. The formation of a German people's army had been proceeding from June 1948, but an excuse to reveal its existence was found later, and on June 18, 1952, the *Volkskammer* approved a resolution for the establishment of a national army. A paramilitary labour service, under the title "Service for Germany," was approved on July 24 for young persons of both sexes who were 17 years old. A Soviet system of administration was introduced into the republic on July 23, when instead of the former five *Länder* there were created 14 new *Bezirke* (provinces, similar to Soviet *oblasfi*). each containing 15 to 16 *Kreise* (districts, similar to Soviet *rayony*). The "sovietization" of eastern Germany was continued by the collectivization of agriculture, which started on July 12, 1952, when the first east German *kolkhoz,* or *landwirtschaftliche* Produktionsgenossenschaft, was founded at the village of Brusewitz, near Schwerin. Revision of the whole system of justice, announced in Oct. 1952, brought the German Democratic Republic into line with the Soviet system.

This increasing sovietization, the raising of workers' production levels, increased persecution of the churches and serious food shortages led to the risings in east Berlin and strikes throughout the Democratic Republic which began on June 16–17, 1953. These were put down by the Soviet army, and some concessions were made.

From Jan. 1, 1954, the U.S.S.R. ended the collection of reparations from the German Democratic Republic and on that day transferred the remaining S.A.G. to the east German government. On March 25, 1954, the Soviet government announced that the German Democratic Republic was "sovereign."

Attachment to East and West Confirmed.—In spite of much propaganda and exchange of notes between the western powers and the U.S.S.R. and proposals and counterproposals from German Democratic and German Federal governments, the possibility of a reunification of the two republics became faint.

While the German Democratic Republic was being completely accommodated in the Russian orbit. between the three western great powers and the German Federal Republic considerable progress was made toward full association of the German Federal Republic with the Atlantic community. Although the general contract signed at Bonn on May 26, 1952, and the agreement on German participation in the European Defense Community signed the following day in Paris were refused ratification by the French national assembly (Aug. 30, 1954), a nine-power conference held in London from Sept. 28 to Oct. 3 of the same year agreed upon a new solution of the same problem. Proposed by the British government, the solution consisted of a series of documents which were signed in their final form in Paris on Oct. 23. First, there were agreements between France, the German Federal Republic, the United Kingdom and the United States on the termination of the occupation regime in Germany; second, there were documents relating to the revision of the Brussels alliance treaty (March 17, 1948) between Belgium, France, Luxembourg, the Netherlands and the United Kingdom and its extension to the German Federal Republic and Italy; finally, there were protocols concerning the entry of the German Federal Republic to the North Atlantic Treaty organization.

On March 21, 1955, President Heuss signed the instrument of ratification of the Paris agreements. As all other signatories also completed the ratification, on May 5 the German Federal Republic became a sovereign country. The Allied High commission at Bonn dissolved itself on the same day. In a proclamation Adenauer said that the goal of his government was "a free and united Germany in a free and united Europe." On May 7, in Paris, Adenauer took part in the establishment of the Western European union, and two days later the German Federal Republic became a full-fledged member of NATO. *(See* below, *Defense.)*

The Soviet reaction to the new situation was to invite (June 7) Adenauer to Moscow to establish diplomatic relations with the German Federal Republic. Adenauer arrived in Moscow on Sept. 9. After three days' hard bargaining he was promised that German prisoners of war would be repatriated in return for which he agreed to the establishment of diplomatic relations between the U.S.S.R. and the German Federal Republic. The number of German servicemen missing in the Soviet campaign was given at Bonn as 1,156,567 and the total of civilian deportees as about 750,000. Of these only about 140,000 were estimated still alive. But Marshal N. A. Bulganin, the Soviet premier, informed Adenauer that there were in the U.S.S.R. only 9,626 prisoners, all "war criminals."

Before leaving Moscow Adenauer sent to Bulganin a letter stating that his government represented the whole of Germany and that final determination of German frontiers must await a peace treaty. On Sept. 15 the Soviet government stated that there were two German governments and two German states, and that the question of German frontiers "was solved by the Potsdam agreement."

On Sept. 16 a government delegation of the German Democratic Republic arrived in Moscow, and four days later a treaty was signed. It stipulated that thenceforward the German Democratic Republic was fully responsible for its own internal and external affairs and that the Soviet had stationed armed forces in eastern Germany "temporarily." Ulbricht, one of the delegates, explained that, while the western powers would not withdraw their troops from western Germany and liquidate their bases there, the presence of Soviet troops on the territory of the G.D.R. would continue to be necessary.

On Sept. 29 the Soviet government announced that it was releasing 8,877 German "war criminals" and handing over 749 serious offenders to the German Federal or Democratic governments.

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POPULATION, RELIGION, EDUCATION

Population. — The changes in area and population from 1871 are given in Table I.

About a quarter of the total population of Germany lived in towns of 100,000 inhabitants and over in 1950. The population of cities of over 250,000 inhabitants compared with the figure for

TABLE I.—*Germany: Area and Population*

From 1871 to 1945

Date	Territorial changes	Area sq.km.	Area sq.mi.	Population
May 10, 1871	Alsace-Lorraine annexed	540,857	208,825	41,059,000
July 1, 1914				67,800,000
June 28, 1919	Restitutions resulting from the treaty of Versailles*	468,620	180,934	59,800,000
Jan. 13, 1935	Saar returns to Germany	470,545	181,677	66,871,000
March 12, 1938	Incorporation of Austria	554,395	214,052	75,300,000
Sept. 21, 1938	Annexation of the Sudetenland	583,494	225,287	79,350,000
March 15, 1939	Annexation of Bohemia and Moravia	632,419	244,177	86,250,000
March 22, 1939	Annexation of Memel (Klaipeda)†	635,218	245,258	86,400,000
Aug. 2, 1945	Restitutions resulting from the Potsdam agreement‡	353,683	136,557	64,194,800

From 1946: the two republics and Berlin

Division	Area sq.km.	Area sq.mi.	Population 1946 census	Population 1950 census	Population 1955 est.
German Federal Republic!	245,820	94,911	45,706,500	49,842,624	52,190,000
West Berlin	481	186	2,012,500	2,146,952	2,195,000
German Democratic Republic	107,863	41,646	18,488,300	18,388,200	17,832,200
East Berlin	403	156	1,174,600	1,189,100	1,139,900
Total	353,683	136,557	64,194,800	68,230,824	70,022,000

*Alsace-Lorraine was returned to France; Saar was created as a territory administered by the League of Nations and incorporated within the French customs regime; Eupen-Malmédy was acquired by Belgium; northern Schleswig was returned to Denmark; Danzig was created as a free city; Memel (Klaipeda) was given to Lithuania, while Pomorze (Pomerania) and Poznania were incorporated with restored Poland, Upper Silesia was partitioned between Germany and Poland on Oct. 20, 1921.

†German wartime annexations to the detriment of Poland (western part of the country incorporated with the greater German Reich and the so-called Warsaw *General-Gouuernement* created); France (Alsace-Lorraine) Luxembourg (included into "Gau Mosel-land"), Belgium (Eupen-Malmédy) and Yugoslavia (northern Slovenia) are not included in the table.

‡Austria and Czechoslovakia regained independence, Memel returned to Lithuania. all the lands east of the Oder-Neisse line, together with the free city of Danzig, were included into Poland, the only exception being the northern half of East Prussia which was incorporated with the U.S.S.R.; Saar was again created as a separate territory united with France by a customs union.

§Excluding the Saar (area 991 sq.mi.; pop. [1955 est.] 992,000), politically re-united with Germany on Jan. 1, 1957.

Sources: *Statistisches Jahrbuch für das Deutsche Reich* (1939–40); *Statistisches Jahrbuch für die Bundesrepublik Deutschland* (1955); *Statistisches Jahrbuch der Deutschen Demokralischen Republik* (1955).

TABLE *11.—Cities With More Than 250,000 Inhabitants, 1939 and 1950*

City	Population 1950	Population 1939	City	Population 1950	Population 1939
Berlin	3,336,475	4,338,756	Bremen	444,549	450,084
Hamburg	1,605,606	1,711,877	Hanover	444,296	470,950
Munich	831,937	840,586	Duisberg	410,783	434,646
Leipzig	613,707*	707,365	Nuremberg	362,459	423,383
Essen	605,411	666,743	Wuppertal	363,224	401,672
Cologne	594,941	772,221	Gelsenkirchen	315,460	317,568
Frankfurt-on-Main	532,037	553,464	Bochum	289,804	303,288
Dortmund	507,349	542,261	Halle	289,680*	220,092
Dusseldorf	500,516	541,410	Magdeburg	261,392*	336,838
Stuttgart	497,677	496,490	Kiel	254,449	273,735
Dresden	496,548*	630,216	Chemnitz	290,153*	337,657

*1955.

1939 is shown in Table II.

The population of the German empire at its establishment in 1871 was about 41,059,000. During the following 40 years it increased rapidly to 64,900,000, according to the census of 1910, and to 67,800,000 at the outbreak of World War I. The population was severely reduced by the war in three ways: the loss of men at the front and of other persons from war causes was estimated at 2,870,000; the birth rate during the war fell to the lowest point in history and remained low during the postwar years; and nearly 7,000,000 persons belonged to the territories which Germany had to surrender by the Versailles treaty.

Hitler's annexations of territory, however, much more than compensated for the war losses. Up to the summer of 1939 the annexations of the Saar, Austria, the Sudetenland, Bohemia-Moravia and Memel had resulted in an increase in population of 17,700,000, bringing the grand total of greater Germany to a figure of 86,400,000.

World War II reduced the population of Germany in much the same way as World War I: losses at the front and from other war causes were estimated at about 4,700,000; the birth rate fell from 20.6 per 1,000 in 1939 (in terms of Germany's 1937 frontiers) to 15 per 1,000 in 1942; and the loss of German territory to the east of the Oder-Neisse line brought about a further reduction of about 9,600,000. Nevertheless, if population figures are taken for the postwar area of Germany (which represents about three-quarters of the total area on Jan. 1, 1938), it will be seen that the population increased from 58,773,000 in 1939 to 68,230,824 in 1950 (excluding the Saar in both cases).

TABLE *111.—Germans in Eastern and Southeastern Europe*

Country	1937	1950	Country	1937	1950
Czechoslovakia	3,2[illegible]	200,000	Italy (Alto Adige)	290,000	214,000
Poland	741,000	100,000	Baltic states	195,000	—
Danzig	350,000	100,000	Memel territory	59,000	—
Rumania	720,000	380,000			
Yugoslavia	575,000	55,000			
Hungary	530,000	150,000	Total	6,600,000	1,099,000

This increase was largely accounted for by the influx of large numbers of German refugees expelled from Poland (in its new frontiers), Czechoslovakia and other countries of eastern and southeastern Europe. (See Table III.) The number of refugees in the German Democratic Republic was not known, but in 1950 the German Federal Republic included 4,500,000 Germans from the territory east of the Oder-Neisse line; 3,400,000 from Czechoslovakia, pre-1939 Poland and eastern European countries; and 1,548,000 from the German Democratic Republic. This last-named number was constantly increased by those Germans who were seeking asylum in the west. By the end of 1955 their number was estimated at 2,526,000.

Although war losses in the postwar German area were more than made good by the influx of German refugees, women outnumbered men to a greater degree. In 1950 there were 113.4 women per 100 men in the German Federal Republic and 124.2 women per 100 men in the German Democratic Republic. A survey of population by age groups is given in Table IV.

The birth rate in Germany between 1871 and 1914, a period of rapid industrial expansion, was, as it had been earlier in England in like conditions, unusually high. It had averaged about 35 living births per 1,000 of the population in the 1850s, rose to more than 39 in the decade after 1871 and then fell slowly but steadily to 27.5 in 1913. During World War I it fell sharply until it reached 14.3 in 1918. It rose again to 25.9 in 1920, but then fell steadily again to 14.7 in 1933. The percentage of marriages per year rose and fell in curves closely parallel to the birth rate.

In 1933 the National Socialist leaders were greatly alarmed by the low birth rate, which they regarded as an obstacle to the industrial and military expansion of the Reich. Several measures designed to increase the population were adopted between 1933 and 1939, the most publicized of which was the system of government marriage loans, a quarter of the loan being repaid for each child born alive. These measures brought about a moderate increase in the population figures, the birth rate having risen to 20 per 1,000 in 1939, whence it again declined in World War II to 15 in 1942 and 16 in 1943.

During 1946–50 the birth rate in the Federal Republic remained at about 16 per 1,000, while the death rate decreased from 12.4 to 10.4. In the Democratic Republic in 1948 the birth rate was 12.8 and the death rate 15.1. Table V illustrates the different development in the two parts of Germany between 1939 and 1952.

TABLE *V.—Natural Population Variations, 1939, 1946 and 1952*
(*In* thousands)

Area	Year	Births	Deaths	Excess of births (+) deaths (−)
German Federal Republic	1939	807	473	+334
	1946	709	534	+175
	1952	762	507	+254
West Berlin	1939	43	36	+ 7
	1946	15	45	− 31
	1952	18	28	− 10
German Democratic Republic	1939	287	184	+103
	1946	185	393	−208
	1952	242	208	+ 35
East Berlin	1939	25	26	− 1
	1946	8	29	− 21
	1952	11	18	− 7

Sourie: *Vierteljahrshefte zur Wirtschaftsforschung* (1953).

In the first years after World War II the eastern German authorities made no effort to check the drastic population developments in their territory, influenced partly, no doubt, by the overcrowded and chaotic conditions which prevailed. Then, however, there was a tendency to introduce population measures reminiscent of the Nazi era. Measures against abortions were tightened up, and in Sept. 1950 a law "for the protection of mother and child and the rights of women" was introduced, with the dual aim of increasing the employment of women in industry and encouraging the production of large families. Improvement along these lines, however, was largely offset by an increasing exodus to the Federal Republic of members of the most productive age groups during the ensuing years.

TABLE IV.—*Population by Age Groups, 1939, 1946 and 1950*
(In percentages)

Age	German Federal Republic 1939 Male	1939 Female	1946 Male	1946 Female	1950 Male	1950 Female	German Democratic Republic 1939 Male	1939 Female	1946 Male	1946 Female	1950 Male	1950 Female
Under14	22.8	21.3	28.2*	22.1*	23.9	20.1	21.1	19.6	28.0	20.1	25.0	19.4
14–50	55.9	55.8	47.2	53.1	51.8	53.0	56.5	55.0	44.0	52.4	47.2	50.2
6	14.2	15.3	15.5	16.1	15.4	17.3	14.5	16.2	17.7	17.8	17.9	19.8
65 and over	7.1	7.6	9.1	8.7	8.9	9.6	7.9	9.2	10.3	9.7	9.9	10.6

*Under 15.
Source: *Bundesministerium für gesamtdeutsche Fragen* (Bonn).

The density of population in Germany (including the Saar, but not the later annexations) increased steadily from 124.2 per square kilometre in 1910 to 134.3 in 1925, 140.3 in 1933 and 147.6 in 1939. It was this growing pressure of population that made the National Socialists proclaim so loudly and insistently that they must have more "living space"

(*Lebensraum*). The most rapid increase in density occurred in the cities, and the National Socialists tried, but with little success, to combat this flight from the country. After the war the density of population in the Federal Republic increased rapidly from 178 per square kilometre in 1946 to 194 in 1950 and 213 in 1955. Regional alterations brought about by the flight from bombed cities and the accumulation of expelled persons in the most easterly Lander grew less marked. But there were still great regional variations resulting from natural conditions, low population density being found in the barren northern area of Lower Saxony, the Swabian and Franconian highlands, the Upper Palatinate hill country, the Bavarian forest and the Alpine border region. In the German Democratic Republic the density of population increased only from 162 in 1946 to 164 in 1950, and then fell back to 158 by mid-1953, as the movement of refugees to the west gathered force. Comparative figures for population density are given in Table VI.

The *Refugees*.—One of the most acute social problems facing Germany at the end of World War II was that of the refugees; *i.e.*, those Germans expelled from former German territory east of the Oder-Neisse line and from Czechoslovakia, Hungary and Poland under the terms of the 1945 Potsdam agreement.

By the end of 1953 there were 8,451,000 expelled persons living in the German Federal Republic, and a further 2,153,000 political refugees from the German Democratic Republic and the Soviet sector of Berlin, who together formed about 22% of the population of the Federal Republic. In the Democratic Republic the refugee population in Aug. 1940 was 4,312,000, 24% of the population. By mid-1953, however, the number was reduced to 3,800,000, as these expelled persons joined in the flight to the west.

TABLE VI.—*Population Density, 1939, 1946 and 1950*

Territory	Population per sq.km.		
	1939	1946	1950
German Federal Republic*	160	178	194
Schleswig-Holstein	101	164	166
Hamburg	2,293	1,880	2,150
Lower Saxony	96	132	144
North Rhine-Westphalia	352	344	389
Bremen	1,394	1,200	1,384
Hesse	165	188	205
Württemberg-Baden†	205	228	249
Bavaria	100	124	130
Rhineland-Palatinate	149	138	152
Baden†	124	119	134
Württemberg-Hohenzollern†	103	106	119
West Berlin	5,719	4,184	4,464
German Democratic Republic‡	140	160	164
Brandenburg	—	92	95
Mecklenburg	—	91	93
Saxony-Anhalt	—	168	171
Thuringia	—	187	188
Saxony	—	324	336
East Berlin	3,940	2,916	2,953

*Area in Sept. 1950. †In March 1952 Wiirttemberg-Baden, Baden and Württemberg-Hohenzollern were united to form the *Land* of Baden-Württemberg. ‡Area in Jan. 1952. In July 1952 the five *Lander* were replaced by 14 new provinces (*Bezirke*).

Sources: *Statistisches Jahrbuch* fur *die Rundesrepublik Deutschland* (1954); *Population of the Federal Republic of Germany and West Berlin, U.S.* Department of Commerce.

The distribution of the refugees in western Germany was from the first extremely uneven, and bore heavily on the rural and relatively poor regions of Schleswig-Holstein, Lower Saxony and Bavaria, lying on the eastern borders of the Federal Republic; the more industrial regions of the west had little accommodation available because of the widespread war damage. A scheme for a fairer redistribution of the refugees was drawn up by the federal government in Nov. 1949, and by the end of 1954 more than 750,000 expelled persons and refugees had been resettled in the industrial areas of North Rhine-Westphalia and Wiirttemberg-Baden. Nevertheless, 48.5% of all expelled persons were still living in Schleswig-Holstein, Lower Saxony and Bavaria.

By July 1955 only one-third of the expelled persons and refugees could be said to be fully integrated in the Federal Republic. A further 50% or so had jobs, but not in their own trades or professions. Just under a fifth were either unemployed, part-time employed, sick or invalid. Moreover, living conditions for many were still below the general standard, and many were still housed in camps.

Assimilation of the refugees in eastern Germany made greater progress, partly because of the Soviet insistence on the permanence of the Oder-Neisse frontier and partly because the nature of the land facilitated land reform on a much larger scale than was possible in the west, but mainly because it was prosecuted more vigorously. According to Soviet statistics 762,300 ha. were divided among the refugees, and it was possible to resettle about 348,000 on 90,600 farms. Attempts were also made to assimilate the refugees into industry, and groups of specialist craftsmen, such as those from the jewelry and glass industries in Czechoslovakia, mere encouraged to continue their trades and to build up new industries in what were formerly agricultural areas.

Religion.—As a result of the Reformation in the 16th century, northern, central and northeastern Germany became Protestant (Lutheran and Calvinist), while the west, south and southeast remained largely Roman Catholic. In both areas, however, enclaves of the other religious denomination remained. Until the large-scale movements of German refugees after World War II, the traditional territorial demarcation of Protestantism and Roman Catholicism in Germany remained basically unaltered, save for some changes brought about in industrial districts and large centres of population as a result of the Industrial Revolution.

The Hohenzollern empire established in 1871 was dominated by Prussia and was thus much more Protestant than Catholic. The antipathy came to the surface in the *Kulturkampf* (see History). As for the various Lutheran and Calvinist churches in Germany, they had always been so organized that the church in each Land' managed its own affairs; and this continued to be the practice after the foundation of the German empire in 1871.

When the empire ceased to exist after the German defeat in World War I, the traditional relationship between state and churches had to be revised. In the first place the various Protestant churches negotiated new treaties with the different Land governments which, in the Weimar republic, had succeeded the former ruling houses in Germany. The Land Protestant churches continued to be completely autonomous, but in 1922 they formed a loose association for purposes of mutual collaboration called the Deutscher Evangelischer Kirchenbund, or German Evangelical Church federation.

The organization of the Roman Catholic Church in Germany was elaborated during the 19th century, and this general organization was recognized in concordats which the church made, during the period of the Weimar republic, with Bavaria (1924), Prussia (1929) and Baden (1932). As a result the Roman Catholic Church in Germany was organized into a number of ecclesiastical provinces, each with an archbishop at its head and each consisting of a number of dioceses. The Roman Church, like the Protestant churches, retained the right to its own denominational schools and the right to levy a tax on its members, which, however, was collected for it by the state.

The old-established Jewish community in Germany was comparatively late in obtaining equality of rights with other citizens. Equality was granted to the Jews in Prussia in 1848, and during the next 20 years most of the other German Liinder followed suit. Like the Protestants, the Jews were organized on a Land basis, and below that on a congregational basis. It has been estimated that in 1933, when the Nazis assumed power, the membership of the Jewish congregations totalled about 500,000 persons. In the same year the religious composition of the country was as follows: Protestant, 62.7%; Roman Catholic, 32.5%; Jewish, 0.7%; other denominations and nonbelievers, 4.1%.

The Nazis made determined efforts to assimilate the Protestant churches in Germany to their organization. In July 1933 the constitution of the German Evangelical Church federation was revised, in conformity with the aims of the Nazi-inspired "German Christians," and as a result a National Synod of the Protestant Church was created and a Reich bishop appointed for the whole of the Protestant Church in Germany in accordance with the leadership principle. Ludwig Muller, the Reich bishop, was a wholehearted Nazi and in Dec. 1933 agreed without any hesitation to the incorporation of the German Protestant youth organization, numbering about 700,000 members, in the Hitler Youth. As a result of these measures opposition grew within the Protestant

TABLE VII.—*Religions in Germany*

Territory	Christians: Protestants Number	%	Christians: Roman Catholics Number	%	Jews Number	%	Others Number	%	No religion Number	%
German Federal Republic*	26,005,088	52.2	21,816,766	43.8	21,974	0.0	1,854,077	3.7		
German Democratic Republic†	15,038,136	81.3	2,233,315	12.1	4,629	0.0	1,185,557	6.4	128,916	0.3

*According to the 1950 census. †According to the 1946 census.

churches, and this crystallized, under the leadership of Martin Niemoller, into the Pastors' Emergency league. A protest meeting was held by the league at Barmen in May 1934, and there a declaration was issued which condemned the totalitarian claims of the Nazi state and maintained the church's right to independence in matters of faith. The Barmen declaration was, in effect, the beginning of the Bekenntnis Kirche, or Confessional Church, as the large group of dissident Protestant clergy led by Niemoller later came to be called.

In an attempt to resolve the difficulties which had arisen with the Protestant churches, the Nazis created in July 1935 a Reich ministry for ecclesiastical affairs, and Hanns Kerrl was appointed to the office. He instituted repressive measures against the Confessional Church, and Niemöller was imprisoned, other ministers were fiercely persecuted, and a strict supervision of church finances was introduced in an attempt to bring the clergy to heel. In 1936 the Confessional Church was declared illegal. However, despite all the oppressive measures and although it weakened itself by internal dissensions, the Confessional Church maintained its opposition to the Nazi regime, and the fine record of Niemoller and his followers greatly helped the restoration of friendly relations between German Protestantism and Protestantism in other parts of the world after the end of World War II.

Despite the incompatibility of the doctrines of National Socialism with those of the Roman Catholic Church, a concordat was signed in 1933 which confirmed most of the traditional rights of the Roman Church in Germany. Soon however the Nazi government began systematically to undermine the authority of the church and secured the suppression of various Roman Catholic lay associations and the virtual elimination of the Roman Catholic youth organization and church schools. In addition the Nazi regime disgraced itself by making extravagant attacks on the character of the Roman Catholic clergy. Leaders of the church defended their faith with great vigour, and throughout the Nazi period, even during the war, aspects of Nazi policy were fearlessly denounced from Roman Catholic pulpits and in pastoral letters.

Against the Jews the Nazis, in accordance with their bitterly anti-Semitic racial doctrines, adopted a policy of extreme persecution which ultimately became one of extermination. As a result, the 307,614 "believing Jews" registered in the census of 1939 had been reduced to a mere 30.000 by 1945.

From 1945 the relations between the state and the churches in the Federal Republic were governed by the relevant provisions of the Basic law or provisional constitution of the republic, which guaranteed to the churches their traditional rights. Though both Roman Catholic and Protestant churches followed a policy of political neutrality, from time to time church leaders in postwar Germany did not fear to voice their opinions on matters of public importance. Thus both Roman Catholic and Protestant leaders attacked the Allied dismantling policy after 1945; and Martin Niemoller in particular attracted much attention because of his opposition to proposals of German participation in a European defensive system, which would involve remilitarization of the country.

The organization of the Protestant Church in Germany was considerably modified after 1945. The former German Evangelical Church federation was dissolved in 1948, and in its place the Evangelische Kirche Deutschlands. or Evangelical Church of Germany, was set up. All the separate Lutheran and Calvinist churches of Germany, save the Church of Bremen, became members of the new body, which like its predecessor was by no means a central government of the German Protestant Church, but merely a loose federation, with members keeping their own identity and powers. Within the Evangelische Kirche Deutschlands a smaller association known as the Vereinigte Evangelisch-Lutherische Kirchen Deutschlands was also established in 1948—a union of all the separate Lutheran churches accounting for about 49% of the total membership of the bigger body.

According to a report made in March 1955 by the Church Office for Statistics in Hanover, over 41,000,000 Germans (roughly 60% of the total population) in the Federal Republic and in the Democratic Republic were Protestants. The largest group within the Protestant Church was the United Evangelical-Lutheran Church nith nearly 18,000,000 members, followed by the Evangelical Union Church with 14,700,000 members.

In the German Democratic Republic, out of a total population of 18,500,000, there were 15,000,000 Protestants; in the Federal Republic there were 26,000,000 Protestants and 22,000,000 Roman Catholics.

The signing of the Bonn conventions in May 1952 led to a campaign by the authorities to undermine the influence of the Protestant Church in the German Democratic Republic. Pressure was applied in particular to the Junge Gemeinde, the church fellowship in which the young people were organized. The campaign, however. was called off in June 1953, and a communiqué issued after a meeting of state and church representatives announced that the state would guarantee the independent existence of the church provided that the church would refrain from unconstitutional interference in economic and political life.

Despite this agreement, however, persecution continued, though less openly, and relations became strained again, in particular over the state policy of holding *Jugendweihe* or secular youth dedication ceremonies, a Marxist equivalent of the Christian confirmation service.

After 1945 the Roman Catholic Church returned to the organization and the state-church relationship embodied in the 1933 concordat, and the Holy See accordingly still recognized the prewar boundaries of the German Roman Catholic dioceses and provinces despite the territorial changes brought about by postwar cessions of German soil and the division of the country.

After World War II the few survivors of the Jewish community in Germany reorganized themselves anew on the traditional basis of the *Lend* and *Gemeinde* (state and local group). The different groups became represented as a whole by the Jiidische Kultus-Gemeinde (Community of Jewish Worship) and by the Zentralrat der Juden in Deutschland (Central Council of the Jews in Germany).

In Jan. 1955 there were about 22,000 Jews in the German Federal Republic and west Berlin, and about 4,600 in the German Democratic Republic.

Education. — The school system in Germany developed from three main types of school existing in the last quarter of the 19th century: the free elementary school for children between the ages of 6 and 14 (*Volksschule*); the intermediate school (*Mittelschule*), which for a small fee offered a six-year course following the first four years of the elementary school and concentrated largely on practical and commercial subjects, including one modern language; and the various types of secondary school, which prepared pupils for entry to the universities or technical colleges by means of the *Abitur* examination, taken at the age of 18 or 19. The oldest and best-known form of secondary school was the classical *Gymnasium*, which, modelled upon the ideas of Wilhelm von Humboldt in the early 19th century, gave a thorough grounding in Greek, Latin and the humanities; then the *Realgymnasium* was instituted in which classical and modern subjects were more evenly balanced: and finally the modern *Realschule*, teaching mathematics, science and modern languages, was established to meet the growing needs of trade and industry.

Certain liberal changes were introduced under the Weimar republic, although the main structure was not greatly altered. The first four years of the elementary school (known as the *Grzindschule)* were made compulsory for all, and for those children who did not enter an intermediate or secondary school two to three years' part-time vocational continuation school were prescribed. The Weimar constitution also intended to make free secondary schooling available to all children according to their ability, but this principle was never applied very widely in the various *Lander,* which were responsible for carrying out educational policy. Two additional types of secondary school were established during the Weimar period—the *Deutsche Oberschule,* which based its teaching more directly on German tradition, and the *Aujbauschule,* which in country districts offered a shorter course of six years to pupils leaving the elementary school at the age of 1z. There were, however. numerous local variations of these main types of schools, Denominational schools were the general rule throughout Germany, although mixed-denominational schools with some religious teaching gained ground under the republic, and there were also a few secular schools where no religious instruction was given.

The Nazi regime introduced certain further changes in the school system. The administration of education was centralized under the Reich and Prussian ministry of education in 1934, and attempts were made to bring about greater uniformity in secondary education. Only the *Deutsche Oberschule,* the *Aujbauschule* and the *Gymnasium* were retained, the first, because of its emphasis on Germanic tradition, reaching a dominant position, while the classical *Gymnasien* were considerably reduced in numbers. Another Nazi innovation was the plan to replace the six-year *Mittelschule* by a free four-year *Hauptschule* of a still more technical nature for selected pupils of physical and racial suitability. Teaching in all the schools became very largely coloured by Kazi theories, and there were in addition special schools for the training of the party Clite. notably the National Political Educational institutions and the Adolf Hitler schools. Although the denominational school was formally retained by the concordat of 1933, the Nazis systematically undermined its position and by 1940 it had finally disappeared from the scene.

Not counting the technical and other institutions of university standing, there were 23 universities in Germany in 1939, some of them mediaeval foundations, others having been founded in the 15th and 16th centuries. The modern period of university development may be said to have begun with the creation of the Prussian national University of Berlin in 1810, and it was inspired to a great extent by the humanistic thought of Humboldt, who insisted on a new independent position for the university, separated from the territorial power, as a "privileged corporation" with self-governing rights. To this important principle he added the two further principles of freedom of teaching and freedom of learning, the latter enabling students to attend whatever lectures they liked and to wander from one university to another, without any sort of tutorial system.

Despite various attempts during the Weimar period to broaden the social basis of the universities, they continued to remain the strongholds of the upper and the prosperous middle classes. In 1929 less than 5% of the students at universities and technical high schools were drawn from the lower class. Moreover, freedom of teaching all too frequently degenerated during the republic into freedom to disseminate nationalist propaganda against the state, and nationalist and antidemocratic ideas pervaded a number of the student associations. In the smaller provincial universities, in particular, Nazi-nationalist student organizations were already firmly established by 1931–32.

Immediately after coming to power Hitler appointed as minister of education (first in Prussia and from April 30, 1934, in the Reich) Bernard Rust, who was responsible solely to Hitler himself; new university rectors responsible only to the minister were appointed, and teaching staffs were severely purged not only of Jews but also of all who could be suspected of opposition to the new theory that the task of a German university was to create Aryan and Germanic man. Dismissals among professors and lecturers amounted to 1,687, while the number of students was reduced from about 150,000 in 1933 to about 60,000 in 1938. Curriculums were revised by the introduction of an ultranationalist approach in teaching history and of pseudoscientific geopolitics embodying the idea of German racial superiority and a German mission and duty to become a 200,000,000-strong leading nation of Europe.

After World War II.—The Potsdam agreement of Aug. 1945 provided for the control of German education by the occupying powers in order to eliminate Nazi and militarist doctrines and to make possible the successful development of democratic ideas. In spite of the immediate postwar chaos in education there was a strong desire, shared by Germans and occupying authorities alike, to introduce school reforms as early as possible, so that the German school might be transformed from a purely instructional institution into a more lively community where the child's independent and critical judgment was encouraged to develop. Varying degrees of school reform were therefore started in the four occupied zones even before general principles were formulated by the Control council in June 1947. This directive prescribed equal educational opportunities for all; the provision of free tuition and school equipment in all schools attended by children of compulsory school age which were supported by public funds, and financial assistance where required in other schools; compulsory full-time school attendance between the ages of 6 and 15, and part-time compulsory attendance until the age of 18 for pupils not taking higher education; the institution of a comprehensive school system in which elementary and secondary education formed two consecutive stages, and not two overlapping types or qualities of instruction; education for responsible citizenship and a democratic way of life; and teacher training in universities or training institutions of university rank.

Progress toward these ideals was far from uniform in the various zones of Germany. The comprehensive type of school was fully established only in the Soviet zope, where educational administration was centralized at a very early stage. This *Einheitssckule* provided for an eight-year elementary stage, followed by four years' secondary schooling either in an *Oberschule* or in a part-time or full-time vocational school. Private schools were abolished. No religious instruction was allowed in the schools, and the teaching was speedily converted to the inculcation of communism. Under pressure of the shortage of skilled labour, preference was later given to the 11-year elementary plus technical school, and this, shortened to a ten-year course by 1955, was threatening to replace many of the *Oberschulen.*

In the Federal Republic the school system reverted very much to the traditional Weimar structure, with considerable variations from *Land* to *Land.* Elementary education, for those 80% or so of children who did not go on to intermediate or secondary schools, consisted of from four to six years' *Grundschule,* followed by four or five years at elementary school, and part-time attendance at vocational schools for six to eight hours a week. In Feb. 1955 it was agreed to introduce greater uniformity in intermediate and secondary schooling. All intermediate-type schools were to be known as *Mittelschulen* and all secondary schools (leading to university matriculation) as *Gymnasien.* But there were longer and shorter courses at each type of school, and in the *Gymnasium* provision was made for classical, modern and mathematics or science classes. Secondary schooling was not everywhere free, but where fees were charged the number of scholarships had risen. In the southwest the denominational school was the general rule; in most other parts the mixed-denominational school with religious instruction nas fairly widely accepted.

The universities were faced with even greater problems at the end of the war; not only were the teaching staffs curtailed by denazification and many of the buildings destroyed, but the number of prospective entrants was abnormally high as a result of neglected studies during the war. Even after certain categories of Nazis and regular officers were excluded it was found necessary to impose a *numerus clausus* during the early postwar years. The great expansion in university attendance after the war may be illustrated by the fact that in 1935–36 there was 1 university student to 895 inhabitants, whereas in 1953 there was 1 to 423 inhabitants in the federal territory, and in west Berlin, where a second university, the Free University of Berlin, was founded in

1948, since the Humboldt university in the Soviet sector was being progressively converted to Communist principles.

A mixed commission of inquiry set up at the end of 1947 to consider the question of university reform in western Germany made various proposals. The most important of them concerned a greater degree of independence of the state, a closer relationship with the community as a whole, the employment of professors with special qualifications for teaching, and the introduction of a *studium generale* with the object of broadening the outlook and knowledge of the students. Apart from the founding of chairs of political or social science at a few of the universities, little had been done by 1954 to carry out the suggested reforms in western Germany. There was, hovever, greatly increased contact with the academic world abroad.

In eastern Germany great importance was attached to the broadening of the social basis of university attendance, and. in 1955, 53% of all students were said to come from workers' and farmers' families. Scholarship grants were available only for these and for students of lower middle-class origin. Political reliability, in the Communist sense, continued to determine academic advancement, and in every faculty students were required to pass a basic course in political science. Apart from the excessive and compulsory concentration on Communist political theory, the universities of the Democratic Republic were suffering from an overspecialization in technical subjects to meet the demands of the five-year plan.

TABLE VIII.—*Attendance at Universities and Technical Colleges*

Institution	Year of foundation	Total number of matriculated students (number of women in parentheses)			
		Winter 1911–12	Winter 1930–31	Winter 1936–37	Summer 1953
Universities					
Berlin	1810	9,829 (845)	14,687 (3,087)	6,717 (999)	8,473 (2,786)
Bonn	1818	3,998 (255)	5,612 (1,192)	2,941 (424)	6,915 (1,533)
Breslau	1702	2,702 (134)	4,481 (871)	2,932 (450)	—
Frankfurt-on-Main	1919	—	3,823 (755)	1,630 (242)	5,909 (1,001)
Guttingen	1737	2,505 (224)	3,851 (568)	1,540 (199)	4,111 (720)
Greifswald	1456	1,124 (74)	1,644 (231)	722 (103)	2,002 (722)
Halle-Wittenberg	1694	2,879 (62)	2,492 (274)	1,065 (172)	4,461 (1,257)
Kiel	1665	1,586 (32)	2,389 (356)	1,069 (178)	2,393 (435)
Cologne	1919 (1388)	—	5,616 (1,057)	2,696 (397)	8,322 (1,347)
Khnigsberg	1544	1,505 (99)	3,208 (625)	1,481 (298)	—
Marburg	1527	1,968 (87)	3,210 (660)	1,318 (303)	3,753 (826)
Münster	1902 (1780)	2,126 (149)	4,149 (879)	2,436 (364)	5,961 (1,370)
Erlangen	1743	1,202 (27)	1,944 (155)	1,080 (91)	2,575 (471)
Munich	1472	6,797 (188)	8,895 (1,711)	5,034 (926)	10,409 (2,160)
Würzburg	1582	1,458 (17)	2,971 (340)	1,785 (314)	2,240 (405)
Leipzig	1409	5,170 (103)	6,938 (938)	2,488 (270)	7,804 (2,440)
Tübingen	1477	1,852 (40)	2,960 (371)	1,792 (230)	4,217 (997)
Freiburg	1457	2,466 (149)	3,397 (754)	2,599 (530)	4,986 (1,203)
Heidelberg	1386	2,231 (165)	3,079 (593)	2,047 (492)	4,973 (1,317)
Jena	1558	1,738 (69)	2,879 (512)	1,478 (317)	3,965 (1,133)
Giessen	1607	1,272 (29)	1,876 (142)	682 (48)	...
Rostock	1419	852 (6)	1,624 (203)	786 (123)	2,552 (708)
Hamburg	1919	—	3,746 (855)	1,704 (321)	5,775 (1,434)
Mainz	1946	—	—	—	3,653 (1,004)
Technical colleges					
Aachen	1870	...	994 (43)	665 (11)	5,374 (163)
Berlin-Charlottenburg	1879	...	4,592 (131)	2,328 (33)	...
Brunswick	1877	...	1,061 (74)	707 (97)	2,569 (212)
Breslau	1910	...	678 (11)	444 (4)	—
Darmstadt	1877	...	2,243 (41)	1,134 (14)	2,992 (61)
Dresden	1890	...	3,814 (405)	1,160 (41)	6,631 (465)
Hanover	1879	...	1,783 (47)	1,016 (25)	2,774 (131)
Karlsruhe	1865	...	1,324 (27)	616 (5)	3,836 (184)
Munich	1877	...	4,049 (96)	1,865 (66)	4,057 (118)
Stuttgart	1862	...	2,002 (73)	993 (29)	4,037 (196)

Sources: *Statistisches Jahrbuch für* **die** *Bundesrepublik Deutschland* (1954); **Statistisches** *Jahrbuch der Deutschen* **Demokrotischen** *Republik* (1955).

CONSTITUTION AND GOVERNMENT

In 1933 the *Reichstag* ceased to have any real function in the state. An enabling act passed by a Sazi-Nationalist majority on March 23, 1933, set aside many of the clauses of the Weimar constitution, including the guarantees of personal liberty, and virtually gave Hitler dictatorial power. He and his cabinet were able to issue decrees having the force of law and, with all other parties except the National Socialist party dissolved, he speedily organized a totalitarian form of state in which the individual *Lander* were gradually shorn of their powers until they existed as little more than administrative divisions, while the state itself was dominated by the National Socialist party. This party established an intricate network of directing bureaus and mass organizations duplicating those of the state in order to secure its hold over every aspect of the life of the country, and its power was reinforced by the ubiquitous secret police or Geheime Staatspolizei (Gestapo).

At the end of World War II Germany was left without a government, and supreme authority was assumed by the U.S., British. French and Soviet commanders in chief, acting both individually in their own zones of occupation and also jointly, in matters affecting the whole of Germany, as the Allied Control council. Agreement on the political and economic principles that should govern Allied policy was reached at Potsdam on Aug. 2, 1945. The unwieldy state of Prussia was split up into a number of more moderate-sized *Länder* and certain other *Land* boundaries were redrawn to eliminate the very small units and to facilitate communications in the four areas of occupation. Gradually a fair measure of self-government was restored to the Germans, first at the level of the commune, and then at *Lund* level, until by the spring of 1947 elected diets and governments were functioning throughout the country. certain central powers being reserved to the occupying powers in each zone. In the meantime fundamental disagreement had developed between the occupying powers as a result of the Soviet refusal to co-operate in treating Germany as an economic whole in the manner prescribed by the Potsdam agreement. As a step toward this end, the U.S. and British zones tvere fused for purposes of economic organization at the beginning of 1947, and the French zone was associated with them in Oct. 1948.

German Federal Republic.—Efforts to establish a central German government by quadripartite agreement at successive conferences of the four foreign ministers having failed, the three western powers eventually decided that governmental development in western Germany could be held up no longer. At a series of talks in London in the spring of 1948, at which representatives from the Benelux countries were also present, principles were enumerated for the formation of a central government in western Germany, for the international control of the Ruhr and for the establishment of a military security board. The ministers-president of the 11 western German *Lander* were authorized to convene a constituent assembly for the drafting of a democratic and federal type of constitution which should combine adequate central authority with a proper degree of self-government for the participating *Lander.* The constitution was to be so formulated that it could be adapted when German unity was once more established. This constitution (known as the Basic law) was adopted by the parliamentary council at Bonn on May 8, 1949.

At first sight the Basic law closely resembled the Weimar constitution in being a federal, republican type of constitution weighted in favour of the central authority. But it granted the *Länder* much more legislative and administrative independence. Education and cultural and religious affairs were now the sole prerogative of the *Länder,* which also had wide legislative powers in the field of public health, press and films. Financial questions, moreover: were no longer the monopoly of the central government; powers of taxation were divided between the *Lander* and the centre, and it was a recognized principle that the two authorities should be self-supporting and independent of each other in their budget economy. Like the Weimar constitution the Basic law provided for a two-chamber legislature, consisting of a *Bundestag,* representing the nation as a whole, and a *Bundesrat,* formed from members of the *Land* governments. The *Bundesrat* was to act mainly in an advisory capacity, although it had powers of suspensory veto and of absolute veto over taxation legislation affecting *Land* interests. The position of the president was far less powerful than under the Weimar constitution. In particular, he had none of the former emergency powers, which now passed in severely curtailed form to the government. The government, however, was correspondingly strengthened, both by the provisions aiming at governmental stability and by the adoption of a system of collective responsibility.

The Basic law was approved by the U.S., British and French military governors with certain important reservations. The exercise of sovereign powers in the new Federal Republic was restricted by the Occupation statute, which was promulgated on the same date as the Basic law (May 12, 1949). By this document the three Allied powers reserved to themselves powers in the field of disarmament and demilitarization; controls in regard to the Ruhr, reparations, decartelization, trade discrimination, foreign interests and claims; foreign affairs; displaced persons; security of Allied forces and their immunities; occupation costs; respect for the Basic law and the *Land* constitutions; control over foreign trade and exchange; the minimum of control required to reduce the need for external economic assistance; and control over the treatment in German prisons of persons falling within the competence of the courts or tribunals of the occupying powers. An important reservation concerned the position of Berlin; it was decided that in view of the practical difficulties involved by the quadripartite occupation of the city, Berlin could not be included in the new Federal Republic, although it should be allowed to send observers to the federal parliament.

The federal government took office on Sept. 20, 1949, in the form of a coalition between the Christian Democratic union, the Free Democratic party and the German party, under the chancellorship of Konrad Adenauer. On the same date military government ceased to exist and Allied control was exercised instead through a civilian Allied High commission. During the following two years the controls enumerated in the occupation statute were gradually reduced, and on May 26, 1952, contractual agreements establishing a new relationship between the three western powers and the German Federal Republic were signed in Bonn. These extended to the Federal Republic full authority over its internal and external affairs except for special rights retained by the Allied powers over the stationing of armed forces in Germany, Berlin, and such matters as unification of Germany and a peace settlement. Because of delays in ratification and the breakdown of the plans for the European Defense Community, these agreements, in a somewhat amended form, came into force only on May 5, 1955, on which date the occupation regime came to an end and the Allied High commission was replaced by the embassies of the three western powers. *(See* above, *History.)*

German Democratic Republic.—On Oct. 7, 1949, a few days after the establishment of the federal government in Bonn, a government for the Soviet zone, thereafter to be known as the German Democratic Republic, was set up in Berlin. For some time past, administration in the Soviet zone had become highly centralized, all matters of importance having been controlled, under Soviet supervision, by a central economic commission and a number of main administrations. At the same time a shadow parliament known as the people's council had been elected on the single list system in May 1949, one of its main tasks being to draft a constitution for the Soviet zone. These two bodies were swiftly transformed into a government and a lower house. The diets of the five Soviet zone *Lander* elected their representatives to the upper house on the basis of 1 to every 500,000 inhabitants, and at a joint session of the two chambers on Oct. 11, 1949, the 73-year-old Communist leader Wilhelm Pieck was elected president of the new republic.

The provisional constitution of the German Democratic Republic also bore a superficial resemblance to the Weimar constitution, but whereas the Bonn constitution amended this in the direction of greater *Land* autonomy, the constitution for eastern Germany strengthened the powers of the centre. It granted the central authority virtually exclusive powers of legislation and a dominating position over finance and taxation. Moreover, although there was ostensibly a two-chamber legislature, the *Länderkammer* was elected entirely on a population basis and was little more than a reflection of the lower house. The *Volkskammer,* the lower house, was according to the constitution to be elected by proportional representation. In practice, however, the single-list system was used for the 1950 elections, the seats being allotted to the various parties in advance under an arrangement made by the Communists which ensured their predominance. The president was elected by the joint assembly of the two houses and had no powers other than purely representational. The minister-president was appointed by the strongest party in parliament, and his government reflected the strengths of the various parties represented in the *Volkskammer.*

East Berlin was rather more closely associated with the Democratic Republio than was west Berlin with the Federal Republic and, as befitted its geographical position in the centre of the Soviet zone, acted as capital for the area.

Revolutionary administrative reforms in the German Democratic Republic were initiated by the Communist Socialist Unity party on July 11, 1952, as part of a plan for intensifying the socialist structure of the country. These were embodied in a law of July 23 which abolished the *Land* governments and parliaments and substituted 14 regional councils and assemblies. The regions *(Bczirke)* into which the original five *Lander* were divided did not in all cases coincide with the *Land* boundaries. The reform aimed at reorganizing the country into units that would facilitate economic planning, and at tightening central control over all local and regional government.

Shortly after the establishment of the German Democratic Republic in 1949 the Soviet Military administration transformed itself into a Soviet Control commission with supervisory powers over the government. In May 1953 this was superseded by a civilian Soviet High commission, military control being vested solely in the Soviet commander in chief. In March 1954 the Soviet High commission relinquished its supervisory powers over the German Democratic Republic, except as regards security, and the nominal sovereignty of the country was more formally endorsed in a treaty between the Democratic Republic and the U.S.S.R. concluded in Sept. 19S j, when the Soviet High commission was finally dissolved. The U.S.S.R. retained its rights and obligations under four-power agreements relating to all-German affairs, and provision was made for Soviet troops to remain for the time being.

Legal System.—Judges and public prosecutors in Germany have always been civil servants. They are appointed for life, subject to the age limit, after university studies; a first examination; three years of basic practice in the courts, in public prosecutors' offices and in private legal practice; and a final examination. The English distinction between barristers and solicitors does not exist in Germany.

At the base of the structure of courts as established in 1879 is the local court *(Amtsgericht)* with jurisdiction over civil and criminal matters of a not very serious nature and such other matters as land registry, bankruptcy, etc. The local courts act as courts of first instance. Above the local court is the district court *(Landgericht),* a court of appeal from the local court and a court of first instance for more serious civil and criminal matters and divorce cases. Above the district courts are the courts of appeal *(Oberlandesgerichte),* of which there is normally one in each *Land;* there was previously also one in each Prussian province. The supreme court of the Reich *(Reichsgericht)* was established in 1879 at the apex of the system. It acted as the final court of appeal in matters of civil and criminal law, as the first and only instance in cases of treason, and also served the purpose of guaranteeing the uniform application of the law.

The courts of appeal and the supreme court were entirely composed of professional judges; certain cases before local courts were heard and tried by a single professional judge assisted by lay assessors and some cases before district courts by a jury under the chairmanship of a professional judge.

Under the Nazi regime, the *Lander* were deprived of their prerogatives in the administration of justice, which was made the exclusive concern of the Reich. The court system was changed in as far as a special supreme court, the people's court *(Volksgerichtshof),* mas established competent for political cases which were withdrawn from the old supreme court of the Reich. At local and district level special courts for those and similar cases were established.

After the collapse of the Nazi regime the occupation powers had supreme authority over the law and its application. It fell to them to cleanse the whole legal system—law, procedure and organization—of Nazi features. Special courts were abolished, from the local level to the people's court; some laws were annulled altogether and some in part. The division between western and eastern Germany resulted in the separate development of both after 1946.

In western Germany after 1946 authority over the legal system was gradually handed back to the administration of the *Lander*, and German jurisdiction over this field was finally restored in 1949. The Basic law of the Federal Republic re-established conditions very largely as they were in the Reich before 1933. The only substantial change mas the abolition of capital punishment. Competence over legal matters rests with the legislative authorities of the Federal Republic; the organization, the appointment of judges and the budgetary provisions of the administration of justice are the concern of the *Länder*. The structure of the system of courts was maintained. The supreme court of the Reich was replaced by the supreme federal court *(Bundesgerichtshof)*, which is supplemented by higher federal courts for taxation. administration and labour. The functions of the federal constitutional court (*Bundesverfassungsgericht*) extend beyond those of the constitutional court of the Weimar republic. The constitutional court decides on litigations between the federation and the *Lander*, on the interpretation of the Basic law and its compatibility with federal and *Land* law. It is called upon to decide whether a political party pursues any aims and methods conflicting with the spirit and letter of the Basic law. The federal president and federal judges can be impeached before the constitutional court. Judges of the constitutional court are elected half by the *Bzmdestag*, the federal parliament. and half by the *Bundesrat*, the legislative body representing the governments of the *Lander*.

In eastern Germany the legal system underwent considerable changes after the enforced introduction of the political and social system of the "people's democracies." Large parts of the civil and commercial code became obsolete by the abolition or restriction of private property in agriculture, industry and trade. The criminal code was extended by that type of offense falling under the heading of economic crimes and sabotage. A new criminal code began to be formulated, and the *Volkskamnzer*, the lower house of the legislature, in Oct. 1952 passed a new criminal procedure la\%-—replacingthe one of 1877—which was to create the procedure for the new code. In this new law, great importance was attached to making criminal procedure lead to respect for the socialist law, for socialist property, for labour discipline and for the protection of democracy.

The structure of courts was maintained until Aug. 1952, when the system mas reorganized to fit in with the new administrative pattern. The new Law on the Constitution of Courts provided for three kinds of courts only: district courts (*Kreisgerichte*, replacing the *Amtsgerichte*), area courts *(Bezirksgerichte*, replacing the *Landgerichte)* and the supreme court; the *Oberlandesgerichte* were eliminated. The underlying principle of the new legal system was the formation of a new class of "people's judges" who would ensure that the courts acted as guardians of the new social and economic order of the state. All criminal and civil matters dealt with by the new district and area courts in the first instance were to come before a senate consisting of one professional judge and two lay assessors (*Schöffen*), who would exercise full judicial functions. The supreme court (established in 1949) hears appeals only on behalf of the state. The *Volkskammer* is nominally the supreme authority in the administration of justice in eastern Germany and holds the functions of a constitutional court.

(See also GERMANIC LAWS, EARLY; GERMAN LAW.)

(I. L. G.; P. G. Rs.)

DEFENSE

Although strictly speaking the German army was founded in 1871, its origins and tradition may be traced back to a much earlier period. Before unification of the German empire several of the German states possessed independent armies, the best and the largest of which was the Prussian. As Prussia acquired hegemony in the Second Reich. Prussian methods and spirit dominated the creation of a new German army.

The Prussian Army.—The Prussian army was a standing mercenary body instituted toward the close of the Thirty Years' War by Frederick William, the Great Elector of Brandenburg. Having an efficient military force of 40.000 at his disposal, this clever and unscrupulous ruler was able to win a position for himself among the powers and to enlarge his dominions considerably. His grandson, Frederick William I, king in Prussia, known as the "sergeant-king," increased the standing army from 40,000 to 89,000 and was the first reigning prince to exchange court dress for military uniform. His army, essentially an infantry force, was drilled to perfection by Leopold I of Xnhalt-Dessau (*q.v.*), a stern disciplinarian. With this same army Frederick the Great was later to conquer Silesia. to resist Austria. Russia and France successfully in the Seven Years' War and to engineer the first partition of Poland. In 1788 it was aptly declared by Mirabeau that "Prussia was not a state possessing an army: rather was it an army which had taken over a nation." However, the inherent vice of a professional army was that, if thoroughly defeated, its only course left was to surrender, which was precisely the fate of the Prussian army at Jena in 1806 when it proved no match for the French with their new spirit, new organization and new battle tactics evolved by Napolean.

By the treaty of Tilsit the Prussian army was limited to 43,000, but Gerhard von Scharnhorst (*q.v.*), who in 1807 was appointed head of a military reorganization commission (Militär Reorganisationscommission), overcame the difficulty by introducing secret universal service on the so-called Krumper system, by which men were passed through the regimental establishments as hastily as possible and dismissed to the reserve. thus giving place to new recruits. The Prussian army of 135,000 commanded by Gebhard von Bldcher and his chief of staff August von Gneisenau which took part in the liberation campaign of 1813–14 was no longer mercenary but a national army. The "nation in arms" idea was born, and universal compulsory service was officially introduced on Sept. 3, 1814, by Hermann von Boyen, minister of war. The periods of service were 3 years in the army, 2 in the reserve and 14 in the *Landwelzr;* the annual contingent was fixed at 40,000.

This system, which survived almost half a century, was radically revised in 1860 when the annual contingent was fixed at 63,000, the period of reserve increased from two to four years and the *Landwelzr* divided into two levies, requiring five years in the first and seven in the second. This reform. planned by Albrecht von Roon, minister of war, and forced by Otto von Bismarck through a reluctant parliament, in fact suppressed the old *Landwehr*, which was considered politically too Liberal and militarily inefficient; it was now only a cadre for reservists from 27 years to 39 years of age. The reform increased the standing army's peacetime strength from 140,000 to 213,000 and transformed the force into an exclusive instrument of royal power. Under the masterly command of Helmuth von Moltke, the army defeated the Austrians in 1866 and the French in 1870; these victories and the position thereby won by Prussia finally reconciled the nation to the 1860 reform.

The Imperial Army and Navy.—After 1871 all the armies of the German states were united, though some retained their peculiarities of uniform and the three Bavarian army corps remained separately numbered. A *Landsturm*, or supplementary reserve, was introduced in 1888 for men of from 40 to 45 years. A great increase in population led to the virtual abandonment of the principle of universal service. More men came before the recruiting officer than it was possible to train, and in 1895 the period of service with the colours was reduced for infantry from three to two years. In 1907, for instance, there were 556,770 men of 20 years, but only 212.660 were assigned the active service, and the peacetime footing of the army was then about 615,000. In 1914 the army was organized in 25 army corps and 50 divisions. Each division consisted of four regiments or 12 infantry battalions, two regiments of field artillery comprising nine batteries of field guns and three of field howitzers (72 pieces in all), etc.

The German navy was begun later. It was only in 1896 that the first program of 17 battleships and eight heavy cruisers was approved by the *Reichstag*. William II and Adm. Alfred von Tirpitz, the navy minister, were the moving spirits behind this expansion, and their aim was to establish parity with the British navy. In Aug. 1914 Germany entered World War I with 35 battleships, 13 battle cruisers, 43 cruisers, eight old cruisers and 13 gunboats; together with destroyers, torpedo boats and submarines the German navy totalled 1,019,000 tons; its peacetime complement was 6,500 officers and 71,000 men.

In Aug. 1914 Germany was able to mobilize 123 divisions, and at the beginning of 1918 their number reached a peak of 246; but while the 1914 model comprised 12 battalions and total effectives of 16,650 men, by 1918 a German division comprised 9 battalions with an average of 9,550 men. The German army fought well in World War I. Among many good generals Erich Ludendorff, perhaps the only leader of genius in this war, was the sole commander who mas able to break through the tangle of the western front. Because of lack of transport and reserves, he lost the initiative and was forced to retreat. but the Allies never succeeded in breaking through the German front, never inflicted on the Germans a defeat in the Cannae style. In 1914, out of 9,750,000 men liable to be called up, 4,900,000 were trained reservists; during World War I, 13,250,000 served with the colours, of whom 1,834;524 were killed. At the time of the Armistice there were 183 German divisions comprising 3,403,000 men.

The **Reichswehr.**—By the treaty of Versailles (1919) Germany was required to reduce its army to seven infantry and three cavalry divisions; the total number of effectives was not to exceed 100,000, including a maximum of 4,000 officers. Universal compulsory military service was forbidden, and only voluntary enlistment was allowed. The treaty also restricted the navy, forbidding Germany to have any submarines and confining its naval strength to six heavy cruisers of not more than 10,000 tons, six light cruisers of not more than 6,000 tons, 12 destroyers and 12 torpedo boats. The personnel of the navy was restricted to 1.500 officers and 13,500 men. Finally, all fortified works, fortresses and field works between a line drawn 50 km. E. from the Rhine and the western frontier were to be demolished, and the whole zone was to be demilitarized. Germany was also forbidden to maintain any air forces.

When a German basic law on the new Reichswehr was promulgated on March 23, 1921, Germany appeared to be formally executing the Versailles disarmament clauses. Actually, however, the stipulations were never honoured. Well protected against the curiosity of the Allied Control commission and also that of a handful of German antimilitarists by Otto Gessler, minister of the *Reichswehr* from March 1920 to Jan. 1929, in nine successive cabinets, Gen. Hans von Seeckt, commander of the *Reichswehr,* successfully played the part of a modern Scharnhorst, his aim being, as he wrote in 1933, to build "not a mercenary army, but an army of leaders" which could be "the iron frame of the Reich." From the outset there was a secret general staff within the *Heeresleitung* officially named *Truppenamt,* and from the outset Seeckt was planning for an army of 35 divisions. Prototypes of new and forbidden weapons were built and tested in the Soviet Union, an outcome of the Rapallo agreement of 1922. The air force and experiments for chemical warfare were organized in the neighbourhood of Moscow, and the armoured centre was at Kama in the Urals. On Seeckt's resignation in Oct. 1926 work was continued by his successors, Gen. Wilhelm Heye (until Oct. 1930) and Gen. Kurt von Hammerstein-Equord (until Feb. 1934).

The **Wehrmacht.**—When Hitler came to power, everything was ready for a rapid expansion of the German army. The Reichswehr comprised only 21 infantry regiments, but by Jan. 1933 it had 46 generals, 120 colonels, 700 lieutenant colonels and majors, 2,000 captains, 5,000 first and second lieutenants and 21,000 noncommissioned officers. It was no wonder that every regiment easily became a division. Only the mass production of weapons and the reintroduction of conscription were lacking. The secret order to start the former was signed by Hitler on May 16, 1933, and the following day he made the first of his "peace" speeches. Conscription was reintroduced, first, on March 16, 1935, for one year, then, from Aug. 24, 1936, for two years.

According to the basic law of March 16, 1935, the Wehrmacht comprised the army (Heer), the air force (Luftwaffe) and the navy (Kriegsmarine). The army was composed of 12 army corps and 36 divisions, but in March 1939 a spokesman of the war ministry announced that the army comprised 18 army corps, 51 divisions (including 39 infantry, 4 light or motorized, 5 armoured and 3 mountain) and a cavalry brigade. The new infantry division comprised three infantry regiments and one artillery regiment. The infantry regiment comprised three battalions of. three companies and one company of 12 heavy machine guns and six heavy 80-mm. grenade throwers; each regiment had a 13th company of infantry guns (six 7j-mm., two 105-mm. and four light antiaircraft guns of 20 mm.), a 14th company of 12 antitank 37-mm. guns, one platoon of engineers and one signal platoon. The divisional artillery regiment had four battalions of three batteries of four pieces; *i.e.,* 36 gun howitzers of 105 mm., four guns of 105 mm. and eight howitzers of 150 mm. In addition the division comprised: a reconnaissance battalion composed of one mounted squadron, one cyclists' squadron and one heavy squadron (three armoured cars, two 75-mm. guns, two light machine guns, four heavy machine guns, three antitank guns and three heavy grenade throwers); an artillery observation battalion; a signal battalion; an engineer battalion; an antitank battalion of 36 guns, etc. The nominal strength of a division was 15,150 men.

Some idea of the expansion of the German army during World War II is given by the following figures: in Sept. 1939 Germany mobilized 77 divisions, 54 of which took part in the campaign against Poland; in May 1940 there were 148 mobilized divisions, of which 117 were launched against France, Belgium and the Netherlands; in June 1941 there were 4,980,000 men in the army alone (including 80,000 in the *Waffen-SS.*) organized in 186 divisions, of which 139, including 32 armoured and motorized, were concentrated against the Soviet Union.

The treaty of Versailles had forbidden Germany to maintain the air force, but had allowed it to have civil aviation. This proved useful for the training of pilots and mechanics and the maintenance of an aircraft industry. The first civil aviation company was formed in Jan. 1919, but the real preparatory work for a future air force began with the creation of the Deutsche *Lufthansa* on Jan. 6, 1926, which absorbed all existing companies. On April 28, 1933, Hitler created an air transport ministry with Hermann Goring as minister; on March 1, 1935, when the formation of an air force was officially admitted, this became an air ministry; Göring was appointed its chief with the rank of colonel general, later of field marshal and lastly of *Reichsmarschall.* In Jan. 1938 Germany was divided into seven air areas comprising 13 groups or Geschwader (9 bomber, 4 fighter), 68 wings or *Gruppen* and 203 squadrons or Staffeln, 2,424 first-line aircraft in all. As a rule, a group comprised three wings and a wing three squadrons of 12 aircraft each.

The air force expanded rapidly and on Sept. 1, 1939, comprised about 4,300 first-line aircraft including 1,180 fighters, 1,180 bombers, 336 dive bombers, 721 reconnaissance and 552 transport aircraft; the naval air force comprised 240 machines. The number of modern aircraft ready for war operations was, however, no more than 3,200; by Dec. 1940 this number was reduced to 1,956; in Dec. 1942 it was 2,074 and in Dec. 1944 it amounted to 3,888, of which 53% were fighters. This failure to enlarge the air force was in striking contrast with the development of anti-aircraft artillery: in Sept. 1939 there were about 2,600 heavy (88-mm. and 105-mm.) and 6,700 light (37-mm. and 20-mm.) anti-aircraft guns; in May 1944 the respective numbers were 14,489 and 41,937. In June 1941 1,480,000 men were enrolled in the air force.

Already by the end of 1934 Hitler had given orders for the secret construction of submarines, and six months later, by the Anglo-German naval agreement of June 18, 1935, Great Britain winked at the scrapping of the Versailles naval limitations. The agreement provided that Germany was not to build beyond 35% of the British tonnage in each category of ships, except that in the case of submarines it might build up to 45%—in which event proportionate tonnage reductions were to be made in other classes of vessels. Such an agreement suited Hitler at the time, but when, after the German annexation of Bohemia and Moravia, Great Britain concluded with Poland a mutual assistance agreement, he denounced the naval treaty on April 28, 1939. The treaty had, in any case, already been violated, and Germany entered World War II with a new navy of two battleships, three battle cruisers of the so-called 10,000-ton "Deutschland" type, two heavy cruisers, six light cruisers, 22 destroyers, 12 torpedo boats, 20 motor torpedo boats and 71 submarines. By June 1941 there were 298,000 men serving in the navy.

On March 7, 1936, Hitler ordered German forces to occupy the neutralized zone of the Rhineland, thus committing "a hostile act . . . calculated to disturb the peace of the world" (art. 44 of the treaty of Versailles) and "an unprovoked act of aggression" (art. 2 of the Locarno treaty of mutual guarantee). In order to intimidate France still further, so that operations could be safely undertaken in eastern Europe, Hitler secretly ordered, on May 28, 1938, the construction of a line of fortifications from the Belgian to the Swiss frontier.

There can be no doubt that this *Westwall* played a considerable part in stiffening the morale of the German people in the weeks preceding the outbreak of World War II.

Germany's expenditure on armaments from 1933 to 1939 was declared by Hitler, in his *Reichstag* speech of Sept. 1, 1939, to have amounted to more than 90,000,000,000 RM.

The Disarmament of 1945.—At the end of World War II, inter-Allied policy with regard to Germany was set down in the Potsdam agreement of Aug. 2, 1945. This stated that the purposes by uhich the Allied Control council should be guided in the occupation of Germany were the complete disarmament and demilitarization of Germany and the elimination or control of all German industry that could be used for military production. All German land, naval and air forces with their organizations, staffs and institutions were to be "completely and finally abolished." Till March 1948 this course was carried out by the quadripartite Allied Control council in Berlin; but the Soviet government then withdrew from the council as a result of disagreements on policy and, in the summer of 1948, began to build up a militarized police force in eastern Germany in violation of the Potsdam agreement.

German Democratic Republic: **"Volkspolizei."**—Communist German armed forces were organized by the department for internal affairs of the Soviet Military administration. The first *Bereifschaften* (alert units) were formed in Sept. 1948. At the end of 1950 the force officially known as the *Kasernierte Volkspolizei* (K.V.P.), or barracks people's police, comprised at least 39 *Bereitschaften,* or battalions, organized as military formations of a particular arm or service. In 1951, in the course of reorganization, 24 *Dienststellen* (regimental combat teams) were formed. On May 1, 1952, Wilhelm Pieck, president of the German Demociatic Republic, threatened the creation of a defense force if the Bonn and Paris agreements (*see* below) were signed; on June 18 the *Volkskammer* approved a resolution for the establishment of a "national army."

On Feb. 17, 1954, at the four-power conference in Berlin. John Foster Dulles, U.S. secretary of state, said that the military personnel of the Democratic Republic amounted to 140,200 men, including 100,000 in the army and the rest in the security troops, the air force and the navy. The army was composed of seven divisions (three mechanized). On May 14, 1955, a treaty of mutual defense was concluded by the U.S.S.R. and the seven European people's republics, including the German Democratic Republic. A unified command for the Communist armed forces was created.

On Sept. 26, 1955, the *Volkskammer* approved the addition of two amendments to the constitution declaring conscription a national duty and authorizing the necessary legislation. On Jan. 18, 1956, it adopted laws for the establishment of a national army and a defense ministry and for the introduction of new uniforms. Tno days later Willi Stoph, a 41-year-old member of the Politburo, was appointed minister of defense.

German Federal Republic in NATO.—Soviet policy in Germany, aiming at the formation of a Communist satellite state, and Communist aggression in Korea in June 1950 caused the western Allies to review the question of German disarmament and demilitarization. On Sept. 18, 1950, the U.S., British and French foreign ministers resolved to end the state of war with Germany and agreed that German participation in an integrated force for European defense was desirable. On Oct. 25 the French national assembly adopted a plan proposed by René Pleven, the premier, providing for a European Defense Community (E.D.C.), in which Germany would play an active part. On Dec. 19 the council of the North Atlantic Treaty organization (NATO) decided to ask the governments of France, Great Britain and the United States to discuss with the government of the German Federal Republic the possibility of a German contribution. The precondition of any useful German association with the defense of Europe was the willingness of the majority of the German people to bear arms again, and it was clear the German people felt no such willingness. However, the pace of international events caused German public opinion, that is, in the Federal Republic, to realize that to help in the defense of the nest was in Germany's own interest. On Feb. 8, 1952, by 209 votes to 1j6. the *Bundestag* rejected the policy of "neutrality" and declared its support for Adenauer's policy of assuming a fair share of the burden of defense. provided that it was on a basis of complete equality.

On May 26, 1952, the convention on relations between the three western powers and the Federal Republic was signed at Bonn; the next day a treaty instituting the E.D.C. was signed in Paris. The Bonn contract declared that the mission of the armed forces stationed by the three powers in the federal territory would be the defense of the free world. of which the G.F.R. and western Berlin formed part. The Paris treaty, concluded between France, the G.F.R., Italy, Belgium, the Netherlands and Luxembourg, defined the E.D.C. as an organization of supranational character, with common institutions and common forces composed of 43 divisions; viz., 14 French, 12 German, 12 Italian and j formed by Belgium, the Netherlands and Luxembourg. The E.D.C. was to be defensive, within the NATO framework. The foreign ministers of the six E.D.C. countries and the permanent representatives on the Atlantic council of the other countries of NATO signed two additional protocols concerning the assistance to be given by the signatories of the E.D.C. treaty to NATO countries and vice versa in the event of aggression. Therefore, while the Bonn contract restored German sovereignty, the Paris treaty kept the Federal Republic out of NATO.

Although by mid-1954 ratification of the E.D.C. treaty was completed in the Federal Republic, as well as in Belgium, the Netherlands and Luxembourg, the French national assembly, on Aug. 30, rejected it, and the whole project fell to the ground. The British government immediately proposed that the German Federal Republic enter NATO as an equal partner; that France accept German rearmament only in a framework where the size of the German contingent was fixed by international agreement and German troop movemepts controlled by the supreme Allied commander in Europe; and that the United Kingdom be committed to keeping its forces permanently on the continent.

A nine-power conference (the United Kingdom, the United States, Canada and the six E.D.C. powers) in London in September planned a new series of agreements which were signed at Paris in October. A protocol specified that German federal armed forces should not exceed the numbers fixed in the E.D.C. treaty of May 27,1952. The Paris agreements were approved by the French national assembly on Dec. 23,1954, and on May 5, 195j, the G.F.R. attained its sovereignty. Four days later the G.F.R. was formally inducted as the 1jth member of NATO.

On July 22, 1955, the first western German armament bill, the Volunteer act, was passed by the *Bundesrat;* the *Bundestag* had adopted it five days before. The act empowered the government to put a maximum of 6,000 officers and noncommissioned officers into uniform to prepare for the establishment of armed forces of 500,-000 men authorized by the Paris agreements. Theodor Blank was appointed head of the ministry of defense and Lieut. Gen. Adolf Heusiger became general inspector of the army.

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SOCIAL CONDITIONS

Employment and Unemployment.—As a result of World War II losses, the economically active proportion of the German population had by 1946 decreased as compared with the prewar situation. In 1939, 51.2% of the population living in the postwar German area was either gainfully employed or registered unemployed, 9.3% was independent of trade or profession and 39.5% was living as dependents. In 1946 the proportions had altered to 45%, 13.2% and 41.8%, respectively.

A further analysis of the employed and unemployed persons for the two periods shows that, in 1939, 23.8% were engaged in agriculture and forestry, 43.9% in industry and crafts, 18% in trade and transport, 10.4% in public and private services and 3.9% in domestic service. The proportions in 1946 were: 27.7% in agriculture and forestry, 40% in industry and crafts, 15.7% in trade and transport, 13.0% in public and private services and 3.6% in domestic service. The position in 1946 was still abnormal in many respects; in particular, a large part of industrial life was still at a standstill, accommodation in the industrial areas was severely limited, and more than 7,000,000 refugees from the east were living in predominantly agricultural areas. By 1950 the occupational distribution of the German population was gradually reverting to its prewar structure, the drift away from agriculture into trade and industry being particularly noticeable. The number of gainfully employed persons in the Federal Republic on June 30, 1954, already exceeded the total in the same area for June 25, 1938, when the German economy was using its full resources, by 4,256,400. The greatest increases in employment were recorded in industry and handicrafts and trade and transport (see Table IX).

TABLE IX.—*Distribution of Gainfully Employed Persons in the Area of the Federal Republic, 1938–54*
(In thousands)

Type of employment	June 25, 1938		June 30, 1951		June 30, 1954	
	Total	Women	Total	Women	Total	Women
Agriculture and forestry	887.7	299.3	1,079.7	381.7	973.2	342.4
Industry and handicrafts	6,706.8	1,250.8	8,248.1	1,832.1	9,412.4	2,139.5
Trade and transport	2,242.6	690.9	2,714.1	894.7	3,255.9	1,236.9
Public services	1,598.7	406.1	2,073.7	787.0	2,168.9	846.7
Domestic service	8.0	802.0	605.0	603.7	689.7	688.3
Total	12,243.7	3,449.1	14,720.6	4,499.2	16,500.1	5,253.7

Source: *Statistisches Jahrbuch für die Bundesrepublik Deutschland.*

Although unemployment after the war never reached the dimensions witnessed in Germany during the world economic crisis (in Feb. 1932 more than 6,000,000 persons were unemployed), the problem in western Germany was serious enough in the first year or two after currency reform in June 1948. Up to that time, when money had little value, open unemployment was not great. Many unemployed did not bother to register, preferring to eke out a precarious existence on the black market, or performing casual labour for whatever food they could get.

The introduction of a currency reform in western Germany in June 1948 brought about a return to more efficient standards in business and industrial life; economies were introduced into the running of both public administration and private works and firms, and there was a gradual change-over to productive goods. The real extent of unemployment then became apparent, and by 1950 it had reached a monthly average of 10% (excluding west Berlin, which had an even higher rate because of its special problem of Russian interference with western trading outlets). This high level of unemployment was largely inherent in the postwar position of western Germany itself: the disruption of its economic structure; the extensive destruction of plants; the Allied prohibitions on industry and shipping; and the increase in population from about 35,000,000 in 1936 to about 47,700,000 at the end of 1949. There was, moreover, the special problem of the crowding together of the vast majority of the refugees in the three rural border regions of Schleswig-Holstein, Lower Saxony and Bavaria. These three Lander accounted for about 90% of the increase in unemployment in the U.S. and British zones in the first six months after the currency reform. The refugees were by no means merely an economic burden—in age and sex they were generally more employable than the average throughout western Germany; the problem was to organize their transfer to the industrial areas that required them.

TABLE X.—*Employment and Unemployment in the German Federal Republic, Period Ending June 30, 1949–55*
(In thousands)

	Gainfully employed		Unemployed		Percentage of the total labour force
	Total	Male	Total	Male	
1949	13,488.7	9,525.0	1,283.3	931.5	8.7
1950	13,845.6	9,693.7	1,538.1	1,081.9	10.0
1951	14,720.6	10,221.4	1,325.7	874.9	8.3
1952	15,170.7	10,493.6	1,240.0	783.9	7.6
1953	15,806.3	10,864.5	1,073.3	676.9	6.4
1954	16,500.1	11,246.4	1,007.7	611.8	5.8
1955	17,175	...	650.0	...	3.6

Source: *Statistisches Jahrbuch für die Bundesrepublik Deutschland.*

During 1950 the federal government embarked on a work-creation scheme involving the expenditure of 3,400,000,000 DM. on a variety of projects, including a housing program, credits to Lander with large refugee populations, and credits to industry. This scheme, together with general economic improvement as industrial conditions gradually became more normal, brought about a decided improvement in the unemployment situation. As a result of the notable economic recovery in the Federal Republic after the currency reform, and of the government's policy in moving unemployed persons from distressed areas, the unemployment figure had dropped to about 650,000, or 3.6%, by June 30, 1955.

Wages and Standard of Living.—During the two decades after World War I, wages and the standard of living fluctuated widely as Germany passed through first the inflation period and then, after a short-lived return toward economic prosperity, the economic depression following 1929. By 1933 wages had declined to a very low level. Although full employment was reached by 1938 and both wages and prices were in general pegged from that time onward, the standard of living on the whole deteriorated as the quality and quantity of consumer goods decreased and taxation and contributions to the National Socialist organizations increased.

Shortly after the occupation in 1945, the Allies directed that existing controls over wages be maintained, subject to the removal of certain inequities and discriminatory measures and to the variations of rates and allowances within the average wage levels. In western Germany there was a general removal of price and rationing control after the currency reform of June 1948, and an initial 15% wage increase was permitted. This was followed in Oct. 1948 by the complete abolition of the wage control legislation and by a return to the recognized measures of collective bargaining between the trade unions and the employers' associations which had been current during the Weimar republic. Table XI shows how the average gross weekly earnings of industrial workers (excluding miners) developed between 1946 and 1951.

TABLE XI.—*Average Gross Weekly Earnings in Manufacturing in the German Federal Republic, 1946–53**
(In RM./DM.)

Year	Yale	Female	All workers	Index 1938=100
1946	38.74	20.75	35.71	88.2
1947	40.10	21.89	36.78	90.8
1948	48.25	27.60	44.30	110.0
1949	61.58	36.26	55.57	140.6
1950	67.65	40.01	60.54	156.6
1951	76.96	44.85	68.52	177.4
1952	82.99	48.02	74.00	191.0
1953	87.19	51.34	77.87	201.3
1954	90.95	53.21	80.99	210.0

'Figures for 1946–49 refer to the bizone only (*i.e.*, the area of the Federal Republic excluding Rhineland-Palatinate, South Baden and Württemberg-Hohenzollern).

Wages continued to improve during 1954, and the government was able to claim that between the year of currency reform (1948) and 1954 average gross weekly earnings had practically doubled, whereas the cost of living index had moved up only one point, as follows (1938=100): cost of living index 168 (1948), 169 (1954); average gross weekly earnings in industry 110 (1948), 210 (1954).

As may be seen, however, at the beginning of the period of industrial recovery earnings were lagging far behind the rise in the cost of living. Moreover, during the period 1947 to 1953 the average weekly hours worked rose from 39.1 to 47.9. Nevertheless, by the end of 1954 the situation of wages in relation to the cost of living was generally satisfactory, and wage claims made during that year were in fact based on a demand by the workers for a larger share in the increased prosperity.

In the German Democratic Republic official wage regulation was introduced by an ordinance of Aug. 17. 1950, referring to wage increases in the state-owned undertakings. which were estimated to employ more than half the total number of industrial workers. This ordinance established a system of wage differentials corresponding to the relative importance of various industries in the national economy. It introduced a greater differentiation of wages for labour with different degrees of skill within the separate industries and laid down equal pay for men and women doing the same work. In general the new wage rates represented an increase of 8% to 30% over the previous rates. Maximum and minimum rates for some of the more important industries are given in Table XII.

TABLE XII.—*Minimum and Maximum Hourly Wages in the German Democratic Republic, as From Aug. 17, 1950*
(In DM.-Ost)

Sector	Minimum ate	Maximum rate	Sector	Minimum rate	Maximum rate
Underground coal and ore mining	1.10	1.95	Chemical raw materials . .	.76	1.54
Underground lignite, slate and potassium workers . .	.98	1.79	Construction .	.76	1.61
Metallurgy . .	.87	1.80	Textiles. . .	.68	1.32
Heavy industries.	.87	1.73	Railways	.83	1.60
Energy	.81	1.60	Forestry . .	.70	1.19
			Sugar . .	.81	1.30
			Retail trading .	.81	1.47

Source: Industry and Labour (International Labour Office).

The differential wage system was carried a stage further on July 1, 1952, when the salaries of skilled workers. engineers and scientists working in certain key industries were raised, very considerably in some cases, in order to attract the "technical intelligentsia" into the service of the five-year plan. Further wage increases in 1953 and 1954 served to redress the balance somewhat between skilled and unskilled workers and between priority and nonpriority industries. In general, wages were rising faster than labour productivity in 1954, and great stress was laid on the need to increase "working norms."

Organized Labour. — In spite of a temporary interruption caused by inflation after World War I, trade unionism developed rapidly between 1913 and 1927, when the membership figure had risen to 8,200,000. More than half the members (4,600,000) were organized in the General German Trade Union association, which had Social Democratic leanings; more than 600,000 belonged to the rather conservative Christian trade unions; a further 150,000 belonged to the Liberal Hirsch-Dunckersche union. There were Communist unions, unions subsidized by the "masters" and unions for clerks, technical employees, foremen and so on.

In the spring of 1933, soon after the National Socialists came to power, all the trade unions were suppressed, many of their leaders imprisoned and their funds transferred to the National Socialist German Labour Front (D.A.F.), the only labour organization nhich was tolerated under the Nazi regime. Both workers and employers were forced into this organization on the principle that all alike belonged to a single community. which was to be guided by the slogan "The common good before the individual good." Hours of work, factory conditions and all similar matters were regulated by trustees of labour appointed by the Reich minister of economics. Strikes and lockouts were forbidden. Wages were in general fixed at the 1933 levels, and after 1937, when a labour shortage began to appear under the pressure of rearmament, restrictions were introduced on changes of employment.

Within the limits of its authoritarian structure the Labour Front engaged in numerous welfare activities for the benefit of the working-class family. The best known of these was the "Strength Through Joy" (Kraft *durch Freude)* scheme, under which scores of thousands were able to take holiday cruises, winter sports holidays and the like at a very low cost.

After World War II the trade union movement developed along different lines in western and eastern Germany. In the western zones the growth of a democratic trade union movement was encouraged, but, on the general principle of recreating democratic institutions from the lowest levels upward, the trade unions were at first authorized to form only locally. The result was a great variety of different types of union, organized in some places according to industries, in others by professions and in yet others in comprehensive associations. In no case were they subdivided into political groupings, however. In the course of time the general scheme emerged as a majority of industrial unions together with a smaller number of professional associations. These gradually federated, first at Land and later at zonal level, and at the beginning of 1950 a single federation, the Deutscher Gewerkschaftsbund, having a membership of more than 5,000,000, was established for the territory of the German Federal Republic. After the establishment of the federal government in Sept. 1949 the trade union movement managed to assert an appreciable influence over the government's industrial policy. It was consulted over the deconcentration of heavy industry, and managed to get accepted its schemes for copartnership between employers and workers (*Mitbestimmung*) in the management of the new coal. iron and steel concerns. Its demands for the nationalization of' various industries, however, were unsuccessful.

In the Soviet zone the trade union movement was reorganized from the top downward. As early as June 1945 an executive committee of the Freier Deutscher Gewerkschaftsbund (F.D.G.B.), or Free German Trade Union federation. was established, and 14 industrial unions and four professional associations were organized. This rigidly centralized apparatus, which was from the first dominated by Communists, gradually extended its network throughout Berlin and the Soviet zone.

Policy, however, was dictated from the centre, and there was also central financial control, so that the local branches had no opportunity of independent development or action. Membership was virtually compulsory; in Aug. 1950 it was given as 4,700,000 (excluding east Berlin). With the rapid reduction of private enterprise in the Soviet zone, the trade unions dropped their original function of representing the workers' interests as against the employers', becoming instead agents of the authorities for the administration of social insurance, for the organization of technical training and political indoctrination, and for ensuring execution of the various economic plans.

In June 1955 the F.D.G.B. statutes were amended and it thereby lost the last vestiges of independence and political impartiality. It was now under the open leadership of the Communist Socialist Unity party, its members lost the right to strike, and it was merely to serve as an instrument for increasing labour productivity and encouraging recruitment into the various semiofficial defense forces. F.D.G.B. membership was virtually compulsory, and by 1955 had reached a figure of just under 5,500,000.

Industrial Management. — When working-class leadership in the winter of 1918–19 threw its weight into the scales against bolshevism, it was clearly realized that the working class must in some way participate in the control of industry. Various schemes of nationalization were abandoned. A system of works councils was created, however, with the object of giving workers some control over industrial management. This move proved a complete failure, as was also the Economic council, a body with certain parliamentary powers on which workers and employees were equally represented. Real power continued to rest with the great associations of manufacturers (Reichsverband der Deutschen Industrie) and the trade unions, which exercised their influence directly on the government.

After World War II it was felt once again in western Germany that in view of the serious disruption of economic life and the large proportion of socially uprooted and impoverished people, some form of economic democracy had to be introduced. The principal political parties and the churches endorsed the demand that the workers have an equal share in industrial management. Many of the new Land constitutions embodied clauses of this nature. Laws were passed again setting up works councils, and some of the *Sander* also issued legislation reorganizing the chambers of trade and industry and allowing the workers and consumers an equal voice on them. On the federal level a law of May 1951 made provision for the workers to share in the management of the coal, iron and steel industries. This was followed in Oct. 1952 by a further law allowing the workers and employees a limited voice in the management of all firms employing more than five persons.

The government of the Federal Republic also put forward proposals for the creation of a new federal economic council, in which the workers could co-operate in economic planning at the highest level. The project broke down, however, over the trade unions' demand for 50% representation on the council.

In the fully planned economy of the Democratic Republic, the ordinary worker had little to say in the running of industry. For, although a fiction of collective agreements was maintained, the free trade unions had no more powers of representing the real interests of the workers than had the Labour Front under Hitler.

An act regulating conditions of labour was issued in Oct. 1949. Although covering such principles as the right to work, the retention of a normal 48-hour week, an annual paid holiday and various other measures of labour protection, its main concern was with the increasing of labour productivity in order to achieve the economic plan. Following an order of June 8, 1950, general collective agreements were to be drawn up by the trade unions and the competent ministries for the various branches of industry, and within these framework agreements the nationalized undertakings and private concerns employing more than 20 persons were to draw up works collective agreements.

These agreements were to contain reciprocal obligations for realization of the planned target, especially in labour productivity, the quality of products, the improvement and extension of the system of technical labour standards, the extension of the system of payment by results and the use of manpower in conformity with the government plan. Since the technical labour standards were continually raised, the average worker's hopes of obtaining better working conditions were still delayed.

Social Insurance. — An extensive system of compulsory, mainly contributory social insurance was built up in Germany during the second half of the 19th century, and in the 1930s unemployment insurance mas introduced.

At the time of the capitulation after World War II, in 1945, the day-to-day administration of the social insurance system was almost at a standstill, but under Allied supervision the system began to function again in a remarkably short time; in the British zone, for example, accident and sickness benefits, and pension payments to widows, the aged and infirm, were being paid again in normal fashion after a few weeks. The aftermath of the war resulted in an increasing burden of expenditure on the social services (*see* Table XIII).

TABLE XIII.—*Expenditure on Social Services in the German Federal Republic*
(In thousand million DM.)

Type	Income 1949	Income 1953	Expenditure 1949	Expenditure 1953
Social security	6,800	14,100	6,200	12,100
Civil servants' pensions	2,200	3,700	2,200	3,700
Welfare	1,900	2,700	1,900	2,700
Health service	—	100	—	TOO
Pensions for war-disabled and veterans' dependents	1,800	2,900	1,800	2,900
Total	12,700	23,500	12,100	21,500

Source: Statistics issued by the German Federal Republic ministry of labour (Nov. 1954).

The continuing importance attached to the social services was shown in the establishment, in Adenauer's second government in Oct. 1953, of a ministry for family affairs, and by the coming into force, on Jan. 1, 1955, of a law on family allowances, by which 25 DM. was payable each month for the third and further children in a family. The increasing complexity of the social services led to the appointment of an advisory council in 1953, whose task was to advise the minister of labour on the reorganization of the system. The council, however, had not made its report by Aug. 1955.

In eastern Germany the social insurance schemes were at first carried on by the separate *Lander*, there being in each of these a separate independent institute for social insurance. By a government decree of April 26, 1951, however, the responsibility for the control and administration of the system of social insurance was transferred to the Freier Deutscher Gewerkschaftsbund (F.D.G.B.), the Communist-run trade union federation. The decree came into force on May 1, 1951.

In the German Democratic Republic expenditure on social services in 1954 amounted to 5,100,000,000 DM.-Ost. Of this sum, 4,700,000,000 DM.-Ost. was provided by contributions, and the state contributed a subsidy of 388,000,000 DM.-Ost.

Housing. — The housing situation in Germany was already serious before World War II broke out. Before the war about 200,000 new dwellings (each for a new household) were built annually, while another 50,000 old dwellings were replaced by new ones; but all these were scarcely sufficient to accommodate the growing population. By 1926, it was estimated, about 950,000 German households were without proper dwellings. and after 1929 efforts were made to reduce this housing shortage by the construction of blocks of flats and small one-family or two-family houses. The number of these buildings constructed annually and the number of families thus housed are shown in Table XIV.

TABLE XIV.—*Housing, 1929-37*

Item	9 9	9.33	1934	935	1936	1937
Buildings constructed	170,783	91,909	128,574	143,185	155,112	168,090
Families accommodated	317,682	178,038	283,995	241,032	310,490	320,057

The destruction and damage caused by World War II were enormous, as Table XV shows.

TABLE XV.—*Houses Destroyed or Badly Damaged During World War II*

Territory	Total of separate dwellings in 1939	Destroyed or heavily damaged dwellings in 1946 (estimate)		Persons per dwelling	
		Number	Per cent of 1939 total	1939	1946*
German Federal Republic	10,700,000	2,600,000	24.3	3.8	5.5
German Democratic Republic	4,600,000	600,000	13.0	3.3	4.3
Berlin	1,500,000	600,000	40.0	2.8	3.4

*Including uninhabited but repairable dwellings.
Source: Wirtschaftswissenschaftliches Institut der Gewerkschaften, Cologne.

An official survey held in 1950 revealed that in Sept. 1950 there were about 9,940,000 dwellings in the Federal Republic, of which about 9,404,000 were normal and 537,000 were emergency constructions. In 1950 the number of dwelling units in western Germany was therefore very nearly the same as in 1939. It must be remembered however that the population of western Germany increased greatly as a result of the influx from the former German territories in the east, and the housing shortage was thus acute.

In 1954 a record number of 541,000 new dwelling units was built in the Federal Republic, as compared with 518,000 in 1953, bringing the total of new dwelling units constructed since 1945 to 3,000,000. During 1954–57 the federal government aimed at constructing a further 2,200,000 units, representing a yearly average of 550,000.

In the German Democratic Republic the five-year plan provided for the construction of 10,100,000 sq.m. of dwelling space in 53 new towns. According to the state statistical bulletin, during 1950–53 (a period including one preplan year), 5,700,000 sq.m. were built. The target for 1954 was 2,000,000 sq.m.

ECONOMIC CONDITIONS

Natural Resources. — Germany, as compared with some other countries, is not rich in natural resources. A little less than one-fifth of pre-1938 Germany was unfit for cultivation, being covered by lakes, moors, river beds, hills and mountains, while the great northern plain, though fertile in some parts, consists in others of thin sandy soils fit to grow only potatoes, rye and fir.

As far as industrial resources are concerned, hard (or deep-mined) coal is the country's greatest natural asset. Coal is fairly widely distributed, but the Ruhr is the main centre of the industry. Many of the coal seams are comparatively thin. especially in the Ruhr; but on the other hand their situation, close to great natural waterways and to efficient canals, is favourable to distribution.

Apart from deep-mined coal, Germany is rich in deposits of lignite or soft coal, also called brown coal. These deposits are not mined, but rather scraped up by means of huge mechanical excavators, much as open-cast mining is carried on. Thus, though lignite has a low caloric content compared with coal. it has the advantage of not being dependent for its production on a supply of skilled miners, and from the beginning of the 20th century the exploitation of the huge deposits (estimated before World War II to be 57,000,000,000 tons) was vigorously carried on. Lignite is extensively used as a fuel in electric power plants, as a base for the production of synthetic nitrate and as cheap raw material for the production of synthetic oil.

Before the loss of Alsace-Lorraine after World War I, Germany was one of the chief steel-producing countries of the world. The loss of the rich iron-ore deposits of Lorraine reduced Germany's annual iron-ore production, for example, from 28,607,900 metric tons in 1913 to a mere 9,791,800 metric tons in 1937.

In addition to its coal and iron resources, Germany has deposits of zinc, copper, lead, silver, tin, bauxite, potash, rock salts and uranium ores. The potash and rock-salt deposits are large, the lead less so and the other mineral resources not considerable. The uranium deposits lie in Saxony, in the Democratic Republic, and it was no secret that from 1945 the Soviet authorities worked them intensively, though their output was unknown. Germany has petroleum deposits in the Hanover and Schleswig-Holstein areas of the Federal Republic and also in the Democratic Republic. Production of crude oil in western Germany in 1954 was 2,664,000 metric tons. The eastern German production of crude oil for 1950 was estimated at 893,000 metric tons.

Broadly speaking. it can be said that Germany is not conspicuously well endowed with natural resources. apart from coal. Invention, hard work and good systems of scientific and technological education rather than abundance of natural wealth contributed to Germany's rapid rise to the position of an economic power. The same factors played an important part in the revival of the country's economy after World War II.

Agriculture. — Up to the end of World War II two main systems of landholding formed the basis of German agriculture, each of them predominating in different parts of the country. The east, especially the country to the east of the Elbe, was a land of big properties, some tracts such as East Prussia and parts of Silesia being in the hands of comparatively few owners. Only about 12.4% of this area was farmed by tenants, the rest being run like home farms under the management of the owners or their administrators with hired agricultural labour.

In the west, in the south and in most parts of central Germany the land was mainly held by peasant proprietors. Some of them, especially in the northwest. owned fairly large farms and employed hired labour. Others, especially in the Rhine valley, were small holders, running their holdings with the help of their families and often engaging in some secondary industrial occupation in order to eke out their means of existence.

Table XVI.—*Distribution of Holdings, 1925*

Size of holdings	Number of holdings	Area covered
0.05–2 ha.	3,027,430	1,587,670 ha.
2–20 ha.	1,850,608	12,082,485 ha.
20–100 ha.	199,825	6,768,629 ha.
100 and more ha.	18,671	5,159,893 ha.

Agrarian Germany, outside certain districts, was thus a kind of peasant democracy, though dominated in some parts by large estate owners farming on a large scale and clinging tenaciously to traditional and somewhat feudal social conceptions. Even before World War II, however, this picture was gradually changing. Big estates were being broken up for various economic reasons, and new peasant agricultural holdings were created by reclaiming swamp and other unused lands. After 1945 a far more radical change took place. The eastern region of large estates, after the detachment of the area east of the Oder-Neisse line, coincided roughly with the Soviet occupation zone. There a drastic system of land reform was introduced in Sept. 1945, affecting all holdings over 100 ha. (247 ac.). Farms and estates numbering 11,465 with a total area of 2,917,826 ha. (7,207,030 ac.) were expropriated, and most of this land was parcelled out in peasant holdings of between 7 and 9 ha. (between 17.3 and 22.2 ac.), the recipients being in the main agricultural labourers and small peasants, together with many refugees from the east. As a result about half of all the farms in eastern Germany now consist of small properties of between j and 20 ha. (between 12.4 and 49.4 ac.), whereas in 1939 these holdings comprised only 21.2% of the total.

Measures of land reform were also carried out by the individual Lander in western Germany, but, since large estates, apart from forest lands, played no great role there, the area available for resettlement was relatively small. The distribution of holdings in this area in 1951 was as follows: 32.9% under 5 ac., 27.5% between j and 12.5 ac., 20.2% between 12.5 and 25 ac., 12.9% between 25 and 50 ac., 5.6% between 50 and 125 ac., and the remainder over 12 j ac.

Not only the pattern of ownership, but also the structure of agriculture altered considerably at the end of World War II. Until then, although mixed farming was to be found everywhere, Germany could be divided into the following distinctive agricultural regions: the clay plains in the east with their crops of rye and potatoes; the loess and black earth of central Germany and Silesia yielding wheat, potatoes and sugar beets; the dairying districts of the damp coastal lowlands and the Alpine forelands; and the fruit and vine-growing district of the west.

Table XVII.—*Land Devoted to Agriculture and Forestry, 1953*
(In thousands of hectares)

Territory	Total area	Agricultural area		Forested land	Built-on area, wasteland and other
		Arable land	Permanent meadows and pastures		
German Federal Republic .	24,427	8,651	5,546	6,912	3,318
German Democratic Republic	10,767	5,089	1,289	2,913	1,476
Berlin	88	27	3	20	38

In 1945 Germany lost about a quarter of its prewar agricultural area, consisting for the most part of arable land which had formerly produced about a quarter of its bread grain and a third of its potato crop. The agricultural balance suffered still further because of the political barrier that grew up between the Soviet zone and the three western zones. Western Germany was left at a distinct disadvantage in regard to arable land as compared with eastern Germany. Whereas in that area 75% of all agricultural land was under the plow, the percentages in the U.S., British and French zones were 59, 55 and 53, respectively. As a result, western Germany was even more dependent on the import of foodstuffs from abroad than was the German Reich before the war.

During the first few years after the war the shortage of fertilizers, seeds, equipment and machinery, as well as of skilled agricultural labour, badly affected the harvests. By 1949, however, both the harvests and the yields per acre were approaching, and in some cases outstripping, the prewar averages for the same areas. As may be seen from Table XVIII, the improvement in the German Federal Republic was considerable.

Livestock was maintained fairly well during World War II. In the final stages of the fighting, however. the number of animals was greatly reduced, particularly in the Soviet and French zones, and in the early postwar years the food shortage in western Germany was so intense that farmers were compelled to slaughter livestock and to convert their grassland to edible crops in order to meet the immediate emergency. This trend was gradually reversed

TABLE XVIII.—*Agricultural Production*
(In thousands of metric tons)

Crop		1937*	1934–38†	1948–52	1953	1954	1955
Wheat‡	G.F.R.	4,467	2,505	2,656	3,180	2,893	3,378
	G.D.R.		1,553	870§	1,188	1,140	1,273
Rye	G.F.R.	6,917	3,081	3,042	3,280	4,100	3,498
	G.D.R.		2,070	2,077§	2,362	2,582	2,464
Barley	G.F.R.	3,638	1,699	1,397	2,072	1,920	2,079
	G.D.R.		1,028	486§	832	800	983
Oats	G.F.R.	5,919	2,843	2,500	2,554	2,473	2,478
	G.D.R.		1,587	1,113§	1,506	1,243	1,470
Potatoes	G.F.R.	55,310	19,603	24,067	24,535	26,769	...
	G.D.R.		13,649	12,842	14,020	16,753	12,108
Sugar beets‖	G.F.R.	15,701	4,118	5,820	8,897	9,289	9,300
	G.D.R.		5,467	4,514	6,186	7,334	6,145

Note G F.R =German Federal Republic; G.D R.=German Democratic Republic.
*Pre-1938 area, including the Saar, which is omitted in the following years. †Post-1945 area. ‡Includes spelt. §1949–50.
‖Beets processed in sugar factories.

in western Germany after 1948 as supplies of foodstuffs became available through the European Recovery program and as the more plentiful supplies of fertilizers and machinery brought about improved crop yields.

TABLE XIX.—*Livestock in German?*
(Post—1945 area, excluding Berlin; in millions of head at the end of the year)

Livestock		1938	1946	1952	1953	1954
Cattle	G.F.R.	12,187	11.185	11.641	11.641	11,521
	G.D.R.	3,647	2,764	3,876	3,796	3,793
Pigs	[illegible]	[illegible]	[illegible]	12,979	12,435	14,525
	[illegible]	[illegible]	[illegible]	8,283	8,208	8,367
Sheep	G.F.R.	2,097	2,250	1,544	1,352	1,226
	G.D.R.	1,771	748	1,429	1,550	1,712
Horses	G.F.R.	1,566	1,556	1,360	1,271	1,172
	G.D.R.	811	642	750	727	695

Note: G.F.R.=German Federal Republic; G.D.R.=German Democratic Republic.

There was a great improvement in meat and milk production in the Federal Republic after 1949, and by 1954 it was practically self-sufficient in meat and dairy products.

TABLE XX.—*Production of Meat and Milk (Post-1945 Area)*
(In thousands of metric tons)

Territory	Meat*			Milk		
	1938	1948–50	1954	1938	1948–50	1954
German Federal Republic	1,765†	1,110	1,936	15,451	11,310	17,054
German Democratic Republic	731	367‡	...	5,230	2,591	4,702

*Beef, veal, pork, mutton and lamb. †Including meat from imported live animals.
‡Excluding mutton and lamb.

Sea food forms an important supplementary source of food supply. Statistics for the German Democratic Republic were not available after World War II. Those for the Federal Republic, however, show that catches after the war outstripped those of prewar years.

TABLE XXI.—*German Fisheries*
(In metric tons and thousands of DM.)

Year	Total catch	Value	Year	Total catch	Value
1938	776,300*	...	1952	638,113	192,117
1950	525,476	144,235	1953	708,128	208,804
1951	654,037	200,657	1954	656,959	228,569

*Germany in pre-1938 frontier; other figures are for the Federal Republic only.

With the loss of the eastern territories in 1954, Germany's forests were reduced by about 23%. They still covered just over a quarter of the country (27%), consisting for the most part of fir, spruce, beech, oak and pine. The forests suffered considerably from overfelling after about 1935, and toward the end of World War II reafforestation was no longer keeping pace with the felling program.

Before World War II Germany was obliged to import about a third of its timber requirements; not only did these imports cease at the end of the war, but there were infinitely greater demands on timber for reconstruction purposes, with a consequent deterioration of supplies badly needed for paper, wood fibre, cellulose and numerous artificial substitute *(Ersatz)* products, as well as for pit props and railway sleepers (ties). With the restoration of normal trade conditions, however, timber felling in Federal Germany was gradually reduced from 29,500,000 cu.m. in 1950 to 24,900,000 cu.m. in 1953.

Viticulture is important on the sunny hillsides of the Rhine, the Main, the Neckar, the Moselle and the Saar, and hops are also grown in the south, particularly in Bavaria. Post-World War II wine harvests varied between 1,363,000 hl. in 1949 and 3,044,000 hl. in 1954, as compared with 1,722,000 hl. in 1932 and 4,525,000 hl. in 1934. Hop production rose very considerably from 9,722 tons (1935–38 annual average) to 15,576 tons in 1953, in which year the Federal Republic replaced Great Britain as the biggest hop producer in Europe.

Agricultural conditions in general passed through a number of different phases after World War I. German agriculture was financially in a bad way under the Weimar republic, with agricultural prices lagging far behind industrial prices and wages. and farms became heavily mortgaged. The National Socialist government aimed to make Germany self-sufficient in food, and this entailed great efforts, which were on the whole successful, to improve and stabilize agricultural conditions. Agricultural prices were fixed at remunerative levels, imports of food were controlled, there was a centrally controlled system of marketing, and the distribution of technical advice and information was greatly developed.

Although farming in the Federal Republic had by 1954 recovered from the immediate postwar crisis, thanks largely to the highly protectionist policy followed by the government, its progress was still slower than that of other branches of the economy. This was a result of disadvantages inherent in the small size and excessive fragmentation of farms, and the disinclination of the farmer to adopt new methods.

In 1953 the government drew up a program of land consolidation, cheap long-term credits, rural housing and technical advisory assistance, but no marked improvement could be expected for several years. In 1954 the Federal Republic produced between 60% and 70% of its food requirements, as compared with 85% for the whole of Germany in the heyday of the Third Reich.

In the early postwar years, farming in eastern Germany suffered from a shortage of both labour and technical equipment. Much labour was attracted into industry, and at the same time the progress of mechanization was slow. Agricultural costs were much higher than in the Federal Republic, and compulsory deliveries at low fixed prices were graded progressively steeply for the "larger" farmer, who was gradually squeezed out. Soon after the end of the war the Communist-dominated Peasants' Mutual Aid organization began to control every aspect of farm life. Then the state agricultural machinery pools (M.A.S.), which were set up in 1949, acquired a virtual monopoly of larger agricultural machinery. By Oct. 1953 there were 605 of these pools, owning 22,500 tractors.

The final phase in breaking the resistance of the independent landowners started in July 1952 with the promotion of collectivization. By the middle of 1953 almost one-third of the productive agricultural land was under some form of collective ownership, either state farms, other publicly owned farms or agricultural production co-operatives. There were 4,800 of the latter in Oct. 1953, covering 730,000 ha.

Between 1946 and 1950 there was a loss of about 400,000 agricultural workers who moved into industry, and from 1952 onward the collectivization policy caused a further flight from the land. Lack of reliable statistics prevented any estimate of the progress made in agriculture in the German Democratic Republic after 1945, but there were various indications that it was far from satisfactory.

Industry. — Germany's industrial progress, so marked during the half century before the outbreak of World War I, was checked for a time by the aftermath of that conflict. The treaty of Ver-

TABLE XXII.—*Distribution and Development of German Industry, 1925–33*

Industrial groups	Persons employed W			Horsepower employed					
				Wind, water, steam power			Electric motors		
	1925	1933	% change	1925	1933	% change	1925	1933	% change
Mining	884,738	495,104	−44.0	2,142,337	1,920,953	−10.3	2,242,800	3,205,246	+42.9
Stone, cement, glass, earthenware	697,827	409,872	−41.3	413,166	373,830	− 9.5	544,769	911,891	+67.4
Iron and steel production	522,829	268,680	−48.6	1,211,309	1,003,370	−17.2	2,770,661	3,181,020	+14.8
Nonferrous metals production	76,737	48,211	−37.2	36,424	32,063	−12.0	236,110	313,395	+32.7
Iron, steel and metal finishing	905,540	597,643	−34.0	97,197	77,591	−20.2	479,089	563,688	+17.7
Machine, ship, vehicle construction	1,286,786	613,120	−52.2	177,217	115,301	−34.9	1,393,722	1,548,641	+11.1
Electrical industry	450,624	253,806	−43.7	7,860	13,689	+74.2	398,402	458,388	+15.0
Optical, time, precision instruments	151,549	101,668	−32.9	4,929	4,442	− 9.9	50,361	65,135	+29.3
Chemical industry	321,550	249,949	−22.3	267,100	397,154	+48.7	688,198	1,171,741	+70.3
Textile industry	1,215,344	857,396	−29.5	580,709	452,118	−22.2	717,423	1,055,259	+47.1
Paper industry	272,840	188,508	−30.9	369,179	295,491	−20.0	464,151	807,036	+73.9
Printing, films, photography	308,696	273,864	−11.6	6,901	7,447	+ 7.9	158,903	228,585	+43.9
Leather and linoleum	167,405	120,021	−28.3	36,719	30,762	−16.2	119,192	161,679	+35.6
Rubber and asbestos	68,388	49,005	−28.4	21,029	8,465	−59.8	75,970	127,463	+67.8
Sawmills, wooden goods, furniture	974,540	612,289	−37.2	431,576	402,240	− 6.8	620,551	975,419	+57.2
Musical instruments and toys	119,805	38,342	−68.0	10,262	6,213	−39.5	34,185	30,316	−11.3
Food, beverage, tobacco industries	1,396,695	1,432,301	+ 2.5	770,076	973,087	+26.4	996,767	1,710,998	+71.7
Clothing and hat industries	1,375,355	1,054,811	−23.3	16,493	14,584	−11.6	90,038	119,535	+32.8
Building and decorating industries	1,545,743	1,025,806	−33.6	244,826	403,489	+64.8	233,543	374,136	+60.2
Water, gas and electric supply	150,202	141,679	− 5.7	266,350	244,047	− 8.4	350,777	781,585	+122.8
Washing, cleaning, shaving industries	208,872	320,926	+53.6	10,932	13,065	+19.5	21,800	55,084	+152.7
Totals	13,102,065	9,153,001	−30.1	7,122,591	6,789,401	− 4.7	12,687,412	17,846,240	+40.7

sailles dislocated some of the leading industries, inflation upset the home market and the scarcity of capital following inflation hampered industrial reorganization. In 192j Germany was starting forward again, after the disrupting effects of the war and inflation, in a great industrial recovery. This continued upward during the next four years when the adoption of the Dawes plan for reparations re-established German credit and allowed Germany to borrow very heavily abroad. Part of the money borrowed was spent in prompt payment of reparations obligations under the Dawes plan; part was spent in public welfare improvements, such as public parks, libraries, baths and playing fields and buildings for the people; and a large part of the remaining money borrowed abroad was spent in the "rationalization of industry"; that is, in the modernization of old plants and the construction of new ones with up-to-date labour-saving machinery. Work previously done by hand was increasingly done by machines. The older forms of horsepower—wind, water and steam machines—were gradually replaced by electric motor power. so that bet een 1925 and 1933 the use of horsepower declined by 4.7%, and the use of electricity increased by 40.7%.

The excessive rationalization of industry, or replacement of hand labour by machines, affected Germany adversely in two ways. It saddled the nation with an intolerable foreign debt at high rates of interest which could not be met when the world depression began in 1929. It also tended to increase the terrible unemployment conditions in Germany which were at their worst in 1932. The number of persons employed in industry had fallen from 13,000,000 in 1925 to 9,000,000 in 1933, a drop of more than 30%.

The results of the industrial censuses of 1925 and 1933, which are shown in Table XXII, illustrate the developments which took place in German industry during this period.

In 1933 another great industrial recovery began. It was stimulated by the National Socialist policy of reducing unemployment by spreading out work at short hours and giving fixed low wages to as many persons as possible. The National Socialists also reduced unemployment by great government expenditure on rearmament and public works such as the *Autobahnen,* other roads, housing and barracks.

By 1939 the feverish effort at rearmament had completely wiped out unemployment and even created a severe labour shortage, in spite of the 22,000,000 then employed. As German exports were insufficient to pay for all the raw materials needed from abroad, Germany also began to suffer from a severe shortage of industrial raw materials. As it also wanted to be as far as possible self-sufficient in case of a future war and blockade, it developed a policy of autarchy. Instead of manufacturing goods from imported raw materials it began to manufacture them as far as possible from its own domestic resources. These substitute products—oil from coal; textiles from wood fibre, cellulose or casein; artificial rubber or buna; etc.—required much more labour, capital investment, horsepower and domestic materials, such as coal and timber, than goods formerly made from imported raw materials. As a result the severity of the labour shortage and raw materials shortage was further intensified.

Coal mining, Germany's basic industry, lost about 16% of the production capacity of 1913, the ceded part of Upper Silesia having an output of 32,000,000 tons of the total German output of 193,000,000 tons. Moreover, 13,000,000 tons a year from the Saar were not available from 1919 to 1935. These losses could not be completely overcome even by 1939. The world's coal situation had changed; lignite (brown coal) had become of great importance, and oil and electricity became serious competitors. Coal production increased to 163,000,000 tons in 1929, sank to 105,000,000 in 1932 and then rose again to 184,500,000 in 1937.

Lignite production increased rapidly after World War I and almost exactly equalled coal production in weight. It is largely used in the form of briquettes in private houses and flats, and also for generating energy in electric power plants and in industry generally.

Germany's total coal production in 1937 was mainly distributed in the following ways: about 10% was used in private houses; another 10% was used on the railways and in ships; 8% furnished energy in electric power plants; 28% was exported; and 34% was used for coking and distillation. The coking process produced coke for smelting iron ore, gas which was piped for hundreds of miles, oil, coal tar, dyes and thousands of other derivatives invaluable for the chemical industry and for the manufacture of many substitute products.

Iron and steel, another of Germany's basic industries, suffered an even greater dislocation as a result of World War I and the cession of Alsace-Lorraine to France. The production of iron ore had been 28,600,000 tons in 1913; of this output the districts remaining to Germany produced but 7,300,000 tons—a reduction of 74.5%. This production did not increase at first; in 1932 it even fell to 1,300,000 tons. The number of separate undertakings was reduced from 328 to 11j, and the number of persons employed from 43,000 to 13,802.

After 1933 Germany's iron and steel production recovered rapidly. Its great lack was iron ore to make up for the ores lost in Lorraine. To overcome this lack of domestic iron ore, Germany in 1937 imported 20,600,000 tons—9,100,000 from Sweden, 5,700,000 from France, 1,500,000 from Belgium and Luxembourg, 1,100,000 from Spain, 800,000 from Newfoundland, 700,000 from Algeria, 500,000 from Norway and a little from other countries. Its own domestic production of iron ore rose from 2,600,000 tons in 1933 to 9,700,000 tons in 1937.

The total of imported and domestic iron ore in 1937 (30,300,000 tons), however, was not enough for Germany's rearmament and other needs. Therefore there was formed, as part of the four-year plan, the Hermann Göring Reich Company for Ore Mining and Iron Smelting. By the use of a new acid smelting process discovered by Max Paschke and Eugen Peetz, this company was to exploit Germany's low-grade ores which lie in the Hanover-Brunswick regions and elsewhere. They have a low iron content of only 14%

to 30%, as compared with an average of 60% or more in Swedish ores, and 30% to 40% in other German ores.

Post-1945.—World War II brought grave damage to German industry, and the victorious powers had to frame a policy for a German industrial system that had collapsed. The policy was set down in the Potsdam agreement of Aug. 2, 1945, which was designed, in the economic sphere, to eliminate or control any branches of industry which could be used for military production; to ensure payment of reparations claims; but also to ensure that Germany, after all claims had been met, should be left with a self-supporting economy.

Table XXIII.—*Percentage Analysis of World Industrial Production*

Year	Germany	United States	Great Britain	France	Other countries*
1880	16	18	32	19	15
1899	17	35	18	7	19
1913	16	38	13	11	25
1919	7	52	12	8	24
1929	11	48	10	4	24
1937	12	45	11	5	26
1948	5	59	9	7	23

*Excluding Russia (U.S.S.R.).
Source: Wirtschaftswissenschaftliches Institut der Gewerkschaften, Cologne.

The Potsdam agreement therefore provided for the total prohibition of armaments and aircraft and sea-going ships, and industries that had potential war importance were to be strictly controlled in order to ensure that production was limited to Germany's legitimate peacetime needs. Surplus productive capacity was to be removed or destroyed. The Potsdam agreement also required that German industry be decentralized by the elimination of all excessive concentrations of enonomic power.

In March 1946 the Allied Control council published a provisional level of industry plan in implementation of the Potsdam agreement. This plan divided German industries into various categories, prohibited, restricted and unrestricted, and if carried out would have resulted in a restriction of Germany's industrial capacity to about 50% to 55% of the 1938 level. The plan was based, however, on various assumptions which were not fulfilled, such as the treatment of Germany as an economic unity, the pooling of resources between the four zones of occupation and the necessity of using the proceeds from current German production in the first place to pay for necessary German imports. Disagreements arose between the U.S.S.R. and the three western Allies on all these points and, though right up to 1947 the western Allies tried to ensure that Germany should be treated as an economic unity by the four occupying powers, circumstances forced them ultimately, in their own as well as Germany's interests, to organize industry in the western zones independently of what the Soviet occupation authorities were doing in their own zone. On Jan. 1, 1947, the British and U.S. zones were fused, for economic purposes, into a bizone, and later the French zone also joined the merger so that a uniform economic policy for the whole of western Germany became possible.

On Aug. 29, 1947, in default of a wider agreement, an Anglo-U.S. plan for a revised level of industry in the bizone was published. This provided for reparations claims and also for security considerations, but it allowed German industrial capacity, including a permitted level of steel production of 10,700,000 metric tons' (11,100,000 metric tons including the French zone), to be retained at roughly the 1936 level. As a corollary to this revised level of industry plan, a dismantling list was published on Oct. 17, 1947, which enumerated 682 plants that were to be removed as reparations or destroyed, as being surplus to the requirements of the new level of industry. In Feb. 1947 the U.S. and British military governments also promulgated laws for the bizone to implement those provisions of the Potsdam agreement forbidding excessive concentrations of economic power.

A new phase in the industrial development of western Germanv began in the early part of 1948 as a result of the Allied intentioh to associate the country in the economic revival to be fostered by the European Recovery program (E.R.P.). In Feb. 1948 the United States, Great Britain and France, in collaboration with the three Benelux countries, had begun discussions which resulted in an agreement to set up an international authority for the Ruhr to control Germany's heavy industries, and a military security board to watch over German industry in general to see that it did not infringe Allied controls. The association of western Germany in the E.R.P., however, made it essential to reconsider the level of industry plan and the dismantling list of 1947. Consequently, in April 1949 the United States, Great Britain and France agreed on a substantial reduction of the dismantling list, and many prohibitions and restrictions on German industry were removed. In Sept. 1950 the foreign ministers of the three powers agreed to a further revision of Allied controls over industry. The remaining restrictions on industry in the Federal Republic were abolished on May 5, 1955, when the Paris agreements restoring sovereignty to the Federal Republic came into force. On the same date the functions of the military security board came to an end.

On May 16, 1949, the occupying powers in western Germany promulgated law no. 27 to redefine Allied policy on the decartelization of German industry. During the inflation of the 1920s the concentration of industry in a few hands had been common in Germany. Vertical combines representing different stages of production and horizontal combines representing works concerned with a particular stage of production had been formed in order to control prices, etc. Some of these combines went no further than standardizing contracts, conditions of payment and so on; others divided markets at home and abroad by agreement; others again created central selling agencies which fixed a uniform price and regulated output with a view to obtaining maximum profits. Most of the basic industries—coal, lignite, pig iron, steel, potash and many others—adopted this highly centralized form of organization, thus securing a kind of co-operative monopoly for their members.

In a few cases the combination went beyond the cartel stage and a real trust was formed, representing the complete fusion of the enterprises concerned. This happened in the steel industry and in the chemical industry in particular. By 1928 there were about 3,000 cartels, some extremely weak, but others, like those in the steel and chemical industries, extremely strong.

Law no. 27, passed by the western Allies to deal with this state of affairs in western Germany, transferred the heavy industries (coal, iron and steel) to German trusteeship during the period of the decartelization that was to be carried out. The first

Table XXIV.—*Industrial Production, German Federal Republic*

(In thousands of metric tons; electricity in millions of kw.hr.; merchant vessels in thousands of gross registered tons; bricks in millions of units)

Product	1938*	1946	1950	1952	1953	1954	1955
Coal	171,797	53,987	111,137	124,802	125,650	128,040	130,728
Lignite	193,462	51,700	75,947	83,547	84,554	87,804	90,360
Metallurgical coke	43,557	14,044†	27,333	37,208	37,829	35,019	40,617
Crude petroleum	552	649	1,119	1,755	2,184	2,666	3,144
Electricity	55,333	...	44,466	56,208	61,453	67,872	75,780
Iron ore (30% iron content)	10,080	...	9,120	12,540	10,752	9,708	11,370
Pig iron	18,045	2,083	9,511	12,958	11,712	12,576	16,488
Crude steel	22,656	2,555	12,121	15,806	15,420	17,436	21,336
Copper, primary	68.8	1.0	48.5	43.3	148.3	66.4	75.2
Zinc, smelter	193.3	14.9	122.8	147.2		167.6	178.8
Lead, smelter	185.2	25.6	66.6	92.7	107.8	110.3	107.6
Aluminum, primary	165.6	...	27.8	100.5	110.3	129.2	137.1
Potash salts	20,677	...	8,927	12,585	12,587	15,576	...
Sulphuric acid	2,272	342	1,446	1,740	1,897	2,092	2,279
Caustic soda	421.6	81.6	335.5	378	442	498	556
Soda ash	1,053	205	735	655	794	935	983
Superphosphates	1,118	198†	355‡	573	441	461	520
Nitrogenous fertilizers	354	212†	465	602	625	696	[illegible]
Cement	15,262	2,328	10,877	12,886	15,378	16,278	18,765
Building bricks	...	608	4,232	4,731	5,082	5,568	5,808
Merchant vessels, launched	481	...	155	520	818	963	929
Motor vehicles (units)							
Cars	274,849	9,962	216,107	301,080	360,100	518,160	705,480
Commercial	63,470	13,485	88,791	126,668	120,700	162,120	203,160

*Germany in pre-1938 frontiers. †1947. ‡1949.

TABLE XXV.—*Distribution* of Employment in Industry in *the* German Federal *Republic, 1953*
(Year average figure)

Industry group	Number of concerns*	Number employed
Coal mining . .	329	564,031
Iron ore mining .	76	23,264
Metal ore mining .	30	11,798
Potassium and rock salt mining . .	39	20,710
Other mining . .	30	2,869
Peat industry . .	150	8,254
Crude oil and natural gas . .	42	12,226
Hard coal by-products . .	17	4,092
Stones and earths .	4,879	226,166
Iron industry . .	120	229,809
Steel construction .	933	138,857
Machinery . .	3,690	605,682
Vehicle production .	610	222,195
Shipbuilding . .	196	76,976
Electrical industry .	1,657	351,386
Optical and precision instruments . .	864	110,882
Metalware	3,103	270,482
Musical instruments, toys, etc. . .	856	45,224
Dairy products .	2,288	40,617
Distilling . . .	408	13,528
Chemicals . .	1,903	312,237
Fine ceramics . .	346	68,186
Glass	494	59,968
Sawmills and woodworking . .	2,949	84,031
Wood products .	2,982	183,343
Wood pulp, cellulose, paper and cardboard . .	340	65,968
Paper products .	1,017	70,205
Printing . . .	2,458	126,188
Plastics products .	395	30,441
Rubber and asbestos products	251	68,201
Leather production	312	35,529
Leather products .	660	31,704
Shoes . . .	792	93,261
Laundries, cleaning dyeing . . .	292	20,858
Textiles . . .	4,407	599,516
Clothing . . .	3,334	240,561
Sugar . . .	79	16,135
Brewing and malting	856	52,497
Tobacco products	650	73,864

*With ten or more employees.
Source: *Statistisches Jahrbuch für die Bundesrepublik Deutschland* (1954).

decartelization orders based on law 27 were issued on July 10, 1951, and transferred property from the former great steel combine known as Vereinigte Stahlwerke, and the firm of Otto Wolff, Cologne, to five specially created, smaller "unit companies."

The abortive Bonn convention of May 1952 on *Settlement of Matters Arising out of the War and the Occupation* (ch. 2) provided that Allied deconcentration and decartelization laws should remain in force until a German law against "restraints of competition" had entered into force. The Paris agreement of Oct. 23, 1954, on the ending of the occupation, cancelled the above provision, with the reservation, however, that Allied decartelization measures affecting the German iron and steel industries, and the former I. G. Farben chemical combine. should remain in force until effective decartelization measures had been carried out by the federal government. Moreover, in a letter to the Allied High commission on Oct. 23, 1954, Adenauer promised that the federal government would oppose all attempts to abrogate or alter existing decartelization measures before the entry into force of a German law.

The federal government produced the draft of a decartelization law on March 2, 1952, but this did not get beyond committee stage during the lifetime of the first federal parliament. On Feb. 17, 1954, Adenauer's new government resurrected the draft bill, with the amendments which had been suggested in committee, and in March 1955 it was given a first reading in the *Bundestag.* The draft bill, together with two alternative drafts, was referred to committee.

The question of the eventual ownership of the heavy industries and of continued Allied supervision of them through the International Ruhr authority and other bodies became prominent as a result of the French proposal (the Schuman plan) for a western European coal and steel authority of which western Germany should be a member. The federal government welcomed the scheme, and a bill providing for ratification of the Schuman plan was introduced into the federal parliament in June 1951. During the first reading of the bill by the *Bundestag* on July 12, 1951, Adenauer stated that removal of existing economic controls was a precondition of the ratification of the treaty by the Federal Republic. The Allied High commission gave the assurances required on Dec. 21, 1951, when it announced that as soon as the Schuman plan entered into force all Allied restrictions on German steel production and all direct Allied control of the German basic industries would be lifted; the only remaining interest of the Allies in those industries would be in the completion of the program of deconcentration. On Jan. 11, 1952, the *Bundestag* voted in favour of German ratification of the Schuman plan treaty.

The European Coal and Steel Community (Schuman plan) came into being on July 25, 1952, and in accordance with the Allied undertaking, all the postwar restrictions imposed by the western occupying powers on German steel production were formally abolished, and the progressive liquidation of the international authority for the Ruhr, set up-by the western powers in 1949, was announced.

The question of nationalization of the heavy industries ranks with *Mitbestimmungsrecht* (the right of workers to take part in management) as one of the main issues which arose over the organization of industry in western Germany after World War II. Insistence of the trade unions on some measure of *Mitbestimmungsrecht* led the government to pass, on April 10, 1951, a law granting *Mitbestimmungsrecht* to the workers in the basic industries (coal, iron and steel) only. The trade unions, however, accepted this law as only a first instalment, and demanded a general introduction of *Mitbestimmungsrecht* throughout German industry. This policy the employers strongly opposed. On July 19, 1952, however, the *Bundestag* passed a *Betriebsverfassungsgesetz* (Works Councils law), which came into force on Nov. 11, 1952. This law. which applied to industry other than coal, iron and steel, provided for a lesser degree of *Mitbestimmungsrecht* than had the previous law applicable to the heavy industries, and was therefore not favourably received by the trade unions or the Social Democratic party. The structure of *Mitbestimmungsrecht* was rounded off on June 9, 195j, when the *Bundestag* passed a *Personalvertretungsgesetz* (Personnel Councils law), which provided for staff collaboration about appointments, promotions, hours of work, etc.. in the federal civil service.

Industry in eastern Germany was severely hampered during the first two years after the end of World War II by the extensive dismantling of equipment and its removal as reparations to the U.S.S.R. Factories, mining equipment, railway lines and overhead electricity wires were among the items removed on a large scale, and in addition many thousands of skilled workers were deported to the U.S.S.R. In the industries left in their zone of occupation the Russians followed a policy of eliminating private ownership and enterprise as far as possible. The process of socialization of industry was formally ended on April 17, 1948, when the Soviet military administration issued order no. 64, which announced that as a result of the measures of expropriation the state had become responsible for about 40% of industrial production in the zone. This figure however was an understatement, since it did not take into account the 126 large industrial Soviet-owned enterprises known as Sowjet Aktiengesellschaften (S.A.G.). At the time of the official ending of the expropriation policy it would seem, in fact, that about 50% of eastern German industrial production capacity was under state or public ownership, 25% in the hands of the S.A.G. and about 25% left in private hands.

As soon as the initial policy of dismantling and removal of equipment and installations to the U.S.S.R. had ceased, the Soviet authorities embarked on a more positive economic policy in their zone, and one aspect of this was a consistent effort to raise the level of industrial production. An expedient to raise industrial production in eastern Germany was the adoption, as in the U.S.S.R., of concerted "plans." On June 30, 1948, a two-year plan was drawn up; and this was replaced, on Jan. 1, 1951, by the five-year plan, which was designed to increase industrial production in the Democratic Republic to 192% of the 1950 level by 1955.

The pressure on the population of the German Democratic Republic to achieve the objects of the five-year plan led to much hardship and discontent, which formed one cause of riots in Berlin and elsewhere in June 1953 (see *History,* above). A few days earlier the government had decided to slacken the tempo, and the disturbances caused this "new course" to be emphasized still further. It involved concessions to private industry, a policy of labour incentives and efforts to increase the quantity and reduce the prices of consumer goods. Also, the Soviet government in Aug. 1953 announced the end of reparations from the Democratic Republic as from Jan. 1, 1954, cancellation of the republic's debts to the Soviet Union, a reduction in the costs of the Soviet forces of occupation, an increase in deliveries of goods from the Soviet Union, large credits and finally the transfer of the 33 remaining S.A.G.'s to the republic. These corporations, representing, it was estimated, 32% of the total industrial production of the German

Democratic Republic, were in fact transferred on Jan. 1, 1954. In March 1954 it was announced that a second five-year plan was to be prepared, to follow the first at the end of 1955.

TABLE XXVI.—*Industrial Production, German Democratic Republic*
(In thousands of mehric tons; electricity in millions of kw.hr.)

Product	1936	1950	1955 Plan	1955 Actual	1960 Plan
[illegible]	3,523	2,805	3,500	2,667	...
Lignite*	101,056	137,050	205,000	200,612	260,000
Liquid fuel' synthetic	500	845	1,355	1,575	2,285
Electricity:	14,000	19,466	31,600	28,695	44,000
Iron ore	406	401	3,700	1,664	...
Pig iron	202	337	1,250	1,517	2,250
Crude steel	1,199	999	3,000	2,507	3,500
Aluminum	—	—	—	26	65
Potash salt	953	1,336	2,000	1,552	2,200
Sulphuric acid	301	245	400	483	725
Caustic soda	124	150	250	257	350
Sodium carbonate	...	102	380	459	730
Nitrogenous fertilizers	229	232	235	293	335
Phosphatic fertilizers	32	25	93	85	200
Synthetic rubber	—	40	60	72	100
Cement	1,686	1,412	2,600	2,971	5,200

*Thermic value: 4.5 tons of lignite per ton of coal.
Source: *Statistisches Jahrbuch der Deutschen Demokratischen Republik* (1955).

TABLE XXVII.—*Index Numbers of Industrial Production*
(For G.F.R., 1936 = 100; for G.D.R., 1950 = 100)

Territory	1948	1950	1952	1953	1954	1955
German Federal Republic	63.1	113.0	144.2	157.3	176.3	202.5
German Democratic Republic	64.6	100.0	142.3	159.6	176.0	189.6

Sources: *Statistisches Jahrbuch für die Bundesrepublik Deutschland* (1955); *Statistisches Jahrbuch der Deutschen Demokratischen Republik* (1955).

Transport and Communications.— Prussia nationalized its railways in 1876–79, and the other German *Länder* followed suit. In 1919 the Reich took over the various railways, but failed to run the unified system at a profit. Later, with the help of funds made available through the Dawes plan, the railways were reorganized, and thereafter their financial position improved. World War II, however, put an intense Strain on the Reichsbahn, and Allied bombing did enormous damage to both rolling stock and tracks. In addition to this the railway network in eastern Germany suffered severely as a result of wholesale removal of rolling stock and tracks by the U.S.S.R. as reparations.

In both eastern and western Germany, moreover, the railways suffered greatly after the end of World War II from the competition of road services, and were thus in a weak financial position. In the Democratic Republic the railways remained a state-owned enterprise; and the railways in western Germany, under a law passed by the *Bundestag* on July 6, 1951, were formally designated as a federal property.

TABLE XXVIII.—*Railway Freight and Passenger Traffic, 1952*

Territory	Track (km.)	Locomotives and rail cars	Passenger coaches	Freight cars	carried	Freight carried (tons)
German Federal Republic (federal railways)	30,674	12,212	22,673	283,222	1,219,009,000	262,371,000
German Democratic Republic	14,785	2,906	7,000	83,896	1,056,000,000	158,287,000

Source: *Statistisches Jahrbuch für die Bundesrepublik Deutschland.*

In 1938 the total length of roads in Germany was estimated to be 213,394,523 km., and of these 3,051 km. represented the new *Autobahnen;* about 12,000 km. of *Autobahnen* were to have been built had not the war interrupted the program. In May 1955, after a ten-year pause, a six-year program for extending the *Autobahnen* in the Federal Republic was approved, part of the expense incurred to be financed from the Transport Finance bill passed in March 1955, increasing taxation on gasoline and diesel oil. In addition, 150,000,000 DM. of the increased revenue accruing under the bill was to be applied to help the federal railways.

German shipping was as greatly affected by World War II as it had been by World War I. Very little tonnage was left to Germany, most having been set aside for reparations. In addition, for security reasons the German shipbuilding industry was severely limited, and many dock and shipbuilding installations were destroyed or removed. Afterward, as stated above, Allied restrictions on the industry in western Germany were progressively removed, until by 1951 only the right to control shipbuilding capacity remained. In 1954 the Federal Republic had 2,227,000 gross registered tonnage of merchant shipping, as compared with about 4,400,000 tons owned by the Reich in 1939.

Before World War II about 20% of German inland traffic was water-borne; but the inland shipping system suffered great damage during the war, both from Allied bombing and from the demolition of bridges and locks on canals by the Germans themselves. Thus, for example, at the end of the war the important Dortmund-Ems canal was completely out of action. After 1945, however, rapid progress was made in both east and west Germany in repairing war damage and in extending the inland watenvays.

TABLE XXIX.—*Inland Shipping, 1952 and 1953*

Craft	German Federal Republic* (Length of waterways, 4,280 km.)	German Democratic Republic† (Length of waterways, 2,643 km.)
Tugs	885	590‡
Boats	3,419	1,219
Self propelled craft	2,170	...

*As at Jan 1, 1953. †Including east Berlin; 1952 figures.
‡Including motor cargo ships.
Source: *Statistisches Jahrbuch für die Bundesrepublik Deutschland* (1954).

In the Federal Republic important projects were being carried out in 1952 for the canalization of the middle Weser and of the Neckar, and in June 1955 the federal and French governments agreed to set up a committee to examine the possibilities of canalizing the Mosel river. In the Democratic Republic a new canal from Niederneuendorf to Paretz, in northwest Berlin, designed to enable inland shipping of the Soviet zone to avoid using the waterways of west Berlin, was opened to traffic on June 28, 1952.

The ban on German civil aviation imposed at the end of World War II was lifted in the Federal Republic on March 3, 1955, when the Allied High commission gave permission for the newly constituted air line Lufthansa to begin internal German services on April 1. In May Lufthansa was permitted to operate European services and in June transatlantic services.

Foreign Trade.— Germany has always suffered from a shortage of raw materials and an inadequate food supply, and the country's existence therefore has depended upon its ability to export manufactured goods to pay for the import of these necessities. Germany's exports really amount to a finishing goods industry on a huge scale. Between 1913 and the outbreak of World War II the relative importance of the principal groups of goods comprising Germany's imports and exports remained fairly constant, despite great changes in the total volume of goods imported and exported.

TABLE XXX.—*Imports and Exports, 1913–54; Relative Importance of Groups of Goods**

Item	1913	1929	1937	1950	1953	1954
Total imports						
Value in millions of RM./DM.	10,778	13,447	5,468	11,373.9	16,818.4	19,337.1
Food and food products	38.2%	40.0%	37.4%	44.1%	36.6%	37.0%
Living animals	2.7%	1.1%	2.0%	2.0%	1.3%	1.3%
Animal products	8.4%	11.5%	8.8%	11.2%	6.7%	6.6%
Vegetable products	22.870	21.9%	20.7%	27.3%	23.1%	22.9%
Luxuries?	4.3%	5.5%	5.9%	3.6%	5.5%	6.2%
Industrial goods ahd materials	61.8%	60.0%	61.7%	55.9%	63.4%	63.0%
Raw materials	34.970	29.2%	36.5%	29.6%	32.6%	28.5%
Half-finished goods	17.2%	17.7%	17.9%	13.7%	15.2%	18.0%
Finished goods	9.7%	13.1%	7.3%	12.6%	15.6%	16.5%
Total exports						
Value in millions of RM./DM.	10,097	13,483	5,911	8,362.2	18,525.6	22,035.2
Food and food products	12.0%	6.5%	1.5%	2.3%	2.6%	2.3%
Industrial goods and materials	88.0%	93.5%	98.5%	97.7%	97.4%	97.7%
Raw materials	13.3%	11.7%	9.8%	14.0%	8.0%	7.7%
Half-finished goods	10.7%	11.8%	9.2%	18.8%	14.7%	13.1%
Finished goods	63.9%	70.0%	79.5%	64.9%	74.7%	76.9%

*Figures for 1913–37 refer to Germany in prewar frontiers; for 1950–54 to the Federal Republic (including west Berlin).
†Coffee, tea, tobacco and alcoholic beverages are classed not as vegetable products but as luxuries.

TABLE XXXI.—*Directions of Trade of the German Federal Republic*

Country	1913*	1927†	1937†	1951	1952	1953	1954
Percentages of total German imports							
United States	15.9	14.4	5.2	18.5	15.5	10.3	11.5
Netherlands	3.1	4.8	3.9	6.9	7.2	7.8	7.9
France	5.4	4.1	2.9	4.2	3.7	4.9	5.0
Sweden	...	...	4.2	5.5	5.7	5.1	4.7
Belgium-Luxembourg	3.2	3.2	3.6	4.1	5.8	5.3	4.5
United Kingdom	8.1	6.5	5.6	3.4	3.2	4.0	4.4
Italy	3.0	3.6	4.0	3.7	4.0	4.6	4.4
Switzerland	...	...	1.7	2.6	2.9	3.6	3.6
Brazil	...	...	3.4	2.1	1.9	2.5	3.5
Argentina	4.6	7.4	5.4	2.9	1.7	1.3	3.0
Austria	...	...	...	...	2.3	2.5	2.9
Saar	—	...	—	...	2.0	2.5	2.7
Denmark	...	...	2.9	2.9	3.0	2.7	2.6
Canada	...	...	...	...	3.3	2.9	2.0
Indonesia	...	...	...	...	1.8	2.0	1.8
Percentages of total German exports							
Netherlands	6.0	10.3	7.9	10.0	8.0	8.9	9.3
Belgium-Luxembourg	5.4	3.3	4.9	6.8	7.1	7.1	7.2
Sweden	2.3	3.8	4.7	6.7	7.3	6.3	6.7
Italy	3.9	4.3	5.3	4.6	5.5	6.6	6.0
Switzerland	2.3	4.5	3.9	6.1	6.4	5.8	5.7
United States	7.1	7.2	3.5	6.8	6.2	6.7	5.6
France	7.8	4.4	5.3	6.7	6.4	5.9	5.4
Austria	...	...	...	...	3.7	3.6	4.7
Denmark	2.8	3.5	3.6	3.7	3.7	4.1	4.2
United Kingdom	14.2	10.9	7.3	6.0	5.7	4.2	3.9
Norway	...	...	...	...	2.3	3.0	2.9
Brazil	...	...	3.0	3.2	3.8	2.5	2.7
India	...	...	...	...	1.3	1.5	1.7
Argentina	2.6	2.8	2.5	2.4	2.0	2.2	1.5
Turker	...	...	...	...	3.4	2.3	1.5

*Germany in pre-1914 frontiers. †Germany in pre-1938 frontiers.

Food steadily averaged about 40% of the total imports. but almost vanished from the list of exports. Correspondingly, the proportion of total exports represented by finished goods increased by about 15% between 1913 and 1937.

The direction of German trade, on the other hand, changed greatly after World War I. Before that war, nearly a quarter of Germany's total trade was with Great Britain and the United States. After World War I, partly because of the tariffs. currency changes and the strong bargaining position of these countries, and partly because of Germany's own restrictions of foreign exchange, tariffs and "clearing agreements." trade with both steadily declined. There was a fairly short-lived increase in trade with the U.S S.R. in the early 1930s until political antagonisms between the two countries became acute.

After World War II Germany found itself still poorer in raw materials and food supplies, with its economy unbalanced and suffering great losses from war damages, reparations and controls. At the same time the shipping resources had vanished and its capital reserves were heavily mortgaged by prewar and postwar debts. Nevertheless, after modest beginnings through the Joint Import-Export agency for the U.S. and British zones, and as the effect of the European Recovery program (E.R.P.). most-favoured-nation treatment from the United States and Great Britain, and the various measures taken by the Organization for European Economic Cooperation (O.E.E C.) to revive western trade in general, the foreign trade of western Germany revived to a remarkable degree.

From 1948 onward western Germany began to play a major role in the expansion of west European trade in general, and between that year and the first half of 1950 the trade with the German Federal Republic accounted for almost half the total increase in the exports of western European countries to each other. By 1953 the total monthly volume of imports and exports from the Federal Republic was already 50% greater than from the same area before World War II. For the first time since World War II, the Federal Republic achieved a surplus of exports over imports in 1952, and this increased considerably in 1953 and 1954.

The structure of the Federal Republic's foreign trade had by the end of 1953 reverted almost exactly to the prewar position of the Reich as a whole. About 37% of imports consisted of food and about 63% of industrial goods and raw materials; exports comprised 2.6% food and 97.4% industrial goods and raw materials. The direction of trade had. however, altered considerably in favour of western Europe and the western hemisphere. In 1953 over half of Federal Germany's imports were from the member states of O.E.E.C. and a further quarter from the United States, Canada and Latin America, while the proportion of its exports to these countries was two-thirds and one-sixth, respectively. The years 1950–53 saw an important expansion of trade with Latin America, in particular. Trade with the Soviet bloc continued to be almost nonexistent.

The foreign trade of eastern Germany after World War II also concentrated largely on the export of industrial goods of high quality, including textiles and chemicals, in return for food and raw materials. But this trade was diverted even more rigidly toward the U.S.S.R. and the satellite states than was western German trade toward the E.R.P. countries. The decisive change in the direction of eastern German trade took place after 1948, the first year of E.R.P. (See Table XXXII.)

During the two-year plan of 1949–50 and the five-year plan which followed in 1951, the tendency was to integrate the economy of the Democratic Republic more closely with the Soviet bloc and gradually to make the republic independent of trade with the west. A long-term trade agreement on the mutual deliveries of goods during the period from 1952 to 1955 was concluded between the U.S.S.R. and the German Democratic Republic in Sept. 1951. It was then claimed that the U.S.S.R. would supply all the wheat, cotton and fodder required by eastern Germany for this period, most of its meat, fat. wool, fish, tobacco, tea. manganese and chromium ores and pig iron, nearly half its requirements of rolling-mill products, and smaller quantities of coke. In return the Democratic Republic would supply the U.S.S.R. with heavy machinery, motors and industrial equipment on a large scale, together with chemical goods, ships, precision instruments, television sets, etc. Supplementary long-term trade agreements were similarly concluded between the Democratic Republic and the other Soviet satellite states.

After 1948 there was a rapid expansion in the trade of the Democratic Republic, which by 1953 had the largest total trade turnover of any of the east European countries and, next to China, was the most important trading partner of the Soviet Union. In that year 41% of east German imports consisted of food, 39% of raw materials and semifinished goods and 20% of manufactured goods. The corresponding figures for exports were 2%, 17% and 81%.

TABLE XXXII.—*Estimated Distribution of the Trade Turnover of the German Democratic Republic*

(Exports plus imports, in millions of U.S. dollars)

Trading partner	1937	1948	1952	1953	1954
U.S.S.R.	35	105	670	940	1,100
Czechoslovakia	30	25	100	130	150
Poland	20	70	220	240	270
Hungary	25	...	80	go	roo
Rumania	30	...	50	60	70
Bulgaria	15	10	30	40	60
Other countries*	25	10	go	140	210
All countries in the eastern group	180	220	1,230	1,640	1,960
Western Europet	580	150	240	310	460
overseas countries	410	30	190	200	210
All countries	1,170	400	1,660	2,150	2,630

*China, Mongolia, North Korea and Albania.
†Including trade with western Germany in postwar years.
Source: *U.N. Economic Survey of Europe* (1954 and 1955).

Finance.—Before World War I government functions were divided between three authorities: the Reich, the *Lander* or states and the local government bodies (districts and municipalities). In the bigger *Lander*, such as Prussia and Bavaria, provinces and government districts stood between the local government bodies and the central government. Administrative systems varied considerably in size, from that of Prussia which involved a population of nearly 40,000,000 to that of Mecklenburg-Strelitz which comprised about 100,000 persons. In Prussia itself there were considerable differences in the various provincial administrative systems.

After the revolution that followed World War I the Reich took over more administrative services than it had previously been responsible for, but police, education, justice, public health and supervision of industry continued to be within the competence of the different *Lander*. These, moreover, had tax-collecting services of their own, though some of the smaller *Lander* entrusted the Reich authorities with the collecting of *Land* taxes, and there was thus some overlapping in many cases between Reich authorities and *Lander* authorities. By 1939 the central government had become the chief taxing authority in Germany, having ousted the *Lander* from their former privileged position, as a result of the centralizing policy of the National Socialists. The central Reich government by that year controlled not only customs and excise but also income tax, corporation tax and the inheritance and property taxes as well. The various *Lander* were still allowed, however, to levy taxes on land, buildings, businesses and other sources of income. As the *Lander* found themselves unable to carry out the tasks incumbent upon them with the proceeds of the taxes left under their own control, they were allowed to share in the proceeds of the most important Reich taxes—the income tax, the corporation tax—and some minor taxes. In this way three-quarters of the income tax and of the corporation tax were handed over to the *Lander*, which in turn had to share with the municipalities the refunds which the Reich had made to the former. The post-World War II financial system in the Federal Republic was based on the principles laid down in its provisional constitution. By these the federal government acquired exclusive legislative rights over some taxes (*e.g.*, customs and financial monopolies) and concurrent legislative powers with the *Lander* in the case of certain other taxes (*e.g.*, the income and property taxes). The revenue from customs and excise (except 'beer) and from certain other taxes accrued to the federal government, while the revenue from beer and various other taxes accrued to the *Lander*. Similarly there was a division of competence with regard to the actual administration of the taxes, the federal finance authorities administering the customs, excise, financial monopolies and certain other taxes, and the *Lander* financial authorities administering the remainder. The Basic law also laid down (art. 109) that "the federation and the *Lander* shall be self-supporting and independent of each other in their budget economy." However, to enable *Lander* with low revenues to maintain an efficient administration, and to equalize as far as possible the burden of expenditure in the different *Lander*, the Basic law authorized the federal government, for these purposes, to draw upon an equalization fund provided from the proceeds of various *Lander* taxes, and to make grants to the poorer *Lander* in accordance with their needs. Table XXXIII shows the receipts and payments made in 1950 in implementation of this *Finanzausgleich* (equalization of financial burdens).

TABLE XXXIII.—*Contributions and Receipts by* Lander *of the Federal Republic for the Financial Fears 1953 and 1954 Under Equalization Fund*
(In thousands of DM.)

Land	Paid in	Land	Received
Württemberg-Baden .	64,020	Bavaria	6,547
Hesse	9,744	Lower Saxony . , .	49,104
Lindau*	456	Rhineland-Palatinate .	27,416
North Rhine-Westphalia	1	Schleswig-Holstein . ,	121,532

*The Bavarian district of Lindau was considered a separate ***Land*** for the purpose of the equalization fund.
Source: *Bundesgesetzblatt* (July 2, 1953).

For budget accounts of the two German republics *see* Tables XXXIV and XXXV.

TABLE XXXIV.—*Budget Accounts of the German Federal Republic*
(In millions of DM., years ending March 31)

Item	1949*	1950	1951	1952	1953	1954	1955†
Revenue . .	512	1,540	11,418	17,146	20,218	21,610	23,078
Expenditure .	512	1,784	12,394	18,530	20,623	20,060	24,902

*Nine-month period beginning June 20, 1948 (currency reform). †Estimate

In eastern Germany the financial system after World War II was at first marked by extreme decentralization. The central zonal administrative organs which were the precursors of the ministries of the German Democratic Republic had indeed no tax revenues of their own and were financed from contributions from the railways and postal services and from contributions from the various *Lander* governments. By a law of Feb. 9, 1950, made retrospective to Jan. 1, 1950, the financial system of the Democratic Republic was centralized. By this law the authority to raise revenue and the right to receive the revenue were taken from the *Lander* authorities and given to the central ministry of finance, which made allocations to the *Lander*, *Kreise* (districts) and ***Gemeinden*** (parishes) to enable them to carry on their necessary work of local administration.

TABLE XXXV.—*Budget Accounts of the German Democratic Republic*
(In millions of DM.-Ost)

Item	1951	1952	1953	1954	1955*
Revenue	28 472.4	33,536.7	34,774.9	36,220.2	38,166.9
Expenditure . . .	8 . 8	33,352.9	34,753.4	9	38,138.1

*Estimate.

Before World War II Germany had an enormous external debt arising from the treaty of Versailles, by which Germany was made responsible for a reparations liability fixed at 132,000,000,000 RM. An agreement in London in 1924 rearranged Germany's financial obligations, however, in accordance with the main principles of the Dawes plan, and an external loan was issued by the Reich government in 1924 as a result. The financial burden of reparations on Germany was lessened once again in 1930 when the Dawes plan was replaced by the Young plan, but the new plan soon proved economically impossible and was suspended at Pres. Herbert Hoover's suggestion in 1931, and thereafter reparations obligations were virtually nullified. Germany still had a very heavy foreign debt, however, because of the large sums borrowed abroad during 1924–29 for the payment of reparations, the reconstruction of German industry and other purposes. Under National Socialism an internal debt was added to this external debt. The Nazi government borrowed vast sums from the German people, and the total public debt of the Reich, the states and the larger towns and cities rose accordingly from 24,000,000,000 RM. in 1932 to an estimated 64,000,000,000 RM. in 1939. After the war the western Allies had to pour financial help into the western zones of Germany to keep them viable, and in this way another debt gradually accumulated for which the Federal Republic in principle accepted liability.

An agreement on German prewar debts was signed in London on Feb. 27, 1952, between the United Kingdom, France, the United States and 1j other creditor countries, and the German Federal Republic, and this agreement, which laid down the terms and procedure for settlement of the debts, came into force on Sept. 16, 1953. Also on Feb. 27, 1952, the United Kingdom, France and the United States signed with the Federal Republic separate bilateral agreements for the settlement of the postwar debts owed to the three countries by the Federal Republic for economic assistance.

Banking and Currency.—The first commercial bank was established in Germany in 1619, but because of the political disorganization of the country it was not until the latter part of the 19th century that a modern co-ordinated banking system developed. A process of centralization set in, and by the 1930s German banking was dominated by the Reichsbank and five other big banks, two of which (the Reichskredit-Gesellschaft and the Berliner Handelsgesellschaft) were purely Berlin institutions, while the other three (the Deutsche Bank, Dresdner Bank and Commerz- und Privatbank) had many branches throughout the country. After the inflation of 1923 the Reichsbank was reorganized by the Dawes plan, and managed to preserve some semblance of independence till June 15, 1939, when a decree placed it directly under the control of Hitler, who exercised the control through Walther Funk, Reich minister of economics and president of the Reichsbank. Apart from the Reichsbank and the big private banks, there were in prewar Germany public banks maintained by the state governments, provinces and municipalities, and these were important as savings banks. Savings, however, suffered because of the 1923 inflation and fell from 19,000,000,000 RM. in 1914 to only 1,250,000,000 RM. in 1924. Later confidence was restored and savings grew from 4,600,000,000 RM. in 1927 to 15,700,000,000 RM. in 1937.

After Germany's collapse in World War II the banking system was developed along different lines in the Soviet zone and the zones occupied by the United States, Great Britain and France. In western Germany banks were allowed to maintain their existence, and accounts, other than those connected with Reich and Nazi property, were not blocked. In eastern Germany on the other hand all banks and stock exchanges were closed and bank balances blocked at the beginning of the occupation.

Though the western Allies did not act as drastically as the Russians, they considerably modified the banking system in western Germany, setting up a federal banking system in place of the former centralized structure. The head of this system was the Bank Deutscher Lander, and each of the 11 *Lander* had its own autonomous bank *(Landeszentralbank)* on which all the banking operations in the *Land* depended. The Bank Deutscher Lander derived its funds from the *Land* banks and acted as their banker. In addition it was the only bank allowed to issue notes, so to that extent centralizing influences were retained. The essentially federal character of the postwar west German banking system may be judged, however, from the fact that no German bank was allowed to maintain branches outside the *Land* in which it was registered.

The policy of the Bank Deutscher Lander was made by a board sitting in Frankfurt composed of the governor and chairman of its managing committee, together with the 11 heads of the *Lander* central banks. The federal character of the Bank Deutscher Lander was further emphasized by its inability to open branches or to do internal German business, generally speaking, except with the *Lander* central banks. In this respect it was quite different from the former Reichsbank, whose influence and ramifications were widespread.

On Nov. 7, 1951, however, the federal government approved a new banking law designed to modify considerably the decentralized system introduced by the occupying powers after the capitulation in 1945. The law proposed to substitute for the 30 or more small *Lander* banks functioning under the system of decentralization nine successor organizationsto the former "big three" (Dresdner Bank, Deutsche Bank, Commerz- und Privatbank), with power to operate in three big regions — covering north, south and west Germany — instead of being confined to *Lander* boundaries. The law came into force on April 1, 1952. By 1954 this reorganization was said to be completed.

The dominant economic requirement in Germany after World War II was a reform of the currency so that money could once more play its essential part in economic life instead of finding its place usurped, as a unit of value and means of exchange! by such commodities in short supply as cigarettes and coffee. After the western Allies had failed to reach an agreement with the U.S.S.R. on an all-German currency reform, they were forced to institute a separate reform in their own zones of occupation, and this reform was carried out in stages in 1948. The old Reichsmark was converted to the new Deutsche Mark at a rate of 10 RM. to 1 DM.; and half the amount resulting from conversion was placed in a blocked account. By a further currency law passed on Oct. 1, 1948, 70% of the blocked accounts were cancelled, 10% retained for compulsory investment and 20% freed for the individual holder to do with as he pleased. Thus in the end the Germans had the free use of 6% of their holdings (though a provision existed by which a later claim up to 10% of former Reichsmark holdings may be allowed).

The reform was severe, but necessary and beneficent in its ultimate effects. By July 1948 money in circulation had been reduced from about 65,000,000,000 RM. to about 10,000,000,000 DM., and this restoration of the purchasing power of the mark and of people's confidence in it was the indispensable foundation of the Federal Republic's subsequent economic recovery. By Dec. 1955 currency circulation amounted to 14,088,000,000 DM. and deposit money to 14,988,000,000 DM. From 1950 the exchange rate of 4.20 DM. = $1 remained unchanged. After Aug. 10, 1953, the rate was free to fluctuate between limits of 1% either side of par.

In the Soviet zone of Germany all existing banks were closed after the occupation had begun, and all bank deposits, totalling about 80,000,000,000 RM., were blocked. Later a decentralized system somewhat on the western model was introduced, and in Feb. 1947 five *Länder* central banks were set up. In 1948, after a separate currency reform was carried out in the Soviet zone, the Deutsche Emissions- und Girobank was set up as a central bank for controlling the new currency. On July 20, 1948, the title of the bank was changed to Deutsche Notenbank, and from that time the new institution began to exercise an ever-greater control over banking activities throughout the Soviet zone in fulfilment of the newly announced two-year plan. The system of centralized planning involved more and more of an encroachment on the functions of the five *Liinder* banks, and in March 1950 this process led to the complete amalgamation of the *Lander* banks with the Deutsche Notenbank. In Nov. 1951 the parliament of the Democratic Republic passed a law making' the Deutsche Notenbank the official state bank with functions enabling it to control the carrying out of the five-year plan in addition to the usual central bank functions such as control of note circulation and foreign exchange transactions.

The currency circulation of the German Democratic Republic was secret. Officially at par with the western Deutsche Mark, in 1955 the Deutsche Mark-Ost was being exchanged in west Berlin on the average at 4.50 DM.-Ost = 1 DM. On Oct. 30, 1953, the eastern Deutsche Mark was "revalued" at an exchange rate of 1 DM.-Ost = 1.80 roubles. (I. L. G.; P. G. Rs.)

GERMERSHEIM, town in the Rhineland-Palatinate. Federal Republic of Germany, at the confluence of the Queich and the Rhine, 8 mi. S.W. of Speyer. Pop. (1959 est.) 7,175. Germersheim existed as a Roman stronghold under the name of Vicus Julius. The citadel was rebuilt by the emperor Conrad II, hut the town itself was founded in 1276 by the emperor Rudolph I, who granted it the rights of a free imperial city. From 1330 to 1622, when it was conquered by Austria, the town formed part of the Palatinate of the Rhine.

From 1644 to 1650 it was in the possession of France; but on the conclusion of the peace of Westphalia it was again joined to the Palatinate. In 1674 it was captured and devastated by the French under Turenne, and after the death of the elector Charles (1685) it was claimed by the French as a dependency of Alsace. As a consequence there ensued the disastrous Germersheim war of succession, which lasted until the peace of Ryswick in 1697. Through the intervention of the pope in 1702 the French, on payment of a large sum, agreed to vacate the town. and in 1715 its fortifications were rebuilt. In July 1744 the French were defeated there by the imperial troops, and in July 1793 by the Austrians. In 1835 the new town was built.

Between 1834 and 1919 Germersheim was strongly established as a German frontier fortress town and remained so until after World War I. During World War II it once again came under attack and over one-third of the town was destroyed in air and ground bombardments. It was rebuilt after the war, however.

Germersheim is the site of the foreign and interpreters' institutes of the University of Mainz, and many other schools are in the town. Industries include enamel and chemical works, and there are dry docks for river shipping; the region is strongly agricultural.

Germersheim is the capital of the district of the same name.

GERMINAL, "the month of buds," the first spring month of the French Republican calendar, substituted for the Gregorian calendar on Oct. 5, 1793. *(See* FRENCH REPUBLICAN CALENDAR.)

GERMINATION, of seeds: *see* PLANT PROPAGATION.

GERMISTON, town in Transvaal, South Africa, 9 mi. E. of Johannesburg and 8 mi. from Jan Smuts International airport. Altitude 5,478 ft. Pop. (1960) 139,407; whites 55,605, coloured 3,350, natives 78,389, Asians 2,063.

The town is an important railway junction, where lines meet from Natal and Cape Province ports, Lourenço Marques, Pretoria and Johannesburg. It is situated in the heart of the Witwatersrand gold-mining area and has the largest gold refinery in the world.

GERO (c. 900–965), margrave of the Saxon east mark, was entrusted in 937 by the German king Otto, afterward the emperor Otto the Great. with the defense of the eastern frontier of Saxony against the Wends and other Slavonic tribes.

In a few years Gero extended the Saxon frontier almost to the Oder, and suppressed a rising of the conquered peoples in a great victory on Oct. 16, 955. In 963 he defeated the Lusatians and compelled the king of the Poles to recognize the supremacy of the German king.

GEROLSTEIN, a village and climatic health resort of Germany, in Rhineland-Palatinate. situated on the Kyll, in the Eifel range, 1,240 ft. above the sea, 28 mi. N. of Trier. Pop. (1950) 3,097. The castle of Gerolstein was built in 1115 and is now in ruins. Gerolstein is celebrated for its lithia waters, which are largely exported.

GÉRÔME, JEAN LÉON (1824–1904), French painter, sculptor and teacher, born at Vesoul, Haute-Saône, on May 11, 1824. was trained by P. Delaroche, whom he accompanied to Italy in 1844–45. His "Cockfight," exhibited at the Paris Salon of 1847, failed to win him the Rome prize but caused a popular sensation. After 1853 he traveled much in the middle east. His enormous "L'Apothéose du Siecle d'August" (exhibited at the Exposition Universelle, 185j) was bought by the state.

Gérôme was a good draftsman in the style of J. A. D. Ingres, an inventive illustrator in the manner of Delaroche. From about 187j he turned increasingly to sculpture.

Gérôme exerted an important influence on the development of U.S. painting through his teaching, as did many other prominent academic French painters of the late 19th century. His pupils included Thomas Eakins, J. Alden Weir, F. A. Bridgman and many others. He died in Paris in the night of Jan. 10–11, 1904.

GERONA, a maritime frontier province in the extreme northeast of Spain, formed in 1833 of districts taken from Catalonia and bounded on the north by France, east and southeast by the Mediterranean sea, southwest and west by Barcelona and northwest by Lerida. In the northwest a small section of the province, with the town of Llivía, is entirely isolated and surrounded by French territory; otherwise Gerona is separated from France by the Pyrenees. The population in 1950 was 322,371. The area is 2,264 sq.mi.

The region has numerous historical associations (see CATALONIA), and it acted as the guardian of the passes through the Pyrenees at the eastern end, performing the same service as Roncesvalles in the west. The three main rivers, the Ter, Muga and Fluvia, rise in the Pyrenees and flow in a southeasterly direction to the sea. Along their banks there is much good arable land, while the lower slopes of the Pyrenees are well wooded with oak, pine and chestnut. Cape Creus is a marked feature of the coast line arid is the most easterly point of the Iberian peninsula. It is formed by the dying down seaward of the Pyrenees. The climate varies locally. The Cerdaiia district and other mountainous tracts are cold during eight months while Gerona, La Bisbal and Santa Coloma have typical Mediterranean features. The coastal fisheries are important especially at Llansá, Rosas, Palamos and Blanes. The cork industry flourishes at San Felíu de Guixols (with fisheriesj, Palafrugell and Cassa. There is also a little metalliferous mining. Much use is made of water power, and the linen, cotton and general textile manufactures are important.

Gerona (*q.v.*) is the capital while Figueras was long a most important frontier fortress. Gerona was held by government troops during the civil war of 1936–39 until after the capture of Barcelona on Jan. 26, 1939.

GERONA, the capital of the province of Gerona in northeastern Spain, on the railway from Barcelona to Perpignan in France and on the right bank of the Ter river, at its confluence with the Oña, a small right-hand tributary. Pop. (1950) 26,163 (mun.).

Gerona is the ancient Gerunda, a city of the Auscetani. It claims to be the place in which St. Paul and St. James first rested when they came to Spain, and it became the see of a bishop about 247. It was for a long time in the hands of the Moors, whose amir, Suleiman, was in alliance with Pippin the Short, king of the Franks about 759. It was taken by Charlemagne in 785, but the Moors regained and sacked it in 795, and it was not until 1015 that they were finally expelled. It gave the title of count to the king of Aragon's eldest son. It has been besieged no fewer than 25 times in all, and only 4 of the sieges have resulted in its capture. Its noblest resistance was in 1809, when it was besieged in May by the French with 35,000 troops under Verdier, Augereau and Gonvion St. Cyr; 40 batteries were erected against it and a heavy bombardment maintained; but under the leadership of Mariano Alvarez de Castro it held out till famine and fever compelled a capitulation on Dec. 12. The French, it is said, had spent 20,000 bombs and 60,000 cannon balls, and their loss was estimated at 15,000 men.

The older part of the town occupies the steep slope of the Montjuich or Hill of the Capuchins; the newer portion stretches down into the plain and beyond the Oña There are still remains of the city walls, and the hill is crowned by what were at one time very strong fortifications, now put to other uses. The cathedral is a fine specimen of Gothic architecture; the nave measures 73 ft. from side to side. The old cathedral on the same site was used as a mosque by the Moors, and on their expulsion in 1015 it appears to have been greatly modified if not entirely rebuilt. New works were carried out during the 14th century, but it was not till the beginning of the 15th that the work on the present structure was really begun. The collegiate church of San Feliu (St. Felix) is mainly of the 14th century, but was modified in the 16th and its façade dates from the 18th. The spire is conspicuous. The Benedictine church of San Pedro de Galligans (or de lós Gallos) is an interesting Romanesque building of early date. It is named from the small Galligans river, an affluent of the Oña, which flows through the city. In the same neighbourhood is a small church with a rare Spanish example of a transverse triapsal plan. Gerona is still the seat of a bishop. There is a public library. Paper, cotton and woollen goods are extensively manufactured.

GERONIMO (c. 1829–1909) was a leader but not chief of a North American Apache Indian band called Chiricahuas. Geronimo gave June 1829 as the date of his birth; the place, No-doyohn canyon, Arizona. His mother taught him tribal legends. Geronimo said that when a boy he "would practise stealing" and "feats of war." He rose to leadership of a faction of braves by exhibiting extraordinary courage, determination and skill in successive raids of vengeance upon Mexicans by whom his mother, wife and children had been killed in 1858. Devastating Apache raids and massacres in Arizona and New Mexico brought action by the U.S. army under command of Gen. George F. Crook which placed offenders, including Geronimo, on reservations. In 1876 Geronimo fled to Mexico. During the following decade he led outlaw bands in intermittent raids against American settlers. In 1886 General Crook finally succeeded in bringing Geronimo to a meeting wherein he and his Apache warriors agreed to surrender if they would be taken to Florida where their families were being held. The terms were agreed to, but on the way the Indians escaped. General Crook was replaced by Gen. Nelson A. Miles, who after months of pursuit finally secured another conditional surrender of the elusive Geronimo and followers. During this final campaign. which lasted 18 months, no fewer than 5,000 troops and 500 Indian auxiliaries had been employed in the apprehension of a band of Apaches comprising only 35 men, 8 boys and 101 women, who operated in two countries without bases of supply. Army and civilian losses totalled 95; Mexican losses were heavy but unknown. Geronimo's losses were 13 killed, but none from direct U.S. army action.

By orders from Pres. Grover Cleveland, and contrary to terms agreed upon by Miles, Geronimo and 14 companions were placed under military confinement. finally! at Fort Sill, Oklahoma. There Geronimo was allowed to carry on stock raising and farming. Before his death on Feb. 17, 1909, this most cunning of Indian fighters dictated to S. M. Barrett Geronimo's Story of *His Life* (1906).

See also Britton Davis, ***The Truth About Geronimo,*** ed. *by* Milo M. Quaife (Chicago, 1951). (O.O. W.)

GERONTOCRACY, government by old men. The degree to which the old are accorded prestige and status varies greatly from society to society and from one social class to another. Yet in both primitive and technological societies and in many, particularly religious, organizations it frequently works out that major policy determination, executive and administrative responsibility, and judicial authority rest in the hands of older people.

In advanced societies outstanding creative works in the arts and sciences are most frequently produced by men in their 30s. The qualities and conditions that make for governmental leadership, however, seem to develop more slowly and to combine in such a way that outstanding leaders as a group are notably older than outstanding scientists are at the time they produce their greatest work.

Among primitive societies the vast majority have older men serving as chieftains, as counselors and in judicial roles. Among Australian tribes, especially, aged men have great authority, and it is here that the best examples of what approaches a "true" gerontocracy—rule by the old men as a class—exist. The Dieri, *e.g.*, are reported to have had, within a general assembly made up of all men fully initiated into adulthood, a great council made up of aged men. This council made the major decisions, administered justice, and regulated the ceremonies and movements of the group.

Relevant facts for more highly developed societies are often a matter of public record, thus permitting a clearer assessment of the role of the aged in governmental matters than is possible in the instance of primitive groups. But surveys in both primitive and advanced societies indicate that, strictly speaking, gerontocracy as a form of government seldom exists. Rather there is often a disproportionate representation of older individuals in governmental activities. Successful candidates for president of the United States, for instance, are most frequently nominated and most frequently serve between 55 and 59 years of age. Peak years of service of prime ministers of England and of presidents of republics other than the United States have also been between 55 and 59. Members of the U.S. president's cabinet have most often served between 50 and 54 years of age, members of the British cabinet between 55 and 59. Where electoral terms are long (as in France) or where appointment is for life, or continued tenure is contingent upon personal desire of the incumbent, a much greater age of service is recorded. Thus appointments to the U.S. supreme court are most frequently made at ages 55 to 59, but over 85% of the service rendered is by men beyond 6j. A variety of evidence suggests that new movements are more frequently started by young men, but as the organization becomes established and stable, older men dominate in the government. In the United States, the passage of time has brought an increased emphasis upon older leadership. For example, the mean ages of representatives and senators in 1799 were 43.50 and 45.2j years respectively. By the mid-1920s mean ages had increased to 53.46 years for representatives and 57.50 for senators. In addition to increased age of the groups as a whole, considerable weight is given to seniority in committee and other assignments through which power is wielded.

In addition to actual service, it is significant that at least in the United States older individuals evince strong interest in political and governmental matters and more frequently exercise the ballot than do the young. For example, a larger proportion of a sample of voters over jj voted in the 1948 presidential election than of those under 35, though both groups voted somewhat less than did those around 50 years of age. Among college graduates, the percentage voting in local and primary elections apparently increases until the 50s and remains at a high level until old age, slightly more than four-fifths of those in the mid-40s and in older age groups reporting such voting.

In general, there appears to be no uniform or even clearly defined pattern of gerontocracy in either primitive or modern societies though in both there is a strong tendency in this general direction. Rarely is advanced age in itself a sufficient qualification for an important post; usually old leaders had attained prominence in some way in their prime and have maintained their prominence into old age. Old men occupy influential positions in overwhelming numbers compared to old women. And, finally, the old are more likely to have governmental responsibility in the more stable societies with advanced economies and more complex organizations.

A number of reasons for the widespread political power of older people suggest themselves. It may be that the qualities required for leadership emerge more slowly than other capacities. that the reputation and broad personal contacts necessary for vote getting and the experience needed to function effectively require years to develop or that older individuals being more conservative and hence more interested in the maintenance of the *status quo* are more highly motivated to seek and retain office. On the other hand, the reasons may lie in the characteristics of the groups who appoint or elect leaders. It has been suggested that a basic conservatism of the mass of the party membership results in the repeated nomination and election of those who by virtue of previous officeholding have served a long "apprenticeship" to the party and represent familiar faces in whom the general population can have confidence. Moreover, the organization of the political group may be a factor in determining the ease with which younger men are introduced into positions of leadership. In groups autocratic in structure vigorous action by the central figures may force a certain mobility of younger talent, not so possible under the election systems of democratic parties. Of interest in this connection is the fact that in the French national assembly of 1946 about 33% of the deputies from the Communist party (a highly centralized party) were under 36 years of ages whereas only 8% of the deputies from the Socialist party were under 36. The latter party, although characterized by a strong organization, is highly decentralized and has a highly democratic system for the appointment of leaders. The rules, procedures and customs of political parties may thus play a significant role in determining the relative influence of the young and the old.

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(R. G. KN)

GERONTOLOGY AND GERIATRICS. Gerontology is the science or the study of aging. Aging affects all matter, animate and inanimate; metals, planets, radiation activity, rocks and colloidal gels change with age just as living organisms do. However, gerontology is chiefly concerned with aging as it affects the processes of life and particularly, of course, the aging of man. Aging is a part of living and, therefore, a factor in growth and development, but gerontology applies chiefly to aging after the peak of maturity.

Gerontology is divided into three major subdivisions: (1) the aging of the individual as a unit; (2) the biological processes of aging affecting the component parts of the individual; and (3) the sociological aspects of aging mankind. The first of these divisions is called geriatrics and pertains to the medical or clinical care of aging or aged persons. In this division, the individual man or woman is the unit. The second division, the biology of senescence, is concerned with the mechanisms of aging as they affect the cells, and chemical reactions of the tissues which make up the organism. The sociological problems of aging populations include economic, political and cultural facets.

These three areas of study are intimately related, both theoretically and pragmatically. The individual is the primary unit, be it man or other living entity. On the one hand, the individual is composed of myriads of tissue cells, each being an entity in itself. On the other hand, society is composed of many millions of individuals. From the purely practical viewpoint, the more we know about the biology of senescence, the more wisely can we guide and maintain the health of aging people; and the more we know of the capacities and limitations of people as they grow older, the more intelligently can we attack the serious social problems which arise from changes in the age composition of populations.

Though aging is as old as time and the aged have always been a medical and social problem, there was no significant interest in gerontology until about 1940. The former lack of interest can be attributed to a number of factors: It was only after 1900 that the numbers of older people in the population became significant. Science is in itself young and thus, naturally, concerned first with the problems of youth, growth and development. The aged were long considered as an unavoidable economic burden. With the tremendous increase in longevity during the 20th century (life expectancy at birth in 1900 was 47 years and in 1952 over 67 for males and over 71 for females) the social pressure of the more mature in our populations demands attention.

Geriatric Medicine.—Geriatric medicine is that part of the science and practice of medicine which deals particularly with the health and illnesses of the aging and the aged. It is perhaps best contrasted with pediatrics, which deals with the health and sicknesses in infants and children. Geriatrics is not a medical specialty in the generally accepted use of the term, since it crosses the lines of all the various specialties. For example, there are special geriatric problems in ophthalmology (diseases of the eye), in dermatology (diseases of the skin), in surgery and in internal medicine Therefore, the adjective "geriatric" is preferred to the noun "geriatrics." Geriatric medicine takes special cognizance of the biologic changes consequent to aging and those disorders which are more frequent in the latter half of life. Geriatric medicine is not limited to the problems of those already senile; it is much more concerned with the aging from full maturity onward. The two most critical decades are those from 40 to 60 years of age. Geriatrics is concerned with both abnormal and sick individuals and the maintenance of health of those apparently well. It is not limited to the purely physical aspects of medicine; the intellectual and emotional changes which occur with normal aging and the psychiatric disorders common in the involutional period and in the *senium* are equally parts of geriatric medicine. Preventive measures offer far more hope of accomplishment than attempts to deal with changes and depreciations already existent.

Medical problems of the mature person are profoundly affected by the changes of age on the one hand and by the characteristics of the commoner disorders in this age group on the other hand. It is extremely significant that aging brings about change; the older person is not the same individual as he was in youth and early maturity. Aging affects all the structures and functions of the living organism. Immunity, physiologic capacities, repair processes, memory, method of thought, nutritional requirements, endurance and the like are all altered by age. These changes occur so gradually and insidiously that they are often ignored, but they are, nevertheless. most significant.

The obvious changes of aging, such as wrinkles and graying hair, are the least important. Among the subtle and obscure changes are a slowing and weakening of the responses of the organism to external stimuli and injurious forces, slowing of the speed of repair following injury, a lessened requirement for food (but a narrowing margin of safety in regard to deficiencies in certain elements) and a very gradual involution of the functional capacities. In terms of everyday living these changes mean that the aging person, by reacting less violently to infection or other injuries, presents milder symptoms and signs of disease. As a result, illnesses are often well advanced in the older person before medical guidance is sought, and the physician is thus greatly handicapped. The lessening of response to adverse environmental conditions is illustrated by the fact that older persons tolerate extremes of heat and cold poorly; undereating or overeating, dehydration or too rapid fluid intake are prone to lead to much more serious consequences than in youth. Adaptability is lessened.

Aging is not all decline, however, since certain attributes improve with aging in the normal person. Though speed diminishes, endurance often actually improves. Judgment very definitely increases as we become more and more mature, assuming that there was intelligence in youth. Age alone does not guarantee good judgment or wisdom, but as judgment is based upon learning from experience and having experiences takes time, the element of age in the development of judgment is inevitable. The ability to learn declines far more slowly than most people assume; careful psychological tests indicate that the ability to learn at 80 is approximately the same as at 12, with the peak occurring at about 22 years of age. However, these studies were conducted with people who wanted to learn; without desire to motivate the effort of learning, ability depreciates more rapidly.

S o disease is limited solely to the later years of life. However, certain disorders occur much more frequently among people over 40 years of age. These same illnesses may occur in youth, although only exceptionally. The disorders common in senescence include particularly arteriosclerosis (so-called hardening of the arteries), hypertension (high blood pressure), diabetes, arthritis, gout and cancers. Of these, the disorders involving the circulation (arteriosclerosis and hypertension) and, therefore, the heart—both directly and indirectly—are by far the most important. Conservative estimates placed the annual deaths attributable to these two circulatory disorders at more than 200,000 in the United States in 1952; more than 250,000 persons were also becoming totally disabled each year because of circulatory disease. These various disorders have certain significant characteristics in common. (1) They begin insidiously and progress without symptoms for a long time. It is often a matter of from 2 to 20 years of insidious progression before evidences of subjective distress or objective physical findings call attention to the fact that something is wrong. Therefore, any effective preventive efforts must begin relatively early in life. (2) Their causation is largely from within rather than from obvious external sources, such as infection. They arise as a result of a summation of many superimposed insults, and in no two instances are the causative factors necessarily identical. This multiple and obscure origin of the causative factors is also a significant obstacle to effective curative or preventive treatment. (3) These disorders are frequently multiple in the same individual, and rather than conferring an immunity or protection they tend to increase the vulnerability to related diseases. (4) The degenerative diseases are characteristically progressive, usually leading to a long period of disability before they destroy.

Geriatric medicine, being concerned with the health as well as the diseases of aging and aged, is much interested in the changes which take place in normal aging people. Because of the insidious and subtle development of either normal or abnormal aging, changes in function must be searched for. The person who waits until they are obvious cannot expect much in the way of correction. The attitude of clinical geriatrics must be one of anticipation and prevention of difficulties rather than hope for dramatic cure. With wiser living, many of the disabling disorders can be so markedly retarded that not only is life extended, but the enjoyment of life is enhanced greatly. The objective of geriatrics is not merely to prolong life, but to permit continued vigour and usefulness. There can be no sharp line of distinction between health and disease, since health is always relative. But disease does not necessarily imply imminent disaster. It is possible to control and retard the progression of many of the depreciations and disorders of age if measures are instituted early enough. There is, unfortunately, an immense lag between medical knowledge and application.

Biology of Senescence.—The second major division of gerontology is concerned with the study of the biology of senescence. Knowledge of the phenomena of involution is meagre in contrast to what has been learned concerning the biologic processes of growth or evolution. Aging, and therefore senescence, is part of living. It is continuous from the moment of conception until death, although the rate of change is variable and not symmetrical. To study the changes of aging is to study the mechanisms of life, for aging is essentially the element of time in living.

As man is composed of millions of minute cells, it is natural to attempt study of the processes of aging in these individual units. This, however, is almost impossible because cells do not age in the generally accepted sense. Instead, once they are mature and fully differentiated, they divide and make two young daughter cells. With the exception of a few cells of the brain, none of man's tissues are as old as he is; the tissue cells are being replaced constantly. The fact that cells do not age has been demonstrated dramatically by tissue culture studies. The classical experiment of Alexis Carrel continued a culture of chicken embryo heart cells for 34 years (1912–46). At the end of this time, these cells were growing with the same vigour and showed no evidence of depreciation over a period several times longer than the normal life span of a chicken. Carrel concluded that in an optimum environment living cells can be immortal. It is notable, however, that in order to continue the survival of these cells, the nutrient media upon which they grew had to be replaced at least every 48 hr. or the tissue cultures deteriorated quickly.

Thus the focus of attention in studies of the biology of aging shifted from the cells to the nonliving, but essential, matrix or internal environment in which they live and function. It is in this portion of the body that the changes of aging are first manifest structurally and are biologically significant. The intercellular portion of the organism includes the blood, lymph, tissue juices, fibres of connective tissue and the matrix of bone and the like. Gradual thickening and increased density of the fibrous supporting matrix occur, impeding the transport of nutrients to the cells and of metabolic debris from the tissues. It is here that we must search for an understanding of the processes of aging and hope to find ways and means of retarding depreciation.

As the rate of aging varies between different species of animals and between different individuals of the same species as well as between different parts of the same individual, age in the biological sense is entirely different from chronological age. For example, a 300-day-old white rat is approximately the biologic equivalent in age of a 30-year-old man. Some men age more slowly than the average. Others are biologically older than their years would indicate. Assessment of biologic age is an extremely difficult problem by no means solved; no single criterion will suffice. The biologic age of an individual is the mean of the total ages of various structures and functions.

Sociologic Gerontology.—Within the first half of the 20th century the average duration of human life in the U.S. increased by about 20 years (*see* above). This prolongation was accomplished largely by reduction in deaths of infants and children, but even for those over 50 years of age there was some improvement in life expectancy. In 1950, women of 50 years of age had a further expectancy of 24 years and men of 50 an expectancy of 21 years more of life. The increasing longevity is world-wide, but not uniform among the various nations. In 1942, Australia and New Zealand led the list with an average life expectancy of 65 years. In the same year, the United States population had an average expectancy of 64.82 years, Great Britain 62, Italy 55, Japan 48, and India 27.

Even more significant from the sociologic viewpoint is the fact that the percentage of various age groups of the population was changing greatly. In the United States in 1900, 17.8% of the population were 45 years old or older. By 1950, this group constituted 28.4%. The median age of the people increased from 26.4 in 1930 to 30.1 in 1950, an increase of 3.7 years in two decades. The sociologic implications of such population changes are immense and complex; such shifts were without precedent in the known history of the world. Here it is possible only to enumerate briefly some of the more obvious and urgent problems.

The problem of employment and utilization of the increasing millions of the elderly involves many collateral questions, such as retirement pensions, housing, job analysis and evaluation of individual capacities. Either an economic system will have to find employment for these individuals suitable to their peculiar capacities or the younger age group must carry the burden of their support in addition to supporting and educating children. The care of relatively helpless senile individuals and those prematurely disabled by chronic diseases was in urgent need of study and attention by the early 1950s. Eighty per cent of deaths resulted from the chronic progressive disorders characteristic of later years. Millions were being partially or totally disabled for long periods. In the United States the rate of admission to hospitals for mental illness of patients suffering from arteriosclerotic dementia, a consequence of aging, increased 536% from 1910 to 1936. In 1949, 32% of first admissions into state hospitals for mental illness were of patients 60 years old or older. The cost of these chronic disorders was truly incalculable.

Other sociologic problems include the effect of an aging population upon the political picture. The aged affect the structure of the family. Culture is affected by these shifts, and the character and duration of education is in need of revision because of longevity; adult education is taking on entirely new significance.

The most hopeful aspect of gerontology was that with enhancing survival, the world populations would become more and more mature. Although long years of life do not guarantee emotional maturation, they are requisite for its development. When men live long enough to have time enough to think, hope for ultimate peace does not seem quite so remote and impossible of fulfilment.

See LONGEVITY; LIFE EXPECTANCY; DEATH RATE.

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(E. J. Sz.)

GEROUSIA, the council of elders at Sparta, corresponding in some of its functions to the Athenian Boulē. In historical times it numbered 28 members, to whom were added *ex officio* the two kings and, later, the five ephors. Candidates must have passed their 60th year; *i.e.*, they must no longer be liable to military service. Vacancies were filled by the Apella; once elected, the *gerontes* held office for life and were irresponsible. The council prepared the business which was to be submitted to the Apella and was empowered to set aside, in conjunction with the kings, any "crooked" decision of the people.

Together with the kings and ephors it formed the supreme executive committee of the state, and it exercised also a considerable criminal and political jurisdiction, including the trial of kings; its competence extended to the infliction of a sentence of exile or even of death.

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GEROW, LEONARD TOWNSEND (1888–), U.S. army officer, commander of the 5th corps and of the 15th army during World War II, was born in Petersburg, Va., July 13, 1888. He was graduated from Virginia Military institute, Lexington, and commissioned second lieutenant of infantry in 1911, serving in France during World War I. Gerow was chief of the war plans division, U.S. war department, 1940–42. In Feb. 1942 he was assigned to command the 29th division, which he took to the United Kingdom in October of that year. He was appointed to command the 5th corps in July 1943, and continued in command during operations in France, Belgium, Luxembourg and Germany from the landings on Omaha beach, Normandy, on June 6, 1944, to the successful conclusion of the battle of the Bulge in Jan. 1945. Gerow then assumed command of the 15th army for the remainder of the war. He was commandant of the Command and General Staff school, Ft. Leavenworth, 1945–47, and commanding general, 2nd army, 1948–50, when he retired as lieutenant general. He later was made a full general. (F. C. PE.)

GERRHA, ancient port on the Arabian coast of the Persian gulf inhabited by Chaldean exiles from Babylon (Strabo, Bk. xvi., and Pliny, *Hist. Nat.* vi. 32). Various identifications of the site have been suggested (Qatif, Kuwait, Salwa), but the ancient name is unquestionably preserved in that of modern 'Uqair (pronounced Ujair, Ojer) as suggested by Philby. Cheesman in 1923 discovered ruins here which tend to confirm this conjecture though the matter still requires further examination. The classical story that the houses here were built of rock-salt is difficult to understand. 'Uqair is now one of the chief ports of Hasa with a growing trade. It has an excellent deep-water harbour with a very difficult approach from Bahrein, where goods are trans-shipped from ocean steamers to sailing boats.

GERRY, ELBRIDGE (1744–1814), American statesman, was born in Marblehead (Mass.), July 17, 1744, the son of Thomas Gerry, a prosperous Marblehead merchant. He graduated at Harvard in 1762 and entered his father's business. In 1772 and 1773 he was a member of the Massachusetts general court, and in 1773 he served on the committee of correspondence which became one of the great instruments of intercolonial resistance. In 1774–75 he was a member of the Massachusetts Provincial Congress. The passage of a bill proposed by him to arm and equip ships to prey upon British commerce (Nov. 1775) was, according to his biographer, Austin, "the first actual avowal of offensive hostility against the mother country which is to be found in the annals of the Revolution." From 1776 to 1781 Gerry was a member of the Continental Congress, where he early advocated independence, and was one of those who signed the Declaration after its formal signing on Aug. 2, 1776, at which time he was absent.

Gerry was again a member of Congress in 1783–85 and in 1787 was a delegate to the Constitutional Convention. He served as an Anti-Federalist in the National House of Representatives in 1789–93. In 1797 he was sent by President John Adams, with John Marshall and Charles Cotesworth Pinckney, on a mission to France to obtain from the government of the Directory a treaty embodying a settlement of several long-standing disputes. The discourteous and underhand treatment of this embassy by Talleyrand and his agents resulted in the speedy retirement of Marshall and Pinckney. The episode is known in American history as the "X Y Z Affair." Gerry remained in Paris for some time in the vain hope that Talleyrand might offer to a known friend of France terms that had been refused to envoys whose anti-French views were more than suspected. This action of Gerry's brought down upon him from Federalist partisans a storm of abuse and censure, from which he never wholly cleared himself.

In 1810–12 he was governor of Massachusetts. His administration was especially notable for the enactment of a law by which the State was divided into new senatorial districts in such a manner as to consolidate the Federalist vote in a few districts, thus giving the Democratic-Republicans an undue advantage. The outline of one of these districts, which was thought to resemble a salamander, gave rise in 1812, through a popular application of the governor's name. to the term "Gerrymander" (*q.v.*). In 1812 Gerry, who was an ardent advocate of the war with Great Britain, was elected vice-president of the U.S., on the ticket with James Madison. He died in office at Washington, D.C., Nov. 23, 1814.

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GERRYMANDER, an American expression which has taken root in the English language, meaning to arrange election districts so as to give an unfair advantage to the party in power by means of a redistribution act, or to manipulate constituencies generally. The word is derived from the name of the U.S. politician Elbridge Gerry (*q.v.*), who was governor of Massachusetts in 1812 at the time his party in the legislature redistricted the state so as to concentrate its strength and dissipate the strength of its opponents. The appearance of one electoral district on the map resembled a salamander. It was represented in cartoons as a winged monstrosity with the label "Gerrymander." It was, however, only a new name for an old practice. In the American colonial period political advantage was often obtained by changing county lines.

See L. F. Schmeckebier, *Congressional Apportionment* (1941); E. C. Griffith, *The Rise and Development of the Gerrymander* (1907).

GERS, a *de'partement* of southwestern France, composed of the whole or parts of certain districts of Gascony; viz, Armagnac, Astarac, Fezensac, Pardiac, Pays de Gaure, Lomagne, Comminges, Condomois and of a small part of Agenais. It is bounded N. by the *de'partement* of Lot-et-Garonne, N.E. by Tarn-et-Garonne, E. and S.E. by Haute-Garonne, S. by Hautes-Pyrénées, S.W. by Basses-Pyrénées and W. by Landes. Pop. (1954) 185,111. Area, 2,429 sq.mi.

The *de'partement* consists of a plateau sloping from a height of 1,100 ft. at the base of the Pyrenees to the Garonne beyond the northern boundary. It is drained by the Save, Gimonne, Arrats, Gers and Baïse diverging fanwise to the Garonne, and by the Arros, Midouze and Douze feeding the Adour in the west. Gers is primarily agricultural. The valleys are fertile, especially in the southwest, and the grain produced is more than enough for local needs. Wheat, maize and oats are the chief cereals. Two-thirds of the wine produced is made into brandy, known by the name of Armagnac. The natural pastures are supplemented chiefly by crops of sainfoin and clover; horses, cattle, sheep and swine are reared in large numbers; turkeys, geese and other poultry are abundant. There are mineral springs at Aurenson, Barbotan and several other places in the department. There are flour mills and tanneries; faïence and cream of tartar are made, and feathers cleaned and prepared. Gers is divided into the *arrondissements* of Auch, Mirande, Condom.

GERSHOM BEN JUDAH (*c.* 950–*c.* 1028), known as RABBENU GERSHOM, and "the Light of the Exile," was the greatest rabbinical authority of the Jews of western Europe. As the brilliant teacher of the rabbinic academy at Mainz in Germany, he was one of the first to transplant the talmudic learning of Babylonia and Palestine to the schools of the west. A consummate scholar, he attracted students from all parts of Europe, and was the mentor, guide and appellate judge of the autonomous and democratically governed Jewish communities of Germany and France, helping to mold their political. social and co-operative institutions. At synods of community leaders he proposed and guided the adoption of legal enactments that shaped the organized life of European Jewry. These enactments prohibited polygamy and limited the husband's right of arbitrary divorce, strengthened the jurisdiction of courts of law and extended the use of the principle of majority rule in community legislation. He wrote many *responsa,* worked on a critical text of the Talmud and on the Masora, and transmitted to his students an extensive oral commentary on the entire Talmud. All rabbinic scholars of Germany and France of the subsequent generations considered themselves the students of his students, and followed faithfully his teachings, his customs and his legal enactments. (I. A. A.)

GERSHWIN, GEORGE (1898–1937), U.S. composer, prominently identified with music of the jazz type, was born in Brooklyn. N.Y., on Sept. 26, 1898. Originally named Jacob Gershvin, he studied piano with Charles Hambitzer and harmony with Edward Kilenyi. and from an early age worked for New York music publishing firms and also wrote popular songs.

Although he had already written the scores for a number of musical comedies. as well as various popular songs, including the highly successful *Swanee* (1919), it was his *Rhapsody in Blue,* an elaborate composition for piano and orchestra in jazz style, that first drew serious attention to the young composer. First performed by the Paul Whiteman orchestra in Aeolian hall, New York city, on Feb. 12, 1924, it became one of his best known works. In 1931 he wrote the score for a musical satire, *Of Thee I Sing* (first musical comedy to be awarded the Pulitzer prize in drama). His folk opera, *Porgy and Bess* (1935), was written in collaboration with his brother Ira Gershwin (1896–), who wrote the lyrics for many of his compositions. Based on the novel *Porgy* (1925) by DuBose Heyward, the opera depicts life on "Catfish Row," a Negro tenement district in a southern U.S. city during the early 20th century. By the second half of the 20th century it had been produced many times in the United States and other countries, including the U.S.S.R. and countries in Latin America and the near east.

Musical comedy scores by George Gershwin include *La, La Lucille* (1919); the *George White Scandals* (1920–24); *Lady Be Good!* (1924); *Song of the Flame* (1925); *Tell Me More* (1925); *Oh Kay* (1926); *Treasure Girl* (1928); *Show Girl* (1929); *Girl Crazy* (1930); and *Let 'Em Eat Cake* (1933).

Among his other compositions were a one-act opera, *Blue Monday* (later called *135th Street)* (1922); the symphonic tone poem, *An American in Paris* (1928); *Piano Concerto in F* (1925); a second *Rhapsody in Blue* (1931); *Cuban Overture* (1932); *Variations on I Got Rhythm* (1934); and a suite of jazz preludes for the piano in 1936. He died in Hollywood, Calif., on July 11, 1937, and was buried at Hastings-on-Hudson, N.Y.

GERSON, JEAN DE (1363–1429), French theologian, chancellor of the University of Paris and a leader of the conciliar movement for church reform, called *doctor christianissmus.* He was born at Gerson (from which his surname is derived) near Reims on Dec. 13. 1363; the family name was Charlier. He was educated at the College of Navarre in Paris, studying theology under Pierre d'Ailly (*q.v.*), who remained his life-long friend. At the university he was elected procurator for the French "nation" in 1383, and in 1387 was sent with the chancellor and others to Clement VII to procure the condemnation of Jean de Montson, a Dominican who had rejected the Immaculate Conception. When D'Ailly was made bishop of Puy in 1395, Gerson was elected chancellor of the university, then at the height of its fame and attracting students from all the lands of Christendom.

In theology Gerson was a follower of the nominalist William Ockham (*see* also NOMINALISM). Impatient with the merely verbal subtleties of decadent scholasticism, he turned away from the whole medieval tradition that had emphasized the value of reason in the discernment of divine truth. For Gerson the good or evil of an action depended solely on the will of God, which human reason could not fathom. He urged students to apply themselves to the study of the Bible and the church fathers instead of indulging in fine-spun arguments on points of speculative theology. It seemed an attractive program to many, but the rejection of human reason as a key to theological truth could as easily lead to religious skepticism as to the purer and simpler faith at which Gerson aimed. His own theological writing was influenced by the mystical tradition of the Victorines and of St. Bonaventura. He had a great reputation as a preacher and a moralist; one of his moral treatises u-as a work warning university students against the obscenity and skepticism of the then very popular *Roman de la rose.* Some scholars have credited Gerson with the authorship of the famous mystical treatise the *Imitation* of *Christ,* but it is most probably not his work.

Gerson is especially remembered for his part in healing the Great Schism which began in 1378 when two rival candidates, Urban VI and Clement VII, disputed the papal throne. *(See* also PAPACY: *The Great Schisnz, 1378–1417.*) At first his attitude was moderate. He deprecated the views of zealots on both sides who held that all members of the opposing party were in a state of excommunication and lacked valid sacraments; but as the schism grew more embittered Gerson came to propound really radical doctrines on church government as the only means of restoring unity. He taught that although the papacy was divinely established as the head of the church, nevertheless the authority of the whole universal church was greater than that of any individual pope. The practical consequence was that a general council could judge and depose a pope. Gerson supported the Council of Pisa (1409) which claimed to depose the two existing "popes" and elect a third. After it became apparent that this had merely produced three "popes" instead of two, the Council of Constance assembled in 1415.

Gerson attended this council and played a leading part in its deliberations (including those that led to the condemnation of John Huss). His views on conciliar authority were accepted, and the schism mas ended by the forced resignation of two "popes" and the deposition of the third. Gerson, however, had one major defeat at the council. In 1408 he had taken the lead in condemning a work of the theologian Jean Petit, who had defended the assassination of the duc d'Orléans by partisans of the duke of Burgundy as justifiable tyrannicide. The case of Jean Petit was reconsidered at Constance, but the council refused to condemn him explicitly. When Gerson left Constance in 1418 he was prevented from returning to France by the threats of the duke of Burgundy, and he went into exile in Germany.

In 1419, on the death of the duke, he returned to France and settled at Lyons. Gerson had always showed a tenderness toward small children, and he spent his last years teaching children and writing hymns and works of devotion. He died with a reputation for exemplary piety on July 12, 1429.

The best editions of his collected works, those of Paris (4 vol., 1606) and Antwerp (5 vol., 1706), are both very imperfect.

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GERSONIDES (LEVI BEN GERSHON) (1288–*c.* 1344), known from his initials, with the title Rabbi, as RALBAG and also called LEO DE BAGNOLAS, LEO HEBRAEUS or MAESTRO LEON, Jewish mathematician, astronomer, philosopher and biblical commentator, was born at Bagnols in Languedoc, of a family distinguished for piety and learning. He lived at Avignon (where the rule of the Angevin counts of Provence and later of the popes was comparatively tolerant), at Orange and at Perpignan. His *De Numeris harmonicis* (written in Hebrew but extant only in the Latin version) was composed at the instance of Philip of Vitry, bishop of Meaux. Other mathematical works of his include a treatise called *De Sinibus, chordis et arcubus,* one of the first European writings on trigonometry. He invented (or improved) an astronomical instrument. which he called Jacob's staff *(baculus Jacob),* for measuring heights and used the camera obscura. These inventions enabled him to correct the astronomical tables of the time. His importance as an astronomer is undisputed but cannot easily be assessed, as the astronomical part of his philosophical work *Milhamot Adonai* ("The Wars of the Lord"; partial Ger. trans. by B. Kellermann, *Die Kämpfe Gottes,* 2 vol., 1914–16) was unfortunately omitted both from the *editio princeps* (1560) and from the second edition (1868), although it had been translated into Latin in 1342. As a philosopher Gersonides develops the synthesis of Aristotelianism and Judaism which Maimonides (*q.v.*) had effected. On account of his familiarity with Averroes' commentaries, he is more firmly grounded in Aristotle than his illustrious predecessor. He himself wrote supercommentaries on the six books of the Aristotelian *Organon* and on Porphyry's *Isagoge,* some of which were printed, with the commentaries of Averroes, in the Latin edition of Aristotle (1550). His pronounced rationalism is in evidence also in his commentaries on the Bible. His orthodox contemporaries mockingly called his main work "Wars *against* the Lord." *See* also JEWISH PHILOSOPHY. (A. AN.)

GERSOPPA, FALLS OF, a cataract on the Sharavati river in Kanara district, Bombay, India. 53 mi. N.W. of Shimoga. The river there crosses the main scarp of the Western Ghats, having cut its headwaters far back beyond the crest. It descends in four cascades one of which, the most striking in all India, has a vertical plunge of 830 ft. The Mahatma Gandhi power station (projected output, 120,000 kw.) utilizes the fall. The power is mainly consumed in the factories and mines of Mysore. Near the village are extensive ruins of Nargabestikere, the former capital of the Jain chiefs of Gersoppa. The area was formerly celebrated for its pepper. Some timber is extracted from its forests. (T. HER.)

GERSTÄCKER, FRIEDRICH (1816–1872), German novelist and writer of travels, was born at Hamburg on May 10, 1816, the son of Friedrich Gerstacker, a celebrated opera singer. In 1837 he went to America and traveled widely in the United States, supporting himself by whatever work came to hand. A diary describing his adventures in America had been published in Germany in the *Rosen,* and he returned to Germany in 1843 to find himself famous as an author. Gerstacker published these popular sketches in 1844 under the title *Streif- und Jagdziige durch die Vereinigten Staaten Nordamerikas.* In 1845 his first novel, *Die Regulatoren in Arkansas,* appeared, and thereafter his literary productions continued uninterruptedly. From 1849 to 1852 he traveled around the world, visiting numerous countries including South America, to which he returned in 1860 to report on the possibilities for German emigration to that country. He recorded his observations in *Achtzehn Monate in Sudamerika* (1862). He continued to travel in many countries and published a number of novels descriptive of the scenes he had visited. He died at Brunswick on May 31, 1872. His works, which dealt with the great world hitherto hidden from the narrow "parochialism" of German life, were immensely popular. Many of his books were translated into other languages, notably English, and became widely known on both sides of the Atlantic. His best works, from a literary point of view, are, besides the above-mentioned *Regulatoren,* his *Flusspiraten des Mississippi* (1848) ; *Tahiti* (1854) ; *Die beiden Sträflinge* (1857); *Aus dem Matrosenleben* (1857); and *Blau Wasser* (1858).

GERSTENBERG, HEINRICH WILHELM VON (1737–1823), German poet, critic and theorist of the *Sturm und Drang* movement. He was born at Tondern, Schleswig, Jan. 3, 1737. After studying law at Jena he entered the Danish military service and took part in the Russian campaign of 1762. He spent the next 12 years in Copenhagen, where he was a friend of the poet Klopstock. From 1775 to 1783 Gerstenberg was official Danish representative at Liibeck, and in 1786 received a judicial appointment at Altona, where he died, Nov. 1, 1823. The text of his cantata *Ariadne auf Naxos* (1767) was set to music by J. A. Scheibe and J. C. Bach (these scores were lost) and later adapted for a famous duodrama by Georg Benda. Gerstenberg also translated Beaumont and Fletcher's *Maid's Tragedy* (1765), and himself wrote a gruesome but powerful tragedy, *Ugolino* (1768). His chief service to the new literary movement was his *Briefe iiber Merkwürdigkeiten der Literatur* (3 vol., 1766–67), in which the critical principles of the *Sturm und* Drang—and especially its enthusiasm for Shakespeare—were first definitely formulated.

As a musician Gerstenberg, a pupil of Scheibe, formulated theories on instrumental and dramatic music opposed to those of Jean Jacques Rousseau.

BIBLIOGRAPHY.—Gerstenberg's *Vermischte Schriften* appeared in 3 vol. (1815–16). The *Briefe Lber Merkwurdigkeiten der Literatur* were republished by A. von Weilen (1888–89). *See* also *A. M*. Wagner, H. *W. von Gerstenberg und der Sturm und Drang*, 2 vol. (1920); J. W. Eaton, *Gerstenberg and Lessing* (1938). For Gerstenberg's musical influence *see* A. Schering, "C.P.E. Bach und das 'redende Prinzip' in der Musik," in *Jahrbuch der Musikbibliothek Peters* (1939).

GERVAIS, (FRANÇOIS LOUIS) PAUL (1816–1879), French paleontologist and zoologist most noted for his work on fossil vertebrates, was born on Sept. 26, 1816, in Paris, where he obtained doctorates in science and medicine. He studied paleontology as assistant to H. M. D. de Blainville, Cuvier's successor as professor of comparative anatomy in the Museum of Natural History. In 1845 Gervais was appointed to the chair of zoology and comparative anatomy in the faculty of sciences at Montpellier of which he was appointed dean in 1856. He returned to Paris in 1865 with professorships in anatomy, comparative physiology and geology at the Sorbonne. Three years later he achieved his ambition of succeeding to the chair of Cuvier and Blainville in the museum. Most important of Gervais' earlier works were his *Zoologie et pale'ontologie françaises* (1848–52), essentially a continuation of Cuvier's and Blainville's publications on the same subject. Among his major later works were *Zoologie et pale'ontologie générales* (1867–75) and uith Van Beneden, a series of important studies on whales—*Ostéographie des cétacés vivants et fossiles* (1868 *et seq.)*. He also published numerous papers on vertebrates brought back by French expeditions abroad, and was the author of such general zoological works as *Histoire naturelle des mammifères* (1855) and, with Van Beneden, *Zoologie médicale* (1859). Gervais died in Paris on Feb. 10, 1879. (A. S. RR.)

GERVASE OF CANTERBURY (d. c. 1210), English monk and chronicler, entered the house of Christchurch, Canterbury, at an early age. He made his profession and received holy orders in 1163, and seems to have resided almost continuously at Canterbury from the time of his admission. The only office which we know him to have held is that of sacrist, which he received after 1190 and laid down before 1197. About 1188 he began the compilation of his *Chronica*. Beginning with the accession of Stephen he continued his narrative to the death of Richard I. Up to 1188 he relies almost entirely upon extant sources; but from that date onward is usually an independent authority. A second history, the *Gesta Regum,* is planned on a smaller scale and traces the fortunes of Britain from the days of Brutus to the year 1209. The latter part of this work, covering the years 1199–1209, is the only part of the *Gesta* which deserves much attention.

See the introductions and notes in W. Stubbs's edition of the *Historical Works* of *Gervase of Canterbury* (Rolls Ser., No. 73, 2 vols., 1879–1880).

GERVASE OF TILBURY (*fl.* 1211), Anglo-Latin writer of the late 12th and early 13th centuries, was a kinsman and schoolfellow of Patrick, earl of Salisbury, but lived the life of a scholarly adventurer, wandering from land to land in search of patrons. Before 1177 he was a student and teacher of law at Bologna; his first employer of royal rank was Henry fitz Henry, the young king of England (d. 1183), for whom Gervase wrote a jestbook which is no longer extant. Subsequently Gervase was a clerk in the household of William of Champagne, cardinal archbishop of Reims (d. 1202), and before 1189 he entered the service of William II of Sicily, who had married Joanna, the sister of Henry fitz Henry. Some time after 1198, he found employment under the emperor Otto IV. Though a clerk in orders Gervase became marshal of the kingdom of Arles, and married an heiress of good family. For the delectation of the emperor he wrote, about 1211, his *Otia Imperialia* in three parts. It is a farrago of history, geography, folklore and political theory—one of those books of table talk in which the literature of the age abounded. The most interesting of his dissertations are contained in the second part of the *Otia,* where he discusses, among other topics, the geography and history of England.

See the *Otia Imperialia* in G. Leibnitz's *Scriptores rerum Brunsvicensium,* vols. i and ii (Hanover, 1707); extracts in J. Stevenson's edition of *Coggeshall* (Rolls series, No. 66, 1875). Of modern accounts the best are those by W. Stubhs in his edition of *Gervase of Canterbury,* vol. i introd. (Rolls series, 2 vols., No. 73, 1879), and by R. Pauli in *Nachrichten der Gesellschaft der Wissenschaften zu Gottingen* (1882). In the older biographies the *Dialogus de scaccario* of Richard Fitz Neal (*q.v.*) is wrongly attributed to Gervase.

GERVINUS, GEORG GOTTFRIED (1805–1871), German historian and Shakespearian commentator, was born on May 20, 1805, at Darmstadt, and died on March 18, 1871, at Heidelberg. In 1835 he became professor of history at Gottingen. His *Geschichte der poetischen Nationallitteratur der Deutschen,* 5 vol. (1835–42), subsequently entitled *Geschichte der deutschen Dichtung,* 5th ed. by K. Bartsch (1871–74), was the first comprehensive and scholarly history of German literature. In 1837 he was one of the seven Gottingen professors dismissed for their protest against the violation of the constitution by the king of Hanover. After some years in Heidelberg, Darmstadt and Rome, Gervinus settled in Heidelberg, where in 1844 he was appointed honorary professor. In the following year he espoused the cause of the German Catholics, hoping for a union of all the Christian confessions and the establishment of a national church. In 1846 he came forward as a champion of the Schleswig-Holsteiners. With other patriotic scholars he founded the *Deutsche Zeitung,* one of the best-written liberal journals published in Germany in the 19th century. Between 1849 and 1852 Gervinus published his important work. *Shakespeare,* in 4 vol. (4th ed., 2 vol. [1872]; Eng. trans, by F. E. Bunnett [1863] new ed. [1877]). During this period he also sketched his *Geschichte des neunzehnten Jahrhunderts,* 8 vol. (1854–60). His parallel study of Handel and Shakespeare appeared in 1868.

See M. Rychner, *G. G. Gervinus. Ein Kapitel über Literaturgeschichte* (1922) (A. Gs)

GESENIUS, HEINRICH FRIEDRICH WILHELM (1786–1842), German orientalist and biblical critic, was born at Nordhausen. Hanover, on Feb. 3, 1786, and was educated at Helmstadt and at Gottingen. In 1811 he became professor of theology at Halle, where he remained until his death on Oct. 23, 1842. To Gesenius, uho was an exceptionally popular teacher, belongs in a large measure the credit of having freed Semitic philology from theological and religious prepossession. and of inaugurating the strictly scientific (and comparative) method

His chief work, the *Hebräisches u. Chaldaisches Handwörterbuch* (1810–12), has passed through several editions (Eng. ed.: Francis Brown, S. R. Driver and Charles A. Briggs, *A Hebrew and English Lexicon of the Old Testament,* 1907).

GESNER, ABRAHAM (1797–1864), Canadian geologist and inventor, noted for his early processes for distilling kerosene, was born in Nova Scotia on May 2, 1797. He qualified as a doctor of medicine in London in 1827. Returning to the dominion, he published in 1836 *Remarks on the Geology and Mineralogy of Nova Scotia,* and in 1843 brought before the Geological society of London "A Geological Map of Nova Scotia, With an Accompanying Memoir." In 1849 he issued a volume on the industrial resources of the country. He dealt also with the geology and mineralogy of New Brunswick and Prince Edaard Island. In 1854 Gesner established a New York company at Newton Creek. L.I., to manufacture kerosene from petroleum Devoting himself later to the economic side of geology in various parts of North America he published in 1861 *A Practical Treatise on Coal, Petroleum and Other Distilled Oils,* which was translated into a number of languages. He died at Halifax, N.S., on April 29, 1864.

GESNER, JOHANN MATTHIAS (1691–1761), German classical scholar and schoolmaster, was born at Roth, near Ansbacb, and died at Gottingen, where he had become professor of rhetoric. His special merit lies in the attention he devoted to the explanation and illustration of the subject matter of the classical authors.

His principal works are editions of the *Scriptores rei rusticae,* of Quintilian, Claudian, Pliny the Younger, Horace, and the Orphic poems (published after his death); *Primae lineae isagoges in eruditionem universalem* (1756); an edition of B. Faber's *Thesaurus erudi-*

tionis scholasticae (1726), continued under title *Novus linquae et eruditionis Romanae thesaurus* (1749); *Opuscula minora varii argumenti* (1743–45); *Thesaurus epistolicus Gesnerianus,* ed. by Klotz (1768–70); *Index etymologicus latinitatis* (1749). *See* C. H. Pöhnert, *J. M. Gesner und sein Verhältnis zum Philanthropinismus und Neuhumanismus* (1898); and Sandys, *Hist. of Class. Schol.* iii, 5–9 (1908).

GESNER, KONRAD VON (1516–1565), German-Swiss writer and naturalist, called by Cuvier "the German Pliny," was born at Zurich. He took his M.D. at Basle in 1541, and then practised at Zurich, where he became lecturer in physics at the Carolinum. He died of plague on Dec. 13, 1565.

To his contemporaries he was best known as a botanist, though his botanical mss. were not published till long after his death (at Nuernberg, 1751–71), he himself issuing only the *Enchiridion historiae plantarum* (1541) and the *Catalogus plantarum* (1542) in four tongues. In 1545 he published his remarkable *Bibliotheca universalis* (ed. by J. Simler, 1574), a catalogue (in Latin, Greek and Hebrew) of all past writers with the titles of their works, etc. A second part, under the title of *Pandeclarium sive partitionum universalium Conradi Gesneri Ligurini libri xxi,* appeared in 1548; only 19 books being then concluded. The 21st book, a theological encyclopaedia, was published in 1549, but the 20th, intended to include his medical work. was never finished. His great zoological work, *Historia animalium,* appeared in 4 vol. (quadrupeds, birds, fishes) folio, 1551–58, at Zurich, a fifth (snakes) being issued in 1587 (there was a German translation entitled *Thierbuch,* of the first 4 vol., Zurich, 1563); this work was the starting point of modern zoology. Not content with such vast works, Gesner put forth in 1555 his book entitled *Mithridates de differentiislinguis,* an account of about 130 known languages, with the Lord's Prayer in 22 tongues, while in 1556 appeared his edition of the works of Aelian. To nonscientific readers, Gesner is probably best known for his love of mountains (below the snow line) and for his many excursions among them, undertaken partly as a botanist, but also for the sake of mere exercise and enjoyment of the beauties of nature. In 1541 he prefixed to a singular little work of his (*Libellus de lacte et operibus lactariis*) a letter addressed to his friend, J. Vogel, of Glarus, as to the wonders to be found among the mountains, declaring his love for them, and his firm resolve to climb at least one mountain every year, not only to collect flowers, but in order to exercise his body.

In 1555 Gesner issued his narrative (*Descriptio Montis Fracti sive Montis Pilati*) of his excursion to the Gnepfstein (6,299 ft.), the lowest point in the Pilatus chain, and therein explains at length how each of the senses of man is refreshed in the course of a mountain excursion.

See Lives by J. Hanhart (Winterthur, 1824) and J. Simler (Zürich, 1566); *see* also Lebert's *Gesner als Arzt* (Ziirich, 1854). A part of his unpublished writing, ed. by Schmiedel, was published at Nuernberg in 1753.

GESNERIACEAE, a family of dicotyledonous plants, consisting of herbs, vines and shrubs, chiefly tropical, a few found in temperate regions. About 100 genera are recognized, with in excess of 1,300 species, the tropical genera being sharply limited geographically as between the tropics of the two hemispheres. Large genera in the old world are *Cyrtandra, Didymocarpus* and *Aeschynanthes,* and in the new world *Columnea, Kohleria, Corytholoma* and *Gesneria.* Many species representing various genera are cultivated for ornamental purposes because of their very showy flowers, those common in the United States being representatives of *Sinningia,* popularly known as *Gloxinia.*

(E. D. ML.)

GESSLER, OTTO KARL (1875–1955), German statesman, was born at Ludwigsburg on Feb. 6. 1875, and entered the legal department in Bavaria in 1905. He was burgomaster of Regensburg in 1911, and of Nuremberg in 1914–19. He was a member of the German Democratic party and was minister of reconstruction in the reich from 1919 to 1920, and from 1920 to 1928 minister of defense. After the entry of German troops into the demilitarized zone in 1920. and the occupation by French troops of Frankfurt. Darmstadt and Hamburg, Gen. Gustav Noske resigned, and Gessler, following him, began his tenure of office as minister of war, faced with the necessity of allaying the suspicion of the Allies. He had as his colleague Gen. Hans von Seeckt and in spite of difficulties succeeded in reorganizing the *Reichswehr.* Gessler became increasingly unpopular with the parties of the left. and the Social Democrats asserted that relations were maintained between the patriotic unions and the *Reichswehr.* He resigned on Jan. 12, 1928. Gessler died March 24, 1955, in Lindenberg, Ger.

GESSNER, SALOMON (1730–1788), Swiss poet, painter and etcher, was born at Zürich on April 1, 1730, and died there on March 2, 1788. The first of his writings to attract attention was his *Lied eines Schweizers an sein bewaffnetes Madchen* (1751); but most of his other work consisted of "Pastoral Idylls" in a rhythmical prose. *Der Tod Abels* (1758) was translated into most European languages. including Welsh. The English version ran through about a score of editions, was appreciated by Sir Walter Scott, Lord Byron and William Wordsworth. and is mentioned by Thomas Hood in his "Dream of Eugene Aram."

This extraordinary popularity, not very intelligible now, was apparently due to the fact that he was one of the earliest poets to combine keen observation and love of nature, profound religious feeling and strong patriotism. He translated some of Pope's *Pastorals.*

Gessner's etchings are better than his somewhat conventional landscapes.

The final collected edition of his works was published at Zürich in 1841. Lives of him were written by J. J. Hottinger (1796) and H. Wolfflen (1884). *See* also his *Briefwechsel mit seinem Sohn* (1861) and Bertha Reed, *The Influence of Salomon Gessner on English Literature* (1905).

GESSO, an Italian word (Lat. *gypsum*) for plaster of Paris, especially when used as a ground for painting, or for modelling or sculpture. (*See* SCULPTURE TECHNIQUE.)

GESTALT PSYCHOLOGY: *see* PSYCHOLOGY, HISTORY OF.

GESTA ROMANORUM, a Latin collection of anecdotes and tales, probably compiled about the end of the 13th century or the beginning of the 14th; one of the most popular books of the time, and the source, directly or indirectly, of later literature, in Chaucer, Gower, Shakespeare and others. Of its authorship nothing certain is known; but it was evidently intended as a manual for preachers.

The name, *Deeds of the Romans,* is only partially appropriate to the collection, since it comprises fragments of very various origin, oriental and European. The style is barbarous, and the narrative ability of the compiler seems to vary with his source; but he has managed to bring together a considerable variety of excellent material. He gives us, for example, the germ of the romance of "Guy of Warwick"; the story of "Darius and His Three Sons," versified by Occleve; part of Chaucer's "Man of Lawe's Tale"; and a tale of the emperor Theodosius, the same in its main features as that of Shakespeare's *Lear.* Owing to the loose structure of the book, it was easy for a transcriber to insert any additional story into his own copy, and consequently the mss. of the *Gesta Romanorum* exhibit considerable variety. The earliest editions are supposed to be those of Ketelaer and de Lecompt at Utrecht, of Arnold Ter Hoenen at Cologne, and of Ulrich Zell at Cologne—all of uncertain date.

An English translation, probably based directly on the ms. Harl. 5,369, was published by Wynkyn de Worde about 1510–15, the only copy of which now known is preserved in the library of St. John's college. Cambridge. In 1577 Richard Robinson published a revised edition of Wynkyn de Worde. and the book proved highly popular. Between 1648 and 1703 at least eight impressions were issued. In 1703 appeared the first volume of a translation by B. P., probably Bartholomew Pratt, "from the latin edition of 1514." A translation by the Rev. C. Swan forms part of Bohn's antiquarian library and was re-edited by Wynnard Hooper in 1877. Critical editions of the Latin text have been produced by A. Keller (Stuttgart, 1842) and Oesterley (Berlin, 1872). *See* also Warton, "On the Gesta Romanorum." dissertation iii, prefixed to the *History of English Poetvy;* Douce, *Illustrations of Shakespeare,* vol. ii; F. Madden, Introduction to the Roxburghe Club edition of *The Old English Versions of the Gesta Romanorum* (1838);

Gesta Romanorum, trans. by C. Swan (1824); M. Komroff (ed.), *Tales of the Monks from the Gesta Romanorum* (1928).

GESTATION PERIOD. The period of gestation or pregnancy in mammals is usually defined as the time, between conception and birth, in which the embryo or fetus is developing in the uterus. This definition raises occasional difficulties since in some species (*e.g.*, in monkeys and man) with long periods during which intercourse may be performed, the exact time of conception may not be known. In these cases it is customary to date the beginning of the period from some well-defined point in the reproductive cycle, such as the beginning of the previous menstrual period. However, as knowledge of the time of ovulation becomes more precisely known correction is made for this factor.

The length of the gestation period varies from species to species, and each has its characteristic average duration. The shortest known gestation is that of the Virginian opossum, about 12 days, and the longest that of the Indian elephant, about 22 months. Very little is known of the causes of this species variation but in most mammals the time of birth is determined by the length of life of the *corpus luteum*, a glandular organ which replaces the ovum in the ovary. The *corpus luteum* secretes a hormone. progesterone, which is essential for the maintenance of pregnancy. When it degenerates and no longer secretes progesterone, birth follows. The length of life of the *corpus luteum* is, therefore, a determining factor in the length of the gestation period. Pregnancy may be extended by the injection of progesterone and the young continue to grow, but they do not live for more than a few days under this treatment. However, this is not the only mechanism, since in the mare and the East African bat *Nycteris luteola*, the *corpora lutea* (plural) degenerate early in pregnancy, yet pregnancy continues. Probably in these species some other organ takes over the secretion of progesterone. Removal of the *corpora lutea* during pregnancy produces variable results. In the monkey and in man they may be removed early, *i.e.*, soon after uterine implantation of the embryos, without interruption of gestation; in other species (*e.g.*, mice. cattle and goats) the *corpora lutea* appear to be essential throughout, since abortion or resorption of the embryos follows their excision.

Gestation Periods
(in days)

Animal	Average	Variation
Ape, Barbary	210	
Ass	365	
Baboon, sacred	183	
Bat, Common European	50	
Bear, American black	215	
Buffalo (Bison)	275	
Camel	406	370–440
Cat	63	60–70
Cattle	284	260–300
Chimpanzee	237	216–261
Chipmunk	31	
Coyote	60–65	
Deer, Virginia	215	
Dog	61	58–63
Dolphin	276	
Elephant, Indian	645	520–730
Ferret	42	
Fisher	338–358	
Fox	52	49–55
Giraffe	395–425	
Goat	151	145–157
Ground squirrel	28	
Guinea pig	68	
Hamster	16½	
Hedgehog, European	35–40	
Horse	337	320–355
Hyena	110	
Kangaroo, giant	38–40	
Lion	108	105–113
Man	267	250–290
Marten, pine	220–265	
Mink	50	39–76
Monkey, capuchin	185	
Monkey, grivet	215	
Monkey, rhesus	164	146–180
Mouse	19	18–20
Opossum, Virginian	12½	
Otter, Canada	62	
Orang-utan	245–275	
Pig, domestic	113	110–120
Rabbit	31	30–32
Raccoon	63	
Rat	22	21.5–22
Rat, cotton	27	
Reindeer	215–245	
Seal, northern fur	350	
Sheep	148	143–159
Skunk	62	
Squirrel, gray	44	
Tiger	105–109	
Whale	*c.* 365	
Woodchuck	28	

Evolutionary Factors.—In the course of evolution the duration of gestation appears to have become adapted to the needs of the species. The degree of ultimate growth is a factor, for smaller animals usually have shorter periods of gestation than do larger forms. Main exceptions to this rule are found in the guinea pig and related South American rodents, in which gestation is prolonged (65 days for the guinea pig and 111 days for the chinchilla), in comparison with 20–30 days which is the usual length for rodents. The young of these species are born in a state of greater maturity than are those of the rat with its period of 22 days Another factor is that, in many species with restricted breeding seasons, the gestation period is adjusted to cause birth at the season when food is most abundant. Thus the mare, a spring breeder with 11 months' gestation, has its young the following spring. while the sheep, a fall breeder with a 5 months' gestation, lambs also in the spring. Animals which live in the open tend to have longer gestations and the young are born in a state of greater maturity than those which can conceal their young in underground burrows or in caves. This applies to rodents generally, and to the bear whose young are born very immature, while the she-bear is in her period of winter sleep; these animals have short periods. The Virginian opossum and marsupials generally have short gestations; 40 days only for the largest kangaroos. The young are born in an extremely immature state and immediately transfer to the pouch in which gestation may be said to continue.

Delayed Implantation.—Embryos of some species experience an arrest in development at the blastocyst (hollow sphere of cells) stage, thus greatly prolonging the gestation period. This is especially true of the fur-bearing carnivores, the martens and weasels. Thus, the European badger and American marten breed in July and August; the embryo develops for a few days, then lies dormant in the uterus and is not implanted in the uterus until January. After implantation, however, development is normal and birth occurs in March. The total gestation period is thus about 250 days—only 50 actually taken up by growth. The dormant period can be reduced by at least three months if the pregnant females are exposed to artificial light during autumn and winter in order to increase daily amounts of light, a result which suggests that the pituitary gland, by its regulation of the *corpus luteum*, may be involved in prolongation. This type of gestation has also been observed in the armadillo and the roe deer; there is reason to suspect that it occurs in bears and seals.

Delayed implantation also occurs in rodents of the rat and mouse family which become pregnant while they are still suckling a litter. Gestation in these is usually 21 days, but under such circumstances it may be prolonged to 30 or 40 days. The prolongation results from the drain on the mother caused by lactation, since the degree of lengthening is directly related to the number of young which are being suckled. Delayed implantation is shown less in larger rodents. such as the common rat (gestation 22 days) and the cotton rat (27 days) than it is in mice.

Minor Variations in the Gestation Period.—If a large series of gestations of one species are plotted as a curve the distribution is found to be normal, *i.e.*, there are few of short length; then the daily frequency increases rapidly to a maximum; and the number of longer gestations falls off rapidly until there are very few greatly prolonged ones. This distribution suggests that either a single factor or a great number of minor factors, all culminating at or near one date determine the length of gestation. The latter is probably near the truth as several minor variations are known to occur—in man, the gestation period for males is three to four days longer than that for females; and in cattle, bulls are carried about one day longer than heifers. In both species the gestation period of twins is five to six days less than it is for singlets. In species such as the rabbit or pig, which bear many at a time, gestation is shorter for large litters than it is for small ones. Heredity, also, influences gestation since in cattle the mean gestation period ior Holstein-Friesians is 279 days, while for Brown Swiss it is 290 days, with other breeds between these extremes. The same tendency is noticeable in horses, where draft horses tend to have a shorter gestation than saddle horses, though Percherons fall into the longer group.

The season of year affects gestation in a few species. This effect is most marked in the horse. in mhich gestations terminating in winter average about 20 days shorter than those ending at any other time of year. The cause of this has not been explained. The age of either parent is without influence on the duration of gestation.

When hybrids are produced by crossing of two species with different gestation periods, the hybrid is carried for a period between those of the two parents. Thus a mare carrying a mule foal (fathered by a jackass) has a gestation period about 10 days longer than her normal period, while a jenny ass carrying a hinny (fathered by a stallion) has a period about 10 days less than the normal for the ass. which is about 365 days. In either case the gestation period of the hybrid is not exactly midway between those of the parents, but is a little toward the mother's species, suggesting that maternal physiology is an influence as well as that of the hybrid.

See also EMBRYOLOGY; EMBRYOLOGY, HUMAN; REPRODUCTION; REPRODUCTIVE SYSTEM; CHILDBIRTH; PREGNANCY.

For a more complete discussion *see* L. B. Flexner's *Gestation* (1955); the gestation periods of many species may be iound in J. H. Kenneth's *Gestation Periods* (1943). (S. A. A.)

GESUALDO, DON CARLOS, PRINCE OF VENOSA (*c.* 1560–1613), Italian composer, was born in Naples about 1560. He was a nephew of Alfonso Gesualdo, archbishop of Naples, and probably a pupil of Pomponio Nenna of Bari. His fame as a lutenist in his own day mas great and spread over all Italy; his madrigals have a peculiar interest today in view of their extreme modernness. A dramatic incident in his life was the murder, in 1590, of his wife with her lover by his orders. He afterward went to the court of Alfonso d'Este at Ferrara, and in 1594 married Donna Eleonore d'Este.

In the same year Gesualdo published his first two books of five-part madrigals. These mere followed by the third, fourth, fifth and sixth books, and in 1613, the complete edition: *Partitura delli sei libri de Madrigali a cinque Voci*. The first four books were masterly in style, but the fifth and sixth showed an extraordinary advance in the direction of modern harmony and close affinity between music and words. Gesualdo seems to have written down such progressions and modulations as pleased him. His instinct for harmonic effect was marvellous as was his grasp of the emotional possibilities in his texts. The union of words and music was complete. Short, exclamatory phrases and compressed harmony in the dramatic portions contrasted vividly with the smooth contrapuntal writing of quieter moments. One of his most characteristic madrigals. *Moro lasso al mio duolo,* is printed in Burney's *General History of Music*. *A* volume of *Sacrae Cantiones* for five. six and seven voices appeared in 1603,

See Hawkins, *Hist. of Music* (1776): Kroyer. *Anfange der Chronzatik im italienischen Madrigal des XVI Jahrhunderts* (1902); Gray and Hesseltine, *Carlo Gesualdo* (1926); and Grove's *Dictionary of Music and Musicians*, "Gesualdo," by Scott Goddard. Modern reprints of the madrigals will be found in *Raccolta nazionale,* vol. lix–lxii: Barclay Squire, *Ausgewählte Madrigale;* L. Torchi. *L'Arte musicale in Italia,* vol. iv; Pr. de la Moskova, *Recueil des morceaux de musique ancienne*.

GETA, PUBLIUS SEPTIMIUS (189–212), younger son of the Roman emperor Septimius Severus, was born at Mediolanum (Milan). In 198 he received the title of Caesar, and in 209 those of Imperator and Augustus. Between him and his brother Caracalla there existed from their eariy years a keen rivalry. On the death of their father in 211 they were proclaimed joint emperors; and after the failure of a proposed arrangement for the division of the empire, Caracalla pretended a desire for reconciliation. He arranged a meeting with his brother in his mother's apartments, and had him murdered in her arms by some centurions.

GETAE, an ancient people of Thracian origin, closely akin to the Daci (*see* DACIA). The original home of the Getae seems to have been the district on the right bank of the Danube between the rivers Oescus (Iskr) and Iatrus (Yantra). The view that the Getae were identical with the Goths is not generally accepted. Their name first occurs in connection with the expedition of Darius Hystaspes (515 B.C.) against the Scythians (*see* SCYTHIA), in the course of which they were brought under his sway, but they regained their freedom on his return to the east. During the 5th century, they appear as furnishing a contingent of cavalry to Sitalces, king of the Odrysae, in his attack on Perdiccas II. king of Macedon, but the decay of the Odrysian kingdom again left them independent. When Philip II of Macedon in 342 B.C. reduced the Odrysae to the condition of tributaries, the Getae made overtures to the conqueror. Their king Cothelas undertook to supply Philip with soldiers, and his daughter became the wife of the Macedonian. About this time, perhaps being hard pressed by the Triballi (*q.v.*) and other tribes, the Getae crossed the Danube. Alexander the Great, before transporting his forces into Asia, decided to make his power felt by the Macedonian dependencies. His operations against the Triballi not having met with complete success, he resolved to cross the Danube and attack the Getae. The latter. unable to withstand the phalanx, abandoned their chief town, and fled to the steppes. where Alexander was unwilling to follow them. About 326, an expedition conducted by Zopyrion, a Macedonian governor of Thrace, against the Getae. failed disastrously. In 292, Lysimachus declared war against them, alleging as an excuse that they had rendered assistance to certain barbarous Macedonian tribes. He penetrated to the plains of Bessarabia, where his retreat was cut off and he was forced to surrender. Although the people clamoured for his execution, Dromichaetes, king of the Getae, allowed him to depart unharmed, probably on payment of a ransom. When the Gauls made their way into eastern Europe, they came into collision with the Getae, whom they defeated and sold in large numbers to the Athenians as slaves. From this time the Getae seem to have been usually called Daci; for their further history *see* DACIA.

The Getae are described by Herodotus (iv, 93–96) as the most valiant and upright of the Thracian tribes; but what chiefly struck Greek inquirers was their belief in the immortality of the soul and their worship of Salmoxis whom the euhemerists of the colonies on the Euxine made a pupil of Pythagoras. They were experts in the use of the bow and arrow while on horseback.

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GETHSEMANE (*i.e.,* "oil press"), the place to which Jesus withdrew with his disciples on the eve of the Crucifixion. The Greek terms used of it in the Gospels suggest that it was an enclosed piece of ground. There was probably a house on it and presumably an oil press. It lay east of Kidron and was a part of the Mount of Olives. The traditional site was secured by the Franciscans (1681), enclosed by them (1848), and laid out as an European flower garden. The "garden" of Christ's time was an orchard. The "Grotto of the Agony" was marked from the 4th century by a sanctuary which was later destroyed. Another church was erected on the site in the 12th century. In 1920 when the church was being rebuilt on the site of the 12th century building, the floor of the 4th century basilica was laid bare, disclosing a different orientation. Plans were altered and re-erection proceeded on the site and along the lines of the primitive church. The Greeks have a garden called Gethsemane distinct from the Latins.

See J M. Gibson, "The Gethsemane of the Fourth Gospel," *Expos.*

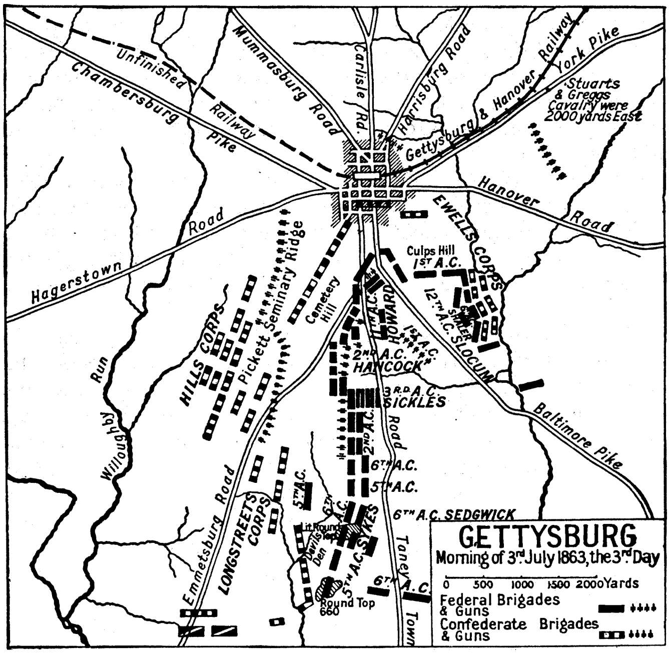
Times, 30 (1918–19), *76 seq.;* B. Meistermann, *Gethsémani; notices historiques et descriptives* (1920); *ib., New Guide to the Holy Land* (1923) 223 *seq.;* G. Orfali, *Gethsémani au notice sur l'Église de l'Agonie . . . d'après les fouilles récentes . . .* 1909 et 1920 (1924).

(E. Ro.)

GETTYSBURG, a borough of southern Pennsylvania, U.S.A., 35 mi. S.W. of Harrisburg; the county seat of Adams county. It is on federal highways 15, 30 and 140; and is served by the Reading and the Western Maryland railways. The population in 1950 was 7,046; in 1940, 5,916 by federal census. It lies in a valley $1\frac{1}{2}$ mi. wide, at an altitude of 520 ft., surrounded by beautiful rolling country and fertile farmlands. In the national cemetery, which was laid out soon after the battle of Gettysburg, are the graves of 3,814 U.S. soldiers; and the spot where Abraham Lincoln, at the dedication in Nov. 1863, delivered his memorable "Gettysburg address" is marked by a monument. The battlefield was made a national military park (2,448.17 ac.) in 1895 and transferred to the jurisdiction of the national park service in 1933. The lines of the battle have been laid out and details of the battle are commemorated by monuments, markers and tablets. Five steel observatories provide views of the entire area. Gettysburg was settled about 1780, became the county seat in 1800 and was incorporated as a borough in 1806.

Battle **of Gettysburg.**—The battle of July 1, 2 and 3, 1863, is often regarded by reliable historians as the turning point of the American Civil War (*q.v.*). It arose from a chance encounter. Lee, the commander of the Confederate army of Northern Virginia, had intended to concentrate his scattered forces at Cashtown while Meade, the Federal commander, although he had a cavalry division in Gettysburg, had no idea of holding the town prior to the battle on July 1. This cavalry division, supported by two weak army corps, was screening the concentration of his army of the Potomac in a selected position on Pipe creek to the southeastward. On June 30, however, one of A. P. Hill's Confederate brigades, sent to Gettysburg to obtain fresh stocks of shoes, had found it occupied by Federal cavalry. This led Hill, on his own initiative, to advance there on July 1 to explore the situation. At the same moment Ewell's corps was moving down toward Gettysburg from the north. Lee's remaining corps, commanded by Longstreet, was in the rear of Hill's corps. Hill's lead, ing brigades met strenuous resistance from the Federal cavalry division of Gen. John Buford, which was promptly supported by the infantry of the 1st Corps under Gen. J. F. Reynolds. The Federals so far held their own that Hill had to deploy two-thirds of his corps for action, and the western approaches of Gettysburg were still held when Ewell appeared to the northward. Reynolds had already fallen, and the command of the Federals, after being held for a time by Gen. Abner Doubleday, was taken over by Gen. O. O. Howard, the commander of the 11th Corps, which took post to bar the way to Ewell on the north side. But Ewell's attack, of which the decisive thrust. at 3.30 P.M. was led by the fiery Jubal Early, swiftly drove back the 11th Corps to Gettysburg; the 1st Corps, with its flank thus laid open, fell back also, and the remnants of both Federal corps retreated through Gettysburg to the Cemetery hill position. They had lost severely in the struggle against superior numbers, and there had been some disorder in the retreat. Still a formidable line of defense was taken up on Cemetery hill and both Ewell and Lee refrained from further attacks, for the Confederates had also lost heavily during the day and their concentration was not complete. In the meanwhile Meade had sent forward Gen. W. S. Hancock, the commander of the Federal 2nd Corps, to examine the state of affairs, and on Hancock's report he decided to fight on the Cemetery hill position. Two corps of his army were still distant, but the 12th arrived before night, the 3rd was near, and Hancock moved the 2nd Corps on his own initiative. Headquarters and the artillery reserve started for Gettysburg on the night of July 1. On the other side, the last divisions of Hill's and Ewell's corps formed up opposite the new Federal position, and Longstreet's corps prepared to attack its left.

Owing, however, to misunderstandings between Lee and Longstreet (qq *v.*), the Confederates did not attack early on the morning of the 2nd, so that Meade's army had plenty of time to make its dispositions. The Federal line at this time occupied the horseshoe ridge, the right of which was formed by Culp's hill, and the centre by Cemetery hill, from which point the left wing stretched southward, the 3rd Corps on the extreme left, however, being thrown forward considerably. The 12th held Culp's, the remnant of the 1st and 11th Cemetery hill. On the left was the 2nd, and in its advanced position—the famous "salient"—which was occu-



PLAN OF THE BATTLE OF GETTYSBURG MORNING OF THE THIRD DAY, JULY 3, 1863, SHOWING DISPOSITION OF UNION AND CONFEDERATE TROOPS

pied contrary to Meade's orders, the 3rd, soon to be supported by the 5th; the 6th, with the reserve artillery, formed the general reserve. It was late in the day when the Confederate attack was made, and valuable time had been lost, but Longstreet's troops advanced with great spirit. The 3rd Corps salient was the scene of desperate fighting; and the "Peach Orchard" and the "Devil's Den" became as famous as the "Bloody Angle" of Spottsylvania or the "Hornets' Nest" of Shiloh. While the Confederate attack was developing, the important positions of Round Top were unoccupied by the defenders—owing to the 3rd Corps having taken up its unduly advanced position. This omission was repaired only in the nick of time. The danger was perceived by the commanding engineer of the army, General Gouverneur K. Warren, who at once notified General George Sykes, commanding the 5th army corps. General Warren asked for troops with which to hold Little Round Top, and Vincent's and Weed's brigades were sent there. The attack on Little Round Top was, after a hard struggle, repulsed. The 3rd corps, in the meantime attacked by troops of Hill's and Longstreet's corps, was pressed back, and the Confederates actually penetrated the main line of the defenders, though for uant of support Wright's brigade (Hill's corps) which achieved this was quickly driven out. Ewell on the Confederate left waited for the sound of Longstreet's guns, and thus no attack was made by him until late in the day. Here Culp's hill was carried with ease by one of Ewell's divisions, most of the Federal 12th Corps having been withdrawn to aid in the fight on the other wing; but Early's division was repulsed in its efforts to storm Cemetery hill. Two of Hill's divisions, Pender and Heth, and Rode's division of Ewell's corps, remained inactive.

That no decisive success had been obtained by Lee was clear to all, but Ewell's men on Culp's hill, and Longstreet's corps below Round Top, threatened to turn both flanks of the Federal position, which was no longer a compact horseshoe but had been considerably prolonged, to the left; and many of the units in the Federal army had been severely handled in the fighting. General Meade did not discuss a plan of retreat on July 2, but during a council of war that night did discuss plans of battle for

July 3. General Lee decided to alter his tactics. The broken ground near Round Top offered so many obstacles that he decided not to press Longstreet's attack further. Ewell was to resume his attack on Meade's extreme right, while the decisive blow was to be given in the centre (between Cemetery hill and Trostle's) by an assault delivered in a pseudo-Napoleonic manner —Napoleon would scarcely have launched his characteristic decisive thrust with one fresh division against an "unstretched" line and strong front — by the fresh troops of Pickett's division, which belonged to the corps of Longstreet, who was put in charge of the central attack. Meade, however, was not disposed to resign Culp's hill, and with it the command of the Federal line of retreat to Ewell, and at early dawn on the 3rd a division of the 12th Corps, well supported by artillery, opened the Federal counterattack; the Confederates made a strenuous resistance, but after four hours' hard fighting the other division of the 12th Corps and a brigade of the 6th, intervened with decisive effect, and the Confederates were driven off the hill. The defeat of Ewell did not, however, cause Lee to alter his plans. Pickett's division was to lead in the great assault, supported by the part of Hill's corps that had not already been engaged. Col. E. P. Alexander, Longstreet's chief of artillery, formed up one long line of 75 guns, and 65 guns of Hill's corps came into action on his left. To the converging fire of these 140 guns the Federals, cramped for space, could oppose only seventy-seven. The attacking troops formed up before 9 A.M., yet it was long before Longstreet could bring himself to order the advance, upon which so much depended, and it was not till about 1 P.M. that the guns at last opened fire to prepare the grand attack. The Federal artillery replied, but after nearly two hours' cannonade its commander, Gen. H. J. Hunt, ordered his batteries to cease fire in order to reserve their ammunition to meet the infantry attack. Ten minutes later, in response to an appeal from Alexander, Pickett asked and received permission to advance, and the infantry moved forward to cross the 1,200–1,400 yds. which separated them from the Federal line. Their own artillery was short of ammunition — therefore Alexander's appeal; the projectiles of that day were not sufficiently effective to cover the advance at long ranges, and thus the Confederates, as they came closer to the enemy, met a tremendous fire of unshaken infantry and artillery.

The charge of Pickett's division is one of the most famous episodes of military history. In the teeth of an appalling fire from the rifles of the defending infantry, who were well sheltered, and from the guns which Hunt had reserved for the crisis, the Virginian regiments pressed on and finally broke bleade's first line. But the strain was too great for the supporting brigades, Heth's division and parts of Pender's and Anderson's divisions. Hancock made a counterstroke, and the remnant of the Confederates retreated. Of Pickett's own division over three-quarters, 3,393 officers and men out of 4.800. were left on the field, two of his three brigadiers were killed and the third wounded, and of 1j regimenta! commanders ten were killed and five wounded. One regiment lost 90% of its numbers. The failure of this assault practically ended the battle; but Lee's line was so formidable that Meade did not in his turn send forward the army of the Potomac —a reluctance for which he has been severely criticized. By the morning of July 5, Lee's army was in full retreat for Virginia. He had lost about 30.000 men in killed, wounded and missing out of a total force oi perhaps 75,000. Meade's losses were over 23,000 out of about 82,000 on the field. The main body of the cavalry on both sides was absent from the field, but a determined cavalry action was fought on July 3 between the Confederate cavalry under J. E. B. Stuart and that oi the Federals under D. McM. Greg:: some miles east of the battlefield, and other Federal cavalry made a dashing charge in the broken ground southwest of Round Top on the third day, inflicting thereby, though at great loss to themselves, a temporary check on the right wing of Longstreet's infantry.

See "Petersburg, Chancellorsville, Gettysburg," *Mil. Hist. Soc. of Mass. Papers*, vol. v (Boston, 1906); Abner Doubleday. *Chancellorsville and Gettysburg* (1908); P. H. Dalbiac, *The American War of Secession* (1911); Walter Clark, *North Carolina at Gettysburg* (1921); D. S. Freeman, R. E. *Lee, A Biography*, 4 vol. (193j).

GEULINCX, ARNOLD (1624–1669), Flemish philosopher and devoted admirer of Descartes, was born at Antwerp in Jan. 1624. Having studied and lectured at Louvain till 1658, when he was deprived of his post, he became a Protestant and, from 1663, lectured at the university of Leyden. He died at Leyden in Nov. 1669.

As Descartes elaborated his theory of knowledge by starting from the *cogito*, so Geulincx developed from it a theory of moral conduct. He goes halfway toward occasionalism, for, unlike N. Malebranche, he allows the self's efficacy to produce changes of state in itself, denying only its power to produce them in bodies—its own or another. (*See* CARTESIANS.)

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GEUM, a genus of hardy perennial herbs (family Rosaceae, *q.v.*), containing about 60 species, widely distributed in temperate and arctic regions; commonly called avens. The erect flowering stalks spring from a cluster of radical leaves. which are deeply cut or lobed, the largest division being at the top of the leaf. The flowers are borne singly or in clusters on long stalks at the end of the stem or its branches. They are white, yellow or red in colour, and shallowly cup shaped. The fruit consists of a number of dry achenes, each bearing a hook formed from the persistent lower portion of the style, and admirably adapted for ensuring distribution. About 20 species are natives of North America, of which ten are common in moist woods in the eastern United States. Several are easy to cultivate and well adapted for borders or rock gardens. There is not much interest in them for gardening purposes: the exception being the showy *G. chiloense*, which is known in several horticultural forms with bright scarlet flowers. This was introduced into England from Chile in 1826. It is now in most British and American gardens, especially the form called Mrs. Bradshaw. Two species occur in Great Britain; *G. urbanum* is a common hedge plant with small yellow flowers and *G. rivale* (water avens) is a rarer plant found throughout the north temperate zone. Both species were once widely used as a corrective of dysentery, as their roots contain an astringent tannin.
(N. TR.)

GEVELSBERG, a town of Germany, in the *Land* of North Rhine-Westphalia, 6 mi. S.W. from Hagen, on the railway to Düsseldorf. It has hardware factories. Pop. (1950) 27,918.

GEWANDHAUS CONCERTS, famous concerts given at Leipzig, probably those of the oldest standing in existence, since they date back to the time when Bach was cantor of the Thomasschule. They acquired special fame under Mendelssohn (1835–43), while other conductors have included Niels Gade (1844–48), K. Reinecke (1860–95), Arthur Nikisch (1895–1922) and W. Furtwängler (1922–28).

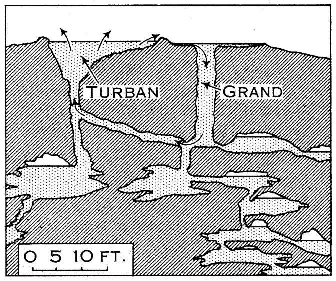
GEX, a town of eastern France, chief town of the *arrondissement* of Gex, in the *département* of Ain; formerly it was the chief town of the canton of Gex when it was included in the *arrondissement* of Nantua; 10 mi. N.N.W. of Geneva and 3 mi. from the Swiss frontier. Pop. (1954) 1,237.

It gives its name to the old Pays de Gex, between Alps and Jura, at various times under Swiss, Genevese and counts of Savoy, until in 1601 it came into the possession of France, retaining, however, until the Revolution its old independent jurisdiction, with Gex as its chief town. The Pays de Gex is isolated by the Jura from the rest of French territory, and until 1926 came within the circumscription of the Swiss customs, certain restrictions being imposed on its products by the French customs. The town is situated 2,000 ft. above sea level at the base of the most easterly chain of the Jura.

GEYSER, an intermittent hot spring which, at more or less regular intervals, spouts its contents of water and steam into the air to heights varying from mere inches to, in exceptionally vigorous geysers, hundreds of feet.

The word stems from "Geysir," the Icelandic proper name, meaning gusher or spouter, which has been applied since 1647 to a particular geyser in southwestern Iceland. In 1847 the German chemist Robert Wilhelm von Bunsen used the word as a technical term for all hot springs similar to "Geysir" in action; the English spelling is geyser.

Geysers are a rare natural phenomenon that occurs mostly in regions of relatively recent volcanic activity. The three areas of highest development are at Yellowstone National park in the United States, and in Iceland and New Zealand. Geysers have also been reported from Alaska, Tibet, Japan, the Malay archipelago, South and Central America. and Nevada. Coldwater springs exhibiting geyser action occur at Kane. Pa.. and Soda Springs, Ida.



FROM BLOSS AND BARTH. BULLETIN OF THE GEOLOGICAL SOCIETY OF AMERICA

HYPOTHETICAL CROSS SECTION THROUGH GRAND AND TURBAN GEYSERS OF YELLOWSTONE PARK

Yellowstone National park in northwest Wyoming possesses the world's greatest concentration of geysers. Whereas all of Iceland contains only 30 known active geysers. Yellowstone's boundaries include some 200 active geysers. almost 10% of the hot springs being geysers. The hot springs and geysers tend to be concentrated along the drainage basins of streams, such areas then being called "geyser basins." This local usage conflicts with the earlier and preferred use of geyser basin to denote the box-1-like depression or crater (see illustration) containing the geyser's pool during quiescence.

The two major geyser basins of Yellowstone National park, the upper basin and the lower basin, are located along the rather level valley floor bordering the Firehole river. The Upper basin, the most spectacular of its type on the globe, possesses a myriad of hot springs and geysers, some with pools containing water above the boiling temperature of 93° C. for that elevation yet. for unknown reasons, not boiling. Old Faithful. the most renowned of the upper basin's jo-odd geysers. erupts to heights of 100 to 150 ft. at intervals of about an hour and for durations of about five minutes. Grand geyser. which erupts irregularly at intervals varying from once to twice a day. majestically expels its water to heights approaching 160 ft.; the eruption, punctuated by short periods of quiescence. may last from 18 to 50 min. and result in the discharge of over 9,000 cu.ft. of water. Castle geyser. whose eruptions may be accompanied by earth tremors. sometimes steams for two hours after the eruption. Beehive geyser, an infrequent performer. was observed to erupt to a height of 219 ft.. the highest measured in the park.

The great geyser district of New Zealand. located near the upper basin of the Waikato river in the south of the province of Auckland. presents a striking profusion of boiling springs. steam jets and mud volcanoes. The geysers were inactive in 1880 but revived after the Tarawera volcanic eruption of 1886: seven gigantic geysers then came into existence, discharging water. steam, mud and stones to heights up to 800 ft. for four hours before quieter conditions prevailed. Waimangu, the greatest of all geysers, was active from 1900 to 1904, occasionally spouting jets to 1,500 ft.; draining nearby Tarawera lake in 1904 caused Waimangu's water level to drop about 3j ft., whereupon geyser action ceased.

Iceland's geysers are mostly concentrated within two areas. one 30 mi. north of Reykjavik. the second extending eastward from Reykjavik toward the active volcano, Hekla. Geysir itself is 30 mi. northwest of Hekla in a broad valley at the foot of a range of hills. During its calm periods Geysir appears as a sea-green pool 60 ft. in diameter and 4 ft. in depth. filling and gently overflowing a bowl-like depression or basin on the summit of a mound of siliceous mineral deposits. or sinter (*q.v.*). Extending downward from the basin's centre is a 10 ft. diameter. 70 ft. deep. well-like shaft whose water temperatures. at various depths. were first measured by V. Lottin in 1836. Ten years later Bunsen and A. L. O. Descloizeaux observed that: (1) Gepsir's temperature increased steadily from its surface downward to the mid-point of its well whereupon, for greater depths. it increased at a lesser rate; and that (2) Geysir's temperature at all depths, except for minor fluctuations. steadily increased as the time for 'the next eruption drew near. Conclusions drawn in Bunsen's classic (1847) paper were: (1 j the steady temperature increase for all depths would, Geysir's temperature-depth relationships being as observed, cause boiling conditions to be most closely approached at mid-depths; (2) an upward movement of the water column in the tube sufficient to cause overflow from the basin would trigger the eruption by elevating the deeper, high-temperature waters to shallower levels of reduced pressure such that the water at mid-level would, during one of these upward surges. exceed the boiling temperature of its new site; (3) the volumes of steam consequently formed at mid-depths would increase the upward surge of the water column to accelerate overflow: and (4) in turn, this accelerated overflow would cause more levels within the geyser column to boil, the chain reaction ultimately producing a full scale eruption.

Bunsen's theory. conceived to fit only Geysir. was widely accepted and extended. perhaps unduly, to cover all geysers. Subsequent work revealed features of geyser action unaccounted for by the theory. For example, H. O. Lang in 1880 noted the necessity of an influx of relatively cooler water to terminate an eruption, otherwise all geysers would simply become steam vents. T. Thorkelsson in 1940 cited convincing evidence in support of his theory that bubbles formed by the dissolved gases in the water. principally nitrogen, carbon dioxide, oxygen and argon, could cause eruptions without the necessity of boiling conditions being attained at depth.

See E. T. Allen and Arthur L. Day, *Hot Springs of the Yellowstone National Park,* Carnegie Institution of Washington, D.C. (1935); T. F. W. Barth. *Volcanic Geology, Hot Springs and Geysers of Iceland,* includes a bibliography of literature on geyser action published between 1780 and 1949, Carnegie Institution of Washington, D.C. (1950).

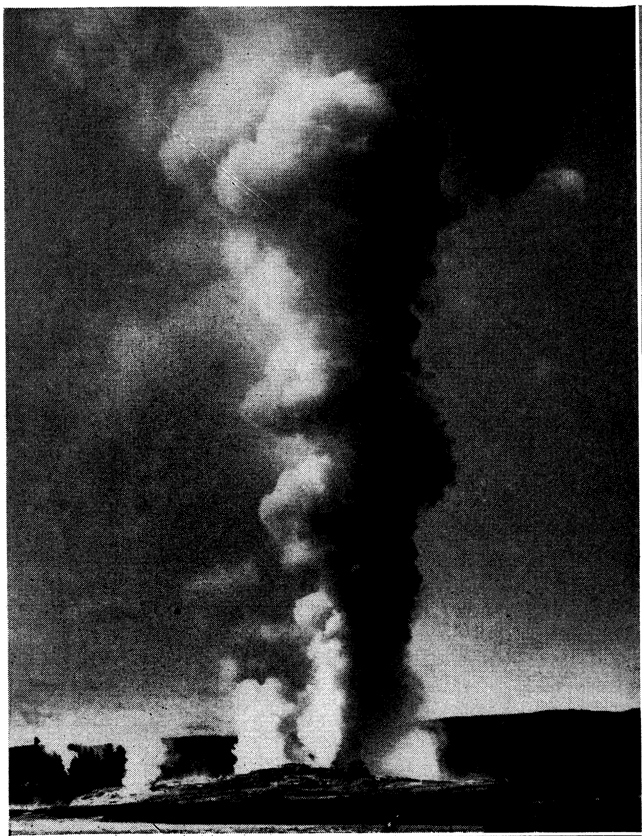
(F. D. B.)

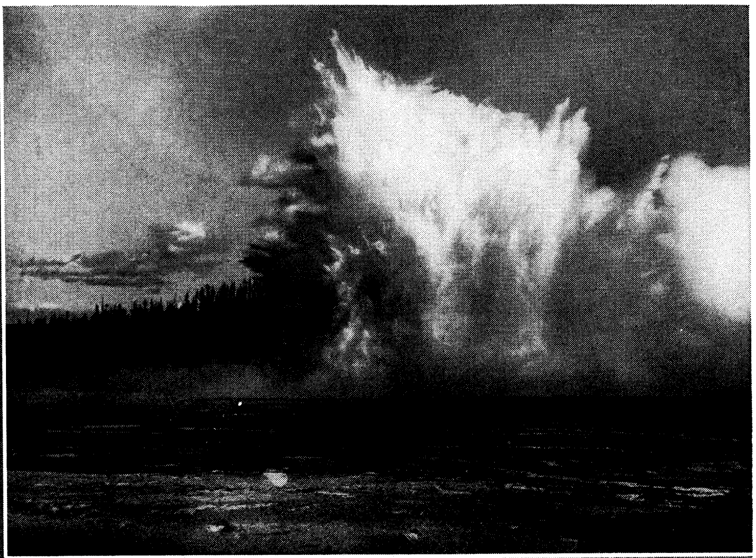
GEZELLE, GUIDO (1830–1899). Flemish poet. was born at Bruges on May 1. 1830, and died at Bruges on Nov. 27, 1899. He was one of the earliest and greatest leaders for the revival of Flemish as a literary language. He wrote in the dialect of west Flanders patriotic and religious poems inspired by deep feeling and a philosophic spirit. His first volumes of poetry appeared in 1862.

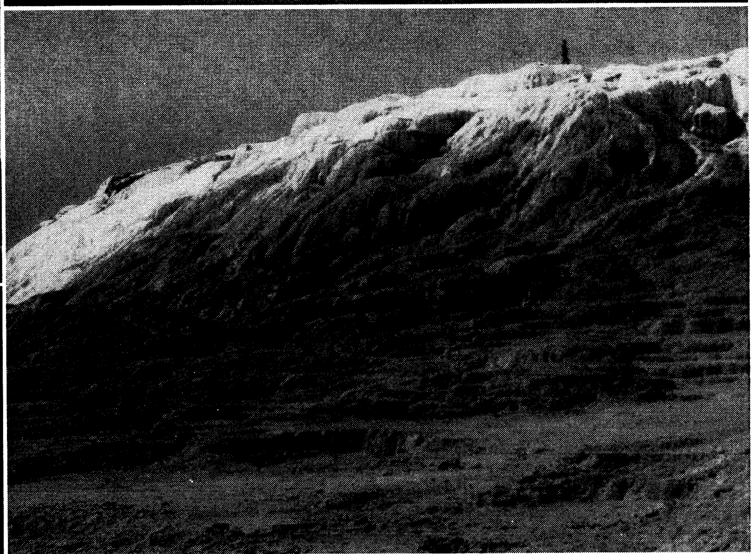
GEZER, a royal Canaanite city described in the Old Testament as on the boundary of Ephraim. in the maritime plain, and near the Philistine border. According to Jerome. Gezer was four Roman miles north of Nicopolio ('Amwas). At this point, near the village of Xbu Shusheh, stands Tell Jezar. whose identification with Gezer was suggested by Clermont Ganneau in 1871 and later confirmed by the discovery of boundary inscriptions with the name Gezer inscribed on rock outcroppings around the site.

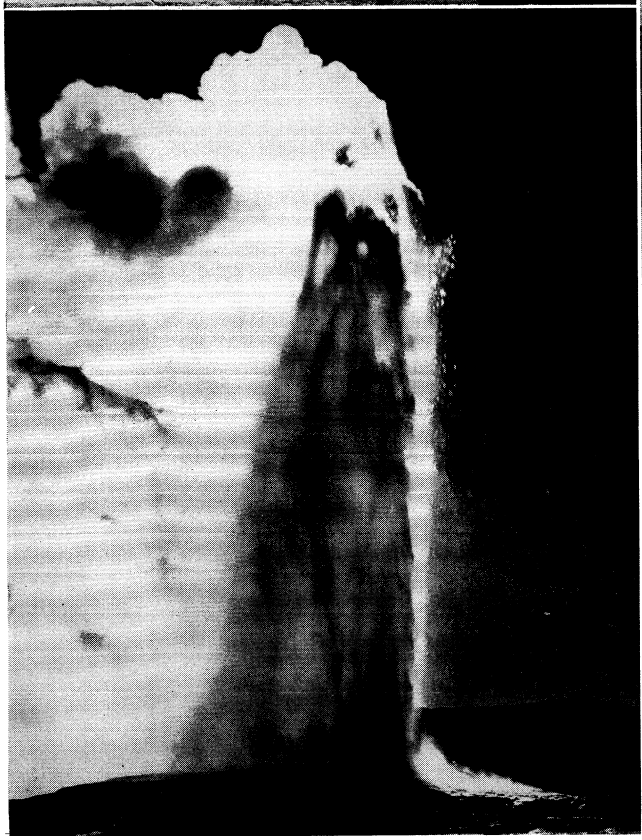
History. — In the time of Papi I (c. 2500 B.C.) Gezer marked the high tide of Egyptian invasion of Palestine, and was an objective in the time of Sesostris I (1980–193j B.C.). It is the Kazir of Thutmose III's lists (*c.* 1500 B.C.) and three of the Tel el Xmarna tablets come from Gezer (Gazri). Merneptah, in quelling the revolt of the Palestinian cities, evidently looked upon Gezer as formidable, for he proclaims himself "Binder of Gezer." and "Seized upon is Gezer" is a triumphal cry in his hymn of victory. Throughout the Maccabean wars Gazera. as it was known. was an important frontier post.

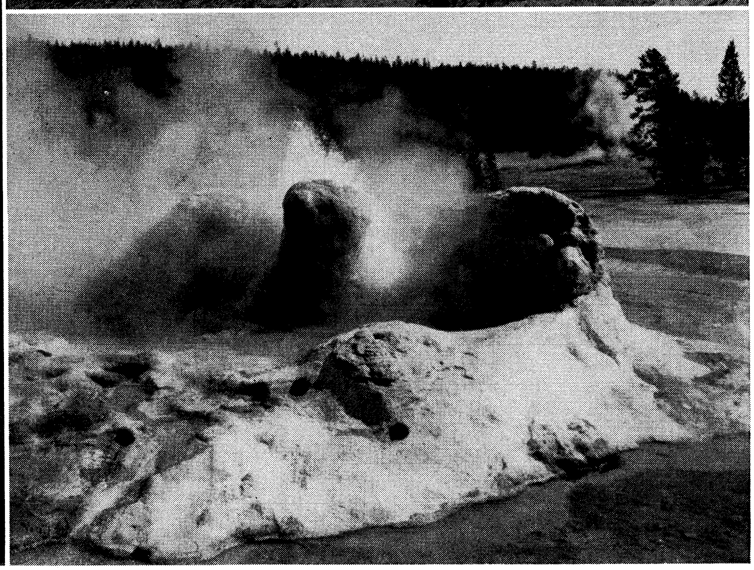
Archaeology. — The site was excavated systematically and thoroughly by Macalister for the Palestine Exploration fund from 1902–05 and 1907–09. The excavations revealed a whole series of strata covering all periods from the Neolithic Age to the time of the Maccabees, together with a long series of structures and objects illustrative of a corresponding variety of cultures and cults. Among the discoveries of special interest are two cuneiform tablets of the 7th century B.C., an alignment of monoliths (mazzeboth). many instances of presumed infant sacrifice. a water tunnel cut to a vertical depth of 94 ft.. an agricultural calendar for the year written on a limestone plaque, and a variety of cult objects. Part of the site. including the acropolis. was not available for excavation. Fresh excavations were begun on the site in 1923–24, at the instigation of a private individual. Tombs and diverse epochs with furniture intact have been disclosed.











PHOTOGRAPHS, (TOP LEFT, TOP RIGHT, BOTTOM LEFT, BOTTOM RIGHT) HAYNES PHOTOS, (CENTRE RIGHT) ELMENDORF FROM EWING GALLOWAY

GEYSERS IN YELLOWSTONE NATIONAL PARK

Top left: The main column of Giant geyser is lifted to 50-60 ft. and a thinner column to a height of 250 ft.

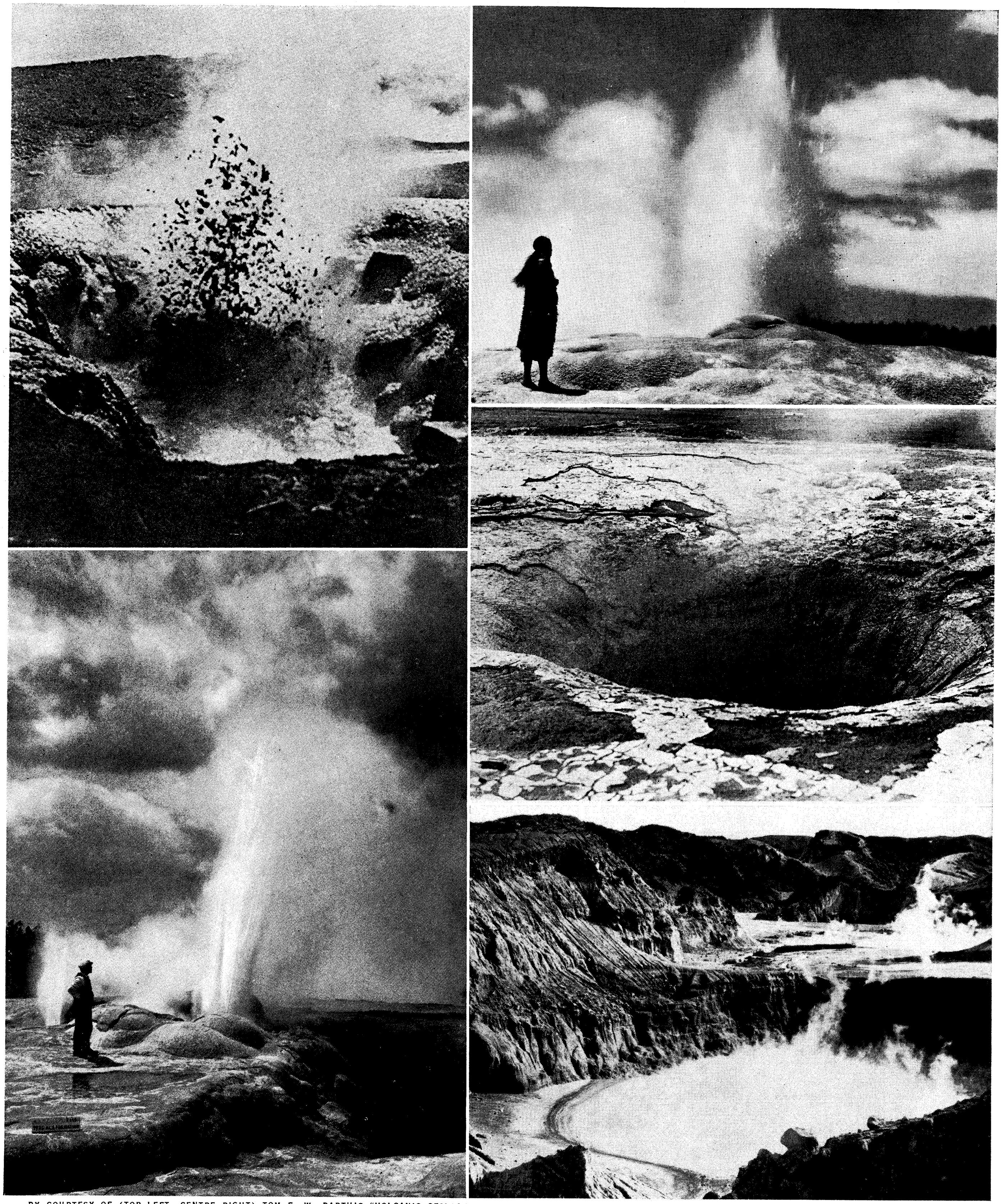
Top right: Excelsior geyser discharges boiling water into Firehole river at a rate of 6 cu.ft. per second

Centre right: Geyserite formation at Mammoth Hot Springs

Bottom left: Old Faithful geyser sends up a column 100--150 ft.

Bottom right: Grotto geyser throws water 20-30 ft.

GEYSER



BY COURTESY OF (TOP LEFT, CENTRE RIGHT) TOM F. W. BARTH'S "VOLCANIC GEOLOGY, HOT SPRINGS AND GEYSERS OF ICELAND"; BY COURTESY OF CARNEGIE INSTITUTION OF WASHINGTON, (TOP RIGHT, BOTTOM LEFT) THE NEW ZEALAND HIGH COMMISSIONER; PHOTOGRAPH, (BOTTOM RIGHT) EWING GALLOWAY

GEYSERS IN ICELAND AND NEW ZEALAND

Top left: Mud pot at Nyihver, Iceland, recorded to have thrown muddy water to a height of 6–9 ft.

Top right: Waikite geyser, New Zealand, throws a column of water over 30 ft. high

Centre right: Dry crater of the great geyser (Geysir) Iceland, after an eruption. Geysir is well known because of the scientific studies made of its water temperature

Bottom left: Pohutu geyser, Rotorua, New Zealand, beginning its eruptive action

Bottom right: Crater of Waimangu geyser, New Zealand, measuring 280 x 400 ft.

See R. A. S. Macalister, *Bible Sidelights from the Mound of Geeer* (1906), *The* **Excavations** of *Gezer, 3* vol. *(1912)*; W. N. Stearns, "The Story of Gezer," *Bibliotheca Saera* 75, 104 *seq.* (1918). (E. Ro.)

GEZIRA (*i.e.* the island) a triangular-shaped territory, comprising the districts of Iiorthern and Old Southern Gezira. Blue Nile province. Sudan. It lies between the Blue and White Niles and extends from their confluence at Khartoum as far south as 13° 30' N. Pop. (1956) 853.782, area 8,465 sq.mi. This vast plain lying about 2,000 ft, above sea level is the site of irrigation works known as the Gezira scheme which depends for its water supply on the dam 'at Sennar (*q.v.*).

The canalization system of the Gezira scheme covers an area of approximately 1.000.000 acres and produces valuable crops of millet, fodder and long-staple cotton. The scheme is run under an agreement between the Sudan government. the Sudan Plantations syndicate and the local Sudanese cultivator. The Sudan government, which bore the cost of constructing the Sennar dam and major canalization and maintains them, receives 40% of the proceeds of the cotton crop; the Sudan Plantations syndicate. which is responsible for the supervision of the growing of the crop, its transport. ginning and marketing. receives 20%: while the Sudanese tenant who provides the labour for the cultivation and picking of the cotton receives 40%. These tenants. about 25,000 in number and each farming an area of 40 acres under rotation, are drawn largely from those formerly cultivating in the area under an uncertain and sporadic rainfall. They continue to draw rent for their lands while they are under irrigation.

In a normal year the scheme produces an average of 4 cwt. of long staple cotton to the acre with a total export value of about £3,000,000 besides about 80,000 tons of millet which forms an essential part of the food supplies of the northern Sudan.

The chief town of the area is Wad Medani (pop. 47.677. 108 mi. S. of Khartoum by rail). in which is situated the administrative headquarters of the Blue Nile province. (G. R. F. B.)

GHADAMES (GADAMES or RHADAMES) (Lat. Cidamus or Cydamus), a town in an oasis of the same name. in that part of the Sahara which forms part of Libya. It is about 300 mi. S.W. of the city of Tripoli and some 10 mi. E. of the Algerian frontier, which closely follows the caravan route from Ghadames to Ghat. The oasis. which stands on the cretaceous Tinghert plateau 1.200 ft. above the sea, is enclosed by a circular rampart more than 3 mi. in circumference, the town being at the S.W. corner. The mean temperature is 73°, the rainfall about 8 in., and the number of rainy days six.

The streets of the town are narrow and vaulted and have been likened to the bewildering galleries of a coalpit. The roofs are laid out as gardens and preserved for the exclusive use of the women. The Ghadamsi merchants have been known for centuries as keen and adventurous traders. Ghadames itself is the centre of a large number of caravan routes, and in the early part of the 19th century about 30.000 laden camels entered its markets every year. Its prosperity was affected by the competition of the Tripolitan merchants about 1873 and by the invasion of Bornu by Rabah in 1893. The chief articles brought by the caravans are ostrich feathers, skins and ivory and one of the principal imports is tea.

In 1845 the population was estimated at 3,000, of whom about 500 were slaves and strangers. and more than 1.200 children; in 1954 it n-as 2.271.

The inhabitants are chiefly Berbers and Arabs: while many Tuaregs (*q.v.*) live outside.

Before the Christian era Ghadames was a stronghold of the Garamantes, who took their name from Garama (see FEZZAN). Remains of the old settlement of the Garamantes exist on the plateau near the town. In the 7th century Ghadames was conquered by the Arabs. Afterward it fell under the power of the rulers of Tunisia, then to a native dynasty which reigned at Tripoli, and in the 16th century it became part of the Turkish vilayet of Tripoli, the political fortunes of which it shared. Italian forces effectively occupied the town and oasis in 1924.

GHALCHA, GHARCHA, a name applied by the Turki-speaking population to the group of tribes about the sources of the Oxus and the mountainous regions near them. These fall into three parts: (1) Yüdghah, held by the Yidakh tribes, south of the Dorah pass over the Hindu Kush, in the British sphere of influence, (2) Wakhan, the Wakhi tribe's seat on the upper Panj, Sanglich and Minjan, on the valleys of the Waroj, in Afghanistan. and (3) Shignan, Roshan, about the confluence oi the Panj and Oxus, Sarikol on the eastern slope of the Pamir, and Yaghnob, on an upper affluent of the Zar-afshan — all in the Russian sphere.

Doubtless Iranian by origin. the Ghalchas are classed as an outlier of the shortheaded Alpine race. and the iorm Gharcha suggests that they may be akin to the Gharjis of Gharjistan. They differ from the Tajiks of Badakhshan in type. They are tall, with hair black, chestnut or red, eyes brown to bluish gray. oval faces and nose slightly aquiline. Converted at an early date to the Shi'a creed of Islam they still profess it. which fact separates them from their orthodox neighbours. Wakhan used to export musk. gold, silver and slaves. and Minjan, lapis lazuli. from mines still worked. but little else is known of them, excepting their dialects which differ in each of the regions mentioned. Of the languages four distinct forms are known: Wakhi. spoken in Wakhan, Shigni or Khigni in Shignan and Roshan. Ish Kashmi and Muriani or Murgi. These tongues possess some forms in common with the Dardic languages (*q.v.*), to the south, thus linking the latter with the Iranian tongues. Persian is the second language.

GHANA, formerly the Gold Coast and Togoland, an independent state within the British Commonwealth lying on the west coast of Africa and bounded on the west, north and east by the republics of Ivory Coast. Upper Volta and Togo. As a British colony the Gold Coast comprised the Gold Coast colony. Ashanti (*q.v.*) and the Northern Territories until 1956, when Togoland. which had been administered with the Gold Coast, became integrated with it. On March 6, 1957. the Gold Coast became an independent state and changed its name to Ghana. It became a republic on July 1, 1960. See GOLD COAST.

GHARIAL: see GAVIAL.

GHAT (formerly, Anglo-Indian GHAUT), a Hindi word originally having some such meaning as "staircase" but now signifying a terraced bank. It is sometimes extended to mean a defile giving access through such a bank or through a hill to a plateau, or even to any steep road or rail incline. The word is specifically applied to the artificial terracing of river banks! as in the bathing and crematory ghats at Benares and other Indian cities, and to ferry landings, Topographically it has come to mean a range oi hills. and in this sense is given to the EASTERN AND WESTERN GHATS, the highlands bordering the eastern and western shores of the Indian peninsula.

The term Eastern Ghats is applied to several discontinuous and dissimilar hill areas (there is a loo-mi. gap across the lower Godavari river and the Kistna river). In the north they are dissected blocks of ancient Peninsular rocks. in the centre (the Cuddapah ranges) worn-down stumps of loftier ancient mountains, and in the south mainly rounded masses of gneiss. In Orissa they sometimes exceed 3.000 ft., but they are lower elsewhere.

The Western Ghats are the crest of the great fault scarp of the western edge of the plateau. Their seaward slopes are very steep and dissected by canyonlike valleys: but on the landward side slopes are gentle and valleys wide and mature. 'The scarp begins south of the Tapti estuary and for its first 300 mi. rises to 3,000–5,000 ft. In this section the plateau is capped by the Deccan lavas, which give it a wall-like face and tabular upper surface. From near Goa southward the ancient gneisses and granites of the plateau form the escarpment. For over 200 mi. summit levels are below 3,000 ft. Hill forms are more rounded; and several of the coastal streams have cut their valleys inland beyond the crestline and captured headwaters of plateau rivers. Beyond the 13th parallel summit levels rise again until the Ghats culminate in the Nilgiri hills (*q.v.*). This great dome of gneiss reaches a height of 8,640 ft. in Mt. Doda Betta. It overlooks the wide Palghat gap which is usually regarded as the southern limit of the Ghats. The streams of the Western Ghats are important sources of power, notably at Gersoppa (*q.v.*) and in the Nilgiris. (T. HER.)

GHAZALI (MOHAMMED IBN MOHAMMED ABU HAMID AL-GHAZALI, in mediaeval Europe known as ALGAZEL) (1058–1111), Islamic theologian and philosopher, was born at Tus of Persian stock. In theology he belonged to the school of Al-Ash'ari, which in his time supported the Seljuk regime, and in 1091 he was appointed professor in Baghdad by the vizier Nizam al-Mulk. After a physical and psychological crisis, he left his professorship in 1095 and spent ten years in seclusion cultivating the mystical life, first for two years in Damascus and then, after a pilgrimage to Mecca, probably again in Baghdad. He was prevailed upon by the sultan to accept a professorship at Nishapur in 1105 but soon left it and lived in retirement at Tus with a few disciples.

Most of Ghazali's numerous works have survived, but not all have been published. Several works appear to have been falsely ascribed to him (see the *Journal* of the *Royal* Asiatic *Society*, pp. 24–45, 1952). His chief book, The Revival *of the Religious* Sciences (*Ihya' Ulum* ad-Din): contains the insight he gained from the crisis of 1095 and subsequent meditations, combining theological orthodoxy with mystical experience. Though few followed him exactly, his work partially reconciled theologians and mystics (Sufis), who had often been violently opposed to one another.

If he is sometimes called the greatest Moslem after Mohammed and entitled "the proof of Islam" (Hujjat *al-Islam*), this is less for that reconciliation than for his defense of orthodoxy against the propaganda of the revolutionary Isma'ili movement and against the Arabic Neoplatonic philosophy of Farabi and Avicenna. Ghazali, by his own reading, mastered the logical technique of these philosophers and then, in his Incoherence *of* the Philosophers (*Tahafut al-Falasifah*), used it against their metaphysical positions where these were opposed to Islamic orthodoxy. Since his time most Islamic theology has had a Greek philosophical basis.

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GHAZIABAD, a municipality, with tehsil (subdivision), in Meerut district, Uttar Pradesh, India, 12 mi. E. of Delhi. Pop. (1951) 43,745. The town was founded in 1740 by Ghazi ud-Din, son of Azaf Jah, first nizam of the Deccan. It is an important railway junction and does some trade in grain and hides. One of the colleges of Agra university is in the town.

GHAZIPUR, a municipality, tehsil (subdivision), and district in the Benares division of Uttar Pradesh, India. The town stands on the left bank of the Ganges, 44 mi. E. of Benares. It is the headquarters of the dwindling opium department, where all the opium grown under government licence used to be collected and manufactured. There are also scent distilleries, using the produce of the rose gardens in the vicinity. Pop. (1951) 33,498; tehsil (358 sq.mi.) 488,237.

GHAZIPUR DISTRICT has an area of 1,308 sq.mi. It forms part of the great alluvial plain of the Ganges, which divides it into two unequal portions. The northern tract lies between the Gumti and the Gogra, whose confluences with the main stream mark its eastern and western limits, respectively. The southern tract is much smaller, enclosed between the Karamnasa and the great river itself. Sugar refining is the chief industry. Pop. (1951) 1,141,278.

GHAZNI, a famous city in Afghanistan, the seat of an extensive empire under two mediaeval dynasties, and interesting in the modern history of India. Ghazni stands on the high tableland of central Afghanistan, in 68° 18′ E., 33° 44′ N., at a height of 7,283 ft., and on the direct road between Kandahar and Kabul, 221 mi. by road N.E. from the former and 92 mi. S.W. from the latter. A very considerable trade in fruit, wool, skins, etc., is carried on between Ghazni and India by the *povindah* merchants. Ghazni, long in decay, is reviving since the opening of the Kabul road for motors. It stands at the base of the terminal spur of a ridge of hills, an offshoot from the Gul-Koh, which forms the watershed between the Arghandab, and Tarnak rivers. The castle stands at the northern angle of the town next the hills, and is about 150 ft. above the plain. The town walls are on an elevation, partly artificial, and form an irregular square, partly of stone or brick laid in mud, and partly of clay built in courses, flanked by numerous towers with three gates. The plain in the direction of Kandahar is bare except near the river, where villages and gardens are tolerably numerous. Abundant crops of wheat and barley are grown, as well as of madder, besides minor products. Snow lies 2 or 3 ft. deep for about three months, and tradition speaks of the city as having been more than once overwhelmed by snowdrift. Fuel consists chiefly of prickly shrubs. In summer the heat is not like that of Kandahar or Kabul, but the radiation from the bare heights renders the nights oppressive, and constant dust-storms occur. Probably the existing site formed the citadel only of the city of Mahmud. The remarks of Ibn Batuta (*c.* 1332) already suggest the present state of things, viz., a small town occupied, a large space of ruin; for a considerable area to the northeast is covered with ruins, or rather with a vast extent of mounds, spoken of as Old Ghazni. The only remains retaining architectural character are two remarkable towers rising to the height of about 140 ft., and some 400 yd. apart belonging, on a smaller scale, to the same class as the Kutb Minar at Delhi (*q.v.*). Arabic inscriptions in Cufic characters show the most northerly to have been the work of Mahmud himself, the other that of his son Masa'ud. On the Kabul road, a mile beyond the Minaret of Mahmud, is a village called Rauzah. Here, in a poor garden, stands the tomb of the famous conqueror. The village stands among luxuriant gardens and orchards, watered by a copious aqueduct.

History.—The city is not positively mentioned by any ancient author but it is possibly the *Gazaca* which Ptolemy places among the *Paropamisadae,* and this may not be inconsistent with Sir H. Rawlinson's identification of it with *Gazos,* an Indian city spoken of by two obscure Greek poets as an impregnable place of war. We seem to have definite evidence of the existence of the city before Mohammedan times (644) in the travels of the Chinese pilgrim, Hsüan Tsang, who speaks of *Ho-si-na* (*i.e.,* probably *Ghazni*) as one of the capitals of *Tsaukuta* or Arachosia, a place of great strength. In early Mohammedan times the country adjoining Ghazni was called *Zābul.* When the Mohammedans first invaded that region Ghazni was a wealthy entrepôt of the Indian trade. Of the extent of this trade some idea is given by Ibn Haukal, who states that at Kabul, then a mart of the same trade, there was sold yearly indigo to the value of two million dinars (£1,000,000). The provinces on the Helmund and about Ghazni were invaded as early as the caliphate of Moawiya (662–680). The arms of Yaqub b. Laith swept over Kabul and Arachosia (Al-Rukhaj) about 871, and the people of the latter country were forcibly converted. Though the Hindu dynasty of Kabul held a part of the valley of Kabul river till the time of Mahmud, it is probably to the period just mentioned that we must refer the permanent Mohammedan occupation of Ghazni. In the latter part of the 9th century the family of the Samanid, sprung from Samarkand, reigned in splendour at Bokhara. Alptagin, originally a Turkish slave, and high in the service of the dynasty, about the middle of the 10th century, losing the favour of the court, wrested Ghazni from its chief (who is styled Abu Bakr Lawik, wali of Ghazni), and established himself there. His government was recognized from Bokhara and held till his death. In 977 another Turk slave, Sabuktagin, who had married the daughter of his master Alptagin, obtained rule in Ghazni. He made himself lord of nearly all the present territory of Afghanistan and of the Punjab. In 997 Mahmud, son of Sabuktagin, succeeded to the government, and with his name Ghazni and the Ghaznevid dynasty have become perpetually associated. Issuing forth year after year from that capital, Mahmud (*q.v.*) carried fully 17 expeditions of devastation through northern India and Gujarat, as well as others to the north and west. The wealth brought back to Ghazni was enormous, and contemporary historians give glowing descriptions of the magnificence of the capital as well as of the conqueror's munificent support of literature. Mahmud died in 1030, and some 14 kings of his house came after him; but though there was some revival of importance under Ibrahim (1059–99), the empire never reached anything like the same splendour and power. It was overshadowed by the Seljuks of Persia and by the rising rivalry of Ghor (*q.v.*), the hostility of which it had repeatedly provoked. Bahram Shah (1118–52) put to death Kutbuddin, one of the princes of Ghor, called king of the Jibal or hill country, who had withdrawn to Ghazni. This prince's brother, Saifuddin Suri, came to take vengeance and drove out Bahram. But the latter, recapturing the place (1149), paraded Saifuddin and his vizier ignominiously about the city and then hanged them on the bridge. Ala-uddin of Ghor, younger brother of the two slain princes, then gathered a great host and came against Bahram, who met him on the Helmund. The Ghori prince, after repeated victories, stormed Ghazni and gave it over to fire and sword. The dead kings of the house of Mahmud, except the conqueror himself and two others, were torn from their graves and burnt, whilst the bodies of the princes of Ghor were solemnly disinterred and carried to the distant tombs of their ancestors. It seems certain that Ghazni never recovered the splendour that perished then (1152). Ala-uddin, who from this deed became known in history as *Jahānsoz* (Burn-all), returned to Ghor, and Bahram reoccupied Ghazni; he died in 1157. In the time of his son Khusru Shah, Ghazni was taken by the Turkish tribes called Ghuzz (generally believed to have been what are now called Turkomans). The king fled to Lahore, and the dynasty ended with his son. In 1173 the Ghuzz were expelled by Ghiyasuddin, sultan of Ghor (nephew of Ala-uddin Jahansoz), who made Ghazni over to his brother Muizuddin. This famous prince, whom the later historians call Mohammed Ghori, shortly afterwards (1174–75) invaded India, taking Multan and Uchh. This was the first of many successive inroads on western and northern India, in one of which Lahore was wrested from Khusru Malik, the last of Mahmud's house, who died a captive in the hills of Ghor. In 1192, the king of Ajmere being defeated and slain near Thanewar, the whole country from the Himalayas to Ajmere became subject to the Ghori king of Ghazni. On the death of his brother Ghiyasuddin, with whose power he had been constantly associated and of whose conquests he had been the chief instrument, Muizuddin became sole sovereign over Ghor and Ghazni, and the latter place was then again for a brief period the seat of an empire nearly as extensive as that of Mahmud the son of Sabuktagin. Muizuddin crossed the Indus once more to put down a rebellion of the Khokhars in the Punjab, and on his way back was murdered by a band of them, or, as some say, by one of the *Mulāhidah* or Assassins. The slave lieutenants of Muizuddin carried on the conquest of India, and as the rapidly succeeding events relieved their dependence on any master they established at Delhi that monarchy of which the shadow was still surviving in 1857. The death of Muizuddin was followed by struggle and anarchy, ending for a time in the annexation of Ghazni to the empire of Khwarizm by Mohammed Shah, who conferred it on his famous son, Jelaluddin, and Ghazni became the headquarters of the latter. After Jenghiz Khan had extinguished the power of his family in Turkestan, Jelaluddin defeated the army sent against him by the Mongol at Parwan, north of Kabul. Jenghiz then advanced and drove Jelalhddin across the Indus, after which he sent Ogdai, his son, to besiege Ghazni. Henceforward Ghazni is much less prominent in Asiatic history. It continued subject to the Mongols, sometimes to the house of Hulagu in Persia, and sometimes to that of Jagatai in Turkestan.

Ibn Batuta (*c.* 1332) says the greater part of the city was in ruins, and only a small part continued to be a town. Timur seems never to have visited Ghazni, but we find him in 1401 bestowing the government of Kabul, Kandahar, and Ghazni on Pir Mohammed, the son of his son Jahangir. At the end of the century it was still in the hands of a descendant of Timur, Ulugh Beg Mirza, who was king of Kabul and Ghazni. The illustrious nephew of this prince, Baber, got peaceful possession of both cities in 1504, and has left notes on both in his own inimitable Memoirs. "It is," he says, "but a poor mean place, and I have always wondered how its princes, who possessed also Hindustan and Khorasan, could have chosen such a wretched country for the seat of their government, in preference to Khorasan." He commends the fruit of its gardens, which still contribute largely to the markets of Kabul. Ghazni remained in the hands of Baber's descendants, reigning at Delhi and Agra, till the invasion of Nadir Shah (1738), and became after Nadir's death a part of the new kingdom of the Afghans under Ahmad Shah Durani. The historical name of Ghazni was brought back from the dead, as it were, by the news of its capture by the British army under Sir John Keane, July 23, 1839, at the cost of 182 killed and wounded. Two years and a half later the Afghan outbreak against the British occupation found Ghazni garrisoned by a Bengal regiment of sepoys, but neither repaired nor provisioned. They held out under great hardships from Dec. 16, 1841, to Mar. 6, 1842, when they surrendered. In the autumn of the same year General Nott, advancing from Kandahar upon Kabul, reoccupied Ghazni, destroyed the defences of the castle and part of the town, and carried away the famous gates of Somnath (*q.v.*).

GHEE, clarified butter used in India (Hindu, *ghi*). The best is prepared from butter of the milk of cows, the less esteemed from that of buffaloes. The butter is melted over a slow fire and set aside to cool; the thick, opaque, whitish, and more fluid portion, or ghee, representing the greater bulk of the butter, is then removed. The less liquid residue, mixed with ground-nut oil, is sold as an inferior kind of ghee. It may be obtained also by boiling butter over a clear fire, skimming it the while, and, when all the water has evaporated, straining it through a cloth. Ghee which is rancid or tainted, as is often that of the Indian bazaars, is said to be rendered sweet by boiling with leaves of the *Moringa pterygosperma* or horse-radish tree.

In India, ghee is one of the commonest articles of diet, and indeed enters into the composition of everything eaten by the Brahmans. It is also extensively used in Indian religious ceremonies, being offered as a sacrifice to idols, which are at times bathed in it. Sanskrit treatises on therapeutics describe ghee as cooling, emollient, and stomachic, as capable of increasing the mental powers, and of improving the voice and personal appearance, and as useful in eye-diseases, tympanitis, painful dyspepsia, wounds, ulcers, and other affections. Old ghee is in special repute among the Hindus as a medicinal agent, and its efficacy as an external application is believed by them to increase with its age. Ghee more than ten years old, the *purāna ghrita* of Sanskrit *materia medicas,* has a strong odour and the colour of lac. Some specimens which have been much longer preserved—and "clarified butter 100 years old is often heard of"—have an earthy look, and are quite dry and hard, and nearly inodorous. Medicated ghee is made by warming ordinary ghee to remove contained water, melting, after the addition of a little turmeric juice, in a metal pan at a gentle heat, boiling with the prepared drugs till all moisture is expelled and straining through a cloth.

GHEEL or GEEL, a town of Belgium, about 30 mi. E. of Antwerp and in the same province.

The population in 1955 was estimated to be 24,829. The legend reads that in the year 600 Dymphna, an Irish princess, was executed there by her father; in consequence of certain miracles she was canonized and made patron saint of the insane.

The old Gothic church was dedicated to her, and in the choir was placed her shrine. with fine panel paintings by, probably, a contemporary of Hans Memlinc. A colony of the insane was established in farms and houses round the little place within a circumference of 30 mi. and is said to have existed since the 13th century.

This area was divided into four sections, each having a doctor and a superintendent attached to it.

GHENT (GENT, Fr Gand), the capital of East Flanders, Belg., stands at the junction of the Lys and the Scheldt. The estimated population of the city proper was 162,997 in 1955; its area is 14.6 sq.mi. Including the three chief suburbs of Ledeberg, Gentbrugge and St. Amandsberg. the population was 218.210 and the total area 20 sq.mi. Ghent has retained more traces of its past than any other Belgian town, Among the old buildings grouped together at its centre is the Gothic cathedral of St. Bavon. begun in the 12th century and finished in 1531, when the tower (262 it.) was com-

BY COURTESY OF THE TOURIST OFFICE OF THE CITY OF GHENT

THREE OF GHENT'S MOST FAMOUS TOWERS: LEFT, ST. NICHOLAS CHURCH. 13TH CENTURY: CENTRE. THE BELFRY. COMPLETED IN THE 14TH CENTURY, ENTIRELY REBUILT IN THE EARLY 20TH CENTURY: RIGHT. CATHEDRAL OF ST. BAVON. COMPLETED IN THE 16TH CENTURY

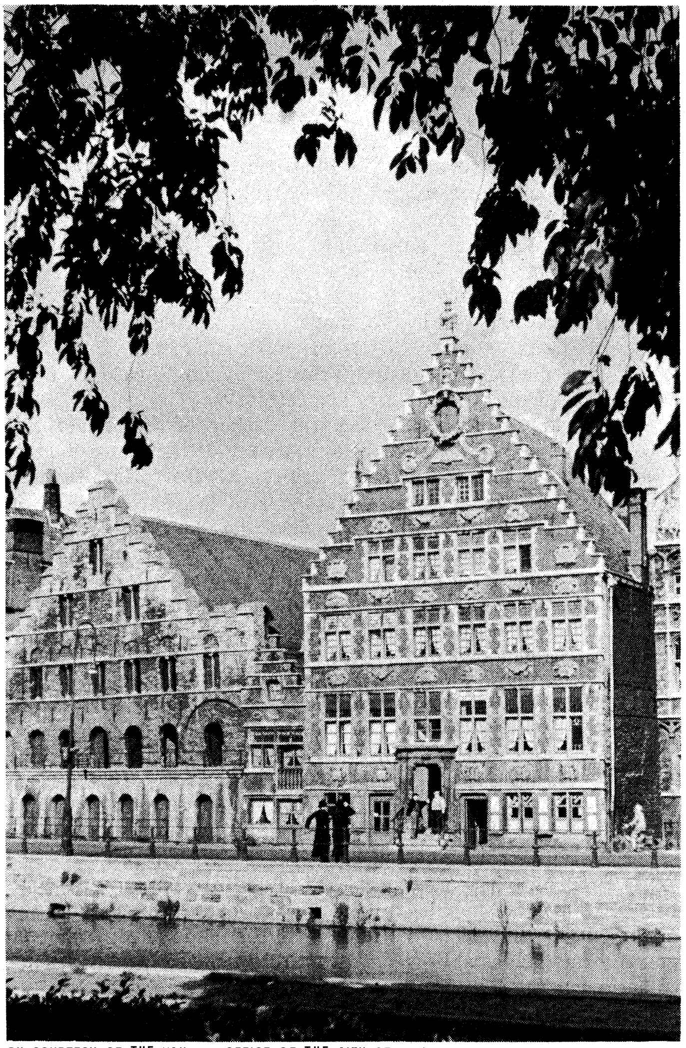
pleted. It contains. among many famous works of art, the great polyptich altarpiece "The Adoration of the Lamb" by Hubert and Jan van Eyck. The original 12 panels, which had been dispersed since 1816. were eventually brought together again under the treaty of Versailles in 1920. The picture was removed by the Germans in World War II but restored in 1945. Other old churches include St. Nicholas (13th century). St. Jacques (12th–14th centuries). St. Michel (15th–17th centuries), and St. Pierre, at one time the oratory of the abbey of the same name. which is also an imposing building. Among other notable abbeys are the abbey of St. Bavon, founded in the 7th century, and the abbey of the Byloke. with its splendid 14th-century gable. Ghent is famous for its Béguines, the name given to members of lay sisterhoods founded in the 1ath century (*see* BÉGUINES) who live in enclosed districts known as *béguinages*. One of the most attractive of these is the Béguinage of Ter Hoyen, which has entirely preserved its original appearance.

In the centre of the city stands the Belfry (14th century), a massive. rectangular construction some 300 ft. high. Its bell tower, frequently altered in the course of centuries and entirely rebuilt 1912–13, is surmounted by a gilded copper dragon. forged in Ghent in 1377. The carillon (mid-17th century'). one of the most important in the country, is composed of 52 bells. The town hall comprises tn-o buildings of different styles, the diversity of which ii a reflection of the diversity which once reigned in the administrarive and judiciary organization of the city: the Schepenhuis van de Keure (an alderman's house). which faces north, was built between 1518 and 1j3j and is a magnificent example of Flamboyant Gothic; the Schepenhuis van Ghedeele (also an alderman's house), which faces east. was completed in 1620 in Renaissance style. The interior of the town hall is no less imposing, with its splendid Gothic staircase and its vast chapel. Not far away is the castle of the counts of Flanders. which was built in 1180 by Philip of Alsace, count of Flanders. in order to humble the troublesome townspeople. Restored at the beginning of the 20th century, this warlike structure with its great keep and circular walls stands in striking contrast to the buildings that surround it. Other historical buildings include the Cloth hall (14th century). the Vleeshuis (meat hall. 1jth century). and the castle of Gerard the Devil, built in the 13th century. which now houses state archives. Ghent is also well-known for its large public squares and market places, of which the principal one is the Vrÿdagmarkt (Friday market), the centre of the life of the medieval city. Of Ghent's many public parks the two chief ones are the Parc de la Citadelle (57 ac.) and the Parc Albert (22 ac.), both in the southern quarter of the town. By the Parc de la Citadelle stands one of the city's numerous museums, the Museum of Fine Arts. It contains two famous paintings by Jerom Bosch. "Christ Carrying the Cross" and "'The Penitence of St. Jerome." The Museum of Archaeology, housed in the abbey of the Byloke. and the Lapidary museum. in the ruins of the abbey of St. Bavon. both have important municipal collections. Ghent possesses a university. founded in 1816 by William I. and also an agricultural college. The university library. which has been contained in a new building since 1941, has a very big collection of buoks and manuscripts. The city of Ghent is also the seat of a bishop.

Ghent is a road and rail junction, and is connected to the mouth of the Scheldt by the Terneuzen canal (built in 1822–29), thus giving it direct access to the North sea. The seaport. which lies north of the city on the canal. is the basis of its industrial activity, and in the 1950s extensive alterations were being made to the canal and its lock, in order to make the port accessible to the largest vessels. Near the city, and particularly toward the east. there is a vast hurticultural region where azaleas, palms. orchids. begonias and many other plants are grown, and every five years a great flower show, the "Floralies." is held, attracting visitors from all over the world. Ghent's principle industries are textiles (cotton and linen), metallurgy. including the making of machines. and chemicals. The making of paper is the chief of the secondary industries. The city is also a centre of commerce and banking.

History.—Ghent was with Bruges and Ypres one of the chief towns of the county of Flanders. It owes its origin to the economic developments which took place in Flanders in the 10th century, and the city itself sprang up on the banks of the Lys, under the protection of the castle which the counts of Flanders had built nearby. The growth of Ghent in the 12th century was rapid, and by the 13th century it was one of the largest towns in northern Europe. Its astonishing prosperity was due largely to the cloth industry. Ghent cloths. which were luxury products made from English wool, were famous all over the known world up to the 1jth century. The city's wealth gave it great political power, which it defended fiercely. It also had considerable privileges and was autonomist and republican. which aroused the hostility of the counts of Flanders and often led to open conflict. At the beginning of the Hundred Years' War, Louis de Nevers, count of Flanders, remained a faithful vassal to the king of France. whereas the city, fearing that the wool trade would suffer unless it continued to be friendly to England, ranged itself on the side of Edward III under the energetic leadership of Jacob van Artevelde. In Jan. 1340, Edward III was given public acknowledgment as king of France in the Vrÿdagmarkt. In March, the same year. John of Gaunt, duke of Lancaster, was born in the abbey of St. Bavon.

The end of the 14th century saw a terrible insurrection against another count of Flanders. Louis de Male. In the following century the policy of the dukes of Burgundy provoked fresh uprisings. The army of Ghent was massacred by Philip the Good at Gavère in 1453, and the city was unsuccessfully besieged in 1488. In 1539



BY COURTESY OF THE TOURIST OFFICE OF THE CITY OF GHENT

GUILD HOUSES ON THE QUAI AUX HERBES. THE OLD PORT OF GHENT. THE HOUSE ON THE LEFT DATES FROM ABOUT 1200, THE OTHERS FROM THE LATE 17TH CENTURY

the people of Ghent rose in revolt against the emperor Charles V (who was born in the city in 1500) as a protest against the crippling taxes they were forced to pay. This rebellion was sternly repressed. Ghent was stripped of its privileges. and the emperor imposed a new constitution which practically ended its communal autonomy, together with its social and economic structure, which had been largely democratic. In the 16th century, too. the cloth industry disappeared. unable to compete with the English cloth trade. During the second half of the century Ghent came into prominence again at the time of the religious troubles and the uprisings against Philip II of Spain. Within its walls was signed the famous Pacification of Ghent in Nov. 1576 (*see* NETHERLANDS). From 1577 to 1584 the city was under Calvinist domination. Ghent continued to decline in importance despite the linen trade which began in the 17th century. However, at the beginning of the 19th century cotton spinning was begun there and in 1827 a port was constructed. Since then Ghent has become the centre of the Belgian textiles industry. During World War I. Ghent was under German occupation from Oct. 9, 1914, until Armistice day. Nov. 11, 1918. The western part was damaged in the final operations. During World War II, German troops again occupied Ghent from May 1940 until its liberation by Allied forces in 1945.

Famous men born in Ghent include Lambert Quetelet (*q.v.*), the astronomer, meteorologist and statistician, and Maurice Maeterlinck (*q.v.*), the dramatist and poet.

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GHERARDESCA, UGOLINO DELLA (c. 1220–1289), count of Donoratico. was the head of the powerful family of Gherardesca, the chief Ghibelline house of Pisa. He allied himself by marriage with the Visconti, leaders of the Guelph faction in the city. For his share in the defeat of the Pisans by the Genoese at the battle of Meloria (1284) *see* MELORIA and PISA: *History*. .He was accused of treachery: and increased his own unpopularity by ceding castles to Florence and Lucca, and by his hesitation to make peace with Genoa, lest the return of the Pisan prisoners, including the leading Ghibellines, should diminish his power. Civil war broke out in Pisa in 1288, stirred up by Gherardesca's rival the archbishop Ruggieri, who captured the count, his two sons, Gaddo and Uguccione, and his grandsons, and starved them to death in the Muda, a tower belonging to the Gualandi family. Dante. in a terrible but magnificent passage. placed Ugolino and Ruggieri in the second ring of the lowest circle of the *Inferno*.

GHETTO, formerly the street or quarter of a city in which the Jews were compelled to live. The term is now used loosely of any locality where they congregate.

The mediaeval *Jewry (Juiverie, Juderia,* etc.) was the inevitable social expression of Jewish solidarity and Gentile aversion, and did not necessarily have any legal implication. The third Lateran Council (1179), which prohibited true believers even from lodging amongst the infidels. laid the foundations of a stricter control, which was sporadically enforced. It was not, however, reduced to a system until the counter-Reformation, when the bull *cum nimis absurdum* of Paul IV. (1555) enjoined for the first time the consistent enforcement of the mediaeval principles of segregation, the Ghetto of Rome being established in the following year. The Papal example ultimately prevailed in almost every city of Italy; and the name *Ghetto,* originally found in Venice, was generally applied to the new quarter thus created. In Germany, where a similar system obtained, the names *Judengasse,* etc., were used instead. In the Papal territories in France the term *Carrière (des Juifs)* was employed. In the rest of Europe the formal institution never generally prevailed. Among the most important examples of it in the north were Frankfort and Prague; in the south, Avignon, Rome and Venice, where the old buildings may still be seen.

Within their Ghettos the Jews enjoyed a considerable degree of autonomy under their own authorities, who were responsible for the collection of the oppressive communal taxation. The Jewish quarter thus formed to some extent an independent corporation, with its own officials, purveyors, guilds, amusements, and courts. Economic activity was however restricted by law to money-lending and a few more of the meanest occupations. The houses tended to be of unusual height, being compelled to extend vertically since there was no room for them to do so laterally. In order to prevent exploitation by Gentile landlords (the Jew was forbidden to hold real estate), security of tenure was guarded by an extension of the old Jewish principle of *Hazakah,* or prescriptive right. In Italy this ultimately acquired full legal status as the jus *gazaga.* The Ghettos were enclosed with walls and gates, which were kept locked at night and on certain church festivals; *e.g.,* from Thursday to Saturday in Holy Week. Outside, and sometimes inside as well, a badge or hat of distinctive colour had to be worn. The French Revolution temporarily swept away the infamous system, though it was widely restored in the reaction that followed. It was abolished however for good by the liberal movements of the 19th century, the last vestige disappearing with the capture of Rome in 1870.

See D. Philipson, Old *European Jewries (1894)*; Israel Abrahams,

Jewish Life in the Middle Ages (1896); S. Kahn, article "Ghetto" in the *Jewish Encyclopedia.*

GHIBERTI, LORENZO (1378–1455), Italian sculptor, who executed the second and third pairs of bronze doors of the baptistery in Florence, was born in Florence in 1378. Trained as a goldsmith under his stepfather, Bartolo di Michele, called Bartoluccio, he was active in 1400 as a fresco painter at Pesaro, whence he returned in the winter of 1400–01 to take part in the competition for the second bronze door of the Florentine baptistery. The seven competitors (who included Filippo Brunelleschi and Jacopo della Quercia) were required to prepare bronze trial reliefs of the sacrifice of Isaac. According to Ghiberti's own account, "the palm of victory" was unanimously awarded to him and in 1403 he received the contract for the bronze door. Work on the door occupied him for 21 years and it was set in place in April 1424.

Each wing of the door contains ten scenes from the New Testament and four reliefs of church fathers and evangelists. The scenes, like the trial relief, are set in quadrilobe frames imitated from those on the first bronze door by Andrea Pisano and the exposed surfaces are gilt. In the *Commentarii* Ghiberti expresses admiration for the work of a German goldsmith, Gusmin, and the style of the trial relief is influenced by French goldsmiths' work. The lyrical narrative technique and the fluent rhythms of the composition are, however, personal to Ghiberti and recur in the earlier reliefs on the bronze door. In the later reliefs, *e.g.,* the "Christ Before Pilate" and "Christ Carrying the Cross," use is made of more complex and ambitious schemes.

The success of the door led to the commissioning in 1425 of the third bronze door of the baptistery, generally known, from a comment of Michelangelo, as the "Gate of Paradise." The panels of this door were cast by 1437 and the door was completed in June 1452. Each wing of the Porta del Paradiso contains five rectangular reliefs of scenes from the Old Testament between figurated borders containing statuettes in niches and medallions with busts. The entire surface of the door is gilt. The change in the shape of the relief field between the earlier and later doors made it necessary to include in the latter a number of separate incidents in each relief, and this in turn involved compositional and spatial problems not present in the earlier door. Especially in the beautiful scene of the "Story of Isaac" these were solved by Ghiberti with remarkable success. The poetic rendering of landscape throughout the reliefs is also notable. Before executing the "Gate of Paradise" Ghiberti produced for the baptismal font at Siena two reliefs of the "Baptism of Christ" and "St. John the Baptist Before Herod" (commissioned 1417, completed 1427), which mark the transition from the style of the earlier to thnt of the later bronze door, and concurrently with the bronze door he designed the shrine of St. Zenobius for the duomo, or cathedral in Florence (commissioned 1432, completed 1442). Ghiberti revived the classical practice of bronze casting on a monumental scale, and for the guild hall of Or San Michele cast three bronze statues of St. John the Baptist (1412–16), St. Matthew (1419–22) and St. Stephen (1425–28). He also designed a number of staine -glass windows for the cathedral in Florence and has been credited with many terra cotta sculptures.

He died at Florence on Dec. 1, 1455.

Ghiberti's *Commentarii* are a document of major importance for the study of Italian art. The first of the three commentaries gives an account of ancient art (based in the main on Pliny); the second describes the course of Italian art from the late 13th century to Ghiberti's own time, and includes the sculptor's autobiography; and the third deals with optics and art theory.

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GHICA (GHIKA or GHYKA) a family which played a great part in the modern development of Rumania, many of its members being princes of Moldavia and Walachia. According to Rumanian historians the Ghicas were of humble origin, and came from Kiupru in Albania.

1. GEORGE (*c.* 1600–1664), the founder of the family, is said to have been a playmate of Küpruli Aga, the famous vizier, who recognized George while he was selling melons in the streets of Constantinople, and helped him on to high positions. George became prince of Moldavia in 1658 and prince of Walachia in 1659–60. He moved the capital from Tîrgovishtea to Bucharest. From him are derived branches of the family which became so conspicuous in the history of Moldavia and Walachia.

2. The Walachian branch starts afresh from the great ban DEMETRIUS or DUMITRU GHICA (1718–1803), who was twice married and had 14 children. One of these, Gregory, prince of Walachia 1822–28, starts a new era of civilization, by breaking with the traditions of the Phanariot (Greek) period and assisting in the development of a truly national Rumanian literature. His brother, Prince Alexander Ghica, appointed jointly by Turkey and Russia (1834–42) as hospodar of Walachia, died in 1862. Under him the so-called *règlement organique* had been promulgated; an attempt was made to codify the laws in conformity with the institutions of the country and to secure better administration of justice. Prince Demetrius Ghica, who died as president of the Rumanian senate in 1897, was the son of the Walachian prince Gregory.

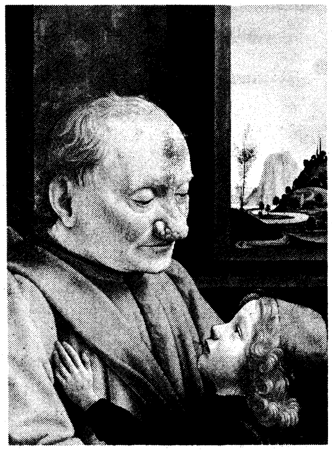
3. MICHAEL (1794–1850) was the father of ELENA (1827–1888), a well-known novelist, who wrote under the name of Dora d'Istria. She married a Russian prince, Koltsov Mazalskiy, in 1849, but the marriage was unhappy, and in 1855 she left St. Petersburg for Florence, where she died in 1888. There she published works characterized by lightness of touch and brilliance of description, such as *Pèlerinage au tombeau de Dante*, *La Vie monastique dans les églises orientales* (1844), *La Suisse allemande*, etc. One of her last works was devoted to the history of her own family, *Gli Albanesi* in *Roumenia: Storia dei Principi Ghika nei secoli XVII.–XIV.* (Florence, 1873).

4. SCARLAT GHICA (1750–1802) was twice prince of Walachia. His grandson JOHN (IOAN) GHICA (1817–1897), a lifelong friend of Turkey, was educated in Bucharest and in the West, and studied engineering and mathematics in Paris (1837–40); returning to Moldavia he was involved in the conspiracy of 1841, which was intended to bring about the union of Walachia and Moldavia under one native prince (Michael Sturdza). The conspiracy failed and John Ghica became a lecturer on mathematics at the university which was founded by Prince Sturdza in Jassy. In 1848 he joined the party of revolution and in the name of a provisional government then established in Bucharest went to Constantinople to approach the Turkish government. Whilst there he was appointed Bey of Samos (1853–59), where he extirpated piracy. In 1859 after the union of Moldavia and Walachia, Prince Cuza induced John Ghica to return. He was the first prime minister under Prince (afterwards King) Charles of Hohenzollern. He joined the anti-dynastic movement of 1870–71. In 1881 he was appointed Rumanian minister in London and retained office until 1889. He died on May 7, 1897 in Gherghani.

GHILZAI, a large and widespread Afghan tribe, who extend from Kalat-i-Ghilzai on the S. to the Kabul river on the N., and from the Gul Koh range on the W. to the Indian border on the E., in many places overflowing these boundaries. They are of the same stock as the Isa' Khel and Lodi Pathans. The Ghilzai clans now rank collectively as second to none in strength of military and commercial enterprise. They are a fine, manly race of people, and it is from some of their most influential clans (Suliman Khel, Nasir Khel, Kharotis, etc.) that the main body of *povindah* merchants is derived.

See *Tribes* and *Castes of the Punjab and North-west Frontier Province,* vol. ii. (1911).

GHIRLANDAJO (GHIRLANDAIO, GRILLANDAJO, originally DOMENICO DI TOMMASO BIGORDI) (1449–1494), one of the finest of the Florentine painters of frescoes, and master of Michelangelo, was born in Florence in 1449. He probably began his career as a goldsmith, but was certainly active as a fresco painter by the early 1470s, his earliest works being influenced both by Andrea del Castagno and by such ceremonial portrait cycles as the Medici chapel frescoes by Benozzo Gozzoli. Three saints at Cercina, near Florence, may be his earliest works, but the "Mater Misericordiae" and the "Pietà," with members of the Vespucci family introduced as mourners (Ognissanti. Florence), probably date. from about 1473. They already show his characteristic style in that they have likenesses of the donors introduced rather incongruously into the sacred scenes, which are themselves depicted with a minute realism influenced by Flemish art. This may be seen most clearly in the "St. Jerome," also in Ognissanti, dated 1480, which may even be copied from an original by Jan van Eyck; the contrast between it and the more sensitive realism of the companion "St. Augustine" by Botticelli is very marked and clearly reveals the fundamentally pedestrian character of Ghirlandajo's art. Before that date, he had already painted the scenes from the life of Sta. Fina (San Gimignano. Pieve; almost certainly 1475), and he had begun to use assistants, a practice he was to carry to great lengths. In 147j he was also working in the Vatican, but the first surviving fresco there is one of the two which formed part of the scenes from the lives of Christ and Moses, commissioned from several painters by Pope Sixtus IV for his Sistine chapel; there is a contract of Oct. 27. 1481. The important fresco is the "Calling of the First Apostles," which is chiefly noteworthy as being stylistically old-fashioned in its reminiscences of Masaccio and as having many portraits of members of the Florentine colony in Rome.



GIRAUDON

"OLD MAN WITH HIS GRANDSON" BY GHIRLANDAJO. IN THE LOUVRE, PARIS

On his return to Florence. Ghirlandajo began in 1482 to paint the "Roman Heroes" in the Sala dei Gigli of the Palazzo Vecchio. Many details from classical antiquity occur in his later works, and it is clear that he had spent much time in Rome in the study of the remains (a sketchbook in the Escurial, Madrid, is attributed to his workshop and contains numerous drawings of the antiquities). During the last years of his life he and his helpers produced two major fresco cycles and a large number of altarpieces, but for all his panel paintings he remained faithful to the old-fashioned tempera technique and never painted in oil himself.

The frescoes and altarpiece in the Sassetti chapel. SS. Trinità, were painted between about 1482 and 1485 for Francesco Sassetti. an agent of the Medici bank. The ceiling has representations of the four sibyls and the walls are devoted to scenes from the life of St. Francis. The "Pope Authorizing the Rule of the Franciscan Order" contains a large number of portraits of the Medici, the Sassetti and other dependents of the Medici, and there can be little doubt that these were intended to show Francesco Sassetti's close ties with the ruling family. The decoration was completed by the altarpiece of the "Adoration of the Shepherds." dated 148j, and showing a blend of interest in classical antiquity in the treatment of the subject, and in contemporary Flemish painting—such as the Portinari altar by Hugo van der Goes—in its handling and detail.

On Sept. 1, 1485, Ghirlandajo signed a contract with Giovanni Tornabuoni (also a Medici banker) to decorate the choir of Sta. Maria Novella with frescoes depicting the lives of the Virgin and the Baptist; the fresco of "Zaccharias and the Angel" bears the date 1490, but the altarpiece was still incomplete at Ghirlandajo's death in Florence on Jan. 11. 1494. This cycle was Ghirlandajo's major work and for it he employed many assistants, among whom was very probably the boy Michelangelo, who certainly served a short apprenticeship under him.

Ghirlandajo's main claim to fame may well lie in his having taught the technique of fresco painting to Michelangelo. The lack of imagination in his works has led to his being ranked well below Botticelli, in spite of the great appeal his realistic detail made to the 19th century. It may be observed that he never received a commission from the Medici themselves, but only from their supporters—wealthy but not perhaps highly sensitive.

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(P. J. MY.)

GHIRLANDAJO, RIDOLFO (1483–1561), Florentine painter, was the son of Domenico Ghirlandajo. He was born in Florence on Jan. 4, 1483, and, since his father died in 1494, he was brought up by his uncle David and presumably received his first training from him in the family shop; but G. Vasari. who knew him, says he was a pupil of Fra Bartolommeo, and it is likely that he was also influenced by F. Granacci and others, in particular Raphael. The two were close friends when Raphael was in Florence between 1504 and 1508, and both were in close contact with Fra Bartolommeo, so that all three must have influenced each other. Ridolfo, however, did not really live up to his early promise and he settled down to enjoy his Florentine fame: producing much decorative work and going into local politics. He and his assistants arranged the decorations for such ceremonial occasions as the entry of Pope Leo X (1515) or of the Emperor Charles V (1536). He also painted many religious pictures and many excellent portraits, his earliest datable work being either the "Madonna and Saints!' (1jog; Accademia, Florence). which is reasonably attributed to him, or the "Coronation of the Virgin" (1504; Louvre museum, Paris). Other works by him are in London, New York, Philadelphia (Johnson collection) and several museums and churches in Florence. Ridolfo died in Florence on Jan. 6, 1561.

See G. Vasari, *Lives of the most eminent Painters, Sculptors and Architects,* vol. viii, Eng. trans. by De Vere (1914); C. Gamba in *Dedalo,* ix (1929) II, 463 ff. and 544 ff.

(P J. MY.)

GHOR or GHUR, a medieval kingdom lying to the southeast of Herat in the western part of modern Afghanistan.

Ghor is mentioned in the *Shahnama* of Firdousi (A.D. 1010) and in the Arab geographies of that time; but the people and princes of Ghor first became known to us in connection with the Ghaznevid dynasty, and the early medieval histories of Ghor and Ghazni are so intertwined that nothing need be added to what will be found under GHAZNI (*q.v.*).

About A.D. 1100 one of the princely families of Ghor, deriving the appellation of Shansabi, or Shansabaniah, from a certain ancestor Shansab. of local fame. acquired predominance in all the country; and Malik 'Izz ud-Din al-Husain of this family was known afterward as "the Father of Kings," from the honour to which several of his seven sons rose. Three of these mere: Amir Kutb ud-Din Mohammed, called the lord of the Jibal or mountains, and Sultan Saif ud-Din Suri, for a brief period master of Ghazni (both of whom were put to death by Bahram the Ghaznevid), and Sultan Ala ud-Din Jahansuz. who wreaked vengeance upon Ghazni and began the conquests which were afterward immensely extended both in India and in the west by his nephews Ghiyas ud-Din Mohammed ibn Sam and Mohammed Ghori. For a brief period during their rule it was boasted. with no great exaggeration, that the public prayer was read in the name of the Ghori from the extremity of India to the borders of Babylonia and from the Oxus to the Straits of Hormuz. After the death of Mohammed Ghori the Indian dominion became independent, and the whole kingdom fell to pieces before the power of Mohammed Shah of Khwarizm and his son Jalal ud-Din (c. 1214–1j), a power in its turn speedily shattered by the Mongol flood.

The princes of Ghor experienced, about the middle of the 13th century, a revival of power which endured for 140 years. This later dynasty bore the name of Kurt or Kărt. The first of historical prominence was Malik Shams ud-Din Kurt, who in 124j held the lordship of Ghor in some kind of alliance with; or subordination to, the Mongols and in 1238 received from the Great Khan Mangu an investiture of all the provinces from Merv to the Indus, including by name Seistan, Kabul. Tirah (adjoining the Khyber pass) and Afghanistan, which he ruled from Herat. He stood well with

Hulagu and for a long time with his son Abaka, but at last incurred the latter's jealousy and was poisoned when on a visit to the court at Tabriz (1276). His son Rukn ud-Din Kurt was, however, invested with the government of Khurasan (1278), but after some years, mistrusting his Tatar suzerains, he withdrew into Ghor and abode in his strong fortress of Khaisar till his death there in 1305. The family held on through a succession of eight kings in all, sometimes submissive to the Mongol, sometimes aiming at independence. But in 1380 Timur came against Herat and carried away the king and the treasures of his dynasty. A revolt and massacre of his garrison provoked Timur's vengeance: he put the captive king to death, came against the city a second time and showed it no mercy (1383). Ghor has since been obscure in history.

The valleys of the Taimani tribes though narrow are fertile and well cultivated, and there are many walled villages and forts about Parjuman and Zarni in the southeastern districts. The peak of "Chalap Dalan" is the Koh-i-Kaisar, which is somewhat more than 13,000 ft. in height. All the country now known as Ghor was mapped during the progress of the Russo-Afghan boundary delimitation.

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GHOSE, LALMOHUN (1849–1909), lawyer, statesman, orator and scholar, was born at Krishnagur, Bengal, on Dec. 17, 1849. He was the second son of Rai Ram Lochun Ghose Bahadur, Principal Sadar Amin of the district. Ghose was called to the bar in England in 1873 and on his return to India began to practise in the Calcutta High Court. Ghose was honorary secretary and principal speaker of a deputation on Indian administration to the Marquess of Hartington. The result was repeal of the Vernacular Press Act and the establishment of a Statutory Indian Civil Service.

Early in 1880, he returned to India, but two months later the Indian Association again sent him to England to continue their opposition to Lord Lytton's policy. Returning in November the same year, he resumed practice at the Bar, and devoted the next two years to various political measures, such as the Vernacular Press Act, Criminal Procedure Code Amendment Bill, etc.

In 1883, he again proceeded to England in order to assist in an appeal of Surendranath Banerjea before the Privy Council. From August 1883 to August 1884, he addressed meetings in London and elsewhere in support of Ripon's policy in the Ilbert Bill and the representation of Indian interests in Parliament. He was the first Indian to seek election to Parliament; in 1885 and again in 1886 the Liberals of Deptford invited him to become their candidate, but on both occasions he was defeated—the second time owing to his support of the Irish Home Rule Bill. He returned to India in 1887.

In 1892, he was elected a member of the Bengal Legislative Council from which he retired in 1895. In 1903, he was elected president of the Indian National Congress at Madras and for some years took an important part in its deliberations. Ghose's last political speech was delivered as chairman of a public meeting called in 1906 at Calcutta to protest against Lord Curzon's partition of Bengal. Ill-health prevented him from taking any further active part in political work, and he died at Calcutta on Sept. 18, 1909.

Ghose was a thorough Constitutionalist and the whole spirit of his utterances was loyal to the British Government. He was the greatest orator of his time in India. As a member of the Bar he was rather an advocate than a lawyer, and commanded the fullest respect of Bench and Bar alike.

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GHOST DANCE. In 1870 there started among the Paiute (Paviotso) of Western Nevada a new faith — the Ghost Dance religion—which in most cases spread rapidly because of the wide feeling, founded on solid fact, that the westward movement of white culture was destined to destroy the native culture. In some cases "the new cult was encouraged by the chiefs as a check to the rival powers of the Shamans" (Spier, see bibliography). The Modoc war of 1873 saw the immediate disappearance of the cult, but it may still survive, or more probably there may survive separate cult-elements which, if re-stimulated and recombined, would present a very close resemblance to the complex of ideas, beliefs and rites which constitute the Ghost Dance religion.

In 1890 changes in the administration with the appointment of inexperienced men in charge of the reserves, led to discontent, notably among the Sioux of Pine Ridge. Pledges had been broken. Messianic ideas of a deliverer who shall restore the world to the godly and punish the transgressors of his ordinances are found in Indian thought, and there is a continuity of idea, inspired by, and probably based on, political conditions, between the ideals of Pontiac; the Paiute dreamer of 1870 named Ta'vibo; Smohalla, the dreamer of the Columbia region whose oratory, activities and personality made him a man of wide influence; the Shaker teachers of Puget Sound; and the doctrines of Wovoka the Messiah, the Paiute who is known as Jack Wilson. The new teaching — in reality the old teaching — reached the Sioux in 1889 and took the form of a prophecy of a new world. Even progressive and intelligent Indians held the belief in the close advent of a liberator who should restore the Indian race, living and dead, to a regenerated earth where the pristine conditions of life should prevail. Administration of Indian reserves had been adequate; intelligent, sympathetic and satisfactory in many cases. The prophecy sometimes allowed the white man to share the predicted felicity. The movement took hostile expression among the discontented Sioux, whose leaders, Sitting Bull and Red Cloud, were irreconcilable enemies of the whites. Sitting Bull, a medicine man rather than a secular chief, was killed on Dec. 15, 1890. By Jan. 16, 1891, the outbreak ended, as a result of the military and political operations conducted by Gen. Miles, who put the agencies in charge of military officers known to and respected by the Indians.

The Ghost Dance begins in the middle of the afternoon or later. No musical instrument is used except by individual dancers. The Sioux wore a "ghost shirt," almost always made of white cloth, tailored in Indian fashion. No metal was allowed to be worn. The ghost stick carried by the leader was a staff about 6 ft. long, with red cloth and red feathers. Other articles used were arrows with bone heads, a bow, a gaming wheel and sticks. The ground was consecrated. The priests were ordained by the conferment of a consecrated feather, either of a crow, the sacred bird of the Ghost Dance, or of the eagle, sacred in Indian lore, given to the candidates by the apostle. The feathers were painted. The dancers were ceremonially painted on the face with elaborate designs, in red, yellow, green and blue, suggested in trances, and were thus strengthened in spiritual vision and physical health. All went to bathe—to wash away all evil, spiritual and material. Attendance was compulsory, as those who stayed away would be turned to stone or punished. Songs, adapted to the simple dance step, were carefully rehearsed. Participants fell into trances and on regaining consciousness narrated their visions. The general psychology of the dance as an element in religious and social life, and as it functions in the lives of primitive people, forms a topic of importance as, in general, sexual display takes place and selection is encouraged—a feature sternly and successfully repressed in the Ghost Dance, in which the whole attention of the performers, the whole community, was successfully concentrated upon the purpose of the dance and upon the message of salvation which it conveyed.

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GIAMBONO (Michele di Taddeo Bono), Italian painter and mosaicist, was active in Venice from 1420 to 1462. He was a representative of the old Gothic tradition in Venice, but was much influenced by Gentile da Fabriano and Pisanello and the new International Gothic introduced by them into Italy. Among the few signed works by him are a large polyptych in the Accademia, Venice, a "Madonna" in the Galleria Nazionale, Rome, and the mosaics of the Mascoli chapel in St. Mark's at Venice, begun in 1444. The mosaics at St. Mark's represent an attempt to introduce three-dimensional representation in a technique that was dominated by the two-dimensional Byzantine tradition, but it is not certain that the architectural settings are his. Other works include a copy, of 1447 (in the Accademia), of an altarpiece by Antonio Vivarini in S. Pantaleone, Venice, and an altarpiece of 1441 in San Daniele del Friuli, near Udine. The National gallery, London, and the Metropolitan museum, New York, are among those possessing works attributed to him.

See E. Sandberg-Vavala in *Journal of the Warburg and Courtauld Institutes,* 20 ff. (1947). (P. J. My.)

GIANNINI, AMADEO PETER (1870–1949), U.S. banker, was born May 6, 1870, at San Jose, Calif., the son of an Italian immigrant. He left school at the age of 13 to work in the fruit and vegetable business and later entered the banking business when he took his father-in-law's seat on the board of the Columbus Savings and Loan society in San Francisco. In 1904 he founded the Bank of Italy in that city, the bulk of his business stemming from small businessmen. After the San Francisco earthquake of 1906, he salvaged the gold and securities from his bank and began making loans for the rebuilding of the city. He began to buy small banks, making them branches of his Bank of Italy, and in 1919 he founded the Bancitaly corporation, which was succeeded in 1928 by the Transamerica corporation, a holding company for his financial interests. In 1930 the banks were consolidated into the Bank of America National Trust and Savings association, which by 1948 had become the largest bank in the U.S., with 517 branches and assets of more than $6,000,000,000. Giannini died June 3, 1949, at San Mateo, Calif.

GIANNONE, PIETRO (1676–1748), Italian historian, who opposed the papal interference in Naples, was born at Ischitella, Capitanata, May 7, 1676. He graduated in law (Naples, 1698), became interested in the New Learning and wrote the *Istoria civile del Regno di Napoli* (1723)—a polemical survey of Neapolitan history in which he espoused the side of the civil power in its conflicts with the Roman Catholic hierarchy. As a result of this the Istoria was placed on the Index and Giannone excommunicated. In Vienna, where until 1734 he received a pension from Charles VI, Giannone prepared his most important work, *Il* Triregno, ossia del *regno* del *cielo, della* terra, e del papa, (3 vol., ed. by A. Parente, 1940). On the transfer of the Neapolitan crown to Charles of Bourbon, Giannone left Vienna for Venice. Unhappily there arose a suspicion that his views on maritime law were not favourable to the pretensions of the Republic, and this, together with clerical intrigues, caused him finally to seek refuge in Geneva (1735). But while visiting a village in Piedmont, he was kidnapped by agents of the Sardinian government and taken to the castle of Miolans (1736). There he wrote his *Autobiografia* (ed. by F. Nicolini, 1905). Giannone was incarcerated for the last 12 years of his life in the fortresses of Ceva and of Turin, where he died March 17, 1748.

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GIANT. In classic mythology the word meant beings more or less manlike, but monstrous in size and strength, like the Titans and the Giants sung by Hesiod in the Tlzeogony, who can heap up mountains to scale the sky and war beside or against the gods. (O.E. *geant* through Fr. *géant* by assimilation from gigantem, acc. of Lat. *gigas.*) But there also appear in the legends of giants some with historic significance. The idea that the giants were earthborn or indigenous races was familiar to the ancient Greeks (see Welcker, *Griechische* Gotterlehre, i, 787). The Bible records the traditions of the Israelites of fighting in Palestine with tall races of the land such as the Anakim (Numb. xiii, 33; Deut. ii, 10; iii; I Sam. xvii, 4). In Homer "the Cyclops and the wild tribes of the Giants" seem dim traditions of pre-Hellenic barbarians, godless, cannibal, skin-clad, hurling huge stones in their rude warfare. Giant legends of this class are common in Europe and Asia. In early times it was usual for cities to have their legends of giants. Thus London had Gog and Magog. whose effigies (14 ft. high) stand in the Guildhall (see GOG); Antwerp had Antigonus, 40 ft. high; Douai had Gayant, 22 ft. high; etc. It was a common opinion that the human race had itself degenerated, the men of primeval ages having been of far greater stature and strength. Yet so far as can be judged from actual remains, it does not appear that giants, in the proper sense, ever existed, or that the men of ancient time were on the whole taller than those now living. It is now usual to apply the word giant merely to unusually tall men and women. In every race of man the great mass of individuals do not depart far from a certain mean or average height, while the very tall or very short men become less and less numerous as they depart from the mean standard, till the utmost divergence is reached in a very few giants and a very few dwarfs. See also GIGANTICISM; REPHAIM.

See P. Lohmann, Archäologisches von en-nebi Samwil: *Zeitschr.* (1904); **E.J** *Wood, Giants and Dwarfs (1860).*

GIANT ORDER: see ORDER.

GIANT'S CAUSEWAY, a promontory of columnar basalt, on the northern coast of County Antrim, N. Ire., lying between Portrush and Ballycastle. Local folklore ascribes its formation to a race of giants who built it as a roadway to Staffa (*q.v.*), where a similar structure occurs. The prismatic forms were caused by the rapid cooling of the lava flows where they entered the sea. The pillars composing the Giant's causeway are mostly irregular hexagons. In diameter they vary from 1j to 20 in., and some are 20 ft. in height. The great causeway is in some places nearly 40 ft. wide and is highest at its narrowest part. It extends outward into a platform and for nearly 100 yd. is above water. Other cliffs to the east exhibit similar columns. The most remarkable of the cliffs is the Pleaskin, the upper pillars of nhich are 60 ft. high; beneath these is a mass of coarse black amygdaloidal rock, of the same thickness, underlain by a second range of basaltic pillars, from 40 to 50 ft. high

GIANT'S KETTLE (GIANT'S CAULDRON), a glacial pothole, *i* e., a deep cylindrical hole in solid rock drilled out by eddying currents of water of subglacial streams, bearing stones, gravel and other detrital matter. The size varies from a few inches to several feet in depth and diameter and upon the retreat of the ice, the hole frequently contains the sand. gravel or boulders which have assisted in its formation. Good examples occur in the Alps (Lucerne), Germany, Norway and U.S. These must not be confused with true potholes which occur in river beds and at the base of sea cliffs.

GIAOUR, a word used by the Turks to describe all who are not Moslems, especially Christians. The word, first employed as a term of contempt, has become so general that in most cases no insult is intended in its use. It is a Turkish adaptation of the Persian gaur.

GIARDINO, GAETANO (1864–193j), Italian soldier, was born at Montemagno, Italy, on Jan. 24, 1864. He joined the army in 1882 and saw service in Eritrea (1889–94) and in Tripoli (1911–12). On Italy's intervention in World War I he was appointed chief of staff to the and army and was promoted brigadier general in Aug. 1915. In June 1916, he was given command of the 48th brigade and played an Important part in the attack on Gorizia. In June 1917, he was promoted lieutenant general, but a few days later was chosen minister of war and made a senator. He held office until after Caporetto, when he was appointed assistant chief of staff to the new commander in chief, Gen. Diaz. In April, 1918, he was given the command of the 4th army in the Grappa sector. At the battle of Vittorio Veneto (Oct. 24–Nov. 3, 1918) he delivered a general attack on the Austrian lines and after a hard struggle forced the enemy to retreat. In 1919 he was promoted *general d'esercito.* In Sept. 1923, as the government of Fiume was unable to carry on, Giardino was sent to take charge of the town, where he remained until its annexation by Italy under the terms of the treaty between Italy and Yugoslavia in Jan. 1924. Giardino died in Turin, Nov. 21, 1935.

GIAUQUE, WILLIAM FRANCIS (1895–   ), U.S.

physical chemist, pioneered in applying the third law of thermodynamics (*q.v.*) to problems of chemical interest and in the investigation of the properties of matter at temperatures lower than any previously attained. Born May 12, 1895, in Niagara Falls, Ont., of U.S. parentage, thus acquiring U.S. citizenship, he was educated at the Niagara Falls Collegiate institute and the University of California (Berkeley). Upon receiving the Ph.D. degree in 1922 he was appointed to the faculty of the department of chemistry at Berkeley. By comparing entropies of gases obtained from experimental low temperature calorimetric measurements with those calculated theoretically from spectroscopic data, Giauque established a firm experimental basis for quantum statistics and the third law of thermodynamics, and led to an understanding of the apparent exceptions to this law. In 1929, with H. L. Johnston, he discovered the oxygen isotopes of mass 17 and 18 and thus disclosed the difference between the physical and chemical atomic weight scales. In 1926 he proposed the adiabatic demagnetization method for obtaining temperatures well below 1° K., and in 1953, with D. P. MacDougall, performed the first successful experiments making use of this method. Giauque's adiabatic demagnetization method is basic to numerous experiments which have since been made in the temperature range below 1° K. He has received the Chandler, Cresson, Nobel (chemistry, 1949), Gibbs and Lewis awards. (J. W. St.)

GIBBET, a primitive form of gallows. It was a custom at one time—though not part of the legal sentence—to hang the body in chains, this being known as gibbeting. *See* HANGING; CAPITAL PUNISHMENT.

GIBBON, EDWARD (1737–1794), English historian, was born at Putney on April 27 (O.S.), 1737. His father, who was also named Edward Gibbon, was M.P. for Petersfield and Southampton until 1747; he married Judith, daughter of James Porten, by whom he was the father of seven children. Edward was the only one to survive childhood, and he was so delicate as a child that his life was often despaired of. He first attended a day-school in Putney, and studied Latin with John Kirkby, author of *Authomates* (1745). He went in 1746 to a school at Kingston-on-Thames, where "at the expense of many tears and some blood, I purchased the knowledge of the Latin syntax." Meanwhile he was reading Pope's *Homer* and Dryden's *Virgil*. His mother died in 1747, and his father moved into Hampshire, but Gibbon lived under the care of his aunt, chiefly at his grandfather's house at Putney. Here he developed his great love of reading, and had the run of his grandfather's library. His 12th year, 1748, he records as "the most propitious to the growth of my intellectual stature." At the end of that year, his aunt, Catherine Porten, opened a boarding-house for Westminster school. Gibbon went with her, and entered the school in Jan. 1749. His health broke down again, and he was taken in 1750 to Bath and Winchester, without much effect. He made one more attempt at Westminster, but it was evident that his health would never stand it, and after this he studied under various tutors. Meanwhile his appetite for history was developing, and he read widely, ranging over every period. On a visit to his father he first discovered later Roman history.

Oxford and **Lausanne.**—About his 16th year his health rapidly improved, and on April 3, 1752, he went to Magdalen college, Oxford, as a gentleman commoner, "with a stock of erudition which might have puzzled a doctor, and a degree of ignorance of which a schoolboy might have been ashamed." He disliked the university and his tutors, and they disliked him. "I spent 14 months at Magdalen college," he says; "they proved the 14 months the most idle and unprofitable of my whole life." While at Oxford he was influenced by Middleton's *Free Inquiry* (1749) to join the church of Rome, and his conversion was completed by Bossuet's *Variations of Protestantism* and *Exposition of Catholic Doctrine*. Gibbon was received into the church on June 8, 1753. He announced his decision in a letter to his father, who became exceedingly annoyed and removed him from Oxford. Soon afterwards he was sent to live at Lausanne, with M. Pavilliard, a Calvinist minister. Here he learned French of necessity, and after five years "spontaneously thought" in that language, which influenced his style to the last. He studied the logic of Crousaz, and "the articles of the Romish creed disappeared like a dream." In less than two years he had returned to Protestantism. He studied widely, classics, philosophy and mathematics, which last he soon abandoned. In 1755 he travelled in Switzerland, studying the Swiss political institutions. In 1757 he met Voltaire. In the same year he fell in love with Susan Curchod, daughter of the pastor of Crassier, who afterwards became Madame Necker. On his return to England his father objected to the marriage, and Gibbon "sighed as a lover," but "obeyed as a son." He found that his father had married again. At this time he met Mallet, who introduced him to Lady Hervey's circle, where his French accomplishments made him welcome. Mallet advised him to counteract the influence of French on his style by reading Addison and Swift. In 1761 Gibbon published his *Essai sur l'étude de la littérature*, begun in Lausanne in 1758. His father urged its publication, hoping that it might introduce him to public notice, but it was more successful abroad than in England. It was translated into English in 1764.

His Later Life.—He was already contemplating a history, but had not chosen his period. In 1763 he left for a tour on the continent. He went first to Paris, where he found the circle of d'Alembert and Diderot congenial, and was tempted to stay there permanently; then to Switzerland, staying a year at Lausanne, and in April 1764 to Italy. Rome was the main object of his visit, and it was in Rome he records "on the fifteenth of October 1764, as I sat musing amidst the ruins of the Capitol . . . that the idea of writing the decline and fall of the city first started to my mind." He returned from the tour in June 1765, visiting Naples, Venice, and Verona on the return journey. The next five years were uneventful. Gibbon lived chiefly at Buriton. He projected and abandoned a history of the Swiss revolution, and in 1770 successfully exposed Warburton's Virgilian theories in *Critical Observations on the Sixth Book of the Aeneid.* But he had by now formed the plan of his history, and settled down to the vast researches it involved. His studies were interrupted in 1770 by his father's death, and his own consequent move to London, but by Oct. 1772 he was fairly started. At first he moved slowly and with hesitation; after the first few chapters, swiftly and without corrections or alterations. In Feb. 1776 the first volume was published, and met with an unprecedented success, passing rapidly through three editions. He was allowed by his publishers two-thirds of the profits on the first edition, which amounted to £490. Hume, in the midst of his congratulations, warned him that he was provoking a controversy in the chapters on the growth of Christianity, and the controversy was not slow in following. His only reply was the *Vindication* (1779), a complete and crushing reply to Davies and others who had attacked him (for a full account see *Bibliographers' Manual*, 1858, pp. 885–886).

In 1774 he became M.P. for Liskeard, which did not interrupt his work, except for an interval in 1779 when he was employed to write a *Mémoire justificatif* in answer to a French manifesto. For this service he was rewarded with a seat at the Board of Trade and plantations worth £800 a year. Gibbon lost his seat in Sept. 1780, but was returned for Lymington in a by-election in June 1781. In April 1781 the second and third volumes of his history appeared, which caused no excitement, but sold fast. Then followed a critical event in his life; Lord North's ministry fell, and Burke abolished the Board of Trade. Gibbon gave up his parliamentary career, which had been mute and inglorious indeed, but had acted as "a school of civil prudence, the first and most essential virtue of an historian," sold everything but his library, and moved to Lausanne in Sept. 1783, where he joined his friend Deyverdun. Here, in a house with a charming garden and a wonderful view, the history was quickly finished; the fourth volume was finished in 1784, the fifth two years later; and, he says, "it was on the day, or rather night, of the 27th of June 1787, between the hours of 11 and 12, that I wrote the last line of the last page in a summer-house in my garden. After laying down my pen, I took several turns in a *berceau*, or covered walk of acacias, which commands a prospect of the country, the lake and the mountains. The air was temperate, the sky was serene, the silver orb of the moon was reflected from the waters, and all nature was silent. I will not dissemble the first emotions of joy on the recovery of my freedom, and, perhaps, the establishment of my fame. But my pride was soon humbled, and a sober melancholy was spread over my mind by the idea that I had taken an everlasting leave of an old and agreeable companion, and that whatsoever might be the future fate of my history, the life of the historian must be short and precarious."

He took the manuscript to London in 1787, and in April 1788 the last three volumes were published, with as great success as before. He returned to Lausanne, where he suffered greatly from the loss of his friend Deyverdun, who died on July 4, 1789. The provisions of Deyverdun's will enabled Gibbon to remain in the same house, and there he wrote his *Memoirs of my Life and Writings* in 1789. In 1793 he came back to England and later in the year was obliged to undergo several operations. He never recovered his strength, and died on Jan. 16, 1794. He was buried at Flitching, Sussex. (J. S. B.; X.)

The **Value** of His Work.—Gibbon's literary art, the sustained excellence of his style, his piquant epigrams and his brilliant irony, would perhaps not secure for his work the immortality which it seems likely to enjoy, if it were not also marked by ecumenical grasp, extraordinary accuracy and striking acuteness of judgment. It is needless to say that in many points his statements and conclusions must now be corrected. He was never content with second hand accounts when the primary sources were accessible: "I have always endeavoured," he says, "to draw from the fountain-head; my curiosity, as well as a sense of duty, has always urged me to study the originals; and if they have sometimes eluded my search, I have carefully marked the secondary evidence on whose faith a passage or a fact were reduced to depend." Since he wrote, new authorities have been discovered or rendered accessible; works in Greek, Latin, Slavonic, Armenian. Syriac, Arabic and other languages, which he was unable to consult, have been published. Again, many of the authorities which he used have been edited in superior texts. The relative weights of the sources have been more nicely determined by critical investigation. Archaeology has become a science. In the immense region which Gibbon surveyed there is hardly a section which has not been submitted to the microscopic examination of specialists.

But apart from the inevitable advances made in the course of a century during which historical research entered upon a new phase, the reader of Gibbon must be warned against one capital defect. In judging the *Decline and Fall* it should carefully be observed that it falls into two parts which are heterogeneous in the method of treatment. The first part, a little more than five-eighths of the work, supplies a very *full* history of 460 years (A.D. 180–641); the second and smaller part is a summary history of about 800 years (A.D. 641–1453) in which certain episodes are selected for fuller treatment and so made prominent. To the first part unstinted praise must be accorded; it may be said that, with the materials at the author's disposal, it hardly admitted of improvement, except in trifling details. But the second, notwithstanding the brilliancy of the narrative and the masterly art in the grouping of events, suffers from a radical defect which renders it a misleading guide. The author designates the story of the later empire at Constantinople (after Heraclius) as "a uniform tale of weakness and misery," a judgment which is entirely false; and in accordance with this doctrine, he makes the empire, which is his proper subject, merely a string for connecting great movements which affected it, such as the Saracen conquests, the crusades, the Mongol invasions, the Turkish conquests. He failed to bring out the momentous fact that up to the 12th century the empire was the bulwark of Europe against the East, nor did he appreciate its importance in preserving the heritage of Greek civilization. He compressed into a single chapter the domestic history and policy of the emperors from the son of Heraclius to Isaac Angelus; and did no justice to the remarkable ability and the indefatigable industry shown in the service of the State by most of the sovereigns from Leo III. to Basil II. He did not penetrate into the deeper causes underlying the revolutions and palace intrigues. His eye rested only on superficial characteristics which have served to associate the name "Byzantine" with treachery, cruelty, bigotry and decadence. It was reserved for Finlay to depict, with greater knowledge and a juster perception, the lights and shades of Byzantine history. Thus the later part of the *Decline and Fall*, while the narrative of certain episodes will always be read with profit, does not convey a true idea of the history of the empire or of its significance in the history of Europe. It must be added that the pages on the Slavonic peoples and their relations to the empire are conspicuously insufficient; but it must be taken into account that it was not till many years after Gibbon's death that Slavonic history began to receive due attention, in consequence of the rise of competent scholars among the Slavs themselves

His Attack on Christianity.—The most famous chapters of the *Declzne and Fall* are the 1jth and 16th, in which the historian traces the early progress of Christianity and the policy of the Roman Government towards it. The flavour of these chapters is due to the irony which Gibbon has employed with consummate art and felicity. There was a practical motive for using this weapon. An attack on Christianity laid a writer open to prosecution and penalties under the statutes of the realm (9 and 10 William III. c. 22, still unrepealed). Gibbon's stylistic artifice both averted the peril of prosecution and rendered the attack more telling. In his *Autobiography* he alleges that he learned from the *Provincial Letters* of Pascal "to manage the weapon of grave and temperate irony, even on subjects of ecclesiastical solemnity." It is not easy, however, to perceive much resemblance between the method of Pascal and that of Gibbon, though in particular passages we may discover the influence which Gibbon acknowledges. For instance, the well-known description (in chap. xlvii) of the preposition "in" occurring in a theological dogma as a "momentous particle which the memory rather than the understanding must retain" is taken directly from the first Provincial Letter The main points in the general conclusions of these chapters have been borne out by subsequent research. The account of the causes of the expansion of Christianity is chiefly to be criticized for its omissions. There mere a number of important contributory conditions (enumerated in Harnack's *Mission und Ausbreitung des Christentums*) which Gibbon did not take into account. He rightly insisted on the facilities of communication created by the Roman empire, but did not emphasize the diffusion of Judaism. And he did not realize the importance of the kinship between Christian doctrine and Hellenistic syncretism, which helped to promote the reception of Christianity. He was ignorant of another fact of great importance (which has only in recent years been fully appreciated through the researches of F. Cumont), the wide diffusion of the Mithraic religion and the close analogies between its doctrines and those of Christianity. In regard to the attitude of the Roman Government towards the Christian religion, there are questions still *sub judice;* but Gibbon had the merit of reducing the number of martyrs within probable limits.

Gibbon's verdict on the history of the middle ages is contained in the famous sentence, "I have described the triumph of barbarism and religion." It is important to understand clearly the criterion which he applied; it is frequently misapprehended. He was a son of the 18th century; he had studied with sympathy Locke and Montesquieu; no one appreciated more keenly than he did political liberty and the freedom of an Englishman. This is illustrated by his love of Switzerland, his intense interest in the fortunes of that country, his design of writing "The History of the Liberty of the Swiss"—a theme, he says "from which the dullest stranger would catch fire." Such views and sentiments are incompatible with the idealization of a benevolent despotism. Yet in this matter Gibbon has been grossly misapprehended and misrepresented. For instance, Mirabeau wrote thus to Sir Samuel Romilly: "I have never been able to read the work of Mr. Gibbon without being astounded that it should ever have been written in English; or without being tempted to turn to the author and say, 'You an Englishman? No, indeed.' That admiration for an empire of more than two hundred millions of men, where not one had the right to call himself free; that effeminate philosophy which has more praise for luxury and pleasures than for all the virtues; that style always elegant and never energetic, reveal at the most the elector of Hanover's slave." This criticism is based on a perverse misreading of the historian's observations on the age of Trajan, Hadrian and the Antonines. He enlarges, as it was his business to do, on the tranquillity and prosperity of the empire in that period, but he does not fail to place his finger on the want of political liberty. as a fatal defect. He points out that under this benevolent despotism, though men might be happy, their happiness was unstable, because it depended on the character of a single man; and the highest praise he can give to those virtuous princes is that they "deserved the honour of restoring the republic, had the Romans of their days been capable of a rational freedom." The criterion by which Gibbon judged civilization and progress was the measure in which the happiness of men is secured, and of that happiness he considered political freedom an essential condition. He was essentially humane; and it is worthy of notice that he was in favour of the abolition of slavery, while humane men like his friend Lord Sheffield, Dr. Johnson and Boswell were opposed to the anti-slavery movement.

BIBLIOGRAPHY.—Of the original quarto edition of *The Decline and Fall,* vol. i. appeared, as has already been stated, in 1776, vols. ii. and iii. in 1781 and vols. iv.–vi. (inscribed to Lord North) in 1788. In later editions vol. i. was considerably altered by the author; the others hardly at all. The number of modern reprints has been very considerable. For many years the most important and valuable English edition was that of Milman (1839 and 1845), which was reissued with many critical additions by Dr. W. Smith (8 vols. 8vo, 1854 and 1872). This has now been superseded by the edition, with copious notes, by J. B. Bury (7 vols. 8vo, 1896–1900; new ed. 1909–13). The edition in Bohn's British Classics (7 vols., 1853) deserves mention. *See* also the essay on Gibbon in Sir Spencer Walpole's *Essays and Biographies* (1907). There are in addition, translations in nearly every European language. Gibbon's *Miscellaneous Works, with Memoirs of his Life and Writings, composed by himself; illustrated from his Letters, with ocrnsional Notes and Narrative,* published by Lord Sheffield in two vols. in 1796, has been often reprinted. The new edition in five vols. (1814) contained some previously unpublished matter, and in particular the fragment on the revolutions of Switzerland. (J. B. B.)

GIBBON, the collective title of the smaller manlike apes of the Indo-Malay countries, all belonging to the genus Hylobates (see PRIMATES), which constitutes the *family* Hylobatidae. One of the distinctive features of this family is the presence of small naked callosities on the buttocks. The extreme length of the limbs and the absence of a tail are other features of these small apes, which are arboreal in their habits. and make the woods resound with their unearthly cries; in agility they are unsurpassed. When they descend to the ground —which they do to obtain water —they walk in the upright posture, either with the hands crossed behind the neck, or held above the head. Their food consists of leaves and fruits. Gibbons may be divided into two groups, the one represented by the siamang. Hylobates (*Symphalangus*) syndactylus, of Sumatra and the Malay Peninsula, and the other by a number of closely allied species.

SILVERY GIBBON (HYLOBATES MOLOCH) MANLIKE SMALL APE OF THE EAST INDIES

The union of the index and middle fingers by means of a web extending as far as the terminal joints is the distinctive feature of the siamang, which is the largest of the group and black in colour with a white frontal band. Black or puce-gray is the prevailing colour in the second group, of which the hulock (H. hoolock) of Assam, H. *lar* of the Malay region and Tenasserim, and H. *agilis* of Sumatra are representatives. The range of the genus extends from the southern bank of the Brahmaputra in Assam to southern China, the Malay Peninsula, Java, Sumatra and Borneo.

GIBBONS, GRINLING (1648–1720), English wood carver, who helped to decorate St. Paul's cathedral. Windsor chapel and many great English houses, was born in 1648. Whether he was born Dutch or English, and when he arrived in London are uncertain. He died in London on Aug. 3. 1720. Gibbons early displayed great talent and was recommended by John Evelyn to Charles II, who employed him in the execution of statuary and ornamental carving He also worked for Sir Christopher Wren. One of his principal works is a life-size bronze statue representing James II in the dress of a Roman emperor.

He is, however, chiefly famous as a sculptor in wood. He executed the ornamental carving for the chapel at Windsor, the foliage and festoons in the choir of St Paul's, the baptismal fonts in St. James's. and an immense quantity of ornamental work at Burleigh, Chatsuorth and other great houses. The finest of all his productions is a ceiling at Petworth. His subjects are chiefly birds, flowers. foliage, fruit and lace, characterized by delicacy and elaboration of details, and truthfulness of imitation. In 1714 Gibbons nas appointed master carver in wood to George I. An example of his incredible realism is the lace cravat carved in limewood. now in the Victoria and Albert museum. London. once ouned by Horace Walpole, who is said to have worn it occasionally.

See A. E. Bullock, *Grinling Gibbons and his Compeers* (1914); *H.* A. Tipping, *Grinling Gibbons and the Woodwork of his Age* (1914). (*J. E.* LE.)

GIBBONS, JAMES (1834–1921), U.S. Roman Catholic cardinal and archbishop, called by Theodore Roosevelt in 1917 the most respected, venerated and useful citizen of the U.S., was born in Baltimore, Md., July 23, 1834. Educated at St. Charles college, Ellicott City, hfd., and St. Mary's seminary. Baltimore, Gibbons was ordained priest on June 30, 1861. After four years as a pastor and volunteer chaplain to the Civil War troops in the military hospitals of Baltimore. he became secretary to Archbishop Martin J. Spalding. In 1868 he was consecrated bishop and appointed to organize the new vicariate apostolic of North Carolina, in which capacity he attended the Vatican council in 1869–70. In 1872 Gibbons was promoted to be bishop of Richmond, and in 1877 he was named coadjutor to the archbishop of Baltimore. During his nine years in the south as a missionary bishop he had traveled widely and met all classes of people; the experience brought home to him the need for a simple and concise statement of the doctrines of the Roman Catholic Church, and as a consequence during his time in Richmond he wrote The Faith of *Our* Fathers (1876), which proved to be the most popular work on Catholic apologetics ever published in the United States; it is still widely sold. In Oct. 1877 Gibbons succeeded to the premier see of Baltimore, and in that office he presided as apostolic delegate over the Third Plenary council of the American hierarchy (1884). In 1886 Pope Leo XIII made him the second American cardinal.

Cardinal Gibbons was a fairly frequent contributor to periodicals' on questions of national interest, and beside The Faith *of Our Fathers* he wrote four other volumes dealing with religious subjects. Upon the opening of the Catholic University of America in Washington (1889) he became its first chancellor and was its powerful protector during the first difficult years.

The spirit in which the cardinal always viewed his native land and its institutions is illustrated by his remark that the constitution of the United States was the greatest instrument of government that ever issued from the hand of man. His sermon upon taking possession in Rome of his titular Church of Santa Maria in Trastevere (March 2j, 1887) was in high praise of the practical workings of the U.S. system of separation of church and state. The nation, in turn, felt a deep affection for him, and at the civic celebration of his golden jubilee as a priest and his silver jubilee as a cardinal (Baltimore, June 6, 1911) the United States witnessed the most distinguished gathering that it had ever seen in honour of a private citizen, led by President Taft. Cardinal Gibbons died on March 24, 1921, loved and esteemed by Americans of every walk of life and of every religious belief.

See John Tracy Ellis, *The Life of James Cardinal Gibbons, Archbishop of Baltimore, 1834–1921,* 2 vol. (1952). (J. T. E.)

GIBBONS, ORLANDO (1583–1625), English composer, was the most illustrious of a family of musicians all more or less able. His father, William Gibbons (d. 1595) was one of the "waits" of Cambridge, and his three sons, and, at least, one of his grandsons, were all good musicians. The eldest son. Edward (c. 1570–c 1650), was priest-vicar and succentor at Exeter cathedral, and some of his music is extant in various libraries. Ellis (1573–1603) contributed two madrigals to Morley's *Triumphs oj Oriana.* Orlando. the youngest and most famous of the brothers, was born at Cambridge. Dec. 25, 1583. At 12 years of age he became a chorister of King's college, Cambridge, and in due course a sizar of the college. taking his degree of Mus.D. in 1606. At the age of 21, he became organist of the Chapel Royal. Gibbons received many marks of royal favour, and in 1619 was appointed one of the king's musicians for the virginals. In 1622 he received the honorary degree of Mus.D. at Oxford, for which occasion he composed the anthem "O. clap your hands." Next year he nas appointed organist of Westminster Abbey, but only lived to hold the post for two years. In 1625 he went to Canterbury to produce a composition written in honour of the marriage of Charles to Henrietta Maria. and there died of apoplexy on June 5, 1625. He was buried in Canterbury cathedral.

The works published by Gibbons during his lifetime were Fantasies in Three Parts, composed for viols (c 1610). said to have been the first piece of music in England printed from engraved copper plates; six pieces for the virginals printed in the collection called Parthenza (1611); *Madrigals and Motets of 5 parts,* Apt for Viols and Voices (1612), which rank among the most exquisite of his works; and two anthems printed in Leighton's Teares or *Lamentaciones* (1614). His fame was kept alive as a composer of church music by the selections from his services and anthems printed by Barnard in his First Book of Selected *Church Music* (1641), and by Boyce in his Cathedral Music (1760–78). Some 40 anthems by Gibbons are in existence. Some'of these are in the polyphonic style of which he was a consummate master; others show him as a pioneer in the new form developed by Blow. Purcell and others of a later generation, for they have solos. often with instrumental accompaniment, and chorus.

Gibbons wrote church services in both the old and the new style, and left 17 hymn tunes marked with his own peculiar dignity of expression.

A collection of Gibbons's church music was edited by Sir F. Ouseley, in 1873; a complete edition is in the Carnegie edition of *Tudor Church Music,* vol iv (1925). His pieces for keyboard instruments nere edited by Margaret Glyn, j vol. (1925), and some of his music for strings by Fellowes (1924). See Margaret H. Glyn, About Elizabeth and Virginal Music and its *Composers* (1924), and E. H. Fellowes, Orlando *Gibbons* (1925).

GIBBS, JAMES (1682–1754), British architect, designer of St. Martin-in-the-Fields. London, was born in Aberdeen on Dec. 23, 1682. In 1700 or 1701 he went to the Netherlands, whence he traveled through France to Italy. In 1703 he entered the Pontifical Scots college in Rome to train for service as a Catholic missionary in his native land, but soon left it to study the arts, first painting and then architecture. In 1709 he went to England, where a sinecure granted by the earl of Mar enabled him to set up as an architect in London.

Gibbs was appointed one of the surveyors to the commissioners for building 50 new churches in London, and in 1714 designed St. Mary-le-Strand, his first public building. In 171j. he lost the surveyorship, but his private practice continued to prosper. Among his most famous buildings were St. Martin-in-the-Fields, London (1722–26),the Senate house at Cambridge (1722–30) and the Radcliffelibrary at Oxford (1737–49). He was an architect of great ability whose Roman training kept his style outside the Palladianism (*q.v.*) that dominated the English architectural scene. His books, especially A Book of Architecture (1728), were influential in Britain and America well into the 19th century. Gibbs died on Aug. 5, 1754, in London.

See Bryan Little, The Life and Work of James Gibbs 1682–1754 (1955), with a bibliography; and John Summerson, Architecture in Britain 1530–1830 (1954), for the best discussion of his architectural style. (Ms. W.)

GIBBS, JOSIAH WILLARD (1839–1903), the most distinguished American mathematical physicist of his day, was born at New Haven, Conn., on Feb. 11, 1839. Entering Yale in 1854 he graduated in 1858, and in 1863 went to Europe, studying in Paris in 1866–67, in Berlin in 1867 and in Heidelberg in 1868. Returning to New Haven in 1869, he mas appointed professor of mathematical physics at Yale in 1871 and held that position till his death on April 28. 1903. His first contributions to mathematical physics were two papers published in 1873 on "Graphical Methods in the Thermodynamics of Fluids," and "Method of Geometrical Representation of the Thermodynamic Properties of Substances by Means of Surfaces." His next and most important publication was his famous paper "On the Equilibrium of Heterogeneous Substances" (1876–78), which. it has been said, founded a new department of chemical science. This was translated into German by W. Ostwald (who styled its author the "founder of chemical energetics") in 1891 and into French by H. le Chatelier in 1899. In 1881 and 1884 he printed some notes on the elements of vector analysis for the use of his students; these were never formally published, but they formed the basis of a textbook on Vector Analysis which was published by his pupil, E. B. Wilson, in 1901. Between 1882 and 1889 a series of papers on certain points in the electromagnetic theory of light and its relation to the various elastic solid theories appeared in the American *Journal of* Science, and his last work. *Elementary* Principles in Statistical Mechanics, was issued in 1902. The name of Willard Gibbs is especially associated with the "Phase Rule." In 1901 the Copley medal of the Royal society of London was awarded him as being "the first to apply the second law of thermodynamics to the exhaustive discussion of the relation between chemical, electrical and thermal energy and capacity for external work."

Gibbs' original scientific papers were assembled in 1928, and published in two volumes by the Yale University Press as The Collected *Works* of J. Willard Gibbs. In 1936 there followed two companion volumes, A Commentary on the Scientific Writings of J. *Willard* Gibbs, written by a group of distinguished authors. The literature devoted to the exposition and applications of Gibbs' contributions is far too voluminous to be outlined here, but an extensive bibliography of books and articles about Gibbs can be found in Josiah Willard Gibbs, The History of a Great Mind (2nd ed., 1952), written by L. P. Wheeler, a former student of Gibbs. This book should be consulted for further biographical information, and for letters and short manuscripts not in The Collected *Works.* (B. B. On.)

GIBBSITE (Hydrargillite), aluminum hydroxide or trihydrate, is an important mineral of many bauxites. Commercial trihydrate bauxite, a major source of aluminum, may contain 60% or more aluminum oxide. or alumina (Al_2O_3), but rarely does this all represent gibbsite. Gibbsite is prominent in bauxites of Arkansas, Jamaica, the Guianas. Brazil, west Africa, India and many other locations. In bauxites. gibbsite is usually fine grained and may be cryptocrystalline, or occasionally relatively coarse in small cavities, or vugs, or veinlets.

Gibbsite in significant deposits is of secondary origin, but small-scale, hydrothermal sources are known. Under extreme weathering conditions. it may develop from any aluminous mineral, especially feldspars or feldspathoids. It may form directly from these or with the intermediate formation of clay mineral, or from boehmite.

Synthetic gibbsite is made from bauxite or high-alumina materials for production of aluminum metal and alumina chemicals. High temperature calcination yields corundum (*q.v.*) but partial calcination may yield a variety of near-anhydrous alumina types of difficultly analyzed structures.

The formula is α-$Al_2O_3.3H_2O$ or structure cell formula 8[Al-(OH),]. Bayerite, a dimorph of gibbsite, is not known in nature. Gibbsite. which is monoclinic prismatic, frequently occurs in tabular crystals of hexagonal aspect. Cleavage is perfect, hardness 2.5 to 3.5, specific gravity 2.4 or slightly less. Refringence is moderate (1.568–1.587). It is soluble in strong mineral acids and alkalies. The theoretically pure mineral contains 65.4% Al_2O_3 and 34.6% H_2O, but natural specimens are generally contaminated by ferric oxide, silica and other impurities. See also Alumina; Aluminum; Bauxite; Corundum, Artificial.

(W. K. Gr.)

GIBEON, an ancient city of Palestine, whose inhabitants successfully tricked Joshua into a truce (Josh. ix). David's select warriors fought with the chosen of Ishbosheth at the "Pool of Gibeon" (II Sam. ii), and there Joab treacherously slew Amasa (II Sam. xx).

But Gibeon was more renowned for its "high place" which the youthful King Solomon made it one of his first cares to visit, and where for a time the tabernacle was deposited. Gibeon is most probably represented today by El-Jib. where there seems to be an echo, if faint and uncertain, of the ancient name. El-Jib is a small village on an isolated hill, 5 mi. N.W. of Jerusalem, and is surrounded by olive groves. There are to be found springs and the remains of a reservoir.

Alt would identify Gibeon with Tell en-Nasbeh.

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(E. Ro.)

GIBRALTAR, a rocky peninsula, projecting southward, about $2\frac{3}{4}$ mi. long with greatest breadth nearly 1 mi., connected with the Spanish mainland by a sandy flat less than 10 ft. above the sea; bounded to the east by the Mediterranean and to the west by the Bay of Algeciras. Since 1713 it has been a British fortress and crown colony controlling the Strait of Gibraltar. Area: 2.25 mi., including reclamations.

Physical Features.— The promontory of Gibraltar, known as "the Rock," shoots abruptly upward from the low ground at the north front in a fine mural precipice, the basal portion of which is partly concealed by a sloping curtain of debris and breccia. This precipitous wall culminates at the Rock Gun (1,330 ft.) from which point the dividing ridge or backbone of the promontory extends southward in a sharp jagged arch. the dominant points of which are Middle hill (1,211 ft.), Signal hill (1,260 ft.), a point above Monkey's Alameda (1,398 ft., the highest of the Rock) and O'Hara's tower (1,380 ft.). At the latter the ridge is sharply truncated, and succeeded to the south by the well-marked plateau of Windmill hill and Europa point. From the Rock Gun to O'Hara's tower the dividing ridge presents to the east a bold escarpment, which is for the most part inaccessible, and in places almost vertical, the cliffs where they are lowest having a drop of not less than 300 or 400 ft., and of more than 1,000 ft. where they approach the sea on the north.

From their base the ground falls rapidly away to the coast line at angles that vary from 30° to 40°. The opposite slopes of the dividing ridge are not so abrupt, the only really precipitous portion that faces the west being the line of cliff that overlooks Gardiner's road and Engineer's road between the Moorish wall and the Mount.

The top of Windmill hill slopes from 400 to 300 ft. above the sea and so is separated by a great cliff from O'Hara's tower on the north; it ends southward in a zoo-ft. cliff, below which are Europa flats that themselves end in a jo-ft. cliff plunging steeply into fairly deep water. Europa point is $11\frac{1}{2}$ nautical miles from the African coast, and its lighthouse is in 5° 21' W. and 36° *6 30"* N.

The Rock is limestone, covered on the west by shales, both of Lower Jurassic age. The limestone has many caves with accumulations of bone breccia, and there are several apparently Pleistocene or still more recent deposits. The cave at the north end overlooking the isthmus near the Devil's tower has yielded evidence of the former presence of 2 j species of mammals, including the elephant and rhinoceros. During tunnelling operations on the east side of the Rock in 1944 a cave (Gorham's) 40 ft. high was found; it was excavated in 1948 and revealed four levels of occupation from Neanderthal to Roman times.

The flora of the Rock is not overly rich, because of the isolation and of the character of much of its surface. The stone pine and the wild olive appear to be long established. The fauna, apart from the Barbary apes, is not of great interest. A Mousterian flint industry was described for Gibraltar— especially the Devil's tower site—by Dorothy Garrod, who also found in 1926 a second skull of Mousterian type (discovery of the first in 1848 antedated by eight years that at Neanderthal). (H. J. F.; X.)

Climate.— June, July and August are practically rainless and May and September nearly so. The rest of the year is delightful, with occasional storms. The thermometer in summer does not often reach go° F. in the shade; from 83° to 8j° may be taken to be the average maximum for July and August, and the mean annual temperature is 64.4°.

The average yearly rainfall is $35\frac{1}{3}$ in., and the highest recorded rainfall in Gibraltar occurred in the winter of 18 j5–56 when it was 77.14 in., the lowest recorded rainfall being in 1800–01 when it was 1 j.12 in. The water supply for drinking and cooking purposes is almost wholly derived from rain water, stored chiefly in underground tanks; there are only two fresh-water wells. Rain reservoirs with a capacity of 12,000,000 gal. are filled with water from specially prepared collecting areas, covering about 50 ac., high up the Rock. There are separate reservoirs for army, navy and civilians.

History.— Gibraltar was known to the Greek and Roman geographers as Calpe or Alybe, the two names being probably corruptions of the same local (perhaps Phoenician) word. The eminence on the African coast near Ceuta which bears the modern English name of Apes' hill was then designated Abyla; and Calpe and Abyla, at least according to an ancient and widely current interpretation, formed the renowned Pillars of Hercules (Herculis columnae), which for centuries were considered as the limits of enterprise to the seafaring peoples of the Mediterranean world. Gibraltar was named after Tarik ibn Zaid, its name being a corruption of Jebel el-Tarik (Mount Tarik).

Tarik invaded Andalusia in A.D. 711 with an army of 12,000 Arabs and Berbers and in the last days of July of that year destroyed the Gothic power in a three days' fight on the banks of the river Guadalete near where Jerez de la Frontera now stands. In order to secure his communications with Africa he ordered the

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THE SIEGE OF GIBRALTAR. 1779–83, SHOWING ARRIVAL OF BRITISH RELIEVING SQUADRON UNDER ADMIRAL DARBY. APRIL 12, 1781

building of a castle on the Rock that the Romans had known as Mons Calpe. This work. begun in the year of the great battle, was completed in 742. It covered a wide area. reaching from the shores of the bay to a point halfway up the northwestern slope of the Rock; there the keep, a massive square tower, still stands and is known as the Moorish castle. Gibraltar was taken in 1309 by the Spaniards and retaken in 1333 by the Moors, from whom it passed in 1411 to the Moorish ruler of Granada. In 1462 it became Spanish once more, passing in 1469 into the family of the duke of Medina Sidonia. In 1502 Gibraltar was formally incorporated with the domains of the Spanish crow?. The Spaniards made great efforts to strengthen the place and succeeded so well that throughout Europe Gibraltar was regarded as impregnable, the engineer Daniel Speckle (1536–89) being chiefly responsible for the design of the fortifications.

Gibraltar was taken, however, by the allied British and Dutch forces after a three days' siege, on July 24, 1704. (See SPANISH SUCCESSION, WAR OF THE.) The capture was made, as the war was being fought, in the interests of Charles, archduke of Austria, but Sir George Rooke, the British admiral, on his own responsibility caused the British flag to be hoisted and took possession in the name of Queen Anne, whose government ratified the occupation. The Spaniards quickly assembled an army to recapture the place, and a new siege was begun in Oct. 1704 by troops of France and Spain under the marquess of Villadarias. The defense of the British admiral, Sir John Leake, and of the military governor, Prince George of Hesse-Darmstadt (who had commanded the land forces in July), caused it to be lifted after six months. By the treaty of Utrecht (1713) Spain formally recognized England's title to Gibraltar. Twice in the diplomatic exchanges of the next few years, England was prepared to consider restitution; but on both occasions the negotiations fell through, and by 1721 English public opinion was adamant against surrender. A Spanish attack in 1720 and another siege in 1727 alike proved abortive, and by the treaty of Seville of 1729 Spain ratified the eession.

Neither in the War of the Austrian Succession nor in that of 1762 did Spain again endeavour to besiege the Rock, but the siege of 1779–83, during the American Revolutionary War, is justly regarded as one of the most memorable sieges of history. Hostilities had begun on June 21, 1; 79, but were confined at first to a strict blockade from the land side, where the Spaniards set about constructing siege batteries under fire from the fortress. On Nov. 14, after a spirited naval action, the privateer "Buck" forced her way into the harbour with supplies; many such incidents followed. In Jan. 1780 Adm. Sir George Rodney won a great victory over Juan de Langara and entered with a convoy. Prince William Henry (afterward King William IV) served as a midshipman during this expedition. Supplies and reinforcements were thrown into the fortress by Rodney, and "the garrison," in spite of the scurvy, "might now be considered in a perfect state of defence," said John Drinkwater (see below). On June 7 an attack by Spanish fire ships was successfully dealt with by the naval force in the bay under Captain Lesley of the frigate "Enterprise." By autumn the supply question had again become acute. Though the enemy's batteries still did not open fire! the siege works steadily progressed, and there were frequent small engagements at sea in which the English were not always successful. Further, the expulsion, with great harshness, of the English residents of Barbary in Jan. 1781 put an end to a service of supply and information which had been of the greatest value. Three more months passed in forced inaction. Then, on April 12, 1781, on the arrival of a British relieving squadron under Adm. George Darby, the whole of the Spanish batteries opened fire. Stores were landed in the midst of a heavy bombardment, and much damage was done to fortifications and military buildings and to the town. The bombardment continued up to June 1, after which the rate of the enemy's fire decreased until by July 12 it had almost ceased. In September the firing again became intense and casualties increased. By October both sides were well covered, and in November the governor, Gen. Sir George Eliott, secretly prepared a great counterstroke. The sortie made on the night of Nov. 26–27 was brilliantly successful, and the Spanish siege works were mostly destroyed. At the close of the year the garrison was thus again in an excellent position.

Early in 1782 a gun-carriage wheel, allowing a large angle of depression, was invented by an officer of the royal artillery, one of many experiments made throughout the siege with guns, mountings, ammunition, methods of fire, etc., both in Gibraltar and in the Spanish camp. The new gun carriage enabled 93% of hits to be obtained at 1,400-yd. range. In April grates for heating shot were constructed by order of the governor; these were destined to be famous. At the same time it was reported that Louis de Berton, duc de Crillon and duc de Mahon, was to command the besiegers (French and Spanish) with J. C. E. LeMichaud d'Arçon as his chief engineer. The grand attack was imminent, and preparations were made to repel it. The chief feature of the attack was to be, as reported on July 26, ten ships "fortified 6 or 7 ft. thick . . . with green timber bolted with iron, cork and raw hides; which were to carry guns of heavy metal and be bomb-proof on the top with a descent for the shells to slide off; these vessels . . . were to be moored within half-gunshot of the walls." Many of the now existing rock galleries in the fortress were made about this time. The garrison made a preliminary trial of the red-hot shot on Sept. 8, and the success of the experiment not only elated the defenders but was partly instrumental in causing Crillon to hasten the main attack. After a preliminary bombardment the famous battering ships took up their positions in broad daylight on Sept. 13 and opened fire. The British solid shot failed to penetrate the massive wooden armour on their sides and roofs, and about noon the ships had settled down to their work and were shooting coolly and accurately. Then the British began to use red-hot shot. All day the artillery duel went on, the shore guns, though inferior in number, steadily gaining the upper hand, and by nightfall the battering ships were in great distress. The struggle continued in the dark, and one by one the ten ships were set on fire. Before noon on Sept. 14 the attack had come to an end, every ship having been blown up or burned to the water's edge. More than 8,300 rounds were expended by the garrison, though less than 100 pieces were in action. The enemy's bombardment was, however, resumed and partial engagements continued up to the third naval relief of the fortress on Oct. 11 by Lord Howe, his tactics completely defeating, without an engagement, the combined French and Spanish fleet. The long siege came to an end on Feb. 6, 1783, when Crillon informed Eliott that the preliminaries of peace had been signed.

The treaty of Versailles (1783) once more confirmed Britain's possession of the Rock, and its history thereafter was comparatively uneventful. Rumors in 1801 of a Spanish and French attack ended after Sir James Saumarez defeated the enemy ships off Algeciras in July. In 1830 the status of "fortress" was changed to that of "crown colony."

During World War I the Rock was of great value as a base for Allied navies, the most important being that of the United States. Thousands of Spanish refugees sought shelter in the fortress during the civil war of 1936–39. After Italy entered World War II in 1940 all women and children were removed from Gibraltar. as well as all male civilians except about 3,000 engaged in essential work. Additional defenses were constructed on the land side of the Rock to guard against attack through Spain, military engineers expanded the interior defenses fivefold. the length of tunnelling being increased from 2 mi. to 10 mi.. and a canal was cut across the isthmus. The repatriation of the 17,000 evacuees in the years following the war created the housing and other difficulties referred to below.

With the changing character of modem war the strategic role of Gibraltar was much altered. The withdrawal of the last royal marine in 1948 and of the last infantry battalion in 1950 severed a connection of almost 250 years; their place was taken by the 78th heavy anti-aircraft regiment, royal artillery. A permanent building scheme for the royal air force, whose association with the Rock began in 1937, was completed in 1956.

Successive Spanish governments. but especially that of Gen. Francisco Franco, stated from time to time that Gibraltar was Spanish territory to which the Spanish people did not renounce their claim—a claim that was never recognized by the United Kingdom government.

The Town. — The modem town of Gibraltar is of comparatively late date, nearly all the older buildings having been destroyed during the great siege (1779–83). The town lies, with most of its buildings crowded together, at the northwestern corner of the Rock and covers an area of only ¾ by ¼ mi. A good deal of land has been reclaimed from the sea. Much of the town, in fact the entire business quarter, is on level ground, and the narrow streets and ramps that go up the Rock only communicate with various private houses, barracks, etc. To the south of the town are the barracks for the military garrison and the majority of the larger official residences, together with sports grounds and other amenities. The Gibraltar museum, which was opened in 1930, contains casts of the Gibraltar skulls, a collection of the flora of the Rock and pictures, coins and stamps.

Population.—After the capture of the town by the British, the former Spanish population emigrated and founded, 6 mi. away, the little town of San Roque. Most of the native inhabitants are descendants of later Spanish and Italian settlers; there are also a number of Maltese and between 2,000 and 3,000 Jews. The Jews form a distinct society of their own. The language of the people is Spanish, not very correctly spoken. English is learned as a foreign language and is rarely spoken in their homes. Thousands of workers cross "the Lines" daily from the neighbouring Spanish town of La Linea de la Concepción, itself a mere suburb of Gibraltar whose population in 1950 was 55,105 (mun.). Though the gates are kept open. the frontier barrier closes at 10 P.M. save for those who have a pass. Aliens are not allowed to reside in Gibraltar without a special permit. which must be renewed at short intervals. After 1900 similar requirements were extended to British subjects not previously resident. In July 1951 the civilian population uas 22.848, an increase of 30% since the previous census of 1931. An official warning was given that if numbers continued to grow some would have to emigrate.

Government and Finance.—Power of legislation was vested until 1950 in the governor, who is also commander in chief, assisted by an executive council (established in 1922) of four official and three nominated unofficial members. By a new constitution there was then created in addition a legislative council, inaugurated on Nov. 23, 1950, of three ex-officio, five elected and two nominated members. Voting for the elected members was by proportional representation, the electorate being the same as for the city council. The governor, who presides over the legislative council, retains the right to enact any measure necessary in his judgment for public order or defense. The city council of four elected members succeeded in 1921 an earlier board of sanitary commissioners; it is responsible for buildings and streets, the civilian water supply and other matters of municipal administration not impinging on defense considerations. An appeal from its decisions, so far as these affect individuals, lies to the supreme court.

The grant of popular representation was allied to the need for direct taxation, a legacy of World War II. Hitherto the main sources of revenue had been: (1) duties on wine, spirits, malt liquors, tobacco and motor spirit (fuel); (2) port and harbour dues; (3) tavern and other licences; (4) posts and telegraphs; (5) rents of crown estate; and (6) stamps and miscellaneous. A rehousing scheme announced in 1945 to relieve the chronic problem of overcrowding in an inelastic space and estimated then to cost £750,000 for 1,000 flats, was revised soon after to a figure of £2,250,000 for 472 flats, a cost no longer within the colony's means. In 1947 a government lottery, calculated to produce, with fortnightly draws, £48,000 annually, was instituted to help with the problem, and a £1,000,000 loan was launched in 1948. In 1949 a trading-profits tax (the first direct taxation ever imposed in Gibraltar) and a new import tax on coffee was announced. Income tax was introduced in 1953. In 1955 import duties were imposed on a number of items.

Trade union legislation dates from 1947; nonresident aliens, who outnumber resident workers, especially in the admiralty dockyard, may not vote on strike issues.

Religion and Education.—Apart from the garrison and civil officials, there are comparatively few members of the Anglican Church. The great majority of the people belong to the Church of Rome, and in 1910 Gibraltar became a Roman Catholic bishopric, independent of the Spanish hierarchy and subject directly to the Vatican. There are, besides an Anglican and a Catholic cathedral, four Catholic churches. Nonconformist churches and four Jewish synagogues. The Anglican bishopric of Gibraltar, created in 1842, ministers to Anglican congregations throughout southern Europe from Madeira to the Caspian.

Education is compulsory for all children between the ages of 5 and 14. The 16 elementary schools (nearly all Roman Catholic) are subsidized by the government. as are also 4 secondary schools and a dockyard technical school; there are, in addition, several private schools. In the mid-1950s there was a total enrolment in government-aided schools of more than 3,500 students.

Commerce.—With few exceptions, Gibraltar has been a free port since 1705—a distinction arising, it is said, from the refusal of a sultan of Morocco to allow much-needed exports from Morocco to Gibraltar if full liberty of trade were not granted to his subjects.

During the great wars of the beginning of the 19th century trade was most active in Gibraltar, and some large fortunes were made. Thereafter the chief business was the coaling of passing steamers. This entered a period of decline after World War I, but with the installation of more modern coaling machinery in 1932 and exemption from the payment of port dues by vessels calling solely for bunkers, coaling enjoyed a modest revival. The increased use of oil fuel by ships, however, made unlikely any restoration of the earlier prosperity. Another source of trade is the export of goods landed for re-export to Morocco, but much of this business which formerly went to Gibraltar was transferred to lines of steamers operating directly between Morocco and British, German and French ports. Nearly all the fresh meat consumed in Gibraltar ordinarily comes from Morocco, and also large quantities of poultry and eggs. A large part of trading activity consists in importing from overseas for resale to the services and to Spaniards from the mainland. Of more than 2,000 tons of coffee imported each year, only 2% is consumed locally. About 3,500 vessels, totalling about 9,000,000 tons, enter and clear each year.

The money, weights and measures in legal use are British. Before 1898 only Spanish money was current, but the great depreciation of the Spanish currency during the war with the United States led to the reintroduction of British currency as the legal tender of Gibraltar. Notwithstanding this change Spanish money is still accepted.

After 1927 the currency included £5, £1 and 10*s*. notes issued by the government of Gibraltar. There are branches of Barclays bank (dominion, colonial and overseas) and the Crédit Foncier d'Algérie et de Tunisie and several private bankers. A government savings bank was founded in 1882 and had over £1,000,000 on deposit by the 1950s.

Harbour and Fortifications.—Early in the 20th century the defenses of Gibraltar were modernized. Old pieces of artillery at or near the sea level were replaced by new weapons placed high up, many of them on the crestline of the Rock, and new dockyard works were undertaken. Gibraltar became an important naval base where ships could lie at anchor secure against attack by surface vessels and be given extensive repair.

The land space available for the purposes of dockyard extension being very limited, a space of about 64 ac. was reclaimed from the sea in front of the Alameda and the road to Rosia; some of the land reclaimed was as much as 40 ft. under water. The large quantity of material required for this purpose was obtained by tunnelling the Rock from west to east and from quarries above Catalan Bay village, to which access was gained through the tunnel. The graving docks occupy the dugout site of the former new mole parade. There are three of these docks, 850, 550 and 450 ft. in length respectively, and a small dock which is available for merchant vessels of light draught. The largest dock is divisible by a central caisson so that four ships can be docked at one time. The docks are all 95 ft. wide at the entrance, with 354 ft. of water over the sills at low-water spring tides. The enclosed harbour covers 440 ac., 250 of which have a minimum depth of 30 ft. at low water. It is closed on the south and southwest by the south (or new) mole and the south mole extension, together 3,660 ft.; on the west by the detached mole, 2,717 ft.; and on the north by the north (or commercial) mole. The last runs westward from Devil's Tongue for about 2,900 ft. and then southward, giving a total length of more than a mile.

The south mole is said to have been begun by the Spaniards in 1620. It was successfully assaulted by landing parties from the British fleet under Sir George Rooke at the capture of Gibraltar by the British in 1704. It is formed of rubble stone floated into position in barges. The mole has a width at its top of 102 ft., and it has a continuous wharf wall on the harbour side, 3,500 ft. long, with water alongside 30–35 ft. deep.

The detached mole is a vertical wall formed of concrete blocks, each block weighing 28 tons. These blocks were built together on the sloping block system upon a rubble foundation of stone deposited by barges and levelled by divers for the reception of the concrete blocks.

The north mole is chiefly used by the navy as a convenient wharf for destroyers and other smaller craft. At the end nearest the town are large stores. Parallel with and inside the western arm of the mole, which is built of rubble, are five jetties faced with a concrete wharf wall and having 20 to 30 ft. of water alongside.

The Devil's Tongue was constructed during the great siege of 1779–83 in order to bring a flanking fire to bear upon part of the Spanish lines.

The old wharf at Waterport was extended and improved by the addition of a new mole, which was provided with sheds for transit cargo, electrical cranes and other equipment to facilitate the handling of cargo. In Jan. 1956 a port development scheme was approved. to cost £1,500,000, to include a deepwater quay and to be financed from Colonial Development and Welfare funds, irom a London market loan and from port revenues.

With the development of air warfare the defense of Gibraltar became a problem of particular difficulty because of the lack of space upon which to construct adequate airfields. At the beginning of World War II there was available only one small landing place with a length of merely 200 yd. A new runway on the narrow isthmus joining the Rock to the mainland mas built with rockspoil from the tunneling of new defenses; it was 190 yd. wide and projected out into the bay for nearly half its length of 1,800 yd.

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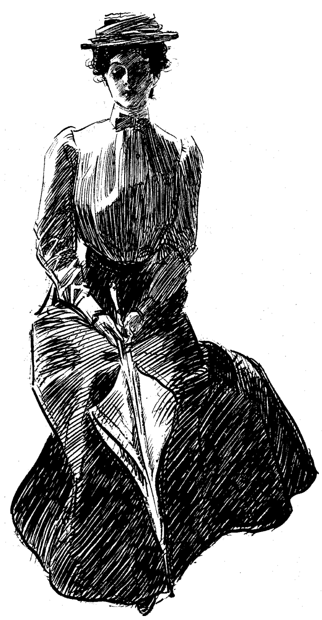
(A. B.; W. B. PN.; W. C. AN.)

GIBSON, CHARLES DANA (1867–1944), U.S. artist and illustrator, creator of the "Gibson girl." was born at Roxbury, Mass., on Sept. 14, 1867. After a year's study at the schools of the Art Students' league, he began with some little drawings for the humorous weekly *Life*.

These he followed up with more serious work, and soon made a place for himself as the delineator of the American girl. at various occupations, particularly those out-of-doors. The "Gibson girl" obtained an enormous vogue, being later published in book form. Some book illustrations followed, notably those for *The Prisoner of Zenda*.

Gibson was imitated by many of the younger draftsmen, copied by amateurs, and his popularity was shown in his engagement by *Collier's Weekly* to furnish weekly for a year a double page, receiving for the 52 drawings the sum of $50,000, said to have been the largest amount ever paid to an illustrator for such a commission. These drawings covered various local themes and were highly successful, being drawn with pen and ink with masterly facility and great directness and economy of line. So popular was one series. "The Adventures of Mr. Pipp." that a successful play was modeled on it. In 1905, although besieged with commissions. Gibson withdrew from illustrative work, determining to devote himself to portraiture in oil, in which direction he had already made some successful experiments; but in a few years he again returned to illustration. He published a number of books of sketches. In 1932 he became a member of the National Academy of Design. Gibson died in New Y'ork city on Dec. 23, 1944.



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"GIBSON GIRL" BY CHARLES DANA GIBSON

See Fairiax Downey, *Portrait of An Era* (1936).

GIBSON, EDMUND (1669–1748), English theologian and jurist. was born at Bampton in Westmorland. In 1686 he entered Queen's college. Oxford. where in 1692 he published a valuable edition of the *Saxon Chronicle* with a Latin translation: indexes and notes.

This was followed in 1693 by an annotated edition of the *De institutione oratoria* of Quintilian, and in 1695 by a translation (2 vol.) of Camden's *Britannia,* "with additions and improvements." with the assistance of William Lloyd. John Smith and other English antiquaries. Gibson was appointed chaplain and librarian to the archbishop of Canterbury, when he began to catalogue the library, and in 1703 and 1710 respectively, he became rector of Lambeth and archdeacon of Surrey.

During the reigns of William and Anne the controversy over the rights and privileges of convocation suggested to him the researches which resulted in the famous *Codex iuris ecclesiastici Anglicani* (2 vol., 1713; and enlarged ed., 1761). This work is a learned and comprehensive discussion of the legal rights and duties of the English clergy, and the constitution, canons and articles of the English Church.

In 1716 Gibson was presented to the see of Lincoln, from where he was in 1720 transferred to that of London, where for 25 years he exercised great influence, being regularly consulted by Sir Robert Walpole on ecclesiastical affairs. He broke with Walpole on the Quakers' Relief bill of 1736. He died Sept. 6, 1748.

Gibson's other works include *Vita Thomae Bodleii* with the *Historia Bibliothecae Bodleianae* in the *Catalogi librorum manuscriptorum* (1697). and the *Reliquiae Spelmannianae* (1698).

GIBSON, JOHN (1790–1866), English neoclassical sculptor, whose attempt to revive polychromed sculpture caused much controversy. was born on June 19, 1790, at Gyffin, Conway, Caernarvonshire. In 1804 he was apprenticed to a monumental mason in Liverpool, in which city he remained until 1817, latterly enjoying the patronage of the writer William Roscoe.

One of his first Royal Academy submissions, "Psyche Borne on the Wings of Zephyrus" (1816), was praised by John Flaxman, under whose persuasion he went to Rome in 1817. There he was befriended by Antonio Canova, leader of the neoclassicists; he was also instructed after 1822 by Bertel Thorwaldsen. His commissions from Rome (he did not return to England. even for visits, until 1844) included "Mars and Cupid" (1819), "Hylas and the Water Nymphs" (1826) and "Hunter and Dog" (1844); he was elected an associate of the Royal Academy in 1833 and a full member in 1838.

In face of opposition, but invoking Greek precedent. he introduced colour into a statue of Queen Victoria done for Liverpool in 1847, tinting only diadem, sandals and robe hem. A repetition of the 1833 "Cupid Tormenting the Soul" was, however, completely coloured—Gibson said at the behest of the god in a vision—and the best-known example of this polychromy was the "Tinted Venus" of 1851–55.

His commemorative sculpture included the Queen Victoria group for the princes' chamber. houses of parliament, London (1850–55), statues of George Stephenson (1844) and Sir Robert Peel (1851) and portrait busts.

Gibson died in Rome on Jan. 27, 1866. The Gibson gallery, Burlington house, contains his bequest to the Royal Academy of casts and a few works in marble.

GIBSON, THOMAS MILNER (1806–1884), English statesman. was the leading associate of Richard Cobden and John Bright and became prominent as a persuasive exponent of their doctrines. He was born at Port of Spain. Trinidad, on Sept. 3, 1806. By birth and marriage an East Anglian landowner. he was elected Conservative member for Ipswich in 1837; converted to free trade. he turned Liberal two years later and lost his seat. He was member for Manchester from 1841 to 1857, when his opposition to the Crimean War led to his defeat, and for Ashton-under-Lyne from 1857 to 1868. Vice-president of the board of trade under Lord John Russell from 1846 to 1848, he became president in 1859 upon Cobden's refusal to enter Lord Palmerston's ministry, relinquishing the presidency of the poor law board. During his long tenure on the board of trade, which ended in 1866, Milner Gibson gave valuable support to W. E. Gladstone's fiscal and financial reforms at the exchequer, and was himself largely responsible for the repeal of "taxes on knowledge." He withdrew from politics in 1868 ard died at Algiers on Feb. 2j, 1884.

Milner Gibson was an effective propagandist for the Anti-Corn Law league, a respected and popular figure in parliament and an adequate administrator. His wife's *salon,* for long a noted meeting place of English and European intellectuals, added to his influence in Liberal society. Consistently loyal to Cobden and Bright, he lacked their reluctance to take office as well as their stature, and found a place in the variegated cabinets of Russell and Palmerston primarily as the best available representative of the "Manchester school." (A. F. T.)

GIBSON, WILLIAM HAMILTON (1850–1896), U.S. illustrator, author and naturalist, was born in Sandy Hook, Conn., on Oct. 5, 1850. He had sketched flowers and insects when he was only eight years old, had long been interested in botany and entomology and had acquired great skill in making wax flowers. His first drawings, of a technical character, were published in 1870. He rapidly became an expert illustrator and a remarkably able wood engraver, while he also drew on stone with great success. He drew for many periodicals, his most popular works being a long series of nature articles published in *Harper's, Scribner's* and *Century*. Gibson died July 16, 1896, at Washington, Conn.

Gibson was an expert photographer, and his drawings had a nearly photographic and almost microscopic accuracy of detail. He was perfectly at home in black and white, but rarely (and feebly) used colours.

GICHTEL, JOHANN GEORG (1638–1710), German mystic, was born at Ratisbon on March 14, 1638. He was admitted an advocate, first at Spires, and then at Ratisbon, but a meeting with the baron Justinianus von Weltz (1621–68), a Hungarian nobleman who cherished schemes for the reunion of Christendom and the conversion of the world, and a natural leaning toward mysticism changed his career. He promoted a society known as the *Christerbauliche Jesusgesellschaft.* The movement in its beginning provoked no active hostility; but when Gichtel began to attack the teachings of the Lutheran clergy and church, especially upon the fundamental doctrine of justification by faith, he was prosecuted and banished (1665). He settled at Zwolle, Holland, where he co-operated with Friedrich Breckling (1629–1711), who shared his views and aspirations. In 1668 he moved to Amsterdam, where he made the acquaintance of Antoinette Bourignon (1616–80), and became an ardent disciple of Jakob Boehme, whose works he published in 1682 (Amsterdam, 2 vol.). He had attracted to himself a small band of followers known as Gichtelians or Brethren of the Angels, who held views at which he had arrived independently of Boehme. But, unlike Boehme, who "desired to remain a faithful son of the Church," the Gichtelians became Separatists (*cf.* J. A. Dorner, *History of Protestant Theology,* ii, p. 185).

Gichtel's correspondence was published without his knowledge by Gottfried Arnold, a disciple, in 1701 (z vol.) and in 1708 (3 vol.). It has been frequently reprinted under the title *Theosophia practica*.

GIDDINGS, FRANKLIN HENRY (1855–1931), U.S. sociologist and one of the founders of systematic sociology in the U.S., was born in Sherman, Conn., on March 23, 1855. He studied engineering at Union college, Schenectady, N.Y., and after graduating in 1877 was a journalist in Springfield. Mass. He succeeded Woodrow Wilson as professor of politics at Bryn Mawr college in 1888 and was professor of sociology at Columbia university from 1894–1928. He died at Scarsdale, N.Y., on June 11, 1931.

Giddings' idea of sociology as the basic social science, formulated in his *Principles oj Sociology* (1896), was derived from A. Comte and L. F. Ward. In his psychological analysis of society he was influenced by Adam Smith, from whom he derived his doctrine of "the consciousness of kind," through which the integration of society is achieved. This was further developed in his conception of social behaviour as "differential responses to stimulation" in his *Studies in the Theory of Human Society* (1922). the best statement of his mature sociological theory. Giddings was stimulated by the theories of Herbert Spencer, Charles Darwin. Ludwig Gumplowicz, Gabriel Tarde, Émile Durkheim, Karl Pearson and others, welding their doctrines into a well-integrated system. In such later works as *The Scientific Study of Human Society* (1924), he emphasized the importance of a statistical approach to sociological problems. On public affairs he wrote *Democracy and Empire* (1900), *Western Hemisphere in the World of Tomorrow* (1915) and *The Responsible State* (1918). *The Mighty Medicine* (1930) and a posthumous volume, *Civilization and Society* (1932), summarized his theory and its applications.

See J. L. Gillin, ch. 7, *American Masters of Social Science,* ed. by H. W. Odum (1927); F. H. Hankins, "Franklin Henry Giddings (1855–1931)," *American Journal of Sociology*, pp. 349–67 (Nov. 1931); C. H. Northcott, ch. 38, in *Introduction to the History of Sociology*, ed. by H. E Barnes (1947); R. G. Hoxie *et al.* (eds.), *A History of the Faculty of Politiral Science, Columbia University* (1955). (H. E. Bar.)

GIDDINGS, JOSHUA REED (1795–1864), U.S. statesman, prominent in the antislavery conflict, was born at Tioga Point, now Athens, Pa.. on Oct. 6, 1795. In 1806 his parents moved to Ashtabula county, O. For several years after 1814 he was a schoolteacher, but in Feb. 1821 he was admitted to the Ohio bar and soon obtained a large practice. He served in the lower house of the state legislature in 1826–28, and from 1838 until 1859 was a member of the national house of representatives, first as a Whig. then as a Free-soiler and finally as a Republican. Recognizing that slavery was a state institution, uith which the federal government had no authority to interfere, he contended that slavery could exist only by a specific state enactment. that therefore slavery in the District of Columbia and in the territories was unlawful and should be abolished. that the coastwise slave trade in vessels flying the national flag, like the international slave trade, should be rigidly suppressed, and that congress had no power to pass any act which in any way could be construed as a recognition of slavery as a national institution. His attitude in the so-called Creole case attracted particular attention. In 1841 some slaves who were being carried in the brig "Creole" from Hampton Roads, Va., to New Orleans, La., revolted, killed the captain, gained possession of the vessel and soon afterward entered the British port of Nassau, Bah. Thereupon, according to British law, they became free. The minority who had taken an active part in the revolt were arrested on a charge of murder, and the others were liberated. Efforts were made by the U.S. government to recover the slaves; Daniel Webster, then secretary of state. asserting that on a U.S. ship they were under the jurisdiction of the United States and that they were legally property. On March 21, 1842, before the case was settled, Giddings introduced in the house of representatives a series of resolutions, in which he asserted that "in resuming their natural rights of personal liberty" the slaves "violated no law of the United States." Giddings was formally censured by the house, and thereupon resigned, appealed to his constituents and was immediately re-elected by a large majority. From 1861 until his death, in Montreal, Que., on May 27, 1864, he was U.S. consul-general in Canada.

Giddings published a series of political essays signed "Pacificus" (1843); *Speeches in Congress* (1853); *The Exiles of Florida* (1858); and a *History of the Rebellion: Its Authors and Causes* (1864).

See *The Life of Joshua R. Giddings* (1892), by his son-in-law, George Washington Julian.

GIDE, ANDRÉ PAUL GUILLAUME (1869–1951), French novelist and essayist, was born in Paris on Nov. 21, 1869, and educated at the École Xlsacienne and the Lycée Henri IV. He made his debut in literature with a half-psychological, half-lyrical confession, *Les Cahiers d'André Walter* (1891). This was followed by the ironical *Le voyage d'Urien* (1893). *Paludes* (1895), depicting the mediocrity of man's life, and *Les Nourritures terrestres* (1897), a work in which his anti-intellectualism was carried to the extreme of advocating a pure voluptuousness for the enrichment of life. In 1902 Gide published his first novel, *L'Immoraliste,* a masterpiece, following the purest classical tradition with clear-cut psychological design and sureness of touch. *La Porte étroite* (1909, Eng. tr. 1924), *Isabelle* (1911), *La Symphonie pastorale* (1919) are comparatively short analytical novels. distinguished by the same merits. In the *Caves du Vatican* (1914) he attempted less successfully the fantastic and humorous novel. This *sotie* is interesting as illustrating the idea of the *acte gratuit;* that is, void of all ethical or social finality. Among Gide's later works were *Les Faux monnayeurs* (1925), an unequal work, encumbered with detail, but of acute analysis; and *Si le grain ne meurt* (1924), an autobiographical account in which sincerity sometimes gives way to cynicism. He wrote *Le Retour* de *l'U.R.S.S.* (1936) after a trip to the Soviet Union left him disillusioned of a former warmth for the soviet experiment. *Imaginary Interviews* (Eng. tr. 1944), a series of interior dialogues about literature. was written during World War II and became a vehicle for Gide's reactions to the German occupation. Gide also wrote several critical essays and translations. His works were collected in French (*Œuvres complètes,* 1j vol.. 1932–39), and his definitive *Journals* were published in English in three volumes (1947–49). Gide was awarded the 1947 Nobel prize for literature. He died Feb. 19, 1951.

GIDE, CHARLES (1847–1932), French economist and supporter of the co-operative movement, was born on June 29. 1847, at Uzès (Gard). Educated at the College d'Uzès, he entered the faculty of law of the University of Paris. He early became professor of political economy, first at Bordeaux, then at Montpellier and from 1898 to 1920 at the University of Paris. He was the author of one of the best introductory treatises on political economy, *Principes d'e'conomie politique* (first published in 1884 and later translated into English and other languages), and joint author with Charles Rist of a work on the history of economic theory, *Histoire des doctrines kconomiques* (3rd ed.. 1920). Gide devoted a great deal of time and energy to the encouragement and furtherance of the co-operative movement in France, and wrote largely on this question. He unremittingly endeavoured to maintain and promote harmonious international relations and especially to preserve co-operation among intellectual workers in different countries.

GIDEON, surnamed JERUBBAAL (in the Douai version of the Bible, GEDEON JEROBAAL), a liberator, reformer and "judge" of Israel who delivered Israel from hordes of desert raiders—Midianites and others (Jud, vi–viii). He is called Jerubbaal also in the narrative, and it'is possible that the exploits of two heroes have been combined in the passage. There are, as a matter of fact, at least two narratives combined in the relevant chapters of Judges. According to one account Gideon is visited by the angel of Yahweh as he is threshing corn in a wine press, to hide it from the Midianites. and is greeted as the future saviour of Israel. A portion of this narrative has been lost, but it must have told of a raid on Tabor by the Midianites, in the course of which Gideon's brothers were killed. Gathering 300 of his clansmen. Gideon first attacked the raiders by night and drove them away in flight, and then, pursuing them beyond Jordan, captured and slew their two chiefs, Zebah and Zalmunnah. He was then offered the throne, but refused it, and made an image from the Midianite spoil. thus leading Israel into idolatry. In the other narrative Gideon is summoned at night by Yahweh to overthrow the altar of Baal and to establish an altar to Yahweh in its place. This is discovered in the morning. and Gideon is saved from the anger of his fellows only by the pleading of his father, who argues that since Baal has been insulted. Baal must take vengeance—if he can. Gideon then gathers all Israel, his force is reduced to 300 in number. and with these. encouraged by a dream which he hears told in the camp of Midian, he assaults the enemy by night. They flee in panic, but find that the fords of Jordan are held against them by Ephraimites. who capture and kill the two chiefs Oreb and Zeeb. The Ephraimites then complain that Gideon, a Manassite, had not summoned them to follow him, and he appeases their anger by pointing to the honour they have won in killing Oreb and Zeeb.

The story is important as illustrating the danger of raids from the desert to which Palestine was subject, and it prepared the way for Abimelech (*q.v.*), Gideon's son, who made the first effort to establish an Israelite monarchy. *See* also JUDGES, THE BOOK OF.

(S. A. C.; T. H. R.)

GIDEONS, THE. The Gideons, the Christian Commercial Men's Association of America, International, was organized by three traveling men at Janesville, Wis., on July 1, 1899. In Nov. 1908, the organization began to place copies of the Bible in hotel guest rooms, a work which made it famous the world over.. On that date, Bibles were placed in the Superior hotel, Iron Mountain (later Superior), Mont. Later the work was extended to include hospitals and penal institutions and schools. During World War II the Gideons supplied the U.S. armed forces with service testaments.

The Bible work of the Gideons is supported through free-will offerings. The emblem of the Gideons is a two-handled pitcher and torch. in memory of the Bible account of Gideon's victory over the Midianites in Judges vii.

GIEDION, SIGFRIED (1893–), Swiss art historian and the first to apply scholarly methods of analysis successfully to 20th-century architecture. was born in Lengnau, Switz., on April 14, 1893. He was influenced by scholars such as Jakob Burckhardt, Alois Riegl. August Schmarsow and his teacher Heinrich Woelfflin. Giedion's initial training in engineering stood him in good stead when he set out to clarify origins and directions of modern architecture: which he was able to observe closely in his capacity. (from 1928) as secretary-general to the International Congresses for Modern Architecture (C.I.A.M.) and through his personal friendship with such leading architects as Walter Gropius and Le Corbusier.

Giedion taught at the Federal Institute of Technology, Ziirich, and at Harvard university and wrote a number of books. His *Space, Time and Architecture* (10th ed., 1954) is indispensable for an understanding of 20th-century architecture. *Mechanization Takes Command* (2nd ed., 1957) dealt with the consequences of industrialization and *Constancy and Change in Art and Architecture* (Mellon lectures for 1957) marked a new stage in Giedion's development by re-examining such basic problems as abstraction, symbol: symmetry and proportion.

Giedion's work was characterized by unorthodox approaches and great strength of perception; in his historical studies he tried to see the past in all its relevance for the present and future.

(E. F. SR.)

GIEN, a town of central France in the *arrondissement* of Montargis. within the *département* of Loiret on the Loire, 39 mi. E.S.E. of Orleans by rail. Pop. (1954) 6.798. Gien has many old houses.

A stone bridge was built there by Anne de Beaujeu, daughter of Louis XI, about the end of the 1jth century. It is the seat of a subprefect. The old castle. used as a law court. was built in 1494 by Anne de Beaujeu, of brick and stone arranged in geometrical patterns. Gien was damaged extensively during World War II.

GIERKE, OTTO VON (1841–1921) was a leader of the German school of historical jurisprudence second only to F. K. von Savigny (1j79–1861). Born at Stettin on Jan. 11, 1841. he studied at the universities of Berlin and Heidelberg and was professor of law at Breslau (1871–84), Heidelberg (1884–87) and Berlin (1887–1921). His first researches, on the history of associations in German law. culminated in *Das Deutsche Genossenschaftsrecht* (4 vol., 1868–1913). This major work was partly translated into English by F. W. Maitland under the title of *Political Theories of the Middle Age* (1900). Its "realist'! doctrine of corporations profoundly influenced legal theory. From about 1888 Gierke turned more to private law, commenting on the German civil code then newly drafted, and publishing *Deutsches Privatrecht* (2 vol., 1895–1905) and *Das Recht der Schuldverhältnisse* (1917). Gierke died at Berlin on Oct. 10, 1921. His son Julius (187j–), born at Breslau on March 5, 18; j, wrote several works on commercial, insurance and maritime law, and was professor at Gottingen from 192j.

See the introduction to F. W. Maitland, *Political Theories* of ***the Middle Age,*** (1900); S. Mogi, *Otto von Gierke* (1932).

GIERS, NICHOLAS KARLOVICH DE (1820–189j), Russian statesman of Swedish extraction, was born on May 21,

1820. He was educated at the lyceum of Tsarskoye Selo, near St. Petersburg (Leningrad). At 18 he entered the service of the eastern department of the ministry of foreign affairs. and spent more than 20 years in subordinate posts, chiefly in southeastern Europe, until he became minister plenipotentiary in Persia in 1863. He remained there for six years, and, after serving as a minister in Switzerland and Sweden. he was appointed in 1875 director of the eastern department and assistant minister for foreign affairs under Prince Gorchakov, whose niece he had married. The Herzegovinian insurrection had broken out, and he could perceive from secret official papers that the incident had far-reaching ramifications. While the Austrian officials in Dalmatia were almost openly assisting the insurgents, Russian volunteers were flocking to Serbia with the connivance of the Russian and Austrian governments, and General Ignatiev, as ambassador in Constantinople, was urging his government to take advantage of Turkey's weakness and bring about a radical solution of the eastern question. Gorchakov did not want a radical solution involving a great European war, but he did nothing to stem the current of popular excitement. Alexander II, personally averse to war. was not insensible to the patriotic enthusiasm, and remained undecided. Giers gauged the situation accurately. As an official and a man of non-Russian extraction he had to be reticent. but in private he condemned severely the ignorance and recklessness of those around him. The event justified his sombre previsions. The so-called patriots wished to defy Europe in order to maintain intact the treaty of San Stefano, and again Giers found himself in an unpopular minority. His influence mas thrown into the scale of peace. His views. supported by Count Shuvalov, finally prevailed, and the European congress assembled at Berlin. He was not present at the congress, and escaped the blame for the concessions which Russia made to Great Britain and Austria. From that time he was practically minister of foreign affairs, for Prince Gorchakov was in weak health. and lived mostly abroad.

On the death of Alexander II in 1881 it was generally expected that Giers would be dismissed, as deficient in Russian nationalist feeling, for Alexander III had strong anti-German Slavophil tendencies. In reality the young tsar was fully determined not to let his hand be forced by men less cautious than himself. He wanted a minister of foreign affairs who would allow him to control the main lines, and occasionally the details, of the national policy. Giers was, therefore, appointed minister of foreign affairs on the retirement of Prince Gorchakov in 1882; he held office until 1894. In accordance with Alexander III's wish, Giers followed systematically a pacific policy. Accepting the Triple Alliance as a *fait accompli,* he sought to establish more friendly relations with the cabinets of Berlin, Vienna and Rome. To the advances of the French government he at first turned a deaf ear, but when the *rapprochement* between the two countries was effected with little or no co-operation on his part, he utilized it for restraining France and promoting Russian interests. He died on Jan. 26, 1895, soon after the accession of h'icholas II.

GIESEBRECHT, (FRIEDRICH) WILHELM (BENJAMIN) VON (1814–1889), German historian. author of the first general history of the medieval empire based on modern critical methods, was born in Berlin, March 5, 1814, and studied under Leopold von Ranke. In 1857 he became professor at Konigsberg and in 1862 succeeded Heinrich von Sybel at Munich, where he died, Dec. 18, 1889. In *Geschichte der deutschen Kaiserzeit* (6 vol., 1855–95; completed by B. von Simson), Giesebrecht concerned himself with political and religious aspects, ignoring legal, social, economic and constitutional history. His romantic view of the emperors aroused controversy, notably with Sybel. Other works include *Jahrbücher des deutschen Reiches unter Otto II* (1840) and the restoration of the important monastery records *Annales Altahenses* (1841).

GIESSEN, a town of Germany, capital of the former province of Upper Hesse, in central Hesse. It is at the confluence of the Wieseck with the Lahn, 41 mi. N.N.W. of Frankfurt am Main on the railway to Cassel. Pop. (1950) 46,712. Giessen was formed in the 12th century out of the villages Selters, Aster and Kroppach, for whose protection Count William of Gleiberg built the castle of Giessen. The town came, in 1203, into the possession of the count palatine, who sold it in 1265 to the landgrave Henry of Hesse. It was fortified in 1530 but in 1805 the walls were demolished. In the old part of the town the streets are narrow and irregular. The principal buildings are the Stadtkirche, the provincial government offices, comprising a portion of the old castle dating from the 12th century, and the town hall (containing an historical collection). The university, founded in 1607 by the landgrave of Hesse, has a library, a botanic garden, an observatory, medical schools, a museum of natural history, a chemical laboratory and an agricultural college. The industries include metal founding and the manufacture of rubber articles, machines, leather, tobacco and beer.

GIFFARD, GODFREY (*c.* 1235–1302), chancellor of England and bishop of Worcester, brother of Walter Giffard (*q.v.*), succeeded his brother as chancellor in 1266, and held that office until 1270. He was bishop of Worcester from 1268 until his death on Jan. 26, 1302. He was a benefactor of his cathedral.

See W. Thomas, *Survey of Worcester Cathedral; Episcopal Registers; Register of Bishop Godfrey Giffard,* ed. by J. W. Willis-Bund (1898–99); and the Annals of Worcester in the *Annales monastici,* vol. iv., ed. by H. R. Luard (1869).

GIFFARD, WALTER (d. 1279), chancellor of England and archbishop of York, was a son of Hugh Giffard of Boyton, Wiltshire, and after serving as canon and archdeacon of Wells, mas chosen bishop of Bath and Wells in May 1264. In August 1265 Henry III appointed him chancellor of England, and he was one of the arbitrators who drew up the *dictum de Kenilworth* in 1266. Later in this year Pope Clement IV named him archbishop of York. He was the chief of the three regents of the kingdom from the death of Henry III in 1272 until the return of Edward I in Aug. 1274, and again in 1275. Giffard died in April 1279.

See *Fasti Eboracenses,* ed. by J. Raine (1863); Giffard's *Register* from 1266 to 1279, ed. by W. Brown.

GIFFARD, WILLIAM (d. 1129), bishop of Winchester; received his see from Henry I (1100). He was one of the bishops elect whom Anselm refused to consecrate (1101) as having been nominated and invested by the lay power. During the investitures dispute Giffard was on friendly terms with Anselm, and drew upon himself a sentence of banishment through declining to accept consecration from the archbishop of York (1103). He was, however, one of the bishops who pressed Anselm, in 1106, to give way to the king. (*See* also ANSELM, SAINT.) He was consecrated after the settlement of 1107. He founded at Waverley, Surrey, the first English Cistercian house (1128) and restored Winchester cathedral with great magnificence.

GIFFEN, SIR ROBERT (1837–1910), British statistician and economist, was born at Strathaven, Lanarkshire, on July 22, 1837. After working for the *Stirling Journal,* he joined the staff of the *Globe* in 1862. He also assisted John Morley on the *Fortnightly Review* and in 1868 he became assistant editor on the *Economist.* In 1873 he was named city editor of the *Daily News.* He later held the same position on *The Times.* In 1876 he was appointed head of the statistical department in the Board of Trade where he became assistant secretary (1882) and controller-general (1892). As chief statistical adviser to the government he was constantly employed in drawing up reports, giving evidence before commissions of inquiry and acting as a government auditor. He retired in 1897 and died in Scotland on April 12, 1910.

GIFFORD, RQBERT SWAIN (1840–1905), U.S. painter and etcher, best known for his coastal views and north African scenes, was born at Naushon, Mass., Dec. 23, 1840. He was a late product of the Hudson river tradition. He worked mainly in New York city, where he was long a teacher in the Woman's Art School of Cooper Union and its director from 1896 until his death, Jan. 15, 1905. He was also an etcher and water colourist of considerable reputation. (D. H. W.)

GIFFORD, WILLIAM (1756–1826), English man of letters who, as first editor of the *Quarterly Review,* attacked Leigh Hunt and what he called the Cockney school of poetry, was born in Ashburton, Devonshire, in April 1756. Orphaned at 12, he was harshly treated by his godfather who resented paying for his schooling and sent him first to a farm, then to sea and finally to a shoemaker as apprentice. Through the kindness of an Ashburton surgeon, William Cookesley, he was sent back to school and to Exeter college. Oxford. He took his degree and in 1782 became tutor to Lord Grosvenor's son and began to publish verse. *The Baviad* (1794) is a satire, after Persius. on the Della Cruscan coterie led by Hester Lynch Piozzi (*q.v.*), and *Tlze Maeviad* (1795) is an attack on the corruptions of the drama. In 1802 he published a translation of Juvenal's *Satires,* prefaced by a short autobiography. An admirer of the classics, he mas also interested in post-Shakespearean dramatists and edited the plays of Philip Massinger (1804–13), Ben Jonson (1816) and John Ford (published posthumously, 1827).

Meanwhile, with George Canning's support, Gifford had founded the *Anti-Jncobin* (1799), and in 1809 he became editor of the new *Quarterly Review* founded by Canning and his friends to counterbalance the Whig *Edinburgh Review.* For the next 15 years he made it the vehicle for his hatred of radicals and also of most rising authors, upon whom. according to Southey, he looked as Tzaak Walton did upon worms. Although ultimately responsible for it. he almost certainly did not write the famous attack on Keats's *Endymion* (1818): hut his habitually malevolent reviews provoked Hazlitt into writing *A Letter to William Gifford, Esq.* (1819) in which he called him "the Government Critic . . . the invisible link, that connects literature with the police." He resigned from the *Quarterly Review* in 1824, and died in London on Dec. 31, 1826.

See R. B. Clark, *William Gifford* (1930).

GIFT, in general English, a term for a present or thing bestowed. *i.e.,* an alienation of property otherwise than for a legal consideration. Formerly in English law property in land could be conveyed by one person to another by a verbal gift of the estate accompanied by delivery of possession. The statute of frauds required all such conveyances to be in writing. and a later statute (8 and 9 Vict. *c.* 106) requires them to be by deed (*q.v.*).

Chattels may be effectually transferred from one person to another by a simple verbal gift accompanied by delivery. But unless the actual thing is bodily handed over to the donee, the mere verbal expression of the donor's desire or intention has no legal effect whatever. The persons are in the position of parties to an agreement which is void as being without consideration. But a declaration of trust. while retaining possession, is good *(see* Williams. *Personal Property).* When the nature of the thing is such that it cannot be bodily handed over, it will be sufficient to put the donee in such a position as to enable him to deal with it as the owner. For example, when goods are in a warehouse, the delivery of the key will make a verbal gift of them effectual; but it seems that part delivery of goods which are capable of actual delivery will not validate a verbal gift of the part undelivered. The gift of such personal property as is not chattels or transferable to bearer requires a written transfer in proper form.

For gift taxes. *see* ESTATE AND INHERITANCE TAXES. *See* also REAL PROPERTY AND CONVEYANCING, LAWS OF.

GIFT EXCHANGE: *see* TRADE, PRIMITIVE.

GIFU, landlocked Japanese prefecture of central Honshū, is dominated by mountains except for a small southern portion, which is the inner part of the Nōbi plain. The plain section has most of the agriculture. the capital Gifu. other leading cities (Ōgaki, Seki, Mino) and most industry—textiles. pottery, paper, cutlery, automobiles, machinery, wood products and chemicals. Forestry is the main occupation in the mountain districts. Economic ties with Nagoya are strong and many industries are either branches or subsidiaries of Nagoya firms. Railways link Gifu with Pacific coast cities and Toyama on the Sea of Japan. Area 4,016 sq.mi. Pop. (1960) 1,638,399. (J. D. EE.)

GIFU, capital and largest city of Gifu prefecture, central interior Honshū, Japan, lies at the foot of Mt. Kinka along the Nagara river in the Nōbi plain. Once a feudal period castle town, it achieved prosperity as a textile making centre with strong Nagoya commercial ties. Many large, modern factories house silk. cotton and wool textile. metals and machinery manufacturing. At the same time. Gifu is well known for its paper umbrellas. lanterns, fans and other traditional handicraft products that are made in hundreds of small household workshops. It serves as the regional commercial centre for the inner Nōbi plain and has the prefectural offices and university, many fine parks, temples and libraries. A summer tourist attraction is nighttime cormorant fishing on the Nagara river, where tame cormorants, with rings around their necks to prevent swallowing, catch and disgorge small trout. Pop. (1960) 304.192. (J. D. EE.)

GIGANTISM: *see* DWARFISM AND GIGANTISM.

GIGLIO, an island of Italy (anc. Igilium), off the southwest coast of Italy, in the province of Grosseto, Tuscany region, 11 mi. W. of Monte Argentario. It measures about 5 mi. by 3 mi. and its highest point is 1,634 ft. above sea level. Pop. (1951) of Giglio Castello, the village at the highest point, 1,043; of Giglio Porto (at the harbour) 1.020. Granite was quarried there by the Romans and is still used. The island is fertile and produces wine and fruit. the cultivation of which has taken the place of the forests of which Rutilius spoke when it served as a place of refuge from the barbarian invaders. Charlemngne gave it to the abbey of Tre Fontane at Rome, with a considerable part of the Maremma. From 1264 to 1406 it belonged to Pisa. then to Florence; then. after being seized by the Spanish fleet, it was ceded to Antonio Piccolomini. nephew of Pius II. In 1558 it was sold to Eleonora, wife of Cosimo I of Florence.

GIGTHI, a Roman city of north Africa, near the west coast of the Little Syrtis (Gulf of Gabès). It lies about 20 mi. N.E. of the modern Medenine. The ruins are considerable, especially those of the forum, surrounded on three sides by Corinthian porticos; there were the capitolium. curia and basilica and various temples. The thermae and a market have also been cleared. To the northwest is the island of Djerba. identified with the land of the lotus eaters. In Roman times it was joined to the mainland by a causeway, the remains of which are still visible. Houmt Souk (Djerba). the chief village, on the north coast of the island is a centre of the sponge fishery. The Spaniards intervened in Djerba in 1510 and after 153j and made it their base of operations against Tripoli in 1560. They were defeated and the Spanish garrison on the island was exterminated.

GIGUE, the courtly version of the English jig from which it derived its name when entering the court circles of continental Europe during the 17th century. Whereas true Scotch and Irish jigs were quick and wild and of indefinite form and rhythm, *gigues* were danced by couples in formal, ballet style and generally in $\frac{6}{8}$ or $\frac{12}{8}$ time as the melodic lines were fashioned of rapidly moving groups of three eighth-notes. In musical literature the *gigue* attained importance as the final movement of the suite (*q.v.*). Invariably written in fugal style, the contrapuntal lines retained the rapid groups of three eighth-notes. *See* JIG. (L. HT.)

GIJÓN, a seaport of northern Spain, province of Oviedo, on the Bay of Biscay and the terminus of railways from Avilés, Oviedo and Langreo. Pop. (1950) 86,523 (mun. 108.546). The older parts of Gijbn occupy the slopes of a rocky peninsula, Santa Catalina point. while its more modern suburbs extend east and west along the shore. The town contains few buildings of architectural interest beyond the 15th-century parish church of San Pedro, with its triple rows of aisles, and the Jovellanos Nautical and Technical institute, which contains a fine collection of drawings. This institute mas founded in 1797 by Gaspar Melchor de Jovellanos (1744–1811), the poet and statesman. a native of Gijbn.

A stretch of sandy beach east of the peninsula has made this the bathing quarter of the town. Westward to Cape Torres extends the Bay of Gijón, the most important roadstead on the Spanish coast between Ferrol and Santander. The construction of a commercial port at Gijón was begun with a royal grant in 1480. An arsenal was added in the reign of Philip II (1556–98), and to this the remnant of the Invincible Armada returned for repairs in 1j88. In 1778 the port was equipped for trade with the West Indies. Its modern prosperity, however, dates from 1884, when railway communication was established with Langreo and other Asturian mining districts. In 1892 the harbour of Musel, at the western end of the bay, was constructed. At the eastern end, protected by Santa Catalina and two moles, lie the outer and two inner harbours of Gijon proper.

Gijón is usually identified with the Roman Gigia, captured by the Moors early in the 8th century; it was one of the first cities to be retaken by King Petayo (720–737). In 844 Gijón successfully resisted a Norman raid; in 1395 it was burned down, and in the 16th and 17th centuries it suffered many attacks by corsairs. In the civil war of 1936–39, the capture of Gijón by nationalist forces in Oct. 1937 marked the end of fighting in the region. Coasting, as well as foreign, trade is considerable. Gijón is also an important industrial centre.

GILA CLIFF DWELLINGS, a national monument (reservation) situated about 35 mi. N. of Silver City in the southeastern part of Catron county, N.M., U.S. The reservation (160 ac. in area) was established on Nov. 16, 1907, to protect a group of four cliff dwellings still in good preservation in the canyon of the west fork of the Gila river.

GILA MONSTER (*Heloderma* suspecturn), with its relative H. *horridum* of Mexico, the only lizards known to be poisonous. The Gila monster inhabits deserts in the southwestern United States, chiefly in Arizona, New Mexico and Utah. It is usually about two feet in length and has a thick body covered with small beadlike tubercles. In colour it is blackish or purplish, with large, somewhat transverse, pinkish or yellowish blotches. The poison fangs are in the lower jaw, but its bite is not proved to cause death in rnan. This lizard is usually sluggish but, especially in the wild state, is aggressive when molested, snapping its powerful jaws from side to side with an unexpected agility, all the while emitting sharp hisses. Its grip is tenacious and cannot be broken by man without some prying instrument. In movement the Gila monster is slow and clumsy, dragging rather than lifting its body over the ground. It is oviparous, depositing its soft-shelled eggs in the sand. (See LIZARD; REPTILES.)

GILAN, the westernmost of the three Caspian provinces of Iran, lying between 37° N. and 38° N. with a breadth varying from 15 mi. to 60 mi. Pop. (1956) 1,629,327. Separated on the north from the U.S.S.R. by the little Astara river, it is bounded on the nest by the province of Azerbaijan, on the south by Kazvin and on the east by Mazandaran. Like all the Caspian provinces of Iran, Gilan consists geographically of two zones: the coastal plain, backed by an almost impenetrable jungle; and the forestclad spurs running out northward from the massif of the Elburz range. These zones present an astonishing contrast in climate, landscape and race. Though the Safid Rud (called Kizil Uzun in its upper reaches) is the only river of any volume, the province is abundantly watered by a great number of smaller streams.

The climate of the plains in the neighbourhood of Resht, the capital is exceedingly damp and relaxing, with a high rainfall (56 in having been recorded), yet over a great part of the area the fall is not sufficiently sure and regular in summer to provide for cultivation without resort to irrigation. The mild and wet winter is broken by the *bad-i-garm* (warm wind). The soil is fertile, consisting mainly of a rich loam lying over sandstone and shingle. The vegetation resembles that of southern Europe, but because of the warm humidity which prevails, it is more tropically luxuriant, and in the lower valleys of the Elburz, up to 5,000 ft., there are forest tracts as dense as any Indian jungle.

The prevailing forest trees are box, oak, ash, beech, elm and hornbeam; the first named comes to rare perfection but unfortunately indiscriminate cutting for export has tended to make it scarce. Many kinds of fruit-bearing trees are to be met with but the quality of the fruit they yield is on the whole disappointing. Two varieties of wild grape occur but the cultivated vine does not thrive; medlar and fig flourish, as do wild pomegranate and watermelon, the latter attaining huge proportions. Oranges and lemons thrive in the gardens, and in the hilly district of Rudbar there is considerable cultivation of olives.

The specialities of Gilan in the direction of fruit are a peculiar variety of pear, in great demand for grafting, and the "Gilan plum" which is well known all over northern Iran.

The fauna is well represented, but tigers, once not uncommon, are now scarce; panther, hyena, jackal, wild boar are to be found as are two species of deer, the fine Maral stag (*Cervus elephus maral*) and the Ahu or roedeer (Capreolus pyargus). Among the birds, pheasant, woodcock, duck, teal, geese and various other waterfowl abound.

The fishing industry on the Caspian from this province became important, but during World War I and later the business was practically at a standstill because of the unacceptable claims advanced by the Soviet government in regard thereto. Early in 1928, however, the parties came to terms; thereafter the fisheries, which produce the finest caviar, worked satisfactorily. Of crops, rice held its own as the fundamental produce of Gilan.

Sericulture which was formerly a very important and practically the sole industry of Gilan was reduced almost to nothing about 1865 by a mysterious epidemic disease which broke out among silkworms alike in Persia and in France; but thanks to the researches of the famous bacteriologist, Louis Pasteur (who was deputed by Napoleon III to study the disease), it was gradually got under control; and from 1890 onward the trade regained some of its former prosperity. Another notable product of the Caspian provinces, though not specially of Gilan, is sugar cane, for the growth of which the climate seems eminently suited. Tea planting was introduced into the Lahijan district in 1901. The government actively participated, and the industry was put on a prosperous and progressive footing. The other crop of importance produced in the province is tobacco, to the cultivation of which considerable impetus was given by the increase in cigarette smoking throughout Iran.

The capital of the province and the most active commercial centre is Resht (*q.v.*), through which the Tehran-Kazvin-Pahlavi motor road runs. The latter place (formerly known as Enzeli) enjoys by far the most lively trade of all the Caspian ports of Iran.

After remaining long independent, Gilan was conquered by Hulagu Khan, who razed the fortifications of Shamiran to the ground in 1227 and formed it into two small principalities, separated by the river Safid Rud and with their capitals at Lahijan and Resht respectively. This remained the position until 1567 when the province was finally incorporated in Persia by the Safavid monarch, Shah Tahmasp.

Gilan was, however, occupied by a Russian force in the early part of 1723, and Tahmasp III, the tenth Safavid Shah, being then without a throne and his country occupied by the Afghans, ceded it, together with Mazandaran and Astarabad, to Peter the Great by treaty. Russian troops remained in occupation until 1734 when they were obliged to evacuate it.

The derivation of the name Gilan from the modern Iranian word *gil* meaning mud (hence "land of mud") is incorrect. It probably means "land of the Gil," an ancient tribe which classical writers mention as the Gelae.

See H. L. Rabino, *Les provinces caspiennes* ***de*** *la Perse. Le Guilan* (1917); J. B. L. Noel, "A reconnaissance in the Caspian provinces of Persia," *Geogr. J.* lvii (1921); L. S. Fortescue, "The Western Elburz and Persian Azerbaijan," *Geogr. J.* lxiii (1924) and "Les provinces caspiennes de la Perse," *La Geographie* xliii (1925).

GILA RIVER. The Gila river rises in southwest New Mexico in Grand and Catron counties near the Gila Cliff Dwellings National monument. The river, 650 mi. long, flows west–southwest over the hot, dry desert land of southwestern United States into the Colorado river at Yuma, Ariz., (elevation 141 ft.). Near Clifton, Ariz., the Gila receives its main charge of water from the San Francisco river. On the San Carlos Indian reservation, near Globe, Ariz., the Gila is dammed by the Coolidge dam completed in 1928. The dam's capacity is 1,250,000 ac.ft. of water, which is used for irrigation in the Casa Grande valley. From Coolidge dam the river flows west about 125 mi. to a point 20 mi. west of Phoenix, where it receives the Salt river, its major tributary from the north-east. Roosevelt dam on the Salt and Coolidge dam on the Gila store all available surface water and the Gila river bed is a dry, desolate, barren waste land to its confluence with the Colorado river near Yuma. Other major tributaries include the San Pedro and Santa Cruz rivers. Important towns on or near the river are Yuma, Florence, Safford, Hayden and Coolidge, all in Arizona.

(M. J. L.)

GILBERT, SIR ALFRED (1854–1934), British sculptor and goldsmith, whose best-known work is the "Eros" memorial fountain in Piccadilly Circus, London, was born in London on Aug. 12, 1854. His first training in art was at Heatherley's art school, London. and he also studied at the Royal Academy schools and under Sir Joseph Edgar Boehm. From 1875 to 1878 he attended the École des Beaux-Arts in Paris under P. J. Cavelier. He then nent to Italy, where he produced his first important works, including "The Kiss of Victory" and "Perseus Arming." In 1884 he returned to England and his "Icarus." commissioned by Lord Leighton, was exhibited at the Royal Academy that year.

In 1885 Gilbert began the memorial (known as "Eros") to the philanthropic earl of Shaftesbury, which was unveiled in 1893. In 1888 he produced the statue of Queen Victoria at Winchester and also made the first sketches for the silver gilt and enamel mayoral chain for Preston, a good example of his talent for delicate craftsmanship. In 1892 he was elected royal academician and began his memorial to the duke of Clarence (one of his most important works), which was placed in the Albert chapel. St. George's, Windsor. In 1904 he became bankrupt and settled in Bruges. Belg., where he remained until 1926 when, at the wish of King George V. he returned to England to finish the Clarence memorial. Gilbert's last important work was the Queen Alexandra memorial opposite St. James's palace, London, unveiled in 1932, in which year he was knighted.

Gilbert died in London on Nov. 4, 1934. (R. Gs.)

GILBERT, CASS (1859–1934), U.S. architect, designer of the Woolworth skyscraper and the U.S. supreme court building, was born at Zanesville. O., on Nov. 24. 1859. He studied at Massachusetts Institute of Technology and in 1883 began his career as an architect in St. Paul, Minn., but later moved to New York. He became most widely known as the architect of the Woolworth building in New York (1913), which, with its 60-story tower rising to a height of 792 ft., lacily ornamented in modified Gothic, is regarded as one of the best designed of early skyscrapers. He utilized the neoclassical style characteristic of the national capital for the treasury annex (1919) and the supreme court building (completed 193j) in Washington, D.C.

Gilbert's other buildings include the Minnesota state capitol at St. Paul; the Endicott building. the Dayton avenue church and St. Clement's Episcopal church in St. Paul; the U.S. customhouse and the Union club, New York; the Brazer building and the Suffolk Savings bank in Boston; Art building and Festival hall (for the Louisiana Purchase exposition) and the Central Public library. St. Louis; Ives Memorial library, New Haven (Conn.); and the Public library, Detroit, He drew the plans for the University of Minnesota and for the University of Texas. Gilbert died on May 17, 1934, at Brockenhurst, England.

GILBERT, GROVE KARL (1843–1918), U.S. geologist. was born at Rochester, K.Y., on May 6, 1843, and graduated at the University of Rochester in 1862. He began the study of geology and in 1869 went as a volunteer assistant on the second Ohio State survey. In 1871 he was assigned to the Wheeler survey and during his three years' service took a remarkable trip by boat up the lower canyons of the Colorado river. by pack train through central Arizona and down the valley of the Gila. and again by boat down the Colorado to the, Gulf of California. As a result of this trip he published two papers characterizing the basin range and plateau provinces and naming and describing ancient Lake Bonneville. He was transferred to the Powell survey in 187j which took him to Utah. and with the formation of the U.S. geological survey in 1879, he was made one of the six senior geologists. In 1884 he was placed in charge of the Appalachian division of geology, and in 1889, upon the creation of the division of geologic correlation, he was placed at its head. After 1892 he relinquished most of his administrative duties and his position as chief geologist in order to return to the fuller study of some of his earlier problems. During this period his studies included the geology of Colorado. Mexico and Alaska, and he visited the latter with the Harriman expedition. The *Bonneville Monograph,* which he himself regarded as his *magnum opus,* was published in 1890. His report on the *Geology of the Henry Mountains,* in which the volcanic structure known as laccolite was first described, and his *History of the Niagara River* (1890) were of particular importance. He had much to do mith planning the federal survey's bibliographic work and the adoption of principles of nomenclature and cartography, which form the basis of the survey's geologic map work.

He died at Jackson, Mich., on May 1, 1918.

See *Bulletin* of the Geological Society of America, vol. xxxi, pp. 26–64, which includes a complete bibliography of his publications; and N. M. Davis, *American Journal of Science,* 4th series, vol. xlvi, pp. 669–681.

GILBERT, SIR HUMPHREY (*c.* 1539–1583), English soldier, navigator and pioneer colonist in America, was the second son of Otho Gilbert, of Compton, near Dartmouth, Devon, and half-brother of Sir Walter Raleigh. He was educated at Eton and Oxford; intended for the law; appointed (July 1566) captain in the army of Ireland under Sir Henry Sidney. In April 1566 he had already joined with Antony Jenkinson in a petition to Elizabeth for the discovery of the Northeast passage; in Nov. 1j66 he presented an independent petition for the "discovering of a passage by the north to go to Cataia." In Oct. 1569 he became governor of Munster; on Jan. 1. 1570 he was knighted. In 1571 he was returned M.P. for Plymouth; in 1572 he campaigned in the Netherlands against Spain without much success; from 1573 to 1578 he lived in retirement at Limehousc, devoting himself especially to the advocacy of a northwest passage (his famous *Discourse* on this subject was published in 1576). Gilbert's arguments, widely circulated even before 1575, were apparently of weight in promoting the Frobisher enterprises of 1576–78. On June 11, 1578, Sir Humphrey obtained his long-coveted charter for northwestern discovery and colonization: authorizing him, his heirs and assigns. to discover, occupy and possess such remote "heathen lands not actually possessed of any Christian prince or people, as should seem good to him or them." Disposing not only of his patrimony but also of the estates in Kent which he had through his wife, daughter .of John Aucher of Ollerden. he fitted out an expedition which left Dartmouth on Sept. 23, 1578, and returned in May 1579, unsuccessful.

In 1579 Gilbert aided the government in Ireland; and in 1583, after many struggles—illustrated by his appeal to Walsingham on July 11, 1582, for the payment of an amount due to him from government, and by his agreement with the Southampton venturers—he succeeded in equipping another fleet for "Western Planting." On June 11, 1583, he sailed from Plymouth with five ships and the queen's blessing; on July 30 he was off the north coast of Newfoundland; on Aug. 3 he arrived off the present St. John's. and selected this site as the centre of his operations. On Aug. j he began the plantation of the first English colony in North America. Proceeding southward with three vessels, exploring and prospecting, he lost the largest near Cape Breton (Aug. 29). Immediately after (Aug. 31) he started to return to England with the "Golden Hind" and the "Squirrel." of 40 and 10 tons respectively. Obstinately refusing to leave the "frigate" and sail in his "great ship," he shared the "Squirrel's" fate in a tempest off the Azores. "Monday, Sept. 9," reports Hayes, the captain of the "Hind," "the frigate was near cast away . . . yet at that time recovered; and, giving forth signs of joy, the general. sitting abaft with a book in his hand, cried out unto us in the 'Hind.' 'We are as near to heaven by sea as by land.' . . . The same Monday night, about twelve, the frigate being ahead of us in the 'Golden Hind,' suddenly her lights were out. . . . in that moment the frigate was devoured and swallowed up of the sea."

See Hakluyt, *Principal Navigations,* vol. iii, pp. 135–181 (1600); Gilbert's *Discourse of a Discoverie for a New Passage to Cataia,* published by George Gascoigne in 1576, with additions, probably without Gilbert's authority; Hooker's *Supplement* to Holinshed's *Irish Chronicle;* Roger Williams, *The Actions of the Lowe Countries* (1618); *State Papers, Domestic* (1577–83); Wood's *Athenaa Oxonienses; North British Review,* no. 45; Fox Bourne's *English Seamen under the Tudors;* D. B. Quinn, *The Voyages and Colonising Enterprises of Sir Humphrey Gilbert* (1940). Gilbert's interesting writings on the need of a university for London, anticipating in many ways not only the modern London university but also the British Museum library and its compulsory sustenance through the provisions of the Copyright act, have been printed by Furnivall *(Queene Elizabethe's Achademy)* in the Early English Text Society Publications, extra series, no. viii. *See* also the lives by W. G. Gosling (1911) and D. B. Chidsey (1932).

GILBERT, SIR JOHN (1817–1897), English painter and illustrator, was born at Blackheath, London, on July 21, 1817. He had had little formal instruction nhen he began to exhibit water colours on historical and romantic subjects at the Gallery of British Art. Gilbert began to exhibit at the Royal Academy in 1838, was elected an associate of the academy in 1872 and a full member on June 29. 1876. Many of his most ambitious works are at the academy. But it is not in these large works in oils that Gilbert was seen at his best. At the gallery of the Old Rater Colour society, to which from 1852. when he was elected an associate exhibitor, until he died (Oct. j. 1897), he contributed 270 drawings, most of them admirable because of the largeness of their style, massive colouration, broad chiaroscuro and vigorous design. "The Trumpeter," "The Standard-Bearer," "Richard II resigning his Crown" (at Liverpool), "The Drug Bazaar at Constantinople," "The Merchant of Venice" and "The Turkish Water-Carrier" are examples.

Gilbert was elected a full member of the Old Water Colour society in 1855, and president of the society in 1871, shortly after which he was knighted.

GILBERT, SIR JOHN THOMAS (1829–1898), Irish Celtic scholar and historian, mas born in Dublin on Jan. 23, 1829. As a young man he studied the records of his native city, and his first important work was a *History of the City of Dublin* (3 vol., 1854–59). He was secretary of the public record office (1867–75). Gilbert was, from 1855, secretary of the Irish Celtic and Archaeological society, and published many original documents relative to Irish history, notably those of the convents of St. Mary and St. Thomas in Dublin.

He died in Dublin on May 23, 1898.

See *Life of* Sir *John T. Gilbert, by* his wife, Lady Gilbert, 2 vol. (1905).

GILBERT, NICOLAS JOSEPH LAURENT (1751–1780), French poet, was born at Fontenay-le-Château in Lorraine. In 1774 he came to Paris. where he became known as an opponent of the Encyclopaedists and a panegyrist of Louis XV. The satiric force of one or two of his pieces, as *Mon Apologie* (1778) and *Le Dix-huitième Siècle* (1775), justify his reputation, which has been further increased by writers, who, like Alfred de Vigny in his *Stello* (ch. 7–13), considered him a victim to the spite of his philosophic opponents. His best-known verses are the *Ode imitée de plusieurs psaumes,* usually entitled *Adieux à la vie.*

GILBERT, RUFUS HENRY (1832–1885), U.S. surgeon and transit expert who played a major role in the development of rapid transit in New York city, was born in Guilford, N.Y.. Jan. 26, 1832. He attended the College of Physicians and Surgeons and then served as a surgeon in the Union army in the Civil War. He had become interested in the development of rapid transit in large cities as a means of allowing movement of population from crowded downtown tenements, with their high incidence of illness, and left the army to pursue that work. After gaining experience with the Central Railroad of New Jersey, he incorporated the Gilbert Electric Railway company in 1872 to build elevated lines in New York utilizing pneumatic tubes set on elevated structures, with cars propelled by air pressure in the tubes. Financing difficulties prevented construction until 1876, however, and forced adoption of the more conventional type of elevated railroad, with trains drawn by steam locomotives. The Sixth avenue line, from Trinity church to Central park, was completed and placed in operation in April 1878. But financiers forced Gilbert from the company and he died July 10, 1885, broken financially, physically and mentally. (J. F. D.)

GILBERT, SEYMOUR PARKER (1892–1938), U.S. lawyer and financial expert, was born in Bloomfield, N.J., on Oct. 13, 1892. He graduated from Rutgers college in 1912, and from Harvard law school in 1915. After admission to the New York bar, he practised with the firm of Cravath and Henderson in New York city from 191j to 1918. In the latter year, on the initiative of R. C. Leffingwood, a former associate secretary of the treasury, he joined the War Loan staff as counsel. In June 1920 he became assistant secretary (later undersecretary) of the treasury in charge of fiscal affairs. He resigned on Nov 17. 1923, and was appointed permanent agent general for reparation payments from Germany under the Dawes plan on Oct. 31. 1924, succeeding Owen D. Young. At the end of his first year. Nov. 30, 1925, Gilbert reported that the initial annuity of 1,000,000,000 gold marks due on reparation payments had been received in full. On Sept. 2. 1926. he turned over to the U.S. treasury the first cash payment. $5,900 000. received by the United States from Germany under the operation of the Dawes plan. At this time, by agreement with the German finance minister. Gilbert modified the amount of immediate cash payments and fixed the total annuities to be paid during the ensuing three years.

Gilbert relinquished his reparations post in 1930 and returned to the United States to become a partner in J. P. Morgan and Co. He died in New York city, Feb 23, 1938

GILBERT (or GYLBERDE), **WILLIAM** (1544–1603), the most distinguished man of science in England during the reign of Queen Elizabeth I, was a member of an ancient Suffolk family, long resident in Clare, and was born on May 24, 1544, at Colchester, where his father, Hierome Gilbert. became recorder. Educated at Colchester school, he entered St. John's college, Cambridge, in 1558, and after taking the degrees of B.A. and M.A. in due course. graduated M.D. in 1569, in which year he was elected a senior fellow of his college. He traveled in Europe, and in 1573 settled in London, where he practised as a physician. He was admitted to the College of Physicians probably about 1576, and he held several important offices. In 1589 he was one of the committee appointed to superintend the preparation of the *Pharmacopoeia Londinensis* which the college in that year decided to issue, but which did not actually appear until 1618. In 1601 Gilbert was appointed physician to Queen Elizabeth I, with the usual emolument of £100 a year. On the death of the queen in 1603 he was reappointed by her successor; but he did not long enjoy the honour, for he died on Nov. 30 (Dec. 10. N S.), 1603, either in London or in Colchester. He was buried in the latter town, in the chancel of Holy Trinity church. where a monument was erected to his memory. To the College of Physicians he left his books, globes, instruments and minerals, but they were destroyed in the great fire of London.

Gilbert's principal work is his treatise on magnetism (*q.v.*), entitled *De magnete, magneticisque corporibus, et de magno magnete tellure* (London, 1600; later editions — Stettin, 1628, 1633; Frankfort. 1629, 1638). This work. which embodied the results of many years' research, was distinguished by its strict adherence to the scientific method of investigation by experiment, and by the originality of its matter. It contains an account of the author's experiments on magnets and magnetic bodies and on electrical attractions, and also his great conception that the earth is nothing but a large magnet, and that it is this which explains, not only the direction of the magnetic needle north and south, but also the dipping or inclination of the needle. A posthumous work of Gilbert's was edited by his brother from two manuscripts; its title is *De mundo nostro sublunari philosophia nova* (1651). He was also the first advocate of Copernican views in England, and he concluded that the fixed stars are not all at the same distance from the earth.

GILBERT, SIR WILLIAM SCHWENK (1836–1911), English playwright and humorist, son of William Gilbert (a descendant of Sir Humphrey Gilbert), was born in London on Nov. 18. 1836. His father wrote novels. the best-known of which were *Shirley Hall Asylum* (1863) and *Dr Austin's Guests* (1866). Several of these novels were illustrated by his son, who developed a talent for whimsical draftsmanship. W. S. Gilbert was educated at Boulogne, at Ealing and at King's college. London. He became a clerk in the education department of the privy council office in 1857. Disliking the routine work, he left the civil service in 1861, entered the Inner Temple. was called to the bar in Nov. 1864. and joined the northern circuit. His practice was inconsiderable, and his military and legal ambitions were eventually satisfied by a captaincy in the volunteers and appointment as a magistrate for Middlesex (June 1891). In 1861 he began to contribute excellent comic verse to *Fun*, with humorous illustrations, the work of his own pen, over the signature of "Bab." These were collected in 1869 under the title of *Bab Ballads*, followed by *More Bab Ballads*. The two collections and *Songs of a Savoyard* were united in a volume issued in 1898, with many new illustrations. The best of the old cuts, such as those depicting the "Bishop of Rum-ti-Foo" and the "Discontented Sugar Broker," were preserved intact.

While remaining a staunch supporter of *Fun*, Gilbert became dramatic critic to the *Illustrated Times*. Early in Dec. 1866 T. W. Robertson was asked by Miss Herbert, lessee of the St. James's theatre, to find some one who could turn out a bright Christmas piece in a fortnight, and suggested Gilbert; the latter promptly produced *Dulcamara*, a burlesque of *L'Elisire d'amore*, written in ten days, rehearsed in a week, and duly performed at Christmas. He sold the piece outright for £30, a piece of rashness which he had cause to regret, for it turned out a commercial success. In 1870 he was commissioned by Buckstone to write a blank verse fairy comedy, based upon *Le Palazs de la vérité*, the novel by Madame de Genlis. The result was *The Palace of Truth*, a fairy drama, poor in structure but clever in workmanship, produced by Mr. and Mrs. Kendal in 1870 at the Haymarket. This was followed in 1871 by *Pygmalion and Galatea*, another three-act "mythological comedy"; *The Wicked World*, written for Buckstone and the Kendals; and in collaboration with Gilbert à Beckett, *The Happy Land* (1873). Gilbert's next dramatic ventures inclined more to the conventional pattern, combining sentiment and a cynical humour in a manner strongly reminiscent of his father's style. These were: *Sweethearts* (Prince of Wales's theatre, Nov. 7, 1874); *Tom Cobb* (St. James's, April 24, 1875); *Broken Hearts* (Court, Dec. 9, 1875); *Dan'l Druce* (Haymarket, Sept. 11, 1876); and *Engaged* (Haymarket, Oct. 3, 1877). The first and last of these proved decidedly popular. *Gretchen*, a verse drama in four acts, appeared in 1879. A one-act piece, called *Comedy and Tragedy*, was produced at the Lyceum on Jan. 26, 1884. Two dramatic trifles of later date were *Foggerty's Fairy* and *Rozenkrantz and Guildenstern*, a travesty of *Hamlet*, performed at the Vaudeville in June 1891. Several of these dramas were based upon short stories by Gilbert, a number of which had appeared from time to time in the Christmas numbers of various periodicals. The best of them have been collected in the volume entitled *Foggerty's Fairy, and other Stories*.

In the autumn of 1871 Gilbert commenced his memorable collaboration (which lasted over 20 years) with Sir Arthur Sullivan. The first two comic operas, *Thespis; or The Gods grown Old* (Dec. 26, 1871) and *Trial by Jury* (Royalty, March 25, 1875), were merely essays. Like one or two of their successors, they were, as regards plot, little more than extended "Bab Ballads." Later (especially in the *Yeomen of the Guard)*, much more elaboration was attempted. The next piece was produced at the Opera Comique (Nov. 17, 1877) as *The Sorcerer*. At the same theatre were successfully given H.M.S. *Pinafore* (May 25, 1878), *The Pirates of Penzance; or The Slave of Duty* (April 3, 1880), and *Patience; or Bunthorne's Bride* (April 23, 1881). In Oct. 1881 *Patience* was removed to a new theatre, the Savoy, specially built for the Gilbert and Sullivan operas by Richard D'Oyly Carte. *Patience* was followed on Nov. 25, 1882, by *Iolanthe; or The Peer and the Peri;* and then came, on Jan. 5, 1884, *Princess Ida; or Castle Adamant*, a re-cast of a charming and witty fantasia which Gilbert had written some years previously, and had then described as a "respectful perversion of Mr. Tennyson's exquisite poem." The impulse reached its fullest development in the operas that followed next in order—The *Mikado; or The Town of Titipu* (March 14, 1885); *Ruddigore* (Jan. 22, 1887); *The Yeomen of the Guard* (Oct. 3, 1888); and *The Gondoliers* (Dec. 7, 1889). After the appearance of *The Gondoliers* a coolness occurred between the composer and librettist; Gilbert thought that Sullivan had not supported him in a business disagreement with D'Oyly Carte. But the estrangement was only temporary. Gilbert wrote several more librettos, and of these *Utopia Limited* (1893) and the exceptionally witty *Grand Duke* (1896) were written in conjunction with Sullivan.

As a master of metre Gilbert had shown himself consummate, as a dealer in quips and paradoxes and ludicrous dilemmas, unrivalled. Even for the music of the operas he deserves some credit, for the rhythms were frequently his own (as in "I have a Song to Sing, O"), and the metres were in many cases invented by himself. One or two of his librettos, such as that of *Patience*, are virtually flawless. Enthusiasts are divided only as to the comparative merit of the operas. *Princess Ida* and *Patience* are in some respects the daintiest. There is a genuine vein of poetry in *The Yeomen of the Guard*. Some of the drollest songs are in *Pinafore* and *Ruddigore*. *The Gondoliers* shows the most charming lightness of touch, while with the general public *The Mikado* proved the favourite. The enduring popularity of the Gilbert and Sullivan operas was abundantly proved by later revivals. Among the birthday honours in June 1907 Gilbert was given a knighthood. In 1909 his *Fallen Fairies* (music by Edward German) was produced at the Savoy. Gilbert was drowned at Harrow Weald, Middlesex, on May 29, 1911. (T. S.)

See "*W. S.* Gilbert, An Autobiography" in *The Theatre* (April 2, 1883, pp. 217 *seq*.); Edith *A.* Browne, W. S. *Gilbert* (1907); *A.* Lawrence, *Life of Sir Arthur Sullivan* (1899); Cellier and Bridgeman, *Gilbert and Sullivan and their Operas* (Boston, 1914).

GILBERT AND ELLICE ISLANDS, British colony consisting of 37 coral atolls and islands spanning the central Pacific ocean. While the total area is only 369 sq.mi. and the population (1956 est.) 37,385, the distances between islands and groups of islands are vast. From Ocean Island in the west it is about 2,200 mi. to Christmas Island in the east, and from Washington in the north at 4° 7 N. latitude it is about 1,000 mi. to Niulakita at 10° 4 ȷ' S. latitude.

The islands form four groups: there are 16 Gilbert islands, 9 Ellice islands, 8 Phoenix islands and 3 Line islands, with Ocean Island as an outlier from the Gilbert Islands.

Gilbert Islands (pop. 28,035). The principal islands in this group, much the most populous in the colony, are Butaritari, Little Makin, Tarawa, Abaiang, Marakei, Maiana, Abemama, Kuria, Aranuka, Nonouti, Tabiteuea, Beru, Nikunau, Onotoa, Tamana and Arorae. These islands lie north and south of the equator between 174° E. and 178° E.

Ellice (Lagoon) Islands (pop. 4,569) lie between 5° and 11° S. and at about 178° E. The group contains a large number of tiny coral islands or atolls, grouped in nine clusters, extending over a distance of about 400 mi. from northwest to southeast. The chief groups are Funafuti or Ellice, Nukulaelae or Mitchell, Niulakita or Sophia, Nukufetau, Nui or Egg, Nanumanga and Niutao or Lynx.

Phoenix Group (pop. 1,461). This group is scattered south of the equator between 171° and 175° W. Individual islands in this group are Gardner, McKean, Hull, Birnie. Sydney, Enderbury, Phoenix, and Canton which is under Anglo-American administration and is an international airport.

Line Islands (pop. 864). These are Fanning Island, which has a relay station on the transpacific cable, Washington Island, and Christmas Island, lying between 157° and 160° W.

Ocean Island (pop. 2,456) is the centre of administration for the colony. It is located at 0° 52' S., 169° 35' E. Ocean Island, an atoll pushed up by volcanic action, is rich in high-grade phosphate.

The islands are on the ethnological borderland between Polynesia and Melanesia and the natives show a mixture of these racial strains, with a larger Negroid element in the Ellice group. The inhabitants of the Nui atoll, in the Ellice group, speak the language of the Gilberts, while the others are Samoan in speech. Research supports the tradition that they came from Samoa originally. Many of the natives have been converted to Christianity.

The temperature varies between 80° and 90° F. by day and drops to a minimum of 70° at night. In an average year rainfall ranges from 40 in. near the equator to 100 in. in the extreme northern Gilberts and around 120 in. in the Ellice Islands.

Almost beyond doubt, this region is of comparatively recent subsidence.

Resources are so limited that copra production is the only commercial agriculture, and phosphate mining the only industry. The principal crops are pandanus fruits and coconuts. Phosphate, copra and shark fins are exported. (*See* also PACIFIC ISLANDS.)

Most of these islands were taken over as a British protectorate in 1892 and annexed as a colony at the request of the native governments in 1915. Ocean Island was annexed in 1916. The Phoenix group, which had been colonized by emigrants from the Gilbert Islands, was included in the colony by an order in council of March 18, 1937. Most of the islands were seized by the Japanese soon after the attack on Pearl Harbor.

They were driven from the Gilberts by U.S. forces in 1943.

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(W. H Is.)

GILBERT DE LA PORRÉE, in Latin, GILBERTUS PORRETANUS or PICTAVENSIS (1076–1154), French theologian and philosopher, was born in Poitiers. A pupil of Bernard of Chartres, he taught at Chartres and in Paris (*c.* 1140) and became chancellor of Chartres and bishop of Poitiers (1142–54). His philosophical treatment of God and of the Trinity provoked St. Bernard's opposition: his doctrine of *"divinitas"* as distinct from "God" was held to be dangerous, or heretical, by the council of Reims (1148). According to him, ideas are in God as models (*exemplaria*), of which the forms innate in individual things (*formae nativae*) are copies (*exempla*). Created things are composite: "what they are," or *subsistens,* depends on a multiple *subsistentia* (species and genus, *quo est*); what is substantial in them underlies (*substat*) the accidents characterizing the individuals. In the *De sex principiis* (by him or by a pupil; ed by A. Heysse, Münster, 1953) relation, together with quality and quantity, is considered to be inherent to substance, as against the other six Aristotelian categories. which Aristotle did not discuss in detail and which are there specially treated.

Gilbert wrote commentaries on four of Boethius' theological treatises, from which he derived many of his doctrines—edited with Boëthius' *Opera* (Basle, 1570) and by J. P. Migne, in *Patrologia Latina,* lxiv (Paris, 1847); commentary on "De hebdomadibus," also edited by N. M. Haring in *Traditio,* ix (New York, 1953)—on the *Psalms,* on the *Apocalypse* (Paris, 1512), on St. Paul's letters and, in the form of sermons, on the *Canticles* (Strasbourg, 1497).

(L. M.-Po.)

GILBERT FOLIOT (d. 1187), bishop of Hereford, and of London, is first mentioned as a monk of Cluny whence he nas called in 1136 to plead the cause of the empress Matilda against Stephen at the Roman court. Shortly afterward he became prior of Cluny; then prior of Abbéville, a house dependent upon Cluny. In 1139 he was elected abbot of Gloucester. The appointment was confirmed by Stephen, and from the ecclesiastical point of view was unexceptionable. But the new abbot proved himself a valuable ally of the empress, and her ablest controversialist. Gilbert's reputation grew rapidly. He was respected at Rome and in 1148 was nominated by the pope to the see of Hereford. He was an Angevin at heart, and after 1154 was treated by Henry II with every mark of consideration. He was Becket's rival for the primacy, and the only bishop who protested against the king's choice. Recket endeavoured to win his friendship by procuring for him the see of London (1163). But Gilbert evaded the profession of obedience to the primate, and apparently aspired to make his see independent of Canterbury.

On the questions raised by the constitutions of Clarendon he sided nith the king, whose confessor he had now become. He urged Becket to yield, and, when this advice was rejected. encouraged his fellow bishops to repudiate the authority of the archbishop. Gilbert was twice excommunicated by Becket. but both on these and on other occasions he showed great dexterity in detaching the pope from the cause of the exile. To him it was chiefly due that Henry avoided an open conflict with Rome of the kind which John afterward provoked.

Gilbert was one of the bishops whose excommunication in 1170 provoked the king's knights to murder Becket; but he cannot be reproached with any share in the crime. His later years were uneventful, though he enjoyed great influence with the king and among his fellow bishops.

See Gilbert's *Letters,* ed. by J. A. Giles (1845); *Materials jor the History of Thomas Becket,* ed. by J. C. Robertson, Rolls series (1875–1885); and Miss K. Norgate's *England under the Angevin Kings* (1887).

(H. W. C. D.)

GILBERT OF SEMPRINGHAM, ST., founder of the Gilbertines, the only religious order of English origin, was born at Sempringham in Lincolnshire, *c.* 1083–89. He was educated in France, and ordained in 1123, being presented by his father to the living of Sempringham. About 1135 he established there a convent for nuns; and to perform the heavy work and cultivate the fields he formed a number of labourers into a society of lay brothers attached to the convent.

Similar establishments were founded elsewhere, and in 1147 Gilbert tried to get them incorporated in the Cistercian order. Failing in this, he formed communities of priests and clerics to perform the spiritual ministrations needed by the nuns. The women lived according to the Benedictine rule as interpreted by the Cistercians; the men according to the rule of St. Augustine, and were canons regular. The special constitutions of the order were largely taken from those of the Premonstratensian canons and of the Cistercians. Like Fontevrault (*q.v.*) it was a double order, both communities living side by side; but, though the property belonged to the nuns, the superior of the canons was the head of the whole establishment, and the general superior was a canon, called "Master of Sempringham." The general chapter was a mixed assembly composed of two canons and two nuns from each of the houses.

The order received papal approbation in 1148. By Gilbert's death (1189) there were nine double monasteries and four of canons only, containing about 700 canons and 1,000 nuns in all. At the dissolution there were some 2j monasteries. The order never spread beyond England.

See Bollandists' *Acta Sanctorum* (Feb. 4); Dugdale, *Monasticon* (1846); Helyot, *Hist. des ordres religieux* (1714), ii. c. 29; R. Graham, *St. Gilbert of Sempringham, and the Gilbertines* (1901), and F. A. Gasquet, *English Monastic Life* (1904).

GILDAS (GILDUS) (516?–570), the earliest of British historians, surnamed by some Sapiens, and by others Badonicus. Two short treatises exist, purporting to be lives of Gildas. and ascribed respectively to the 11th and 12th centuries; but they seem to confuse two, if not more, persons who had borne the name. Gildas was almost certainly an ecclesiastic. He went abroad, probably to France, in his 34th year, where after 10 years of hesitation and preparation, he composed the work bearing his name.

His materials, Gildas tells us, were collected from foreign rather than native sources. The *Cambrian Annals* give 570 as the year of his death.

The writings of Gildas have come down to us under the title of *Gildae Sapientis de excidio et conquestu Britanniae.* The work is now usually divided into three .portions—a preface, the history proper, and an epistle—the last, largely made up of Scriptural passages brought together for the purpose of condemning the vices of his countrymen and their rulers, being the longest but least important. In the second portion, he passes in brief review the history of Britain from its invasion by the Romans until his own times.

Among other matters he refers to the persecution under Diocletian, the election of Maximus as emperor by the legions in Britain, final abandonment of the island by the Romans and the coming of the Saxons under Vortigern. Unfortunately his statements are vague and obscure. With one exception (the date of the battle of Mount Badon referred to in connection with the date of his own birth, *see* ARTHCR) no dates are given, and events, are not alnays taken up in the order of their occurrence. These faults become serious when, as is the case from nearly the beginning of the 5th century to the date of his death, Gildas's brief narrative is our only authority for most of what passes current as the history of England. Thus it is on his sole, though in this instance perhaps trustworthy, testimony that the famous letter rests. said to have been sent to Rome in 446 by the despairing Britons, commencing: "To Agitius (Aetius), consul for the third time, the groans of the Britons."

Gildas's treatise was first published in 1525 by Polydore Vergil, but with many avowed alterations and omissions. In 1568 John Josseline, secretary to Archbishop Parker, issued a more accurate edition; and in 1691 a still better edition appeared at Oxford by Thomas Gale. The next English edition described by Potthast as *editio pessima* was published by the English Historical society in 1838, and edited by the Rev. J. Stevenson. The text of Gildas founded on Gale's edition collated with two other manuscripts, with elaborate introductions, is included in the *Monumenta Historica Britannica,* edited by Petrie and Sharpe (1848). Another edition is in A. W. Haddan and W. Stubbs, *Councils and Eccles. Documents* relating to Great Britain (Oxford. 1869); *see* also Theodor Mommsen's edition in *Monum. Germ. hist. auct. antiq.* xiii, *Chronica minora saeculorum iv-vii,* vol. iii (1898).

For useful bibliographical notes *see* C. Gross, *Sources of English History* (1915) and *E.* K. Chambers, *Arthur of Britain* (1927).

GILDER, RICHARD WATSON (1844–1909), U.S. editor and poet, was born in Bordentown, N.J., on Feb. 8, 1844. Unable to attend college, he worked on the *Newark* (N.J.) *Daily Advertiser* and was cofounder of the *Newark Morning Register*, which soon failed. He held positions on *Hours at Home* (1869) and *Scribner's Monthly* (later the *Century Magazine*), becoming editor of the latter in 1881.

Throughout this time Gilder had been contributing verse and descriptive pieces to various magazines and newspapers, but the greatest development of his poetic talent came after he met his future wife. Helena de Kay, an art student at Cooper Union. Her knowledge of art and music broadened his interests. and after their marriage in 1874 their home became a social centre for some of the most distinguished persons of the day. The immediate fruit of this relationship was *The New Day* (1875). a series of love sonnets, and a sequel volume, *The Celestial Passion* (1887). In Gilder's later verse the lyric impulse is somewhat obscured by the numerous "causes" that occupied his energies. Perhaps most memorable of these were his efforts in behalf of international copyright law, civil service reform, and as chairman of the New York Tenement House commission.

After several collapses from overwork, Gilder died in New York city on Nov. 18, 1909.

A collected edition of Gilder's verse appeared in 1908. Autobiographical material may be found in *Grover Cleveland: a Record of Friendship* (1910) and his *Letters* (1916).

See also Brander Matthews, "Richard Watson Gilder," ***North American Review*** (Jan. 1910).

GILDERSLEEVE, BASIL LANNEAU (1831–1924), U.S. classical scholar, born in Charleston. S.C., on Oct. 23, 1831, graduated at Princeton in 1849, and studied at Berlin. Bonn and Gottingen. From 1856 to 1876 he was professor of Greek in the University of Virginia. holding the chair of Latin also in 1861–66, and in 1876 he became professor of Greek in the newly-founded Johns Hopkins university, a position from which he retired in 1915. In 1880 *The American Journal of Philology* was established under his editorial charge.

He published a *Latin Grammar* (1867; revised. with the co-operation of Gonzalez B. Lodge, 1894 and 1899) and a Latin series for use in secondary schools (1875). both marked by lucidity of order and mastery of grammatical theory and methods. His edition of *Persius* (1875) is of great value. But his bent was rather toward Greek than Latin. His special interest in Christian Greek was partly the cause of his editing in 1877 *The Apologies of Justin Martyr,* "which" — to use his own words — "I used unblushingly as a repository for my syntactical formulae." His *Syntax of Classical Greek* from Homer to Demosthenes with C. W. E. Miller (part i, 1900; part ii, 1911) collects these formulas. Gildersleeve edited in 1885 *The Olympian and Pythian Odes of Pindar,* with a brilliant and valuable introduction. His views on the function of grammar were summarized in a paper on *The Spiritual Rights of Minute Research* delivered at Bryn Mawr in 1895, and his collected contributions to literary periodicals appeared in 1890 under the title *Essays and Studies Educational and Literary.* He was also the author of *Hellas and Hesperia* (1909) and of *Creed of the Old South* (1915). He died in Baltimore on Jan. 9, 1924.

GILDING, the art of spreading gold, either by mechanical or chemical means, over the surface of a body for the purposes of protection or ornament. The art of gilding was known to the ancients. According to Herodotus, the Egyptians were accustomed to gild wood and metals; and gilding by means of gold plates is frequently mentioned in the Old Testament. Pliny informs us that the first gilding seen at Rome was after the destruction of Carthage, under the censorship of Lucius Mummius, when the Romans began to gild the ceilings of their temples and palaces, the capitol being the first place on which this enrichment was bestowed. Owing to the comparative thickness of the gold-leaf used in ancient gilding, the traces of it which yet remain are remarkably brilliant and solid. Gilding has in all times occupied an important place in the ornamental arts of Oriental countries; and the native processes pursued in India at the present day may be taken as typical of the arts as practised from the earliest periods.

Modern gilding is applied to numerous surfaces and by various processes, making the art an important part of widely different ornamental and useful arts. It forms an important and essential part of picture framemaking, is largely employed in connection with cabinet-work, decorative painting and house ornamentation, and is of great importance in bookbinding and ornamental leather work. Further. gilding is much employed in electro-gilt reproductions and in electro-plating, and is also a characteristic feature in the decoration of pottery, porcelain and glass. Any of these various processes may, however. fall under one of two heads — mechanical gilding and chemical gilding.

MECHANICAL GILDING

This embraces all the operations by which gold-leaf is prepared *(see* GOLDBEATING), and the several processes by which it is mechanically attached to the surfaces it is intended to cover. It thus embraces the burnish or water-gilding and the oil-gilding of the carver and gilder, and the gilding operations of the house decorator, the sign-painter, the bookbinder, the paper-stainer and several others. Polished iron, steel and other metals are gilded mechanically by applying gold-leaf to the metallic surface at a temperature just under red-heat, pressing the leaf on with a burnisher and reheating, when additional leaf may be laid on. The process is completed by cold burnishing. Copper and wood are perhaps the most widely used bodies for the application of gilding.

Copper Gilding. — For the gilding of copper, employed in the decoration of temple domes and other large works, the following is an outline of the process employed: The metal surface is thoroughly scraped, cleaned and polished, and then sufficiently heated in a fire to remove any traces of grease or other impurity which may remain from the operation of polishing. It is then dipped in an acid solution prepared from dried unripe apricots, and rubbed with pumice or brick powder. Next, the surface is rubbed over with mercury, which forms a superficial amalgam with the copper, after which it is left some hours in clean water, again washed with the acid solution and dried. It is now ready for receiving the gold, which is laid on in leaf, and, on adhering, assumes a grey appearance from combining with the mercury, but on the application of heat, the latter metal volatilizes, leaving the gold a dull, greyish hue. The colour is brought up by means of rubbing with agate burnishers. The weight of mercury used in this process is double that of the gold laid on, and the thickness of the gilding is regulated by the circumstances or necessities of the case. For the gilding of iron or steel, the surface is first scratched over with chequered lines, then washed in a hot solution of green apricots, dried and heated just short of red-heat. The gold-leaf is then laid on, and rubbed in with agate burnishers, when it adheres by catching into the prepared scratched surface.

Wood Gilding. — In applying gilding to wood, after the surface has been sand-papered in order to remove all sharp edges, followed by a very careful dusting, the glue priming size stage is of first importance.

Priming. — Glue size is made by mixing an ounce of glue to a gill and one-half of water, and allowing it to soak at least two hours, after which the mixture is placed in a double boiler and heated until it has become all liquid; then it is removed to set. The combination, which is of jelly-like appearance, can then be cut into blocks or squares, and is generally known as the stock glue size. It is the supply base for all following sizes where glue is used as an ingredient.

Sizing, a term used mostly by painters, is primarily applied to the act of glazing the surface oi the material to be gilded. For this preparation, the stock glue size is thinned by mixing a two-thirds proportion of water and dissolving the combination by heat in a double boiler, being careful not to place the vessel near an open fire.

It is necessary for this size to be painted on the raw wood when the combination is still warm. It is well also to have the surface moderately warm so that the size will not form a film on the surface of the wood, but will soak into the grain and act as a filler. It is also necessary to remove any superfluous liquid and blank spaces that may appear just after the glue size is applied. From two to five hours are required for the wood to dry. The glue priming size is followed by the whiting size. This size is made by adding another one-third portion of water to the stock glue size and then heating.

The First Coat of Whiting. — After this mixture has reached the proper temperature, which is somewhat under boiling, sprinkle in the best quality of bolted whiting until the mixture becomes a thick cream.

The first coat of whiting should be applied in a stipple-like fashion, which enables the second coat to have a gripping surface on which to take a better hold. This stippling should be given at least two hours to dry. After the first coat has been applied and allowed sufficient time to dry, the surface should be carefully examined for imperfections such as miscuts, openings at joints, or nail holes. These imperfections require considerable care in filling with putty, made in the following manner: —

Putty Filler. — Make a depression in the stock dry whiting, and pour in a small amount of stock size glue, which should be heated. Take a putty stick and work it around until it becomes a doughy mass of whiting and glue. When it has finally been kneaded sufficiently to allow handling, work it in the palm of the hand until it becomes as pliable as common painter's putty. In placing this prepared putty into the blemishes on the wood, moisten each particle immediately before putting it into place. It is also advisable to use a little moisture in smoothing over the surface and removing any superfluous putty.

The second coat of whiting or filling coat is also called the smooth coat. It is applied as evenly and smoothly as possible, with the exception of the parts that are desired to retain a stippled effect, in which case, the stipple is repeated and applied on the parts as in the previous coat. Do the stippling before finally smoothing the other surfaces with a brush

The third coat, if necessary, is next applied. This all depends on the surface to be gilded and the amount of ornamentation, and is mainly intended to produce a pleasing effect. When the desired body of whiting has been applied and has dried for at least two hours, the parts which are to remain smooth are rubbed down with a damp cloth. If necessary, especially in deep ornamentation, a brush will answer this purpose better. After the moist smoothing of the surface has been accomplished, it is gone over with a fine piece of sandpaper (o or oo) in order to remove the burr which is caused by the damp smoothing. After removing all dust after sand-papering, it is ready for its first coat of gold size.

Gold Size is applied in much the same manner as paint would be applied, which means working it out smoothly so as to prevent any surplus remaining in comers or causing puddles. Where ornamentation is deep, puddles or floods in hollows are causes of crackling and endless trouble, and one of the most common warnings to an apprentice is, "Don't let the depths fill up."

A Second Coat, and sometimes a third, is applied in like manner, being careful again to allow the surface to dry well after each application and sandpaper to remove any surface burrs. After this, the wood is again dusted off carefully and a coat of very weak size is applied, by heating a piece of stock glue until it is completely dissolved. This weak size must not be applied in a hot state and must be of an even, cool temperature before applying; in fact, less warm than luke-warm. The weak size must be applied by a long soft-haired brush, avoiding puddles in the depths and with such a gentle touch that you do not disturb the gold size. A weak size solution is made as follows: A piece of stock size glue the size of a lima bean dissolved in one gill of hot water, allowed to cool, add a few drops of denatured alcohol.

Burnished gold size is made as follows: Take a desired amount of the basic (red clay, blue clay or any one of many more colours as it comes in the jar) place it in the vessel and add cold water. Stir until it has reached such a consistency that the brush will stand upright in it, then place it in the heater to remain only long enough to take off the chill. The stock glue, having previously been placed in a heater to bring to a very high temperature, is poured, a little at a time, into the clay, stirring the mixture in a rapid, agitative manner, adding glue until it reaches the consistency of just wanting to drip from the brush in a heavy, creamy form; the jar containing the burnished gold size is covered and allowed to set over night to ascertain its strength, which should be of a jelly consistency.

A test of gold size for immediate use is made as follows: Apply very thinly, a coat of the size on the thumb nail or two other finger nails, so that it may dry through the heat of the finger and fanning in the air. When this has dried, take the opposite thumb nail and begin to burnish the nail that holds the gold size. If it comes off, it lacks glue; if it is dull and slaty looking, it lacks body clay; but if it burnishes by the finger nail action and has a mellow lustre, the test is successful and the size is ready for use.

Hints on Application. — Gold size must never be cold, nor can it be warm when it is applied. In laying gold-leaf with the hair tip, a solution of a few drops of alcohol in water should be added to the gold sizing before the leaf is flipped on. Also, if possible, keep the wood tilted so that the liquid will run down and not remain in puddles in any one spot. Burnishing must be done within 48 hours, the sooner the better, after the liquid and gold size have dried; but the minimum should be four hours for drying. After burnishing the surface, it may be necessary to apply small patches of gold in spots where it did not adhere in the first laying.

Faulting, or patching, is done in the same manner as gilding with the exception that the solution in this case should contain a greater percentage of alcohol, which quickens the drying. Small patches dry in about 30 minutes. After the patching has been completed, then, with a soft brush, preferably goat hair or badger, dust off all surplus particles of gold, so that they will not mix with the lacquer which follows. When the burnishing has been done, take some weak size and with a camel's hair brush, apply very lightly a coat all over, not with a heavy brush motion, but just laying it on. When dry, which takes about one hour, the wood is ready for lacquering.

Lacquering is the process in which pure white shellac, diluted with denatured alcohol until it flows in a watery state, is applied with a camel's hair brush in a light manner. The lacquer must dry for about ten hours, after which the wood is ready for toning.

Any desired effect may be obtained by dissolving a pigment with turpentine and adding a few drops of painters' dryer, which acts as a binder. It should have the consistency of thin, transparent white raw umber or zinc white. This medium is freely applied, allowing it to settle into the depths, removing the surplus from all high light with cheese cloth or soft, absorbent cloth. After a few moments, the final effect can be obtained by an additional light wiping with the cloth, although the best results are often obtained by using the fingers instead of a rag. It is advisable not to tone, at any one time, a greater surface than can be kept under control, because within ten minutes, this tone so strongly adheres to the lacquer that erasure is difficult. (A. E.)

CHEMICAL GILDING

This embraces those processes in which the gold used is at some stage in a state of chemical combination. Of these the following are the principal:—

Cold Gilding. — In this process the gold is obtained in a state of extremely fine division, and applied by mechanical means. Cold gilding on silver is performed by a solution of gold in aqua-regia applied by dipping a linen rag into the solution, burning it, and rubbing the black and heavy ashes on the silver with the finger or a piece of leather or cork.

Wet Gilding is effected by means of a dilute solution of chloride of gold with twice its quantity of ether. The liquids are agitated and allowed to rest, when the ether separates and floats on the surface of the acid. The whole mixture is then poured into a funnel with a small aperture, and allowed to rest for some time, when the acid is run off and the ether separated. The ether will be found to have taken up all the gold from the acid, and may be used for gilding iron or steel, for which purpose the metal is polished with the finest emery and spirits of wine. The ether is then applied with a small brush, and as it evaporates it deposits the gold, which can now be heated and polished. For small delicate figures a pen or a fine brush may be used for laying on the ether solution.

ire-gilding or **Wash-gilding** is a process by which an amalgam of gold is applied to metallic surfaces, the mercury being subsequently volatilized, leaving a film of gold or an amalgam containing from 13 to 16% of mercury. In the preparation of the amalgam the gold must first be reduced to thin plates or grains, which are heated red hot, and thrown into mercury, previously heated, till it begins to smoke. Upon stirring the mercury with an iron rod, the gold totally disappears. The proportion of mercury to gold is generally six or eight to one. When the amalgam is cold it is squeezed through chamois leather for the purpose of separating the superfluous mercury; the gold, with about twice its weight of mercury, remains behind, forming a yellowish, silvery mass of the consistency of butter. When the metal to be gilded is wrought or chased, it ought to be covered with mercury before the amalgam is applied, that this may be more easily spread; but when the surface of the metal is plain, the amalgam may be directly applied to it. When no such preparation is applied, the surface to be gilded is simply bitten and cleaned with nitric acid. A deposit of mercury is obtained on a metallic surface by means of "quick-silver water," a solution of nitrate of mercury, the nitric acid attacking the metal to which it is applied, and thus leaving a film of free metallic mercury. The amalgam being evenly spread over the prepared surface of the metal, the mercury is then sublimed by a heat just sufficient for that purpose; for, if it is too great, part of the gold may be driven off, or it may run together and leave some of the surface of the metal bare. When the mercury has evaporated, which is known by the surface having entirely become of a dull, yellow colour, the metal must undergo other operations, by which the fine gold colour is given to it.

First, the gilded surface is rubbed with a scratch brush of brass wire, until its surface is smooth; then it is covered with a preparation called "gilding wax" and again exposed to the fire until the wax is burnt off This wax is composed of bees-wax mixed with some of the following substanaes: viz., red ochre, verdigris, copper scales, alum, vitriol, borax. By this operation the colour of the gilding is heightened; and the effect seems to be produced by a perfect dissipation of some mercury remaining after the former operation. The dissipation is well effected by this equable application of heat. The gilt surface is then covered over with nitre, alum or other salts ground together, and mixed up into a paste with water or weak ammonia. The piece of metal thus covered is exposed to a certain degree of heat, and then quenched in water. By this method its colour is further improved and brought nearer to that of gold, probably by removing any particles of copper that may have been on the gilt surface. This process, when skilfully carried out, produces gilding of great solidity and beauty; but owing to the exposure of the workmen to mercurial fumes, it is very dangerous, and besides there is much loss of mercury.

Gilding of Pottery and Porcelain. — The quantity of gold consumed for these purposes is very large. The gold used is dissolved in aqua-regia, and the acid is driven off by heat, or the gold may be precipitated by means of sulphate of iron. In this pulverulent state the gold is mixed with one-twelfth of its weight of oxide of bismuth, together with a small quantity of borax and gum water. The mixture is applied to the article with a camel's-hair pencil, and after passing through the fire is of a dingy colour, but the lustre is brought out by burnishing with agate and bloodstone, and afterwards cleaning with vinegar or white lead (*see* POTTERY AND PORCELAIN).

GILDS: *see* GUILDS.

GILEAD, a name used to denote the whole of the territory occupied by the Israelites between the plateaus of Moab and the Hauran, and sometimes in a wider and more general sense to denote the region extending from the river Arnon, to the base of Hermon. It is a country of high forest ridges (average height, 2,500 ft.) lying between the Jordan and the desert plateau. The base slopes are of sandstone partly covered by white marls and the upper of limestone scored and riven by numerous *wadis.* Whilst the gentle declivities towards the eastern plateau have tended to be bare of trees, the western slopes, prior to the World War, were well clothed with oak, terebinth and pine. Gilead is in the main a fertile and beautiful land. "The pastures are everywhere luxuriant, and the wooded heights and winding glens, in which the tangled shrubbery is here and there broken up by open glades and flat meadows of green turf, exhibit a beauty of vegetation such as is hardly to be seen in any other district of Palestine."

History.—The name Gilead first appears in the narrative of the reconciliation of Jacob and Laban (Gen. xxxi.), where the comppsite nature of the narrative renders identification of locality difficult, and was in use in the time of Josephus, and even later, but with no precise geographical definition. In the Israelitic conquest of the territory east of the Jordan Sihon was crushed at Jahaz, south of Heshbon (Num. xxi., 23) and Og, king of Bashan, smitten at Edrei (Deut. i., 5). In the division of the land the southern half of Gilead fell to Reuben and Gad (according to one account) and the northern half to Manasseh. Gideon on the soil of Gilead swept back the routed hosts of Midian (Judges viii.); Jephthah the Gileadite smote the Ammonites from Xroer to Minnith (Judges xi.) and dealt faithfully with the treacherous men of Ephraim when their tongues betrayed them at the fords of Jordan (Judges xii.). Gilead was the scene of the fierce barrle between David and Absalom. Round Ramoth-Gilead many bitter struggles were waged and Ahab perished before its walls. The land, too, played a prominent part in the Maccabean revolt.

It was the fate of the Gileadites to meet the first shock of the Syrian onslaughts and the rolling tide of Assyrian invasion. The Gilead hill country appears to have bred a bold, independent people, but kindly and hospitable. Its intricate country formed a refuge for royalty expectant or in eclipse. Saul's son, Ishbosheth, was here made king by Abner. To its friendly shelter Absalom fled before the anger of his father and abode three years, and David, too, when Absalom's rebellion was at its height, found harbourage and a kindly welcome. It was men of Jabesh-Gilead who risked their lives to recover the bodies of Saul and his sons from the walls, or market-place of Beth-Shan (Beisān). From his home amongst the Gilead hills Elijah emerged to become one of the world's great spiritual leaders, and twice at least did Jesus visit the region — the land beyond Jordan. To Josephus it was Peraea, a land of small provinces whose names re-echoed the centres in which Greek colonists had established themselves during the reign of the Seleucidae. Gilead had as chief cities in Old Testament times, Mahanaim, Succoth, Penuel, Mizpeh, Jazer, Ramoth-Gilead, Jabesh-Gilead, and in later times Pella (Fihl), Gerasa (Jerāsh) and others. Ramoth and Mahanaim were stations of two out of three of Solomon's commissariat officers. The country was later extensively and intensively Romanized, and it is difficult to determine where the Old Testament cities of Gilead lie. Gilead is now part of Jordan.

The balm associated with Gilead is probably to be identified with mastic, the resin furnished by *Pistachia lentiscus*. (E. Ro.)

GILES, SAINT, patron of Saint-Gilles, a town in southern France (*département* of Gard) on the site of an ancient abbey claiming his relics and protected by Charlemagne. One of the 14 Holy Helpers. or auxiliary saints, Giles was venerated throughout Europe as patron of cripples, beggars and blacksmiths; and pilgrims to his tomb contributed much to the prosperity of the medieval town and abbey. The saint's symbols. the hind and arrow, refer to famous but conflicting legends based upon a 10th-century uncritical biography which claims that he, a young Athenian aristocrat, after visiting St. Caesarius of Arles (d. 543), lived as a hermit until wounded by Flavius, king of the Goths. who was pursuing a hind that had fled to Giles for safety. Later Flavius built an abbey, making Giles abbot. His feast day is Sept. 1.

See F. Brittain, *Saint Giles* (1928) ; *H* Thurston and D Attwater, *Butler's Lives of the Saints,* vol. iii, pp 457–458 (1956). (A. B WR.)

GILES OF ROME (Lat. AEGIDIUS ROMANUS) (*c.* 1245–1316), Italian theologian and philosopher. known honorifically as doctor *fundatissimus* ("the best-grounded teacher"). The intellectual leader of the Augustinian hermits, Giles nas probably a pupil of Thomas Aquinas in Paris, and for eight years refused to submit to the ecclesiastical condemnation of Aquinas' philosophical doctrines (1277). Giles mas general of his order from 1292 to 129S and archbishop of Bourges from 1295 to 1316. Developing in an original way Augustinian and Thomistic doctrines. he maintained that God's existence is both directly evident to the human mind and demonstrable from sense experience: that essence and existence are distinct (his polemic with Henry of Ghent became famous), both being "things" at the same level, that is. by participation in God's ideas and in God's existence respectively; and that the pope must have direct political poner over the whole of mankind. His vast literary production includes commentaries on Aristotle, on the De causis, on Peter Lombard's Sentences and on parts of the Bible; theological works (Quodlibeta and Theoremata, notably the *Theoremata* de esse et essentia, ed. by E. Hocedez [1930]); political treatises (*De ecclesiastica* potestate against Philip IV of France, ed, by R. Scholz [1929], and the very popular De *regimine principum*); and *Errores* philosophorum, edited by J. Koch with English translation by J. Riedl (1955). Numerous editions of collected and individual norks of Giles appeared in the 15th, 16th and 17th centuries; for a catalogue see G. Bruni. Le operc di Egidio *Romano* (1936).

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GILES, PETER (1860–193j). Scottish comparative philologist. who was master of Emmanuel college, Cambridge, from 1911 until his death. nas born near Aberdeen on Oct. 20, 1860. He was educated at the local parish school, the University of Aberdeen, Freiburg im Breisgau, and Gonville and Caius college. Cambridge, where he took a first class in the classical tripos. won a large number of scholarships (including two for New Testament and international law) and was appointed reader in comparative philology in the university in 1891. He was the author of a Short *Manual* of Comparative *Philology* for Classical *Students* (1895) and of many articles in works of reference. A man of strict integrity Giles managed the affairs of Emmanuel college in a businesslike way and raised its status in Cambridge by securing only good appointments among its fellows. He died on Sept. 17. 1935, at Cambridge.

See an appreciation *by* J. Whatmough in *Word Study,* vol 30, no. 1, pp. 1–3 (1954). (J. WH)

GILGAL (*i.e.,* "circle" of sacred stones), the name of several places in western Palestine mentioned in the Old Testament. The most important is that situated near Jericho (Josh. iv, 19; xv, 7). Josephus recorded that it was ten stadia, and Jerome that it was two Roman miles from Jericho, but neither was explicit in its location. The latter speaks of it as a deserted place held in deep veneration by the natives. The sacredness of the spot may have been due to the erection there of the 12 memorial stones (Josh. iv. 20). Zschokke (1865), Conder (1874) and Dalman (1911) identified it with sites at or near Khirbet el-Ethilek, between Jericho and Jordan, and about $1\frac{1}{2}$ mi, from Jericho. Another Gilgal (mentioned in Josh. xii, 23) appears to have been situated in the maritime plain. This has been identified with Jiljuliyeh, 4 mi. N. of Antipatris. A third Gilgal (II Kings iv, 38) was in the mountains near Bethel. evidently the modern Jiljuliyeh, about 7 mi. N. of Bethel (Beitin). A fourth Gilgal (Deut. xi. 30) would seem to be suggested in the neighbourhood of Mt Gerizim. A place called Juleijil, 1 mi. E. of the foot of Mt. Gerizim, is a likely identification (E. Ro.)

GILGAMESH, EPIC OF, the title of one of the most important literary products of Babylonia, from the name of the chief personage in the tales of nhich it is composed.

Though the Gilgamesh epic is known to us chiefly from the fragments found in the royal collection of tablets made by Assur-bani-pal. king of Assyria (668–626 B.C.), for his palace at Nineveh, internal evidence points to the high antiquity of at least some portions of it; and the discovery of tablets II and III and of a fragment of the epic in the older form of the Babylonian script (c. 2000 B.C.) confirms this view. It is equally certain that the epic originating in Babylonia is a composite product: it consists of a number of independent stories or myths originating at different times and united to form a continuous narrative with Gilgamesh as the central figure. This raises the question whether the independent stories were all told of Gilgamesh or were transferred to Gilgamesh as a favourite popular hero. Internal evidence lends its neight to the latter theory.

Gilgamesh is said to have been a king in the first dynasty of Erech and to have reigned 126 years. The name is Sumerian, and fragments of an early Sumerian poem concerning him have been found at Nippur. Why and how he came to be a popular hero in Babylonia cannot be determined, but the epic indicates that he came as a conqueror and established himself at Erech. There are in the first part of the epic dim recollections of actual events, but solid fact is soon left, and the epic soars to the heights of genuine myth. Gilgamesh becomes a god and, in certain portions of the epic, clearly plays the part of the sun-god of the springtime. taking the place apparently of Tammuz or Adonis. though the story shows traits that differentiate it from the ordinary Tammuz myths.

A separate stratum in the Gilgamesh epic is formed by the story of Enkidu. introduced as the friend of Gilgamesh, who joins him in his adventures. No doubt Enkidu, who symbolizes primeval man, was a figure originally entirely independent of Gilgamesh, but his story was incorporated into the epic.

Another stratum is represented by the story of a favourite of the gods known as Ut-Napishtim (or in Sumerian Zi-u-sud-ra), the Xisuthros of Berossos. who is saved from a destructive storm and flood that destroys his fellow citizens of Shuruppak. Gilgamesh is artificially brought into contact with Ut-Napishtim, to whom he pays a visit for the purpose of learning the secret of immortal life and perpetual youth which he enjoys. During the visit Ut-Napishtim tells Gilgamesh the story of the flood and of his miraculous escape. Nature myths have been entwined with other episodes in the epic, and finally the theologians took up the combined stories and made them the medium for illustrating the truth and force of certain doctrines of the Babylonian religion.

In its final form, the Gilgamesh epic covered 12 tablets, each tablet devoted to one adventure in which the hero plays a direct or indirect part. Of all 12 tablets, portions have been found among the remains of Assur-bani-pal's library, but some of the tablets are so incomplete as to leave even their general contents in some doubt. The fragments do not all belong to one copy. Of some tablets, portions of two, and of other tablets, portions of as many as four copies have turned up, pointing to the great popularity of the production. The best preserved are tablets VI and XI. uhile of those partially preserved a considerable number can be restored. A brief summary of the contents of the 12 may be indicated as follows:

In the first tablet, after a general survey of the adventures of Gilgamesh, his rule at Erech is described, where he enlists the services of all the young able-bodied men in the building of the great wall of the city. The people sigh under the burden imposed, and call upon the goddess Aruru to create a being who might act as rival to Gilgamesh, curb his strength and dispute his tyrannous control. The goddess consents and creates Enkidu, who is described as a wild man. living with the gazelles and the beasts of the field. Enkidu, whose name points to the tradition which made Ea (*q.v.*) the creator of humanity, symbolizes primeval man. Through a hunter, Enkidu and Gilgamesh are brought together, but instead of becoming rivals, they are joined in friendship. Enkidu is induced by the snares of a maiden to abandon his life with the animals and to proceed to Erech, where Gilgamesh, who has been told in several dreams of the coming of Enkidu. awaits him. Together they proceed upon several adventures. which are related in the following four tablets. At first. indeed. Enkidu curses the fate which led him away from his former life. and Gilgamesh is represented as bewailing Enkidu's dissatisfaction. The sun-god Shamash calls upon Enkidu to remain with Gilgamesh, who pays him all honours in his palace at Erech. With the decision of the two friends to proceed to the forest of cedars in which the goddess Irnina—a form of Ishtar—dwells, and which is guarded by Khumbaba. the second tablet ends. In the third tablet, very imperfectly preserved. Gilgamesh appeals through the goddess Ninsun, mother of Gilgamesh, to the sun-god Shamash for his aid in the proposed undertaking. The fourth tablet contains a description of. the formidable Khumbaba, the guardian of the cedar forest. In the fifth tablet Gilgamesh and Enkidu reach the forest. Encouraged by dreams. they proceed against Khumbaba, and dispatch him near a specially high cedar over which he held guard. In the sixth tablet Cilgamesh is wooed by the goddess of love, Ishtar. Gilgamesh. recalling to the goddess the sad fate of those who fall victims to her charms, rejects the offer. In the course of his recital snatches of other myths are referred to, including the famous Tammuz-Adonis tale, in which Tammuz, the youthful bridegroom, is slain by his consort Ishtar. The goddess, enraged at the insult: asks her father Anu to avenge her. **A** divine bull is sent to wage a contest against Gilgamesh, who is assisted by his friend Enkidu. This scene of the fight with the bull is often depicted on seal cylinders. The two friends by their united force succeed in killing the bull, and then after performing certain votive and purification rites return to Erech, where they are hailed with joy. In the seventh tablet Enkidu is smitten with sore disease, but the fragmentary condition of this and the succeeding tablet is such as to envelop in doubt the accompanying circumstances, including the cause and nature of his disease. The eighth tablet records the death of Enkidu. The ninth and tenth tablets, exclusively devoted to Gilgamesh, describe his wanderings in quest of Ut-Napishtim, from whom he hopes to learn how he may escape the fate that has overtaken his friend. He goes through mountain passes and encounters lions. At the entrance to the mountain Mashu, scorpion men stand guard, from one of whom he receives advice as to how to pass through the Mashu district. He succeeds in doing so, and finds himself in a wonderful park, which lies along the seacoast. In the tenth tablet the goddess Sabitu, who, as guardian of the sea, first bolts her gate against Gilgamesh, after learning of his quest, helps him to pass in a ship across the sea to the "waters of death." The ferryman of Ut-Napishtim brings him safely through these waters, despite the difficulties and dangers of the voyage, and at last the hero finds himself face to face with Ut-Napishtim. In the 11th tablet, Ut-Kapishtim tells the famous story of the Babylonian flood. Ut-Napishtim and his wife are anxious to help Giigamesh to new life. He is sent to a place where he washes himself clean from impurity. He is told of a weed which restores youth to the one grown old. Scarcely has he obtained the weed when it is snatched away from him by a serpent, and the tablet closes somewhat obscurely with the prediction of the destruction of Erech. In the 12th tablet Gilgamesh succeeds in obtaining a view of Enkidu's shade, and learns through him of the sad fate endured by the dead. With this description, in which care of the dead is inculcated as the only means of making their existence in Aralu where the dead are gathered. bearable, the epic, so far as we have it, closes.

The reason why the flood episode and the interview with the dead Enkidu are introduced is quite clear. Both are intended as illustrations of doctrines taught in the schools of Babylonia; the former to explain that only the favourites of the gods can hope under exceptional circumstances to enjoy life everlasting; the latter to emphasize the impossibility for ordinary mortals to escape from the inactive shadowy existence led by the dead, and to inculcate the duty of proper care for the dead. That the astro-theological system is also introduced into the epic is clear from the division into 12 tablets. nhich correspond to the yearly course of the sun, while throughout there are indications that all the adventures of Gilgamesh and Enkidu, including those which have a historical background, have been submitted to the influence of this system and projected onto the heavens. This interpretation of the popular tales. according to which the career of the hero can be folloued in its entirety and in detail in the movements in the heavens. in time. with the growing predominance of the astral-mythological system, overshadowed the other factors involved, and it is in this form, as an astral myth. that it passes through the ancient world and leaves its traces in the folk tales and myths of Hebretvs. Phoenicians. Syrians, Greeks and Romans throughout Asia Minor and even in India.

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GILGIT, a territory in the northwest of Kashmir containing Gilgit hill station. It gives its name also to the Gilgit river, the Gilgit *wazarut* lying to the south and to the Gilgit political agency comprising a number of states and principalities whose territories extend toward Chitral. Afghanistan, the U.S S.R. and Sinkiang. The whole area, which has been administered by Pakistan since 1947 (see below), was previously under the jurisdiction of the maharaja of Rashmir, excepting the states in the political agency which were administered by a British officer directly responsible to the government of India. These states, which included Hunza, Nagar, Ashkuman, Yasin, Ghizar, the little republic of Chilas. etc., formerly acknowledged the suzerainty of Kashmir, paying an annual tribute in gold or grain, but they formed no part of its territory.

Within the wider limits of the former Gilgit agency are many mixed races, speaking different languages, which have all been usually classed together under the name Dard. The Dard, hoaever, are unknown beyond the limits of the Kohistan district of the Indus valley to the south of the Hindu Roh, the rest of the inhabitants of the Indus valley belonging to Shin republics, or Chilas. The great mass of the Chitral population are Kho (speaking Khouar), and they may be accepted as representing the aboriginal population of the Chitral valley (See HINDU KUSH.) Between Chitral and the Indus the "Dards" of Dardistan are chiefly Yeshkuns and Shins, and it would appear from the proportions in nhich these people occupy the country that they must have primarily moved up from the valley of the Indus in successive waves of conquest, first the Yeshkuns and then the Shins. The Shins are of Hindu origin and spread themselves northward and eastward as far as Baltistan, where they collided with the aboriginal Tatar of the Asian highlands. The *wazarat* of Gilgit contained a population (1941) of 76,526, all Mohammedans, mostly of the Shiah sect, but not fanatical. The dominant race is that of the Shins, whose language is universally spoken. This is one of the so-called Pisacha languages. an archaic Aryan group intermediate betueen the Iranian and the Sanskritic.

In general appearance and dress all the mountain-bred peoples extending through these northern districts are very similar. Thick felt coats reaching below the knee, loose "pyjamas" with cloth "putties" and boots (often of English make) are almost universal, the distinguishing feature in their costume being the felt cap worn close to the head and rolled up round the edges.

Routes in the Gilgit Agency.—One of the oldest recorded routes through this country is that which connects Mastuj in the Chitral valley with Gilgit, passing across the Shandur range (12,250 ft.). It now forms the highroad between Gilgit and Chitral, and has been engineered into a passable route. From the north three great glacier-bred affluents make their way to the river of Gilgit, joining it at almost equal intervals: and each of them affords opportunity for a rough passage northward. (1) The Yasin river, which follows a fairly straight course from north to south for about 40 mi. from the foot of the Darkot pass across the Shandur range (15,000 ft.) to its junction with the Gilgit river, close to the little fort of Gupis, on the Gilgit-Mastuj road. Much of this valley is cultivated and extremely picturesque. At the head of it is a grand group of glaciers, one of which leads up to the well-known pass of Darkot. (2) Twenty-five miles (by map measurement) below Gupis the Gilgit receives the Ashkuman affluent from the north. The little Lake of Karumbar is held to be its source, as it lies at the head of the river. The same lake is sometimes called the source of the Yarkhun or Chitral river, and it seems possible that a part of its waters may be deflected in each direction. The Karumbar, or Ashkuman, is nearly twice the length of the Yasin, and the upper half of the valley is encompassed by glaciers, rendering the route along it uncertain and difficult. (3) Forty miles or so below the Ashkuman junction, and nearly opposite the little station of Gilgit, the river receives certain further contributions from the north which are collected in the Hunza and Nagar basins. These basins include a system of glaciers of such gigantic proportions that they are probably unrivalled in any part of the world. The glacial head of the Hunza is not far from that of the Karumbar, and, like the Karumbar, the river commences with a wide sweep eastward, following a course roughly parallel to the crest of the Hindu Kush (under whose southern slopes it lies close) for about 40 mi. Then striking south for another 40 mi., it twists amid the barren feet of gigantic rock-bound spurs which reach upward to the Muztagh peaks on the east and to a mass of glaciers and snow fields on the west, hidden amid the upper folds of mountains towering to an average of 25,000 ft. The next great bend is again to the west for 30 mi., before a final change of direction to the south at the historical position of Chalt and a comparatively straight run of 25 mi. to a junction with the Gilgit. The valley of Hunza lies 10 mi. from the point of this westerly bend, and 20 (as the crow flies) from Chalt.

Glaciers and **Mountains.**—Conway and Godwin Austen have described the glaciers of Nagar, which, enclosed between the Muztagh spurs on the northeast and the frontier peaks of Kashmir (terminating with Rakapushi) on the southwest, and massing themselves in an almost uninterrupted series from the Hunza valley to the base of those gigantic peaks which stand about Mt. Godwin Austen, seem to be set like an ice sea to define the farthest bounds of the Himalayas. From its uttermost head to the foot of the Hispar, overhanging the valley above Nagar, the length of the glacial ice bed known under the name of Biafo is said to measure about 90 mi. Throughout the mountain region of Hunza and Nagar the valleys are deeply sunk between mountain ranges, which are nowhere less than 15,000 ft. in altitude and which must average above 20,000 ft. As a rule. these valleys are bare of vegetation. Where the summits of the loftier ranges are not buried beneath snow and ice they are bare, bleak and splintered, and the nakedness of the rock scenery extends down their rugged spurs to the very base. Sun-baked in summer and frost-riven in winter, the mountainsides are but immense ramps of loose rock debris, only awaiting the yearly melting of the upper snow fields, or the advent of a casual rainstorm, to be swept downward in an avalanche of mud and stones into the gorges below. Here it becomes piled and massed together, till the pressure of accumulation forces it out into the main valleys, where it spreads in alluvial fans and silts up the plains. This formation is especially marked throughout the high level valleys of the Gilgit basin.

Passes.—Each of these northern affluents of the main stream is headed by a pass, or a group of passes, leading either to the Pamir region directly or into the upper Yarkhun valley from which a Pamir route diverges. The Yasin valley is headed by the Darkot pass (15,000 ft.), which drops into the Yarkhun not far from the foot of the Baroghil group over the main Hindu Kush watershed. The Ashkuman is headed by the Gazar and Kora Bohrt passes, leading to the valley of the Ab-i-Punja; and the Hunza by the Kilik and Mintaka, the connecting links between the Taghdumbash Pamir and the Gilgit basin. They are all about the same height—15,000 ft. All are passable at certain times of the year to small parties, and all are uncertain. In no case do they present insuperable difficulties in themselves; but the gorges and precipices which distinguish the approaches to them from the south, the slippery sides of shelving spurs whose feet are washed by raging torrents, the perpetual weary monotony of ascent and descent over successive ridges multiplying the gradient indefinitely —these form the real obstacles blocking the way to these northern passes.

Gilgit Station.—The pretty little station of Gilgit (4,890 ft. above sea level) spreads itself in terraces above the right bank of the river nearly opposite the opening leading to Hunza, almost nestling under the cliffs of the Hindu Koh, which separates it on the south from the savage mountain wilderness of Darel and Kohistan. It includes a residency for a political officer, with about half a dozen homes for the accommodation of officials, barracks suitable for a battalion of troops, and a hospital. Evidences of Buddhist occupation are not wanting in Gilgit, though they are few and unimportant. Such as they are, they appear to prove that Gilgit was once a Buddhist centre! and that the old Buddhist route between Gilgit and the Peshawar plain passed through the gorges and clefts of the unexplored Darel valley to Thakot under the northern spurs of the Black mountain.

Connection With West Pakistan.—The Gilgit river joins the Indus a few miles above the little post of Bunji, where a suspension bridge spans the river. A little below Bunji the Astor river joins the Indus from the southeast, and this deep pine-clad valley indicates the continuation of the highroad from Gilgit to Kashmir via the Tragbal and Burzil passes. Another well-known route connecting Gilgit with West Pakistan lies across the Babusar pass (13,690 ft.), linking the lovely Hazara valley of Kaghan to Chilas; Chilas (4,150 ft.) being on the Indus. 50 mi. below Bunji. This is a more direct connection between Gilgit and the plains of West Pakistan than that afforded by the Kashmir route via Gurais and Astor, which latter route involves two considerable passes—the Tragbal (11.585 ft.) and the Burzil (13.776 ft.). Like the Kashmir route, it is no defined by a good military road.

History.—The Dards (Daradae) are located by Ptolemy with surprising accuracy on the west of the upper Indus, beyond the head aters of the Swat river (Soastus), and north of the Gandarae; *i.e.*, the Gandharis, who occupied Peshawar and the country north of it. This region was traversed by two of the Chinese pilgrims of the early centuries of the Christian era, who have left records of their journeys; viz., Fahien, coming from the north, *c*. 400, and Hsuan Tsang, ascending from Swat, *c*. 631. The latter says: "Perilous were the roads, and dark the gorges. Sometimes the pilgrim had to pass by loose cords, sometimes by light stretched iron chains. Here there were ledges hanging in mid-air; there flying bridges across abysses; elsewhere paths cut with the chisel, or footings to climb by." Yet even in these inaccessible regions were found great convents and miraculous images of Buddha. How old the name of Gilgit is we do not know, but it occurs in the writings of the great Mohammedan savant al-Biruni, in his notices of Indian geography. Speaking of Kashmir, he says: "Leaving the ravine by which you enter Kashmir and entering the plateau, then you have for a march of two more days on your left the mountains of Bolor and Shamilan, Turkish tribes who are called *Bhattavaryan*. Their king has the title Bhatta-Shah. Their towns are *Gilgit,* Aswira and Shiltash, and their language is the Turkish. Kashmir suffers much from their inroads" (tr. Sachau, i, 207). It is impossible to say what ground the writer had for calling the people Turks. But it is curious that the Shins say they are all of the same race as the Moguls of India. whatever they may mean by that. Gilgit, as far back as tradition goes, was ruled by rajas of a family called Trakane. When this family became extinct the valley was desolated by successive invasions of neighbouring rajas, and in the 20 or 30 years ending with 1832 there had been five dynastic revolutions. The most prominent character in the history was a certain Gaur Rahman or Gauhar Aman, chief of Yasin, a cruel savage and manseller, of whom many evil deeds are told. Being remonstrated with for selling a *mullah,* he said, "Why not? The Koran, the word of God, is sold; why not sell the expounder thereof?" The Sikhs entered Gilgit about 1842 and kept a garrison there. When Kashmir was made over to Maharajā Gulab Singh of Jammu, in 1846, by Lord Hardinge, the Gilgit claims were transferred with it. And when a commission was sent to lay down boundaries of the tracts made over, Vans Agnew (afterward murdered at Multan) and Lieut. Ralph Young of the engineers visited Gilgit, the first Englishmen who did so. The Dogras (Gulab Singh's people) had much ado to hold their ground, and in 1852 a catastrophe occurred, parallel on a smaller scale to that of the English troops at Kabul. Nearly 2,000 men of theirs were exterminated by Gaur Rahman and a combination of the Dards; only one person, a soldier's wife. escaped, and the Dogras were driven away for eight years. Gulab Singh would not again cross the Indus, but after his death (in 1857) Maharaja Ranbir Singh longed to recover lost prestige. In 1860 he sent a force into Gilgit. Gaur Rahman just then died, and there was little resistance. The Dogras took Yasin twice, but did not hold it. They also, in 1866, invaded Darel, one of the most secluded Dard states, to the south of the Gilgit basin, but withdrew again. In 1889, in order to guard against the advance of Russia, the British government, acting as the suzerain power of Kashmir, established the Gilgit agency. On the British withdrawal in 1947 the place of the political agent was taken by a Kashmiri governor. In Nov. 1947 the Gilgit scouts rose in revolt, imprisoned the governor and proclaimed Gilgit's accession to Pakistan. When the fighting between India and Pakistan ceased in Kashmir (*q.v.*) in 1949, a cease-fire line was established. The whole of Gilgit, including the agency and the *wazarat,* lay north of this line, within the area occupied by the forces of Pakistan, and from that date was administered by the government of Pakistan. The states and principalities of the former British agency were included in an agency established by Pakistan on the British model.

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GILIA, a genus of about 100 species of mostly herbs of the Polemoniaceae family. It is a polymorphic genus, mostly native to western North America, a few to South America, and containing annual, biennial and perennial species that show much variation in growth habit, inflorescence and flower colour. The following are popular garden plants: G. *capitata,* an annual of about two feet with dense globose heads of light-blue flowers; G. *rubra,* commonly known as standing cypress, is a common, leafy-stemmed garden perennial, three to five inches high, with a narrow panicle of externally bright scarlet flowers that are yellowish and dotted with red on the inside; G. *aggregata,* known as scarlet or skyrocket gilia, a biennial, one to three feet high with showy scarlet to white flowers; and G. *tricolor,* known as bird's-eyes, an annual one to three feet, with loose clusters of fragrant flowers with yellowish tubes, purple throats and lilac or violet roundish corolla lobes. All are of easy culture in the flower garden, and even the biennials and perennials will often flower from seed within a single season.

(J. M. BL.)

GILKIN, IWAN (1858–1924), Belgian poet, was born at Brussels on Jan. 7, 1858. He was a member of the group of poets known as La jeune Belgique, and his earlier work shows strongly the influence of Baudelaire. He wrote *Damnation de l'artiste* (1890), *Ténèbres* (1892) and other poems collected under the title of *La Nuit* (189;). Other volumes of verse followed. His most individual work is to be found in his dramatic poem *Prométhée* (1899) and the blank verse drama *Le Roi Cophétua.* Gilkin died at Brussels on Sept. 30, 1924.

GILL, SIR DAVID (1843–1914), British astronomer, skillful observer of solar and stellar parallax and pioneer in the use of photography for mapping the stars, was born at Aberdeen, Scot., on June 12, 1843, and educated at Marischal college and at the University of Aberdeen. In 1872 he became director of Lord Lindsay's private observatory at Dunecht near Aberdeen, whence he undertook expeditions to observe the transit of Venus at Mauritius in 1874 and the close approach to the earth of Mars at Ascension Island in 1877.

In 1879 Gill was appointed H.M. astronomer at the Cape of Good Hope in succession to E. J. Stone. In 1888 and 1889 he carried out, with the co-operation of many astronomers, a program of intensive observation with the heliometer of selected minor planets. This led to the first determination (1901) of the solar parallax with modern accuracy ($8''.804 \pm 0''.0046$). While at the Cape observatory Gill completed the Cape Photographic Durchmusterung (1885–89), introduced observations of stellar parallax with the heliometer (*q.v.*), arid served as one of the original council for the International Astrographic Chart and Catalogue. He was made knight commander of the Order of the Bath in 1900.

Gill died in London on Jan. 24, 1914. (O.J. E.)

GILL, (ARTHUR) ERIC ROWTON PETER JOSEPH (1882–1940), English sculptor, engraver, typographical designer and essayist. He fiercely defended the principle that designer and workman should be one; and the popularity of his Perpetua (1925) and Gill sans-serif (1927) type faces is evidence of a successful application of this and of his purifying influence on type design. Gill was born on Feb. 22, 1882, at Brighton, Sussex, where his father was an Independent minister. From 1897 his family lived at Chichester, where the boy would have seen the unique Romanesque bas-reliefs at the cathedral. At his father's wish he was articled in 1899 to a London architect, R'. D. Caroe. but in 1903 he turned to letter carving and typography, following spare-time studies at the new Central School of Art with Edward Johnston, a pioneer of early 20th-century lettering styles. Until 1910 Gill worked mainly as a letter cutter and carver on tombstones, but in 1909 he turned to figure sculpture. A "Madonna and Child" of 1910 brought him into public notice, arid in 1911, befriended by Augustus John, Roger Fry and others, he held an exhibition at the Chenil gallery, London. This early group also includes a "Crucifixion" (1910; Tate gallery, London), in Hoptonwood stone, a material he was to make fashionable in the 1920s and 1930s; a "Cupid" (1910) in Portland stone; and a "Torso" (1912; Manchester City Art gallery) in the softer Bath stone. The "Crucifixion" is inspired by Saxon and Romano-British sculpture, but also in its limbs. hands and feet by Paul Gauguin's works, such as the "Christ Jaune"; the head resembles certain elongated ones of Picasso's "Negro" period. There is early evidence of other derivations as far apart as 6th-century Greece (in the "Contortionists") and certain Mexican (Aztec) crouching figures (in the "St. Simeon Stylites"). Gill was received into the Roman Catholic Church in 1913 (later becoming a Dominican tertiary), and carved the "Stations oi the Cross" ior the new Westminster cathedral (1913–18); these reliefs, though slightly perfunctory in conception, are the clearest evidence of his knowledge of the Chichester sculptures. In other works from about 1912 to 1927 Gill appears to lack the ingenuousness and force of earlier years; but monumentality and confidence return in two figures over life size: a caryatid in pine (1927) and "Mankind" (1928; Tate gallery), a colossal torso of majestic quality. Gill's other works include the Stations of the Cross at St. Cuthbert's church, Bradford, Yorkshire (1920–24), the reliefs on Broadcasting house, London (1933), and the splendid "Creation of Adam" for the council hall of the League of Nations, Geneva (1935–38). Gill was a prolific writer and set forth his ideals clearly in his writings; *Christianity and Art* (1927); *Sculpture, an Essay on Stone Cutting—With a*

Preface About God (1917); *Id quod visum placet, A Practical Test of the Beautiful* (1926); *Beauty Looks Ajter Herself* (1933); *Money and Morals* (1934); *Work and Leisure* (1935); *The Necessity of Belief* (1936); *Work and Property* (1937).

Gill died at Harefield, Uxbridge, Middlesex on Nov. 17, 1940.

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GILL or BRANCHIA, the name given to any structure specially adapted for aquatic respiration. The essential features of gills are thinness and large surface of exposure to facilitate transit of respiratory gases; hence they are generally filamentous, feathery or plate-shaped body projections. Gills occur in some Annelida, most Mollusca, the larger Crustacea, aquatic Arachnida, aquatic larvae of insects, fishes, and most larval and a feu- adult Xmphibia. Gills often have accessory functions, as producing food-concentrating currents and brooding of young (as in bivalve mollusks). *(See* ANNELIDA; ARACHNIDA; CRUSTACEA; FISHES; MOLLUSCA.)

The word is also applied to structures resembling the branchiae of fishes, such as the wattles of a fowl or the radiating films on the underside of fungi.

In liquid measure a gill is one-fourth of a pint.

GILLES LI MUISIS or LE MUISET (*c.* 1272–1352), French chronicler, was born probably at Tournai, and in 1289 entered the Benedictine abbey of St. Martin in his native city, becoming prior of this house about 1329, and abbot two years later. Gilles wrote two Latin chronicles. *Chronicon majus* and *Chronicon minus,* dealing with the history of the world from the creation until 1352. This work, edited by J. J. de Smet, in *Corpus chronicorum Flandriae, tome* ii (Brussels, 1841), and by H. Lemaitre for the Société de l'Histoire de France (1906), is valuable for the history of northern France and Flanders during the first half of the 14th century.

Gilles also wrote some French poems, and these *Poésies de Gilles li Muisis* were published by Baron Kervyn de Lettenhove (1882).

GILLESPIE, GEORGE (1613–1648), Scottish clergyman, was born at Kirkcaldy on Jan. 21, 1613, where his father, John Gillespie, was parish minister, and was educated at the University of St. Andrews. He was acting as private chaplain to the earl of Cassillis when he wrote his first work, *A Dispute Against the English Popish Ceremonies Obtruded Upon the Church of Scotland* (1637), which was burned by order of the privy council. In April 1638 Gillespie was ordained minister of Wemyss (Fife), and in the same year was a member of the Glasgow assembly, before which he preached (Nov. 21) a sermon against royal interference in matters ecclesiastical. In 1642 Gillespie was translated to Edinburgh. In 1640 he had accompanied the commissioners of the peace to England as one of their chaplains; and in 1643 he was appointed one of the four Scottish commissioners to the Westminster assembly, where he displayed great power as a controversialist. In 164j he returned to Scotland and is said to have drawn the Act of Assembly sanctioning the directory of public worship. On his return to London he had a hand in drafting the Westminster confession of faith, especially chapter one. Gillespie was elected moderator of the assembly in 1648. He died at Kirkcaldy on Dec. 17, 1648.

Gillespie's principal publications were controversial and chiefly against Erastianism.

See *Works,* with memoir, published by Hetherington (1843–46).

GILLESPIE, THOMAS (1708–74), Scottish clergyman, was born at Clearburn, Duddingston, Midlothian, in 1708. He received ordination at Korthampton in Jan. 1741. In September of the same year he was admitted minister of the parish of Carnock, Fife, the presbytery of Dunfermline admitting as valid the ordination he had received in England, and allowing a qualification of his subscription to the church's doctrinal symbol, so far as it had reference to the sphere of the civil magistrate in matters of religion. Having absented himself from the meetings of presbytery held for the purpose of ordaining one Andrew Richardson, an unacceptable presentee, as minister of Inverkeithing, he was deposed by the assembly of 1752 for maintaining that the refusal of the local presbytery to act in this case was justified. He continued, however, to preach, first at Carnock, and afterward in Dunfermline, where a large congregation gathered round him. In 1761, in conjunction with Thomas Boston of Jedburgh and Collier of Colinsburgh, he formed a distinct communion under the name of the "Presbytery of Relief"—relief, that is to say, "from the yoke of patronage and the tyranny of the church courts." The Relief Church eventually became one of the communions combining to form the United Presbyterian Church (*q.v.*).

Gillespie died on Jan. 19, 1774.

GILLETTE, WILLIAM HOOKER (1853–1937), U.S. playwright and actor, most successful in portraying the cool, resourceful man of action and associated particularly with the character Sherlock Holmes, was born at Hartford, Conn., on July, 24, 1853. After graduation from Hartford high school, he studied at various times at New York university, Massachusetts Institute of Fine Arts and Boston university.

Gillette served with a number of stock companies and made his first appearance as an actor at the Globe theatre in Boston, Mass., in 1875 in *Faint Heart Ne'er Won Fair Lady*. His play *The Professor,* a light comedy in which he appeared in the title role, was produced at the Madison Square Garden theatre in New York city in 1881. *Esmeralda,* his second successful play, produced later in 1881, ran for a year and was later revived from time to time.

Held by the Enemy, a Civil War spy story (produced in Brooklyn, N.Y., in 1836) and *Secret Service* (Philadelphia, 1895) are considered among his best original works. His famous play *Sherlock Holmes,* first produced in New York in 1899 and later in England, was frequently revived in both countries with Gillette in the leading role. His only motion-picture appearance was as Sherlock Holmes in a production of 191j. He died at Hartford, Conn., on April 29, 1937.

GILLINGHAM, a municipal and parliamentary borough of Kent, Eng., on the Medway, next to Chatham with which it and Rochester form the three "Medway towns." Pop. (1951) 70,676. Area 13.0 sq.mi. Its population is largely industrial, employed in the Chatham dockyards, part of which are in the borough, and in local industries. A number of residents are attached to the services in the local establishments. The church of St. Mary Magdalene ranges in date from Early English to Perpendicular. There was formerly a palace of the archbishops of Canterbury in the town.

Gillingham was incorporated in 1903, and in 1929 the boundaries were extended to include Rainham parish.

GILLOT, CLAUDE (1673–1722), French painter and engraver, best known as the master of Watteau and Lancret, was born at Langres on April 27, 1673. His sportive mythological landscape pieces, with such titles as "Feast of Pan" and "Feast of Bacchus," opened the Academy of Painting at Paris to him in 1715; and he then adapted his art to the fashionable tastes of the day. He was connected with the opera and theatre as a designer of scenery and costumes. He died in Paris on May 4, 1722.

GILLOTT, JOSEPH (1799–1873), English pen maker, was born at Sheffield on Oct. 11, 1799. He set up in business in Birmingham, and about 1830 he turned his attention to the manufacture of steel pens by machinery; in 1831 he patented a process for placing elongated points on the nibs of pens. Subsequently he invented other improvements, getting rid of the hardness and lack of flexibility, which had been a serious defect in nibs, by cutting. in addition to the centre slit, side slits, and cross grinding the points.

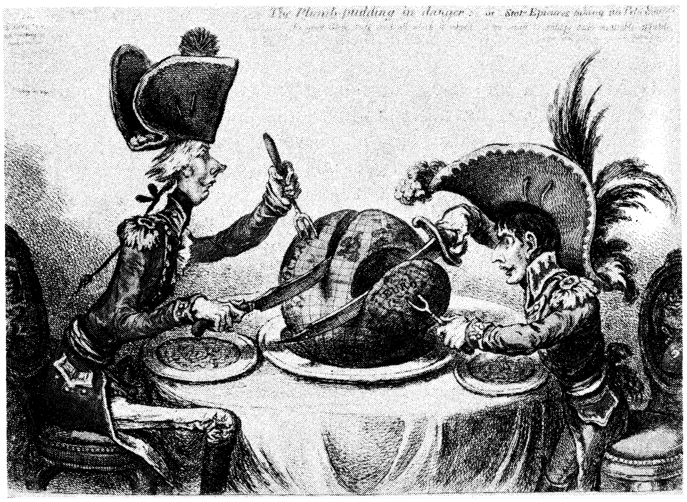
Gillott was a liberal art patron and one of the first to recognize the merits of J. M. W. Turner. He died at Birmingham Jan. 5, 1873.

GILLOW, ROBERT (d. 1773), the founder at Lancaster of a distinguished firm of English cabinetmakers and furniture designers whose books begin in 1731. He was succeeded by his eldest son Richard (1734–1811), who was taken into partnership about 1757, when the firm became Gillow and Barton, and his younger sons Robert and Thomas. The business was continued by his grandson Richard (1778–1866). The firm were architects as well as cabinetmakers, and the first Richard Gillow designed the classical custom house at Lancaster.

About 1761 premises were opened in Oxford street, London. For a long period the Gillows were the best-known makers of English furniture. Sheraton. Hepplewhite and Robert Adam designed for them. Between 1760 and 17jo they invented the original form of the billiard table. They were the patentees (about 1800) of the telescopic dining table. For a Captain Davenport they made, if they did not invent, the first writing table of that name.

GILLRAY, JAMES (17j7–1815). English caricaturist. who lampooned the political figures of his day. was born at Chelsea. Gillray began by learning letter-engraving and later was admitted as a student to the Royal Academy. supporting himself by engraving and perhaps by caricatures signed with fictitious names. William Hogarth's works were a source of study and delight for him in these years. Soon his own caricatures began to appear; the first that is certainly his is "Paddy on Horseback." published in 1779. The name of Gillray's publisher and print seller. Miss Humphrey~is inextricably associated with his. He lived in her house during all the years of his fame and his prints were shown in the windows of her shop.

A number of his most trenchant satires were directed against



"THE PLUM PUDDING IN DANGER" BY JAMES GILLRAY

"Farmer George"—King George 11—and his court. After the French Revolution. Gillray became a conservative and he issued caricatures ridiculing Napoleon and the French and glorifying John Bull. His last work. from a design by Bunbury, is entitled "Interior of a Barber Shop in Assize Time" and is dated 1811. While engaged on it he became mad, although he later had occasional intervals of sanity. He died on June 1. 1815.

Gillray's caricatures may be divided into two classes: the social and political. The political caricatures form a historical record of the latter part of the reign of George III. They were circulated not only over Britain but throughout Europe and exerted a powerful influence. In this series George III. the queen. the prince of Wales. Fox. Pitt. Burke and Napoleon are the most prominent figures. Among Gillray's best satires on the king are: "Farmer George and His Wife.'! companion plates, in one of which the king is toasting muffins for breakfast, and in the other the queen is frying sprats; "The Anti-Saccharites," where the royal pair propose to dispense with sugar to the great horror of the family; "A Connoisseur Examining a Cooper"; "Temperance Enjoying a Frugal Meal"; and "Royal Affability." "The First Kiss These Ten Years." a satire on the peace, is said to have greatly amused Napoleon.

Like most of the English caricatures of the time, Gillray's plates were executed in etching with stipple and coloured by hand. They were produced for popular consumption and perhaps this is one of the reasons for that hurried vitality and spontaneity which make them so lively and timely. The injustices and pretentions which they depict as ridiculous absurdities are always present in some form or other. and in the work of Gillray they are leveled to the ground of truth by combination of conviction. vitality, acute human observation, fantasy and artistic naïveté. Unlike Daumier, Gillray does not situate the caricature in the realm of great art, but he does bring it to the threshold.

See Thomas Wright and R H. Evans. *Historical and Descriptive Account of the Caricatures of James Gillray* (1851); Mary Dorothy George, *Catalogue of Political and Personal Satires . . . in The British Museum,* vol. v–ix (1935–1949). (H. Es.; X.)

GILLYFLOWER, a name applied to various flowers, but most commonly to the clove pink, *Dianthus caryophyllus,* of which the carnation is a cultivated variety, and to the stock. *Matthiola incana,* a well-known garden favourite. The word is sometimes written gilliflower or gilloflower, and is reputedly a corruption of July flower, "so called from the month they blow in." The name n-as originally given in Italy to plants of the pink tribe, especially the carnation, but has in England been transferred to several cruciferous plants.

The gillyflower of Chaucer and Spenser and Shakespeare was, as in Italy, *Dianthus caryophyllus;* that of later writers and of gardeners. *Matthiola.* The principal other plants which bear the name are the wallflower, *Cheiranthus cheiri,* called wall gillyflower in old books; the dame's violet: *Hesperis matronalis,* called variously the queen's, the rogue's and the winter gillyflower; the ragged robin. *Lychnis floscuculi,* called marsh gillyflower and cuckoo gillyflower; the water violet. *Hottonia palustris,* called water gillyflower; and the thrift. *Statice armeria,* called sea gillyflower. As a separate designation it is usually applied to the wallflower.

GILMAN, DANIEL COIT (1831–1908). U.S. educator, first president of Johns Hopkins university, was born in Norwich, Conn.. on July 6. 1831. After his graduation at Yale in 1852 he went to St. Petersburg, Russia, as attaché, then studied at Berlin (1854–55). For 17 years he worked at Pale as assistant librarian. professor of physical and political geography and secretary of the governing board. From 1872 to 1875 he was head of the University of California at Berkeley. In 187j he became first president of Johns Hopkins. This post he filled until 1901, after which, until 1904, he served as the first president of the Carnegie institution at Washington, D.C. He died at Norwich on Oct. 13, 1908.

Gilman's influence upon higher education in the United States was great, as was his contribution to the organization of the Johns Hopkins hospital, of which he was made director in 1889. Under him Johns Hopkins had an immense influence, especially in the promotion of original and productive research. Through his services on numerous foundations and boards devoted to education, and as president of the National Civil Service Reform league, he further aided in educational and social betterment in the United States.

See Fabian Franklin, *Life of Daniel Coit Gilnzan* (1910); John Thomas Faris, *Men Who Conquered* (1922).

GILMAN, LAWRENCE (1878–1939), U.S. music critic. who wrote on many aspects of modern music. was born at Flushing, N.Y., July 5, 1878. Educated in the New York public schools and the Collins Street Classical school (Hartford, Conn.). he studied art with William M. Chase and at the Art Students league in New York city. He was an illustrator for the *New York Herald* (1896–98). He became music critic for *Harper's Weekly* in 1901, also serving as assistant editor (1903–11) and managing editor (1911–13). He was an editor of *Harper's Magazine* (1913–15) and music; drama and literary critic of the *North American Review* (1915–23), leaving to become the *Yew York Herald Tribune* music critic, a position he held until his death in Franconia, N.H., Sept. 8. 1939. He wrote program notes for the New York Philharmonic society and for the Philadelphia orchestra (1921–39).

Gilman wrote *Phases of Modern Music* (1904), *Edward MacDowell* (1905; revised and enlarged. 1909), *The Music of Tomorrow* (1907), *Stories of Symphonic Music* (1907), *Aspects of Modern Opera* (1909), *Nature in Music* (1914), *Wagner's Operas* (1937) and *Toscanini and Great Music* (1938).

GILMORE, PATRICK SARSFIELD (1829–1892), U.S. bandmaster. was born in Ireland: and settled in America about

1850. He organized the best wood wind and brass players of Europe and America, playing in the remoter areas and introducing Wagner, Liszt and other great composers where they had been unknown. He was responsible also for many great orchestras, including one at the World's Peace Jubilee, Philadelphia, 1872, when the orchestra numbered 2,000 and the chorus 20,000. He died at St. Louis Sept. 24, 1892.

GILPIN, BERNARD (1517–1583), English clergyman. the "apostle of the north," was born at Kentmere in 1517 and educated at Queen's College, Oxford, where he was elected fellow in 1j42; in the same year he was ordained. Gilpin was one of the first scholars elected to Wolsey's new foundation at Christ Church. At Oxford he defended the doctrine of the church against Hooper. but his confidence in his own cause was somewhat shaken by a public disputation in which he supported Hooper against Peter Martyr. In 1552 he preached before Edward VI a sermon on sacrilege. in which he denounced the expropriation of church property. About this time he became vicar of Norton in the Durham diocese, and obtained a licence, through William Cecil, as a general preacher throughout the kingdom during the king's lifetime.

On Mary's accession he went abroad to study at Louvain. Antwerp and Paris, returning to England in 1556 as rector of Easington and archdeacon of Durham. His outspokenness excited hostility, and he was brought before Tunstall, bishop of Durham, on a charge of heresy. Tunstall dismissed the case. and presented Gilpin with the rich living of Houghton-le-Spring. and when the accusation was renewed, he again protected him. Gilpin's enemies, however, obtained a royal warrant for his apprehension from Bonner, bishop of London, but his arrival in London was fortunately delayed by an accident in which he broke his leg, and he was freed from danger by the news of Queen Mary's death. He died at Houghton on May 4, 1583.

Gilpin steadily refused promotion. He held a great position in the north, and displayed a magnificent hospitality at Houghton to all classes of his parishioners, and treated them with great generosity in critical times. He built and endowed a grammar school, maintained a large number of poor children at his own charge, and helped the more promising pupils to enter the universities.

See Christopher Wordsworth, *Ecclesiastical Biography*, vol. iii, 4th ed., w-hich contains a contemporary sketch by G. Carleton, originally, printed in Bates's *Vitae selectorum aliquot virorum*.

GIL POLO, GASPAR (?1530–1591), Spanish novelist and poet, was born at Valencia. He finds a place in the history of the novel as the author of La Diana enamorada, a continuation of Montemayor's Diana, and perhaps the most successful continuation ever written by another hand. One of the most agreeable of Spanish pastorals, it was imitated by Cervantes in the *Canto* de *Caliope,* and was translated into English, French. German and Latin. The English version of Bartholomew Young, published in 1598 but current in manuscript 1j years earlier, is said to have suggested the Felismena episode in the *Two Gentlemen* of *Verona;* the Latin version of Caspar Barth, entitled *Erotodidascalus* (Hanover, 1625), is a performance of uncommon merit as well as a bibliographical curiosity.

GILSONITE is a native bitumen (*q.v.*), an asphaltite, found near the Colorado–Utah border in the Uinta basin. It is named after S. H. Gilson, one of its discoverers; the alternarive names uintaite or uintahite are derived from its location. Gilsonite is a lustrous, jet-black solid bitumen exhibiting conchoidal fracture. It gives a brown streak, ranges in specific gravity from 1.03 to 1.10 and is soluble in carbon disulfide. The melting point varies from 110° to 260° C.. depending on chemical composition.

Gilsonite occurs as veins filling parallel, vertical fractures. The largest veins are several miles long, thousands of feet deep and about 20 ft. thick. Maximum annual production before 1950 was about 75,000 tons, when it was used largely in manufacturing paints and other coating materials. Gilsonite production increased after 1957, when it was mined hydraulically and transported as a water slurry by pipeline to refineries for conversion to coke and gasoline. (S. R. SN.)

GILYAKS, a Palaeo-Asiatic people originally widespread throughout the Lower Xmur and the north of Sakhalin. The clan forms a society based on common rights and marital duties. The men in one class: A. had to take wives from another class. B. The women in class A had to marry men—not from B but from a third class, C. Thus brother and sister mated into different clans. The classificatory system of relationship is developed on these lines: common fire, community in the bear rites, common enemies, community in blood money and common tabus bind the clans together. Shamanism and bear worship existed. Death was due to evil spirits and the corpse was cremated, except in certain special cases.

See M. Czplicka, *Aboriginal Siberia* (1914).

GIMA'A: see ARABS.

GIMBAL, a mechanical device for hanging an object in order that it may keep a horizontal and constant position. while the body from which it is suspended is in free motion, so that the motion of the supporting body is not communicated to it. It is thus used particularly for the suspension of compasses or chronometers and lamps at sea, and usually consists of a ring freely moving on an axis. within which the object swings on an axis at right angles to the ring.

The word is derived frorn the O. Fr. *gemel*, a term for a ring formed of two hoops linked together and capable of separation, used in the 16th and 17th centuries as betrothal and keepsake rings. They sometimes were made of three or more hoops linked together.

GIMLET, a tool used for boring small holes. It is made of steel, with a shaft having a hollow side. and a screw at the end for boring the wood; the handle of wood is fixed transversely to the shaft. A gimlet is always a small tool. A similar tool of large size is called an auger. See TOOL.

GIMP or GYMP. Probably a nasal form of the Fr. guipure, from *guiper,* to cover or "whip" a cord over with silk, a stiff trimming made of silk or cotton woven around a firm cord, often further ornamented by a metal cord running through it. It is also sometimes covered with bugles, beads or other glistening ornaments. The trimming employed by upholsterers to edge curtains. draperies, the seats of chairs, etc., is also called gimp; and in lace work it is the firmer or coarser thread which outlines the pattern and strengthens the material.

Gimp is also a shortened form of gimple (the O.E. wimple), the kerchief worn by a nun around her throat, sometimes also applied to a nun's stomacher.

GIN, a potable distilled spirit, deriving its principal flavour from the juniper berry (*juniperus communis*). The origin of gin was medicinal and is attributed to Franciscus de la Boe (1614–1672). professor of medicine at the University of Leyden. Holland, who distilled spirits in the presence of the juniper berry in order to prepare a specific with known diuretic properties. The juniper berry was known by its French name of *genièvre,* which the Dutch altered to *genever*, and the English to gin.

By 1792 Holland was producing 14,000,000 gallons, of which 10,000,000 were exported. British soldiers returning from the wars on the continent brought the taste for gin to England. However, it was Queen Anne who gave gin distilling its impetus during her reign (1702–14), when she raised the duties and taxes on imports and lowered the excise on home products.

There are two basic types of gin, those produced in the Netherlands and those produced elsewhere, principally in England and America. The difference derives from the fact that the Dutch utilize very rich, full-bodied spirits and distill their gin at a very low proof, usually below roo. while the English and American distillers use highly purified spirits, distilling their gins off at about 160 U.S. proof.

Dutch gins are known as Geneva. Genever, Schiedam or Hollands. Low proof spirits distilled from a mash of at least one-third barley malt are rectified. The resultant spirits, together with the flavouring agents. are redistilled, coining off at between 94 and 98 proof. Dutch gins are malty in flavour and have a very full body. Other "botanicals" are included with the juniper berries. but not in the variety employed in England and the United States.

English gin is produced by rectifying high proof grain whisky or spirits to assure complete purity and flavour-free spirits. These are then reduced with water to proof strength (114.2 U.S. proof), placed in a pot still together with the flavouring agents, and the whole redistilled. The resultant gin is reduced to 80, 86 or 94 U.S. proof; depending on the market for which it is intended, and allowed to rest for a very short period before bottling for the market.

The "botanicals" used to flavour gin in England and the United States are juniper berries, preferably from Germany and Italy; orris? angelica and licorice roots; bitter almonds: caraway, coriander, cardamon, anise and fennel seeds; calamus, cassia bark, lemon peel. sweet and bitter orange peels, etc. Each gin producer has developed his own secret formulas, using some or all of the foregoing.

American gin producers follow the English method. usually employing solely 190 proof grain spirits. Their gin stills often have a tray or gin head in which the botanicals rest and through which the alcoholic vapours swirl as they rise.

Usually. gin is not aged. Some U.S. producers do age their gin although under U.S. regulations no claim of age may be made for gin. Such aged gins have a pale golden colour.

English and American gins are dry gin. The term London Dry gin is used in the United States and has lost its geographical significance. Old Tom gin is a slightly sweetened gin. while fruit flavoured gins are produced by adding such flavors as orange. lemon, raspberry or pineapple to finished gin.

Sloe gin is a gin in name only. It is a sweet liqueur with the acid tang of the sloe berry.

Hollands gin is generally drunk neat or mixed with water, while dry gins are consumed in a variety of fashions — neat. in cocktails such as the dry martini and long drinks such as the Tom Collins. or mixed with tonic water. *See* also ALCOHOLIC BEVERAGES; DISTILLED. (H. J. GN.)

GINDELY, ANTON (1829–1892), Austrian historian. noted for his work on Bohemian history and on the period of the Thirty Years' War. was born in Prague. Sept. 3. 1829, the son of an Austrian father and a Czech mother. He studied at Prague and in 18jj made the first of his journeys investigating archives in Bohemia. Poland and Germany. There he gained access to the records of the Moravian Brethren. which led him to write several works. including *Geschichte der böhmischen Briider* (1857). In 1862 he became professor at Prague and in 1867 official Bohemian archivist. He was also the editor of *Monumenta historiae bohemica* (j vol., 1864–90).

Gindely's other important works include *Geschichte des 30 Jährigen Krieges* (1869–80), *Rudolf 11 und seine Zeit* (1863 and 1868) and a criticism of Wallenstein, *Waldstein während seines ersten Generalats* (2 vol. 1885–86), which caused controversy.

His *Geschichte der Gegenreformation in Böhmen* was edited by T. Tupetz (1894). Gindely died in Prague. Oct. 24, 1892.

GINER DE LOS RÍOS, FRANCISCO (1840–1915), Spanish philosopher and jurist, was born in Ronda (Andalusia) on Oct. 10, 1840 He graduated in Granada. and in 1867 went to the University of Madrid as a professor of jurisprudence and there came under the influence of Sanz del Río, Krause's famous disciple. In accordance with his belief that philosophy should have a concrete influence on practical life, he devoted himself to the educational question. Twice Giner resigned his chair, together with several of his colleagues, in a stand for liberty of thought in the university against a reactionary government, and was twice reinstated.

He helped found the Institución Libre de Enseñanza, an educational institute which did much to improve teaching methods in Spain. by the application of philosophical thought to the problems of education. His greatest influence was personal and direct, for he was a born teacher, a man of refined sensibility, pure in his life as in his ideals.

Giner published several volumes of essays — literary, educational. philosophical and religious — as well as *Leccioizes Sumarias de Psicologiu* (1871); *Psicologiu; Idea del Derecho,* with Alfredo Calderón, trans. from the German of Roder (188j); *Resumen de Filosofía del Derecho,* with Alfredo Calderón (1898); and other works.

A complete edition of his numerous works was undertaken a year after his death.

See S. de Madariaga, ***The Genius of* Spain** (1923).

GINGEE, a rock fortress of southern India, in the South Arcot district of Madras. It consists of three hills, connected by walls enclosing an area of 7 sq.mi. The origin of the fortress is shrouded in legend. When occupied by the Mahrattas at the end of the 17th century, it withstood a siege of eight years against the armies of Xurangzeb. In 1750 it was captured by the French, who held it with a strong force for 11 years. It surrendered to the English in 1761.

GINGER, the rhizome or underground stem of *Zingiber officinale* (family Zingiberaceae; *q.v.*), a perennial reedlike plant growing from 3 to 4 ft. high. The flowers and leaves are borne on separate stems, those of the former being shorter than those of the latter and averaging from 6 to 12 in. The flowers themselves are borne at the apex of the stems in dense ovate-oblong conelike spikes from 2 to 3 in. long, composed of obtuse strongly-imbricated bracts with membranous margins, each bract enclosing a single small sessile flower. The leaves are alternate and arranged in two rows, bright green. smooth. tapering at both ends. with very short stalks and long sheaths. which stand away from the stem and end in two small rounded auricles. The plant rarely flowers and the fruit is unknown.

GINGER. THE UNDERGROUND STEM OF THE PLANT ZINGIBER OFFICINALE, WHICH HAS BEEN USED AS A SPICE FROM EARLY TIMES

Though not found wild. it is considered with good reason to be a native of the warmer parts of Asia, where it has been cultivated from an early period and the rhizome imported into England. From Asia the plant spread into the West Indies, South America, western tropical Africa and Australia.

The use of ginger as a spice has been known from very early times; it was supposed by the Greeks and Romans to be a product of southern Arabia and was received by them by way of the Red sea; in India it has also been known from a very remote period.

Ginger is known in commerce in two distinct forms. coated and uncoated ginger, *i.e.*, having or lacking the epidermis. For the first. the pieces, called "races" or "hands," from their irregular palmate form: are washed and simply dried in the sun. In this form ginger presents a brown, more or less irregularly wrinkled or striated surface. and when broken shows a dark brownish fracture, hard, and sometimes horny and resinous. To produce uncoated ginger the rhizomes are washed, scraped and sun dried, and are often subjected to bleaching. either from the fumes of burning sulfur or by immersion for a short time in a solution of chlorinated lime. The whitewashed appearance that much of the ginger has. as seen in the shops. is due to the fact of its being washed in whiting and water. or even coated with sulfate of lime. Cncoated ginger, as seen in trade, varies from single joints an inch or less in length to flattish irregularly branched pieces of several joints, the "races" or "hands." and from 3 to 4 in. long; each branch has a depression at its summit showing the former attachment of a leafy stem. The colour. when not whitewashed, is a pale buff; it is somewhat rough or fibrous, breaking with a short mealy fracture, and presenting on the surfaces of the broken parts numerous short bristly fibres.

The principal constituents of ginger are starch, volatile oil (to which the characteristic odour of the spice is due) and resin (to which is attributed its pungency). Its chief use is as a condiment or spice, but in medicine to promote the digestive activity of the stomach it is also used internally. The rhizomes, collected in a young green state. washed, scraped and preserved in sirup, form a delicious preserve, which is largely exported both from the West Indies and from China.

Cut up and preserved in sugar, ginger forms an agreeable candy.

GINGER ALE, a sweetened, carbonated beverage, the predominating flavour and pleasant warmth of which are derived mainly from the underground stem, or rhizome, of *Zingiber officinale.* Though originally carbonated by fermentation, modern ginger ales are artificially saturated with carbon dioxide gas. The Jamaican and African varieties of ginger rhizome yield the finest-flavoured beverages. the flavour and pungency of the rhizome being dependent upon the essential oil and oleoresin, which are its principal active constituents.

Other flavouring materials are frequently added; for example, spices, citrus essences, fruit juices, foam producing substances, etc.. and occasionally peppery materials: such as capsicum, to increase the pungency of the beverage.

lhere are two general types: pale dry ginger ales tend to be less sweet, more acid, lighter, milder and highly carbonated; golden. or aromatic. ginger ales tend to be sweeter! less acid, darker and generally more pungent. The joint committee of definitions and standards of the U.S. department of agriculture in 1922 defined ginger ale as the carbonated beverage prepared from ginger ale flavour. sugar sirup. harmless organic acid. potable water and caramel colour. Ginger ale flavour, or ginger ale concentrate. was defined as the flavouring product in which ginger is the essential constituent. with or without the addition of other aromatic and pungent ingredients, citrus oils and fruit juices.

In preparing a carbonated ginger ale, a sirup is first made. this being compounded from water. sugar, ginger ale flavour or extract. citric or tartaric acid. caramel colour and possibly foam essence. Such a sirup is employed in making the carbonated beverage in the manner which is described under SOFT DRINKS.

(R. W. ME.)

GINGER BEER is the generic term for three classes of nonexcisable (less than 2% proof spirit) ginger-flavoured beverages: brewed fermented ginger beer, beverages made by the artificial carbonation of brewed ginger-flavoured concentrates, and nonbrewed ginger beers.

The principal differences between ginger beer and ginger ale lie in the rather higher gravity and greater proportion of extractive matter in ginger beer; in the appearance. ginger beer usually being cloudy while ginger ale is brilliantly clear; and also in the fact that ginger ales frequently contain certain capsicum extracts which increase the sharpness of the beverage.

Until about 1850, brewing and fermenting of mixtures of ginger. other spices and bitter vegetable substances constituted the only known method of making ginger beers, many of which had alcoholic contents in the region of 10%–12% proof spirit. The restrictions created in Great Britain by the Excise act of 1855 led to the manufacture of ginger beer by the dilution of brewed concentrates with carbonated water. Nonbrewed ginger beers later became popular, although many of these beverages have a pronounced lemon flavour; they frequently contain a foam-producing extract—usually an extract of quillai bark.

The production of ginger beer by fermentation is carried out by first making an aqueous infusion of a mixture of vegetable products among which ginger predominates. The following is a suitable mixture: bruised Jamaica ginger 6 parts. liquorice extract 2 parts, hops 3 parts, cloves 3 parts, gentian $\frac{1}{4}$ part. Five parts of such a mixture are boiled in 200 parts of water for 20 to 30 min.; the extract is strained and sweetened with 6 or 7 parts of sugar. Caramel colour is added as desired, the extract cooled to about 70° C. and; after adding 1 fl.oz. of brewer's yeast, allowed to ferment for 24 hours. Citric acid is then added to the liquor according to the taste of the manufacturer. and the beverage is bottled after standing for a few days to permit the mucilaginous matter to settle out. The bottled product is pasteurized by some manufacturers.

(W. P.-D.)

GINGHAM, a fabric usually made with a plain weave; it originally was made completely of cotton fibres but later much of it was made of manmade fibres. The name comes from the Malayan word *gingan,* meaning striped, and thence from the French *guingan,* a term used by the Bretons to signify cloth made from striped colouring.

Medium or fine yarns of varying quality are used to obtain the plain, check or stripe effects. The cloth is yarn-or skein-dyed or printed. and it runs to about six yards to the pound. Texture thread counts average 64 x 56 per square inch. The warp and the filling may be the same, even-sided and balanced.

Gingham is strong, rather stout, substantial and serviceable. It launders easily and well. but lower-textured fabric may shrink considerably unless preshrunk. Prices of gingham have a wide range; designs or patterns run from the conservative to gaudy, wild effects.

Uses include dress goods. trimming. kerchiefs. aprons, children's wear and beachwear. It is very popular in summer dress wear for women and children. Ginghams on the market in the early 1960s included chambray gingham, nurses' gingham, Scotch, tissue and zephyr.

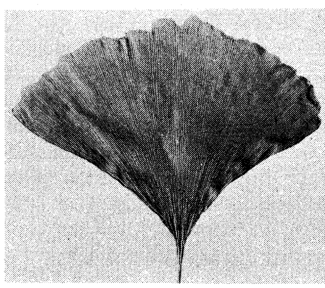
(G. E. L.)

GINGUENÉ, PIERRE LOUIS (1748–1815), French author, was born at Rennes, in Brittany. He was educated at a Jesuit college in his native town and went to Paris in 1772. He wrote criticisms for the *Mercure de France,* and composed a comic opera, *Pomponin* (1777). The *Satire des satires* (1778) and the *Confession de Zulmé* (1779) followed. His defense of Piccinni against the partisans of Gluck made him still more widely known. He welcomed the Revolution, and joined Giuseppe Cerutti, the author of the *Mémoire pour le peuple français* (1788), and others in producing the *Feuille villageoise,* a weekly paper addressed to the villages of France. Imprisoned during the Terror, he escaped death by the downfall of Robespierre. He assisted, as director-general of the "commission extcutive de l'instruction publique," in reorganizing the system of public instruction, and was an original member of the Institute of France. In 1797 he was for a few months minister plenipotentiary to the king of Sardinia. He was appointed a member of the tribunate, but Napoleon had him expelled at the first "purge.!' He was one of the commission charged to continue the *Histoire littéraire de la France.*

Ginguené's most important work is the *Histoire littéraire d'Italie* (14 vol., 1811–35), unfinished at the time of his death.

GINKGO or MAIDENHAIR TREE (Ginkgo *biloba),* a tree grown since ancient times about temples in China where it is considered a sacred plant. Although reported as native in western China, it is not positively known to occur in a truly wild state.

It is a smooth, sparingly branched tree, sometimes 120 ft. high, with deciduous fan-shaped leaves, 2–4 in. broad and nearly as long, which in form, veining and aspect resemble those of the maidenhair fern. Botanically, the closest allies of the ginkgo are the cycads. Like them, it is dioecious. *i.e.,* the pollen and seed cones are on different individuals.



JOHN H. GERARD

LEAF OF THE GINKGO TREE (G. BILOBA)

As the sole survivor of a numerous group of plants with a very long geological ancestry the ginkgo may be legitimately regarded as a "living fossil." It has existed essentially unchanged for millions of years, or probably for a longer period than any other living tree, tracing back directly to the fossil Cordaitales of the Palaeozoic. Fossil species occur in the Triassic. Jurassic and Tertiary formations in the British Isles, and forms with leaves very similar to those of the living ginkgo are abundant in Triassic and Jurassic rocks of the Pacific coast of North America, especially in Oregon and Alaska.

The ginkgo is cultivated as an ornamental tree in temperate countries. groning without protection in many parts of Europe and also in North America as far north as the Great Lakes

For its structural peculiarities *see* GYMNOSPERMS: *Ginkgoales,, Cycadales*

GINNING: *see* COTTON AND THE COTTON INDUSTRY.

GINSBURG, CHRISTIAN DAVID (1831–1914). Hebrew scholar, nas born on Dec. 25. 1831, at Warsaw. Shortly after conversion in 1846, he went to England. where he published a translation of the Song of Songs, with a commentary (1857), a translation of Ecclesiastes (1861) and treatises on the Karaites (1862), on the Essenes (1864) and on the Kabbala (1865) From the appearance in 1867 of Jacob ben Chajim's *Introduction to the Rabbinic Bible* (Hebren and English. with notices) and the *Massoreth Ha-Massoreth* of Elias Levita, in Hebrew. with translation and commentary. Ginsburg ranked as an eminent Hebrew scholar In 18'70 he was appointed to the committee for the revision of the English version of the Old Testament His lifework culminated in the publication of the *Massorah* (1880–86), and the Masoretico-critical edition of the Hebren Bible (1894) and the elaborate introduction (1897).

His later works include: *Facsimiles of Manuscripts of the Hebrew Bible* (1897–98) and *The Text of the Hebrew Bzble in Abbreviations* (1903), in addition to a critical treatise "on the relationship of the so-called Codex Babylonicus of A.D. 916 to the Eastern Recension of the Hebrew Text" (1899). Ginsburg died on March 7 1914.

GINSENG (SANG) is the plant and roots of two species of *Panax* (family Araliaceae) used as a drug in China. *Panax quinquefolius* is the American ginseng. which is native of rich cool woods from Quebec and Manitoba southward to Florida. Alabama. Louisiana and Arkansas Approximately 150 ac are cultivated in America Almost all of the carefully dried root of ginseng is exported to Hong Kong, from where it is distributed in southeast Asia The export from America amounts to about 100.000 lb annually *Panax ginseng,* Asian ginseng. native of Manchuria and Korea and cultivated in Korea and Japan is more appreciated in some markets than is the American ginseng.

The Chinese from time immemorial have considered ginseng to be a cure for most diseases and infirmities. In fact the generic name of the plant. *Panax,* is derived from Greek words translated as "panacea." a cure-all. The continued demand for ginseng roots. and especially those roots that may resemble a man in form. is probably due to a belief widely held among the Chinese that ginseng is an aphrodisiac. There is no evidence, however. to indicate that ginseng has any value. either as a drug or as an aphrodisiac.

The export of wild ginseng root from America to the orient began in the early 1700s. In 1773 the sloop "Hingham" sailed from Boston for China with 55 tons of ginseng aboard. Shipments have continued from that time until the present. The greatest amount shipped in any year was 622.761 lb. in 1862. The price of ginseng varied from 49 cents to $27 a pound during the century 1858–1958.

Ginseng has been in cultivation in America since about 1870. and in Korea since at least the early years of the century. In the years 1895 to 1903 or 1904 a ginseng "boom" took place in America. Extravagant and sometimes fraudulent representations were made concerning the fortune to be made from ginseng culture. Hundreds of gardens mere started and stock companies were formed to grow ginseng on a grander scale. A leaf disease of ginseng became prevalent in 1904, ruining many plantations and discouraging growers.

Most ginseng gardens are small. less than one acre. Intensive cultivation is practised and nearly all labour involved must be done by hand. Rich soil, woodlands with adequate natural shade or rich farm land with artificial shade, is necessary. Ginseng requires five to seven years to mature from seed. The value of the crop depends on the care with nhich the root mas prepared and the market when it is sold The grading of ginseng root is a highly subjective art. The value of cultivated ginseng root is about 60% of a comparable grade of wild root.

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(L. O. W.)

GINZBERG, LOUIS (1873–1953). Talmudic scholar and teacher, was born at Kovno. Lithuania on Nov. 28. 1873, and was educated in the Lithuanian rabbinical schools of Kovno and Telshe and at various German universities He mastered the Talmud in his youth. and his secular studies gave him command also over western methods of research. Moving to the United States in 1899, he became editor of rabbinical literature of the *Jewish Encyclopedia.*

In 1902 Ginzberg became professor of Talmud at The Jewish Theological Seminary of America, remaining there until his death on Nov 11. 1953.

Ginzberg's best-known works are *Legends of the Jews* and the *Commentary on the Talmud of Jerusalem* (in Hebrew). Into the first he gathered all the folklore in Jewish tradition bearing on Scripture. and in two volumes of notes, with enormous erudition and remarkable insight. he traced these legends to their sources. In the second work, of which only the commentary on the first treatise of the Talmud was completed, Ginzberg included discussions bearing on the whole rabbinic system and showing the scope and development of rabbinic theology and ritual. His massive studies in the development of Halakah (Jewish religious law) demonstrated that sociological and economic factors influenced the evolution of Jenish law in its creative periods. (L. F.)

GIOBERTI, VINCENZO (1801–1852), Italian philosopher and politician, was born at Turin where he mas educated. He was ordained priest in 1825. Partly under the influence of Mazzini, the freedom of Italy became his ruling motive in life—its emancipation. not only from foreign masters, but from modes of thought alien to its genius, being linked in his mind with papal supremacy, though in an intellectual rather than political way. On the accession of Charles Albert he received a court chaplaincy, but he resigned this office in 1833. and shortly afterward was arrested on suspicion of political intrigue. Imprisoned and banished without a trial, Gioberti went to Paris, and a year later. to Brussels, where he remained until 1845, teaching philosophy and writing philosophical uorks. An amnesty having been declared by Charles Albert in 1846. Gioberti returned to Italy in 1847 and uas enthusiastically received. He was soon elected president of the chamber of deputies. At the close of the same year a new ministry was formed headed by Gioberti; but with the accession of Victor Emmanuel in March 1849, his active life came to an end. For a short time he held a seat in the cabinet, though without a portfolio; but an irreconcilable disagreement soon followed, and he was sent on a mission to Paris where he remained until his death on Oct. 26, 1852.

Gioberti's writings are more important than his political career. Writing against the speculations of Rosmini-Serbati, he reconstructs. as he declares, ontology, and begins with the assertion that the *Ens* creates *ex nihilo* the existent, which is the universal idea in God become finite and individual. God is the only being *(Ens)*; all other things are merely existences. God is also the origin of all human knowledge, and we apprehend Him by intuition. A knowledge of both being and existences, and of their mutual relations. is necessary as the beginning of philosophy.

Gioberti is in some respects a Platonist. He identifies religion with civilization. and in his *Del primato morale e civile degli Italiani* (1843) concludes that the church is the axis on which the well being of human life revolves. In it he pictures the supremacy of Italy. brought about by the restoration of the papacy as a moral dominion. founded on religion and public opinion. In his later works, the *Rinnovamento* and the *Protologia,* he is thought by some to have shifted his ground under the influence of events. In his first publication La *Teorica del sovran-naturale* (1838) he supported the reality of revelation and the future life. In the *Introduzione allo studio della filosofia* (3 vol., 1839–40) he states his reasons for requiring a new method and new terminology. and brings out the doctrine that religion is the direct expression of the *zdea* in this life, and is one with true civilization in history. Civilization is a conditioned mediate tendency to perfection, to which religion is the final completion; it is the end of the second cycle expressed by the second formula, the *Ens* redeems existences, the many return to the one.

In 1846 appeared his essays on the more popular subjects, *Del bello* and *Del buono*. *Del primato morale e civile degli Italiani* and its *Prolegomeni* and his attack on the Jesuits, *Il Gesuita moderno* (1847). no doubt hastened the transfer of rule from clerical to civil hands. The hope that the loss of the papal temporal power would lead to a revival of religion expressed in the *Rinnovamento civile d'Italia* (1851), together with the pantheistic ontologism of his philosophy led to Gioberti's writings being placed on the *Index*. They were edited by G. Massari (1856–61).

See G. Massari, *Vita de* V. *Gioberti* (1848); A. Rosmini-Serbati, *V. Gioberti e il panteismo* (1848); A. Mauri, *Della vita e delle opere di V. Gioberti* (1853); B. Spaventa, *La Filosofia di Gioberti* (1863); G. Prisco, *Gioberti e l'ontologismo* (1867); P. Luciani, *Gioberti e la filosofia nuova italiana* (1866–72); D. Berti, *Di* V. *Gioberti* (1881). *See* also L. Ferri, *L'Histoire de la philosophie en Italie au XIX^e^ siècle* (1869); C. Werner, *Die italienische Philosophie des 19. Jahrhunderts*, ii (1885); R. Mariano, La *Philosophie contemporaine en Italie* (1866); D. Carutti, *Il Pensiero Civile di V. Gioberti* (1901); G. Gentile, I *Profeti del Risorgimento Italiano* (1923).

GIOIOSA-IONICA, a town of Calabria, Italy, province of Reggio di Calabria. It is 65 mi. N.W. by rail from the town of Reggio and 38 mi. direct; 492 ft. above sea level. Pop. (1951) 5,002. Near the station, which is on the east coast of Calabria 3 mi. below the town to the southeast, are the remains of a small theatre belonging to the Roman period but the name of the city to which it belonged is unknown. Remains of baths and other buildings also have been found.

GIOJA, MELCHIORRE (1767–1829), Italian writer on philosophy and political economy, was born at Piacenza, on Sept. 20, 1767. Renouncing his orders in 1796, he went to Milan, and on the arrival of Napoleon in Italy, advocated a republic under the dominion of the French in a pamphlet *I Tedeschi, i Francesi, ed i Russi in Lombardia*. Under the Cisalpine Republic he became historiographer and director of statistics. He was several times imprisoned, in 1820 on a charge of being implicated in a conspiracy with the Carbonari. After the fall of Napoleon he retired into private life, and died at Milan on Jan. 2, 1829.

Besides the *Nuovo Prospetto delle scienze economiche* (1815–17), a summary of what had already been written on economics, administration and finance, Gioja's more important productions which reflect his passion for statistics and his inclination toward the English economists, are *Del merito e delle ricompense* (1818), *Filosofia della statistica* (2 vol., 1826) and contributions to the *Annali Universali di Statistica* founded by him in 1824. His complete works appeared at Lugano (1832–49).

GIOLITTI, GIOVANNI (1842–1928), Italian statesman, was born at Mondovi, province of Cuneo, on Oct. 27, 1842, and educated at the Lycée and at Turin university, where he graduated in law in 1861. After working in an advocate's office for some years, he was appointed king's procurator in Turin, and then held appointments in the ministry of justice and the ministry of finance. In 1882 he was appointed councilor of state and elected deputy for Cuneo. As deputy he took part in the attack on Magliani, minister of finance, which led to the fall of the Depretis cabinet. On March 9, 1889 Giolitti was appointed finance minister in the Crispi cabinet, but resigned at the end of 1890. On the fall of the Rudini cabinet in May 1892, Giolitti succeeded to the premiership, but his ministry fell after 18 months in disastrous circumstances. The building crisis and the commercial rupture with France had impaired the situation of the state banks and one, the Banca Romana, had been further undermined by maladministration. A bank law, passed by Giolitti failed to effect an improvement. The senate refused to confirm Giolitti's conferment of senatorial rank on Tanlongo, director general of the Banca Romana, and an interpellation in parliament on the position of the bank led to Tanlongo's arrest and prosecution. A parliamentary commission of enquiry, appointed to investigate the condition of the state banks acquitted Giolitti of personal dishonesty.

Giolitti left the country for a short time and kept in the background for several years. He gradually regained much of his former influence, however, since he outlined a series of reforms in the social and agrarian field. He became minister for the interior in the Zanardelli cabinet, succeeding Zanardelli, who resigned on account of ill-health, in Nov. 1903. During his tenure of office, he lost the support of the Socialists by the strong measures he was fdrced to take to quell serious disorders in various parts of the country. In March 1905, feeling himself no longer secure, he resigned, indicating Fortis as his successor.

When Sonnino became premier in Feb. 1906, Giolitti did not openly oppose him, but his followers did, and Sonnino was defeated in May, Giolitti becoming prime minister again. For three years he remained in Dower, and bv clever management of the elections. was returned by a strong majority in 1909. Opposition against him in parliament grew rapidly, however, led by Sonnino, and his cabinet fell in Dec. 1909, the chamber rejecting a bill of fiscal reforms which included a graduated income-tax. He played a leading part in opposition during the succeeding ministries of Sonnino and Luzzatti, and became premier for the fourth time in March 1911. During this period in office, he introduced a new franchise law (Oct. 26–Nov. 2, 1913) which practically amounted to universal suffrage, raising the electorate from 3,000,000 to 8,000,000.

The chief event of Giolitti's fourth cabinet was the Libyan war; adversary as he had always been of colonial adventures, he decided that the conquest of Libya was necessary in order to preserve Italy's prestige in a Europe where Austria-Hungary had annexed Bosnia-Herzegovina two years before and where France was slowly conquering Morocco. When the Turks, defeated, asked for peace, which was concluded at Ouchy, Switz., Giolitti extended the electorate, saying that Italians who die at war must have a right to vote. In 1913 the elections took place and gave him a great majority, but with an increase of Socialists. The opposition changed from the extreme right to the extreme left. Giolitti, discouraged by dissension among his supporters, and feeling opposition to his rule increasing not only in parliament, but in the country as a whole, seized the opportunity of a hostile vote by the Radical group to resign on March 10, 1914. He was succeeded by Salandra.

When World War I broke out his attitude was in favour of absolute neutrality, and on the eve of Italian intervention he attempted to upset the Salandra cabinet by his personal influence over the parliamentary majority. He was frustrated by formidable popular demonstrations in favour of participation on the side of the Entente; he expressed, however, his views in a famous letter to C. Peano. later on minister of the treasury with him in 1920–21, in which he declared that even without going to war Italy might gain considerably.

Giolitti believed that Italian resources were unequal to war and that her unpreparedness would have serious consequences. But in the dark hour after Caporetto he appeared again in the chamber and made an eloquent appeal to Italians to stand firm and united in face of disaster. After the war the disappointment over the peace settlement, the heavy burden of suffering and loss caused by the war, and the extreme socialistic policy of the Nitti cabinet brought about the return of Giolitti. On Oct. 12, 1919 he made the well-known election speech, the "Discorso di Dronero" outlining his future policy, and explaining his previous attitude, and on June 15, 1920 the fifth Giolitti cabinet was formed. He succeeded in forming a cabinet which comprised a number of non-Giolittians of all parties, but only a few of his own "old guard," so that he won the support of a considerable part of the chamber. although the Socialists and the Popolari (Catholics) rendered his hold somewhat precarious. His policy of inactivity during the occupation of the factories by the workmen organized by Socialist leaders in Sept. 1920 provoked the irritation not only of the manufacturers but among many of the middle classes. He appears greatly to have overestimated the strength of the Socialists, and therefore gave them a free hand with the object of avoiding bloodshed, and also perhaps to prove to the workmen that they could not run industry without the capitalists and the technical experts. When he realized the strength of the national reaction, he allowed the fascists free rein to re-establish order and exercise many of the functions pertaining to the government, while he assumed an attitude of Olympic calm and posed as being *au-dessus de* la *mêlée,* so as to avoid compromising himself with any party.

In foreign affairs Giolitti succeeded in achieving a solution of the Adriatic problem, and with Count Sforza carried through the Treaty of Rapallo (*q.v.*). He dissolved the chamber on April 7, 1921. and was confirmed in power by the elections on May 15. But he resigned with his cabinet at the end of June, being succeeded as premier by his war minister Bonomi whom he designated to the crown as his successor. Giolitti took no part in the subsequent events; on the eve of Mussolini's so-called "march on Rome" he thought that his duty was to go at once to the capital and oppose the adventure; but Prime Minister Facta persuaded him to remain in his lonely distant country place and went as far as to make him believe the falsehood that floods had destroyed the railways.

When Mussolini made his first "elections" in 1924, Giolitti presented a list of his own in Piedmont, independent from the government. which. in the language of the time. meant opposition; but Giolitti's opposition became extreme only after Matteotti's murder; although he was 82 he spoke in the chamber with great firmness against the fascist regime.

Giolitti's influence. in spite of his age, remained very strong in Piedmont until his last moments. He died in his country place in Piedmont on July 17, 1928.

Before his death Giolitti had published *Memorie della mia vita,* which have been translated in English under the title *Memoirs of My Life.*

For a synthetic judgment of Giolitti as a statesman, *see* Benedetto Croce, *History of Contemporary Italy;* and for Giolitti's action in his last cabinet, *see* the chapter on Giolitti in Count Carlo Sforza, *Makers of Modern Europe* (1930).

GIORDANO, LUCA (1632–170j), the most celebrated and prolific Neapolitan painter of the late 17th century, u-as born in Naples in 1632. His nickname *Luca fa presto* ("Luke, work quickly") is said to derive'from his father's admonitions. which were certainly heeded. He probably learned his technical virtuosity at a very early age, since he was the son of a painter-copyist, His other nickname, Proteus, was due to his skill in producing pastiches in the style of almost any other artist, including even Durer and Rembrandt, but it seems that he never made any copies in the strict sense of the word. Since he is said to have painted a complete high altarpiece in one day, it is no wonder that his output was huge: both in oil and in fresco. His range of subject matter was equally great. although most of his pictures naturally deal with religious or mythological themes.

Giordano's earliest dated work is of 1651. but he is not recorded in the painters' guild until 1665. He was very much influenced at the beginning of his career by the work of Jusepe de Ribera. the major Neapolitan artist of the first half of the century, and it is likely that he was actually Ribera's pupil. His style underwent a profound change as a result of journeys to Rome, Florence and Venice. The lightness and brightness of Veronese's decorative works in Venice and the recent work by Pietro da Cortona in Rome and Florence induced him to abandon the gloom and drama of Ribera in favour of a more decorative approach; and the influence of Pietro da Cortona's frescoes in the Pitti palace, Florence, is particularly evident in Luca's huge ceiling fresco in the ballroom of the Medici-Riccardi palace. Florence, begun in 1682 and completed in the following year. In 1682 he also painted the ceiling of the Corsini chapel in Sta. Maria del Carmine, Florence.

He went to Spain in 1692 as court painter to Charles II, returning via Genoa to Naples in 1702. The frescoes in the Escorial are often held to be his best works, but nearly 50 pictures in the Prado museum: Madrid, all painted in Spain: testify to his unflagging energy.

Much the greater part of his output nevertheless remained in Naples, particularly in the churches, but many of his frescoes were destroyed or damaged in World War II. The great St. Benedict cycle of 1677 in the abbey of Monte Cassino was entirely destroyed, but the "Christ Expelling the Traders from the Temple" (1684) in the Gerolomini (S. Filippo Neri) in Naples survived the damage to the church. His last great work in Naples was the ceiling of the Cappella del Tesoro in S. Martino, begun on his return in 1702 and completed in April 1704. Giordano died in Naples on Jan. 12, 1705. His usual signature was "Jordanus." and this has led to confusion with Jacob Jordaens, with whose work Luca's has very little in common.

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(P. J. My.)

GIORGIO, FRANCESCO (1439–1502), Italian engineer, architect, painter and sculptor, was born on Nov. 14. 1439, at Siena. and died there in 1502. He was engaged on constructive and decorative work in his native town from 1463 to 1478 when he was employed by the duke of Urbino as architect and military engineer. In 1490 he constructed the model for the dome of Milan cathedral, and five years later invented the mines used at the siege of Naples. Some of his paintings, which show the influence of Fra Filippo Lippi, are in the Siena gallery.

His *Trattato di architcttura civile e militare* was edited *by* C. Saluzzo in 1841

GIORGIO, FRANCESCO DI: *see* FRANCESCO DI GIORGIO.

GIORGIONE (GIORGIONE DA CASTELFRANCO, originally GIORGIO BARBARELLI) (1477 or 1478–1510), Italian painter of the Venetian Renaissance, was born at Castelfranco. Contemporary documents call him Zorzo or Zorzi da Castelfranco. The form of Giorgione or Zorzon (meaning tall or great George) cropped up 40 years after his death. Because of an unfounded tradition, appearing about 1650, of his illegitimate descent from the local gentry family of Barbarelli, he is often referred to as Giorgione Barbarella or Barbarelli. Giorgio Vasari, writing before 1550, states that Giorgione was of very humble origin.

Giorgione presents a fascinating problem in the history of Renaissance art. The few documents available and the contemporary literary sources show that he aas held in high esteem at a relatively young age, and that his work was regarded as a sort of turning point in art between the 15th and the 16th centuries and as the beginning of a new, "modern." style based on the effects of colour and light; they also show that his fame was not limited to Venice. The number of his documented works is exceedingly small, even allowing for the short span of his active life, a mere 12 to 13 years. By the 17th century. a Giorgione myth based on anecdotes had come into existence, of which the writings of Ridolfi are a telling expression. Giorgione was erroneously claimed as ancestor of a romantic trend in Venetian painting after 1600 (*e.g.,* Pietro della Vecchia). which displayed dramatic accents and violent contrasts of light and shade.

The Giorgione literature since 1870 shows such a lack of consensus that a great Italian art historian (A. Venturi) could exclaim: "Everybody makes his own Giorgione." Two opposite tendencies, however, can be distinguished among the critics of that period: one "expansionist" (H. Cook, Monneret de Villard, L. Justi). attributing to Giorgione more and more pictures, especially those displaying a softly emotional, moody character; the other "restrictive" (Gronau. Lionello Venturi, Hourticq) trying, among this welter of mostly very subjective attributions, to go back to the facts securely established by the earliest sources. About 1870–80, G. B. Cavalcaselle and G. Morelli did great service in dispelling this fog. The Giorgione exhibition in Venice in 1955 provided an opportunity for putting some order into chaos.

Vasari says that Giorgione entered Giovanni Bellini's workshop, but his early work proves that his compositions were influenced more by Vittore Carpaccio (*q.v.*) and by the classicism of Francesco Francia and Lorenzo Costa. Also, the treatment of light on shining surfaces as introduced in Venice by Antonello da Messina in his altarpiece of S. Cassiano (1475) must have impressed the young artist.

The contemporary inscription on the back of a painting entitled "Laura" (Vienna) mentions its completion, on June 1, 1506, by Giorgione, who is described as a colleague of Vincenzo Catena. On Aug. 14, 1507, and Jan. 24, 1508, the Council of Ten ordered payment to Giorgione for a painting for the audience room of the Ducal palace; by May 23, 1508, this painting was certainly completed. On Aug. 1, 1508, the frescoes on the façade of the German Merchants' hall were underway. In Sept. or Oct. 1510, Giorgione died of the plague that raged in Venice. Shortly after his death, Isabella d'Este, marchioness of Mantua, wrote to her agent T. Albano, entreating him to secure a nativity scene by Giorgione, said to be in his estate; Albano replied that Giorgione had done this subject twice, but that neither of the owners wished to sell.

Count Baldassare Castiglione. writing in Rome not later than 1524, mentioned Giorgione among the "most excellent" painters, together with Leonardo, Mantegna. Rafael and Michelangelo. The most valuable source, however, consists of the notes written by the Venetian patrician Marcantonio Michiel between 1520 and 1543, each entry being carefully dated. He mentions 12 paintings and one drawing by Giorgione; also one painting of which he is not quite sure and tuo copies after Giorgione. Most of these works are lost. as is the picture of an armoured St. George mirrored in a pond and in two looking glasses, described by Paolo Pino in 1548. Two of the paintings mentioned by Michiel, however, can be identified: the "Three Philosophers" (or magi), in the Vienna gallery; and the landscape with the thunderstorm (*tempesta*), depicting a young man and a woman nursing her baby. in the academy in Venice. To these should be added the portrait "Laura," in the Vienna gallery; the altarpiece in the parish church of Castelfranco; and the fresco-fragment of a female nude in the academy in Venice—the only fragment that has survived, though in an appalling state of preservation, of Giorgione's decoration of the German Merchants' hall. These five pictures. and especially the four oil paintings, dated betneen 1505 and 1508, are the hard core on which the knowledge of Giorgione's art rests.

Giorgione's technique is the contrary of a "sweeping movement." His brush stroke consists of very fine disconnected lines and dots. The modeling is achieved by a sort of hatching that resembles the technique of water-colour miniatures and is related to what was later called pointillism. Its effects are to make the entire surface seem to vibrate. so that the atmosphere between individual objects, permeated by light. becomes the subject of artistic rendering.

This new feeling for nature is the source of the charm and the peculiar mood emanating from Giorgione's paintings. It has been aptly called pantheistic. This feeling, though not caused by, is intimately related to the philosophical "naturalism" informing the contemporary Venetian and Paduan humanists grouped around Barbaro and Pietro Pomponazzi.

On the criterion of this unmistakable "trembling" brush stroke, the following additional pictures can be confidently attributed to Giorgione: "The Testing of Moses" (Uffizi, Florence), but only the nine figures on the left and the distant part of the landscape (the rest, as also the companion piece, the "Judgment of Solomon," is clearly by an assistant, possibly G. Campagnola); the "Adoration of the Magi" (National gallery, London); the "Judith" (Leningrad); the three exquisite little mythological panels (two in Padua and one in the Philipps memorial, Washington, D.C.); the little "Madonna with Child" (Leningrad, the head is badly repainted); the "Madonna with SS. Catherine and John" (Academy, Venice); the ex-Benson "Nativity" (Kress collection, National gallery, Washington, D.C.) and the ex-Allendale "Adoration of the Shepherds" (same collection); the only extant drawing is a landscape with a seated man (ex-Koenig, Museum of Rotterdam). The "Boy With Arrow" (Vienna) is doubtful (possibly a studio picture with partial collaboration of the master). All these should be dated before 1505; likewise, the so-called "Vendramin" portrait (Berlin); the original parts of the portrait of a young woman (Duveen. N.Y., much restored); the "Old Woman" ("Col Tempo," Academy, Venice); and the heads and a few other parts of the two youths in the "Concert champêtre" (Louvre, Paris), the rest being completed by the young Titian (*q.v.*), who was an assistant in Giorgione's workshop about 1508 and possibly later (Titian's collaboration is proved by the statuary conception of the standing woman and the broad, sweeping, dramatic brushwork). To the end of Giorgione's short life belong the unfinished "Madonna with SS. Anthony and Roch" (Madrid) and the fragment of a self-portrait (Braunschweig); X-rays have revealed that it is painted over an earlier, unfinished Madonna by Giorgione. However, Giorgione's development after 1508 (the year of the frescoes) is very dim and not likely to become clearer, because of lack of material.

BY COURTESY OF KUNSTHISTORISCHES MUSEUM

"THREE PHILOSOPHERS" BY GIORGIONE. IN THE KUNSTHISTORISCHES MUSEUM, VIENNA, AUSTRIA

Among many, the following paintings that have been variously attributed to Giorgione should be rigidly excluded from his work: The Dresden Venus and the "Concert," both by Titian; the "Boy With Flute," possibly by Titian; the "Three Ages," possibly by G. Bellini; the "Concert," possibly by Lotto; the "Judgment of Solomon," by Sebastiano del Piombo; the "Adulteress," probably by D. Mancini; the double portrait (Venezia palace, Rome); the "Knight and Page" (Uffizi); the so-called "Broccardo" (Budapest); and the two pictures of singing men (Borghese, Rome). The last six paintings belong to a later development.

Giorgione did not form a school. properly speaking. But his influence was colossal and decisive—on Titian, Sebastiano Del Piombo and Bellini, and on the entire tradition of Venetian painting and its derivations, through Velazquez to Manet.

See also PAINTING: Rise of European Schools: Venice.

See A. Morassi, ***Giorgione*** (1942); P. Zampetti, G. *e* i ***Giorgioneschi*** (Catalogue of Giorgione Exhibition in Venice), with bibliography, 2nd ed. (1955). (E. H. BU.)

GIOTTINO (GIOTTO DI MAESTRO DI STEFANO), an early Florentine painter, whose name occurs in 1368 in the records of the guild. His father is sometimes identified with a pupil of Giotto, who attained some fame. In 1369 Giottino was called to Rome to assist in paintings in the Vatican. To his early period are ascribed the frescoes in the lower church of Assisi representing the "Coronation of the Virgin" and two scenes of the legend of St. Nicholas. They differ somewhat in style from his later work—the frescoes in the chapel of the Bardi family in Sta. Croce in Florence representing the miracles of Pope St. Silvester.

These works are animated and firm in drawing, luminous in colour, with naturalism carried further than by Giotto. They are among the most important paintings of Giotto's school. A "Descent From the Cross," in the Uffizi at Florence, also has been ascribed to Giottino.

Much confusion has arisen because Vasari identified Giottino with the painter Maso, who was active between 1320 and 1350, and to whom Ghiberti ascribed the frescoes of the St. Silvester legend.

GIOTTO (GIOTTO DI BONDONE) (1266/67?–1337), Italian painter, was born at Vespignano near Florence. For more than six centuries he has been revered as the father of modern art and the first of the great Italian masters. He certainly achieved great personal fame in his own lifetime, as Dante says in the *Dioine Comedy (Pur.* xi, 94–96) "Cimabue thought to hold the field in painting, but now Giotto has the cry, so that the fame of him is obscured." The mere fact that he was mentioned in Dante, even though not in a particularly flattering context, was sufficient to establish and maintain this fame in 14th- and 15th-century Italy and legends soon began to crystallize around his name. When, in 1550, Giorgio Vasari published the first modern history of art he naturally began with Giotto as the man who, even more than his master Cimabue, broke away from the dark ages and ushered in the "good modern manner."

As early as the middle of the 15th century the story was told of Giotto as a shepherd boy drawing his father's sheep on a piece of flat stone and being discovered by Cimabue, who took him to Florence. Still earlier, however, the Anonymous Dante Commentator (of *c.* 1400) had told an entirely different story. for, according to him, Giotto was apprenticed to the wool trade in Florence but spent all his time in Cimabue's shop, so that finally his father transferred his apprenticeship. Both stories agree in making Giotto Cimabue's pupil and this tradition is probably largely correct. Nevertheless, whatever he may have learned from Cimabue it is certain that, like Nicola Pisano about 30 years earlier, he was truly a reviver of classical ideals and a great innovator at the same time, bringing the new humanity, which St. Francis had brought to religion, into painting.

In Giotto's works the human beings who are his exclusive subject matter act with dedicated passion their parts in the great Christian drama of sacrifice and redemption. By comparison, all his predecessors and most of his immediate successors painted a puppet-show with lifeless manikins tricked out in the rags of the splendid, hieratic and impersonal art of Byzantium, which was to be entirely superseded by the urgent emotionalism of the Franciscan approach to Christianity.

The Date of Giotto's Birth.—The date of Giotto's birth can be taken as either 1266/67 or 1276, but the 10 years' difference is of fundamental importance in assessing his early development and is crucial to the Assisi problem *(see* below). It is known that Giotto died. Jan. 8, 1337 (new style; 1336, old style); this mas recorded at the time in the Villani *Chronicle.* About 1373 a rhymed version of the Villani *Chronicle* was produced by Antonio Pucci, town crier of Florence and amateur poet, and in this it is stated that Giotto was 70 when he died. He was thus born in 1266/67, and it is clear that there is 14th-century authority for the statement (possibly Giotto's original tombstone, now lost). Vasari, ho ever, gives 1276 as the year of Giotto's birth and it may be that he was copying one of the two known versions of the *Libro* di *Antonio Billi,* a collection of notes on Florentine artists. In this version, the *Codex Petrei* (Biblioteca Nazionale, Florence), the statement that Giotto was born in 1276 at Vespignano, the son of a peasant, occurs at the very end of the "Life" and may have been added much later, even, conceivably. from Vasari. In any case, whether Vasari or "Antonio Billi" first made the statement, it cannot have the same authority as attaches to Pucci, who was about 27 when Giotto died.

Certainty of the date of Giotto's birth, if settled by new documents, could help to solve the problem of his work at Assisi and the question of the origins of his style.

The **Assisi** Problem.—This, the central problem in Giotto studies, may be summed up as the question whether Giotto ever painted at Assisi and, if so. what? There can be no reasonable doubt that he did work at Assisi. for there is a long literary tradition which goes back to the *Chronicle* of Riccobaldo Ferrarese nho wrote in or before 1319; *i.e.,* when Giotto was alive and famous. Later writers down to Vasari expanded this and made it clear that Giotto's works were in the great double church of S. Francesco. By Vasari's time several frescoes in both upper and lower churches were attributed to Giotto. the most important being the cycle of 28 scenes from the life of St. Francis of Xssisi in the nave of the upper church and the "Franciscan Virtues" and some other frescoes in the lower church.

In the 19th century it was observed that all these could not be by the same hand and the new trend toward scepticism of Vasari's statements led to the position adopted by F. Rintelen in which he rejected all the Assisi frescoes and dated the St. Francis cycle to a period after Giotto's death. This extreme view has been generally abandoned, and indeed a dated picture of 1307 can be shown to derive from the St. Francis cycle. Nevertheless, many scholars prefer to accept the idea of an otherwise totally unknown "Master of the St. Francis legend" on the grounds that the style of the cycle is irreconcilable with that of the Padua frescoes, which are universally accepted as Giotto's. This involves the idea that the works referred to (in Giotto's lifetime) by Riccobaldo cannot be identified with anything now extant and must have perished centuries ago, so that Ghiberti. Vasari and others mistakenly transferred the existing St. Francis cycle to Giotto. Five hundred years of tradition are thus written off.

Still more difficult, the St. Francis frescoes. major works of art, must be attributed to a painter who cannot be shown to have created anything else. whose name has disappeared without trace although he was of the first rank and, odder still, one formed by the combined influences of Cimabue the Florentine and P. Cavallini the Roman, influences which coalesce at Assisi and may be taken as the influences which formed Giotto himself. Arising out of the fusion of Roman and Florentine influences at Assisi, there was later a tendency to see the hand of Giotto, as a very young man, in the works of the "Isaac Master," the painter of two scenes in the nave above the St. Francis cycle of "Isaac and Esau" and "Jacob and Isaac." If this theory is accepted it is easy to understand that Giotto, as a young man, made such a success of this commission that he was entrusted with the most important one, the official painted biography of St. Francis based on the new official biography written by St. Bonaventura. In fact, the whole of our mental picture of St. Francis stems largely from these frescoes. Clearly, a man born in 1276 mas less likely to have received such a commission than one ten years older, if, as mas always thought, the commission was given in 1296 or soon after by Fra Giovanni di Muro, general of the Franciscans. (For reasons why this date is not necessarily binding, *see* bibliography, P. Murray.) The works in the lower church are generally regarded as productions of Giotto's followers (there are, indeed, resemblances to his works at Padua) and there is real disagreement only over the "Legend of St. Francis." The main strength of the non-Giotto school lies in the admittedly sharp stylistic contrasts between the St. Francis cycle and the frescoes in the Arena chapel at Padua; especially if the Assisi frescoes were painted 1296–*c.* 1300 and those of the Arena, *c.* 1303–05; for the interval between the two cycles is too small to allow for major stylistic developments. This argument becomes less compelling when the validity of the dates proposed and the Roman period *c.* 1300 are taken into account. As already mentioned, the Assisi frescoes may have been painted before 1296 and not necessarily afterward, and the Arena frescoes are datable with certainty only in or before 1309, although probably painted c. 1305–06; clearly, a greater time lag between the two cycles can help to explain stylistic differences: as can the experiences which Giotto underwent in what was probably his second Roman period.

Roman Period c. 1300.—Three principal works are attributed to Giotto in Rome. They are the great mosaic of "Christ Walking on the Water" (the "Navicella") over the entrance to St. Peter's, the altarpiece painted for Cardinal Stefaneschi, in the Vatican gallery, and the fresco fragment of "Boniface VIII Proclaiming the Jubilee" in S. Giovanni Laterano. Giotto is also known to have painted some frescoes in the choir of Old St. Peter's but these are lost. It is known from the *Necrology* (1343) that Cardinal Stefaneschi was a great benefactor of St. Peter's and that he employed Giotto to make the "Navicella" but the date 1298 for this commission does not occur in the actual text, although it is often said to occur, on the authority of F. Baldinucci, who saw another version in the 17th century.

It is known, however, that the religious jubilee of 1300 was very largely unpremeditated and the "Navicella" is most probably a commemoration of its success, and therefore commissioned at almost any date after 1300. In any case, it was almost entirely remade in the 17th century except for two fragmentary heads of angels (in the museum of St. Peter's and in Boville Ernica), so that old copies must be used for all stylistic deductions.

The fresco fragment in S. Giovanni Laterano was cleaned in the 20th century and was tentatively reattributed to Giotto on the basis of its likeness to the Xssisi frescoes. The original attribution cannot be traced beyond the 17th century, but, on the other hand, the "Stefaneschi Altar" (Vatican), with its portrait of the cardinal himself, must be one of the works commissioned by him. It is, nevertheless, so poor in quality that it cannot be by Giotto's own hand. It may be observed that several works bearing Giotto's signature, notably the "St. Francis" (Paris. Louvre) and the altarpieces in Bologna and Florence (Sta. Croce). are generally regarded as school pieces bearing his trade-mark. whereas the "Ognissanti Madonna" (Uffizi, Florence), unsigned and virtually undocumented, is so superlative in quality that it is accepted as entirely by his hand.

The Crucifix in Sta. Maria Novella and the "Madonna" in S. Giorgio sulla Costa (both in Florence) may be possibly identifiable with works mentioned in very early sources and if so they throw light on Giotto's early style (before 1300). It is also possible that, about 1305, Giotto went to Avignon but the evidence for this is slender.

Paduan Period.—There is thus no very generally agreed picture of Giotto's early development and many of the surviving documents and pictures are capable of more than one interpretation. It is with some relief. therefore, to turn to the fresco cycle in the chapel in Padua known as the Arena or Scrovegni chapel. Its name derives from the fact that it was built on the site of a Roman amphitheatre by Enrico Scrovegni, the son of a notorious usurer mentioned by Dante. The founder is shown offering a model of the church in the huge "Last Judgment," which covers the whole west wall. The rest of the small bare church is covered with frescoes in three tiers representing scenes from the lives of SS. Joachim and Anna, the life of the Virgin, the Annunciation (on the chancel arch) and the Life and Passion of Christ, concluding with Pentecost. Below these three narrative bands is a fourth containing monochrome personifications of the Virtues and Vices. The chapel was apparently founded in 1303 and consecrated on March 25, 1305. It is known that the frescoes were completed in or before 1309 and they are generally dated *c.* 1305/6, but even with several assistants it must have taken at least two years to complete so large a cycle.

The frescoes are in relatively good condition, and all that has been said of Giotto's power to render the bare essentials of a setting with a few impressive and simple figures telling the story as dramatically and yet as economically as possible is usually based on the narrative power which is the fundamental characteristic of these frescoes. These dominating figures, simple and severe, are the quintessence of his style, and anatomy and perspective were used—or even invented—by him as adjuncts to his narrative gifts and he never attained to the skill which so often misled the men of the 15th and 16th centuries. In the Padua frescoes the details are always significant. whereas it is a characteristic of the Assisi cycle that there occurs from time to time a delighted dwelling on details that are not absolutely essential to the story.

ALINARI

DETAIL FROM "DESCENT FROM THE CROSS," A FRESCO BY GIOTTO. IN THE ARENA CHAPEL. PADUA

Sta. Croce Frescoes.—Documents show that Giotto was in Florence in 1311–14 and 1320 and it u-as probably during these years, before going to Naples (c. 1329?), that he painted frescoes in four chapels in Sta. Croce belonging to the Giugni, Tosinghi-Spinelli, Bardi and Peruzzi families. The Giugni chapel frescoes are lost as are all the Tosinghi-Spinelli ones, except for an "Assumption" over the entrance, not universally accepted as by Giotto. The Bardi and Peruzzi chapels contained cycles of St. Francis and the two SS. John, respectively, but the frescoes were whitewashed and were not recovered until 1852, when they were damaged in the process of removing the whitewash and then heavily restored. Much the same happened to a portrait of Dante in the Bargello, also in Florence, for which there is a traditional attribution to Giotto. The account taken of the restorations to the Bardi and Peruzzi chapel frescoes and of the similarities and dissimilarities between the Bardi St. Francis frescoes and those at Assisi tends to vary according to the writer's views on the Assisi problem, but most students would agree that it would be imprudent to ascribe much of the actual handling (as distinct from the design) to Giotto himself in either chapel. There is no evidence for the dating of the chapels, nor is it certain which came first, but they are probably approximately contemporary. The date 1317 is often advanced as a terminal point for the Bardi chapel, since it contains a representation of St. Louis of Toulouse, who was canonized in that year. This is inadmissible since his halo may well have been added, and in any case it is not unknown for holy personages to be represented as haloed before their formal canonization.

Naples and the Last Florentine Period.—On Jan. 20, 1330, King Robert of Naples promoted Giotto to the rank of "familiar" (member of the royal household), which implies that he had been in Naples for some while, possibly since 1328. and he remained there until 1332/33. All the works he executed there have been lost, but traces of his style may be distinguished in the local school. On April 12, 1334, he was appointed capomaestro, or surveyor, of the cathedral of Florence and architect to the city. This was a tribute to his great fame as a painter and not on account of any special architectural knowledge. On July 19 of the same year he began the campanile, or bell tower, of the cathedral. It was later altered but is known, in part at least, from a drawing in Siena. He may have designed some of the reliefs carved by Andrea Pisano on the campanile; certainly the bronze doors of the baptistery by Andrea show clear traces of Giotto's frescoes in Sta. Croce. Indeed the whole course of painting in Tuscany was dominated by his pupils and followers—by Taddeo Gaddi, Bernardo Daddi, Maso, Orcagna and the Lorenzetti in Siena—but none of these really understood all of his innovations and it was not until Masaccio (b. 1401) and Michelangelo (b. 1475) that his true successors arose.

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GIOVANNI DI PAOLO (c. 1399–1482), the name commonly given to Giovanni di Paolo di Grazia, a long-lived, enormously productive Sienese painter of great individuality. He probably mas a pupil of Taddeo di Bartolo, whose style is reflected in his earliest dated work. the "Madonna" of 1426 at Castelnuovo Berardenga. In that year Giovanni fell under the influence of the art of Gentile da Fabriano, who was then active in Siena. The earliest example of Gentile's influence, dominant for a decade, is the "Madonna" of 1427 in the Robert von Hirsch collection. Basel, Switz. During the 1440s and early 1450s Giovanni produced his most important works. These include the monumental altarpiece of the "Presentation of Christ" of 1447–1449 in the Siena gallery, the somewhat later altarpiece of "St. John the Baptist," only ten scenes of which work are known. and 12 splendid miniatures in a antiphonary in the public library. Siena. The brooding "Madonna" altarpiece of 1463 in the Pienza cathedral marks the beginning of Giovanni's late period, of which the coarse "Assumption" polyptych of 1475 from Staggia is the last important example.

Giovanni's tormented spirituality and expressionist style were little appreciated before about 1920, but from that time Giovanni's tense, often highly dramatic art aroused constantly increasing interest. Not only the colouristically and formally attractive figures and landscapes of the painter's early and middle period, but also the harsh, ugly forms of the 1460s and especially the 1470s are of interest. as they illustrate the artist's changing vision of the world during the course of his development.

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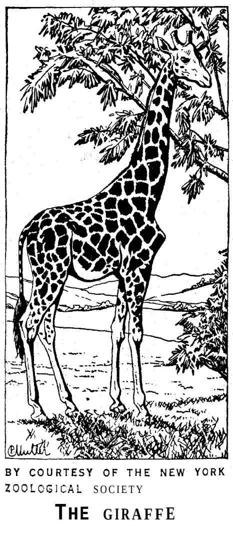
GIPPSLAND: *see* VICTORIA.

GIRAFFE, the tallest of all mammals, reaching 18 ft. 7 in. in height, the type of the family Giraffidae. The classic term "camelopard" has fallen into disuse.



BY COURTESY OF THE NEW YORK ZOOLOGICAL SOCIETY

THE GIRAFFE

Skin-covered horns are present in both sexes. and there is often an unpaired one in advance of the pair on the forehead. Among other characteristics may he noticed the length of the neck and limbs. the absence of lateral toes. and the long tufted tail. The tongue is remarkable for its length (up to 18 in.) and elasticity. It is covered with numerous large papillae, and forms an organ for the prehension of food. Giraties inhabit open country and browse on tall trees. To drink or graze they are obliged to straddle. the forelegs apart; but they are capable of going long without nater. They can gallop at over 30 mi. an hour. When standing among mimosas they are difficult of detection. They are almost entirely voiceless. One fawn is produced at a birth Formerly giraffes were found in large herds, but persecution led to their extermination in many districts. Formerly widespread over southern Europe and India, giraffes are now confined to Africa south of the Sahara. Apart from the Somali giraffe (*Giraffa reticulata*), characterized by its deep liver-red colour, there are numerous local subspecies of the ordinary giraffe (*G. camelopardalis*).

GIRALDI, GIAMBATTISTA (known also as CINZIO, the Italian form of his "academic" name, CYNTHIUS) (1504–1573), Italian novelist, poet and dramatist, a typical representative of mid-16th-century Italian literary ideals, was born in Ferrara He studied under Celio Calcagnini and succeeded him in the chair of rhetoric there (1541), later moving to the universities of Turin and Pavia. He died in Ferrara.

Giraldi was influenced both by the Paduan reintroduction of Aristotelian literary principles and by the Catholic reaction to it. In his *Discorso intorno al comporre de' romanzi* (1549) he defended the legitimacy of the romantic epic. and in his poem *Ercole* (1557) he tried to reconcile the Aristotelian rules nith modern taste. In his *Discorso sulle comedie e sulle tragedie* (1543) he reacted against the austerity of the classical tragedies and in his own tragedies—*Orbecche* (1541) ; *Didone* (1542) ; *Altile* (1543) ; *Cleopatra* (1543); *Selene; Eufimia; Arrenopia; Epitia,* from which Shakespeare's *Measure for Measure* derives; and *Antivalomeni* (1549)—he included new dramatic elements while conforming to the Aristotelian rules. His *Ecatomnziti* (1565). 112 stories collected according to the pattern of Boccaccio's *Decameron,* aims at stylistic distinction as well as showing a liking for direct narrative, in the manner of Matteo Bandello. They are moralistic in tone and were translated and imitated in France. Spain and England: Shakespeare's *Othello* derives from Giraldi's story of the Moor of Venice. He tried to renew the pastoral drama with his *Egle* (1545).

In spite of his ambition toward erudition, all Giraldi's literary attempts are amateurish: they remain interesting examples of the transition from Renaissance to Counter-Reformation ideals.

BIBLIOGRAPHY.—*Scritti estetici di G. B. Giraldi* (1864) ; C Guerrieri-Crocetti, *G B Giraldi ed il pensiero critico del sec XVI* (1932) ; R Piccioni, "Vita di G B Giraldi." in *Atti e memorie per le provincie modenese e parmense,* XVIII (1886) ; G Perale, *Sul valore morale degli "Ecatommiti"* (1907) ; A Milano, *Le tragedie di G B Giraldi Cinthio* (1901) ; L Dondoni, "Un interprete di Seneca del '500: G B Giraldi." in *Rendiconti Ictituto Lombardo, Classe di Lettere,* etc , xciii (1959). (G A.)

GIRALDUS CAMBRENSIS (GERALD DE BARRI) (*c.* 1146–1220), medieval historian, was born at Manorbier castle. Pembrokeshire, the son of William de Barri. He studied at Paris until 1172 when he nas appointed to collect tithe in Wales. In 117j he became archdeacòn of Brecon. and on the death of his uncle in the following year. an attempt was made to elect him bishop of St. David's, but Henry II was unwilling to see anyone with ponerful native connections a bishop in Wales. Giraldus in 1180 was made commissary to the bishop of St. David's, and in 1184 one of the king's chaplains. While accompanying Prince John to Ireland he wrote his interesting *Topographia Hibernica* and his *Expurgatio Hibernica,* a strongly prejudiced history of the conquest In 1188 he went with the primate, Baldwin to Wales to preach the third crusade and nhile there acquired material for his *Itinerarium Cambrense.* He then set out for the Holy Land, but in 1189 was sent back to Wales by the king to keep order. Having successively refused the sees of Bangor and Llandaff, he retired to Lincoln from 1192–98 and wrote his *Gemma ecclesiastica* and *Vita S Remigii.* In 1198 he nas elected bishop of St. David's. but Archbishop Hubert's objection necessitated three visits to Rome and a violent indication of the independence of St. David's from Canterbury. In the end, the pope ordered a new election. the prior of Llanthony being elected in 1202. Giraldus spent the rest of his life in retirement. and produced the *Descriptio Cambriae, De rebus a se gestis,* his autobiography. *De Instructione principis,* and the *Vita Galfridi Archiepiscopi Eborecensis.*

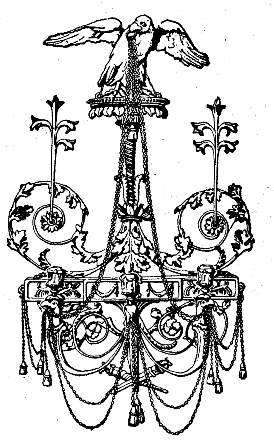
Giraldus was an excellent Latinist, well versed in the social and intellectual life of his day. His eloquence. his humour and naïve vanity, his keen, though impressionistic, observation of customs, traditions, scenery. etc., and his friendships with his great contemporaries, such as Innocent III. Richard Coeur-de-Lion, King John, Stephen Langton, St. Hugh of Lincoln and Grosseteste, all contribute to making him one of the most vivid and enterprising of writers.

As historical material, however, Giraldus' works must be estimated both in the light of his violent party spirit and of his intense patriotism.

His writings were edited by J. S. Brewer, *et al.*, in the "Rolls series," 8 vol. (1861–91). The *De Invectionibus* was edited by W. S. Davies in *Y Cymmrodor,* vol. xxx. (1920). The *Topographia,* the *Expugnatio,* the *Itinerarium* and the *Descriptio* were translated in Bohn's "Library series" (1863) and the last two again in "Everyman's Library" (1908).

GIRANDOLE [from the Ital. *girandola*], an ornamental and luxurious candleholder that came into use about the second half of the 17th century, and was commonly made and used in pairs. In the great 18th-century period of French house decoration the famous *ciseleurs* designed some exceedingly beautiful examples. Various metals have been used for the purpose and some have been made in hardwoods.

Gilded bronze has been a frequent medium, but for table purposes silver is still the favourite material.



BY COURTESY OF THE METROPOLITAN MUSEUM OF ART

AN 18TH CENTURY GIRANDOLE MADE BY ADAM AND HEPPLEWHITE

GIRARD, JEAN BAPTISTE (known as PÈRE GIRARD or PÈRE GREGOIRE) (1765–1850), French-Swiss educationalist, hailed in Switzerland as a second Pestalozzi, was born at Fribourg and educated for the priesthood at Lucerne. In 1804 he began his career as a public teacher, first in the elementary school at Fribourg (1805–23), then, on being driven away by Jesuit hostility, in the *Gymnasium* at Lucerne until 1834. In that year he retired to Fribourg and devoted himself to the production of his books on education, *De l'enseignement régulier de la langue maternelle* (1834; 9th ed., 1894; Eng. trans. by Lord Ebrington, *The Mother Tongue,* 1847) and *Cours éducatif* (1844–46). Father Girard's books influenced educational methods elsewhere. He abandoned the system of cramming children's minds with rules and facts, seeking instead to stimulate their intelligence.

GIRARD, STEPHEN (1750–1831), U.S. financier and philanthropist, founder of Girard college in Philadelphia, was born in a suburb of Bordeaux, Fr., on May 20, 1750. His father was a sea captain, and the son cruised to the West Indies and back, 1764–73. In May 1776 he settled in Philadelphia as a merchant. In June of the next year he married Mary (Polly) Lum, daughter of a shipbuilder, who, two years later, after Girard became a citizen of Pennsylvania (1778), built for him the "Water Witch," the first of a fleet trading with New Orleans and the West Indies. Most of Girard's ships were named after his favourite French authors, such as "Rousseau," "Voltaire," "Helvétius" and "Montesquieu." His beautiful young wife became insane, and spent the years from 1790 until her death in 1815 in the Pennsylvania hospital. In 1810 Girard used about $1,000,000 deposited by him with the Barings of London for the purchase of shares of the much depreciated stock of the Bank of the United States—a purchase of great assistance to the United States government. In May 1812 he established the Bank of Stephen Girard. He subscribed in 1814 for about 95% of the government's war loans of $5,000,000, of which only $20,000 besides had been taken. In 1793, during the plague of yellow fever in Philadelphia, he volunteered to act as manager of the hospital at Bush hill; again during the yellow fever epidemic of 1797–98 he took the lead in relieving the poor and caring for the sick. He died in Philadelphia on Dec. 26, 1831. His philanthropy was shown in his disposition by will of his estate, the bulk of which went to Philadelphia to be used in founding a school or college, in providing a better police system, and in making municipal improvements and lessening taxation. Girard's heirs-at-law contested the will in 1836. In 1844 Daniel Webster, appearing for the heirs, made a famous plea for the Christian religion, but Justice Joseph Story handed down an opinion adverse to the heirs (*Vidals* v. *Girard's Executors*). Work upon the buildings was begun in 1833, and the college was opened in Jan. 1848. The principal building, planned by Thomas Ustick Walter (1804–87), has been called "the most perfect Greek temple in existence." To a sarcophagus in this main building the remains of Stephen Girard were removed in 1851. The course of training is partly industrial—for a long time graduates were indentured until they came of age—but it is also preparatory to college entrance.

See H. A. Ingram, *The Life and Character of Stephen Girard* (1884); George P. Rupp, "Stephen Girard—Merchant and Mariner," in *1848–1849: Semi-Centennial of Girard College* (1898).

GIRARDIN, DELPHINE DE (1804–1855), French author, was born at Aix-la-Chapelle, the daughter of Sigismund Gay and the writer Sophie Gay. She published two volumes of miscellaneous pieces, *Essais poétiques* (1824) and *Nouveaux Essais poétiques* (1825). A visit to Italy in 1827, during which she was enthusiastically welcomed by the literati of Rome and even crowned in the capitol, was productive of various poems, of which the most ambitious was *Napoline* (1833). She was married in 1831 to Émile de Girardin (*q.v.*). The contemporary sketches which she contributed from 1836 to 1848 to the feuilleton of *La Presse,* under the *nom de plume* of Charles de Launay, were collected under the title of *Lettres parisiennes* (1843 and 1853), and obtained a brilliant success. *Les Contes d'une vieille fille à ses neveux* (1832), *La Canne de Monsieur de Balzac* (1836) and *Il ne faut pas jouer avec la douleur* (1853) are among the best known of her romances; and her dramatic pieces in prose and verse include one-act comedies, *C'est la faute du mari* (1851), *La Joie fait peur* (1854), *Le Chapeau d'un horloger* (1855) and *Une Femme qui déteste son mari,* which did not appear until after the author's death. Among the frequenters of her salon were Théophile Gautier and Honoré de Balzac, Alfred de Musset and Victor Hugo. She died on June 29, 1855. Her collected works were published in six volumes (1860–61).

See Sainte-Beuve, *Causeries du lundi,* t. iii; G. de Molènes, "Les Femmes poètes," in *Revue des deux mondes* (July 1842); Taxile Delord, *Les Matinées littéraires* (1860); G. d'Heilly, *Madame de Girardin, sa vie et ses oeuvres* (1868); Imbert de Saint Amand, *Mme. de Girardin* (1875); H. Malo, *Une Muse et sa mère, Delphine Gay* (1924) and *La Gloire du vicomte de Launay* (1925).

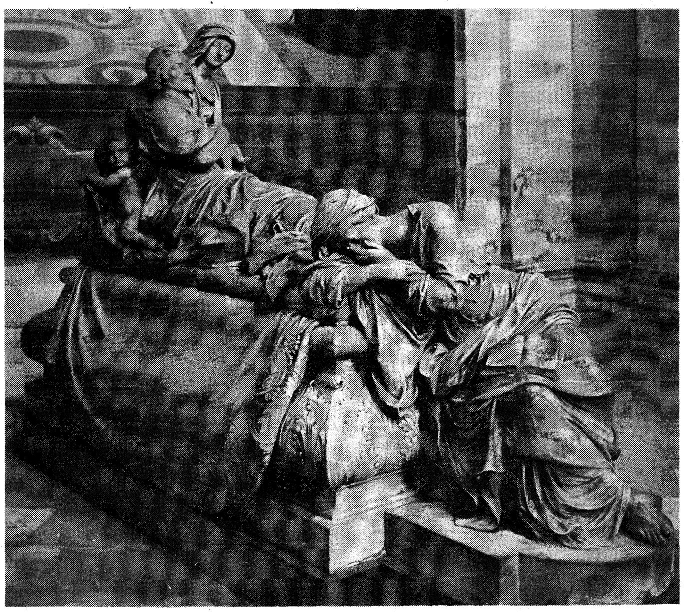
GIRARDIN, ÉMILE DE (1802–1881), French publicist, was born in Paris, the son of Gen. Alexandre de Girardin and of Madame Dupuy, wife of a Parisian advocate. He became inspector of fine arts under the Martignac ministry just before the revolution of 1830, and was an energetic and passionate journalist. In 1836 he inaugurated cheap journalism in a popular Conservative organ, *La Presse,* the subscription to which was only 40 francs a year. This undertaking involved him in a duel with Armand Carrel, the fatal result of which made him refuse satisfaction to later opponents. In 1839 he was excluded from the chamber of deputies, to which he had been four times elected, on the plea of his supposed foreign birth (he was wrongly alleged to have been born in Switzerland), but was admitted in 1842. He resigned early in Feb. 1847, and on Feb. 14, 1848, sent a note to Louis Philippe demanding his resignation and the regency of the duchess of Orleans. In the legislative assembly he voted with the Mountain. He pressed eagerly in his paper for the election of Prince Louis Napoleon, of whom he afterward became one of the most violent opponents. In 1856 he sold *La Presse,* only to resume it in 1862, but its vogue was over, and Girardin started a new journal, *La Liberté,* the sale of which was forbidden in the public streets. He supported Émile Ollivier and the Liberal empire, but plunged into vehement journalism again to advocate war against Prussia. His most successful *coup* was the purchase of *Le Petit Journal.*

Girardin married in 1831 Delphine Gay (*see* above), and after her death in 1855 Guillemette Joséphine Brunold, countess von Tieffenbach, widow of Prince Frederick of Nassau. He was divorced from his second wife in 1872.

His writings include: *De la presse périodique au XIX^e siècle* (1837); *De l'instruction publique* (1838); *Études politiques* (1838); *De la liberté de la presse et du journalisme* (1842); *Le Droit au travail au Luxembourg et a l'Assemblée Nationale,* 2 vol (1848); *Les Cinquante-deux* (1849, etc.), a series of articles on current parliamentary questions; *La Politique universelle, décrets de l'avenir* (1852); *Le Condamnt du 6 mars* (1867), an account of his own differences with the government in 1867 when he was fined 5,000 fr. for an article in *La Liberté; Le Dossier de la guerre* (1877), a collection of official documents; *Questions de mon temps, 1836 à 1856,* articles extracted from the daily and weekly press, 12 vol. (1858).

GIRARDON, FRANÇOIS (1628–171j), French sculptor, the most purely classical of the sculptors employed at Versailles, was born at Troyes. where he was baptized on March 17, 1628. He attracted the attention of Chancellor Pierre Séguier who brought him to Paris to study under François Anguier, and afterward sent him to Rome. He returned about 16jo and became a member of the academy in 1657. He worked for Sicolas Fouquet at Vaux-le-Vicomte and after the minister's fall was extensively employed in the decoration of the royal palaces. In 1663 he was working under Charles Le Brun on the Galerie d'Apollon at the Louvre, and in 1666 received the commission for'his most famous work, the "Apollo Tended by the Nymphs," for the Grotte de Thétis at Versailles. The inspiration for this elaborate work (later moved and its grouping altered), seems to derive partly from Hellenistic sculpture (particularly the Apollo Belvedere), and partly from Nicolas Poussin's paintings Of his other works for Versailles the most notable are the relief on the Bain des Nymphes (1668–70), perhaps inspired by Jean Goujon's Fontaine des Innocents, and "The Rape of Persephone" (pedestal completed 1699), in which he challenges comparison with Giovanni Bologna's "Rape of the Sabines." The effect of this group is marred by its present situation in the centre of the colonnade at Versailles where it can be seen from all sides instead of from a fixed viewpoint as originally intended.

Although superficially a baroque artist, Girardon's deep-seated classical tendencies emerge in the careful relating of sculpture to site. This is evident in his two principal works outside Versailles, the equestrian statue of Louis XIV in the Place Vendôme (1683–92), which was destroyed during the Revolution, and his tomb of Richelieu in the Sorbonne (1675–77). He undertook comparatively little portrait sculpture, but the classical bias of his mind and his abilities as a decorator made him the ideal collaborator with Le Brun (who designed many of Girardon's .numerous works for Versailles), just as Charles Antoine Coysevox (*q.v.*) was with Le Brun's successor, Jules Hardouin Mansart.



LEVY AND NEURDEIN

TOMB OF CARDINAL RICHELIEU BY FRANÇOIS GIRARDON IN THE CHURCH OF THE SORBONNE. PARIS. PIETY SUPPORTS THE FIGURE OF THE DYING CARDINAL. WHILE CHRISTIAN DOCTRINE WEEPS AT HIS FEET

As Coysevox's star rose, that of Girardon sank, and he received few royal commissions after 1700. He died in Paris on Sept. 1, 1715.

See P. Francastel, *Girardon* (1928) and *La Sculpture de Versailles* (1930); *M.* Oudinot, "François Girardon. Son rôle . . . à Versailles et aux Invalides," *Bulletin de la Societé de l'Histoire de l'Art Français,* pp. 204 ff. (1937). (F. J. B. W.)

GIRAUD, HENRI HONORÉ (1879–1949), French army officer, was born in Paris on Jan. 18, 1879. After graduating from St. Cyr in 1900, he served in French Morocco until World War I. Captured by the Germans in 1914, he successfully escaped —a feat he repeated in World War II. 28 years later. He returned to Morocco in 1922 and participated in the Rif war. In World War II, Giraud commanded the 7th army and. for a few days before his capture in May 1940, the 9th army. His second escape occurred in April 1942.

Seven months later, after secret negotiations with the Allies, he was whisked to north Africa in the wake of the Anglo-American landings. Appointed commander in chief of the French forces, he raised and equipped, largely with American matériel, 250,000 combat troops. From June to Oct. 1943 he was co-president (uith Charles de Gaulle) of the French Committee of Sational Liberation. Differences with de Gaulle resulted in his retirement in April 1944.

After the war, Giraud was elected to the constituent assembly. He also served as vice-president of the Conseil Supérieur de la Guerre.

He died in Dijon on March 11, 1949, and was buried at the Invalides, in Paris.

His publications include two memoirs: *Mes Évasions* (1946) and *Un seul but, la Victoire* (1949). (M. V.)

GIRAUDOUX, HIPPOLYTE JEAN (1882–1944), French author and diplomatist, was born on Oct. 29, 1882, at Bellac (Haute Vienne) and educated at the *École Normale* in Paris. He became head of the press service in the French foreign office, and later secured an appointment in the diplomatic service. He wrote a series of novels and plays which showed extraordinary originality and wit. Although the influence of André Gide is apparent, the style is unmistakably Giraudoux's own. and has undoubtedly influenced contemporary writers. René Lalou has described his method as being in literature what impressionism is in painting.

The most important of his novels are *Simon le pathétique* (1918), partly autobiographical in character; *L'Adorable Clio* (1920), one of the lightest and yet the most profound of war studies; *Suzanne et le Pacifique* (1921); *Siegfried et le Limousin* (1922). in which the hero, a French poet, becomes a prisoner of war in Germany, loses his memory, rises to a high political position, and then has to decide whether he shall return to France and learn to be a Frenchman once more; *Bella* (1926), in which the principal personages in Paris political life are described; *Juliette au pays des hommes* (1924) and *Pleins Pouvoirs* (1939). His collection of short stories. *Provinciales,* provides a good example of his impressionist methods.

As a dramatist Giraudoux won a prominent place. His greatest successes were *Amphitryon 38, Intermezzo* and *La guerre de Troie n'aura pas lieu.*

Giraudoux died in Paris, Jan. 31, 1944.

GIRDLE, a band of leather or other material worn round the aaist. either to confine the loose and flowing outer robes so as to allow freedom of movement, or to fasten and support the garments of the wearer. Among the Romans it was used to confine the *tunica,* and it formed part of the dress of the soldier; when a man quitted military service he was said *cingulum deponere,* to lay aside the girdle. Money being carried in the girdle. *zonam perdere* signified to lose one's purse, and, among the Greeks, to cut the girdle was to rob a man of his money. Girdles and girdle-buckles are not often found in Gallo-Roman graves. but in the graves of Franks and Burgundians they are constantly present, often ornamented with bosses of silver or bronze, chased or inlaid.

In the Anglo-Saxon dress the girdle makes an unimportant figure, and the Norman knights, as a rule, wore their belts under their hauberks. After the Conquest, however, the artificers gave more attention to a piece whose buckle and tongue invited the work of the goldsmith. That of Queen Berengaria lets the long pendant hang below the knee, following a fashion which frequently reappears.

In the latter part of the 13th century the knight's surcoat is girdled with a narrow cord at the waist, while the great belt, which had become the pride of the cavalier, loops across the hips carrying the heavy sword aslant over the thighs or somewhat to the left of the wearer.

But it is in the second half of the following century that the knightly belt takes its most splendid form. Under the year 1356 the continuator of the chronicle of Nangis notes that the increase of jewelled belts had mightily enhanced the price of pearls. The belt is then worn, as a rule, girdling the hips at some distance below the waist, being probably supported by hooks as is the belt of a modern infantry soldier. The end of the belt, after being drawn through the buckle, is knotted or caught up after the fashion of the tang of the Garter. The waist girdle either disappears or as a narrow strap is worn diagonally to help in the support of the belt. Ornament covers the whole belt, commonly seen as an unbroken line of bosses enriched with curiously worked roundels or lozenges which, when the loose strap-end is abandoned, meet in a splendid clasp. About 1420 this fashion tends to disappear, the loose tabards worn over armour in the jousting-yard hindering its display. The belt never regains its importance as an ornament, and, at the beginning of the 16th century, sword and dagger are sometimes seen hanging at the knight's sides without visible support.

In civil dress the belt of the 14th century is worn by men of rank over the hips of the tight short-skirted coat, and in that century and in the 15th and 16th there are sumptuary laws to check the extravagance of rich girdles worn by men and women a-hose station made them unseemly. Even priests must be rebuked for their silver girdles with baselards. Purses, daggers, keys. penners and inkhorns, beads and even books, dangled from girdles in the 15th and early 16th centuries. Afterwards the girdle goes on as a mere strap for holding up the clothing or as a sword-belt. At the Restoration men contrasted the fashion of the court, a light rapier hung from a broad shoulder-belt, with the fashion of the countryside, where a heavy weapon was supported by a narrow waistbelt. Soon afterwards both fashions disappeared. Sword-hangers were concealed by the skirt, and the belt, save in certain military and sporting costumes, has no more been in sight in England. Even as a support for breeches or trousers, the use of braces has supplanted the girdle.

In most of those parts of the Continent — Brittany, for example —where the peasantry maintains old fashions in clothing, the belt or girdle is still an important part of the clothing. Italian non-commissioned officers find that the Sicilian recruit's main objection to the first bath of his lifetime lies in the fact that he must lay down the cherished belt. With the Circassian the belt still buckles on an arsenal of pistols and knives.

Folklore and ancient custom are much concerned with the girdle. Bankrupts at one time put it off in open court; French law refused courtesans the right to wear it; St. Guthlac casts out devils by buckling his girdle round a possessed man; an earl is "a belted earl" since the days when the putting on of a girdle was part of the ceremony of his creation; and fairy tales of half the nations deal with girdles which give invisibility to the wearer. (O. B.)

GIRGA or GIRGEH, a town of Upper Egypt on the west bank of the Nile, 313 mi. S.S.E. of Cairo by rail and about 10 mi. S.S.E. of the ruins of Abydos. Pop. (1956 est.) 41,200. The town stands on a sharp bend of the Nile. Many of the houses are of brick decorated with glazed tiles. The town is noted for the excellence of its pottery. Girga is the seat of a Coptic bishop. It also possesses a Roman Catholic monastery, considered the most ancient in the country. As late as the middle of the 18th century the town stood a quarter of a mile from the river, but is now on the bank.

GIRGENTI, a town in Sicily *(see* AGRIGENTUM).

GIRISHK, a village and fort in Afghanistan, on the right bank of the Helmund 78 m. W. of Kandahar on the road to Herat; 3,641 ft. above the sea. The fort is the residence of the governor of the district (Pusht-i-Rud). It commands the fords of the Helmund and the road to Seistan, from which it is about 190 m. distant; and it is the centre of a rich agricultural district. Girishk was occupied by the British during the first Afghan War; and a small garrison under a native officer, successfully withstood a siege of nine months. The Dasht-i-Bakwa, a level plain of considerable width, stretches beyond Girishk towards Farah.

GIRL GUIDES. The aim of the Girl Guides association is to help its members, through character training, to become good citizens with a sense of service and responsibility not only to their own families and communities but also nationally and internationally.

The movement has no political or sectarian aims and is open to all girls of appropriate age who are prepared to make the twofold promise of the Brownie or the threefold Guide promise. A Brownie promises to do her best to do her duty to God and the queen and to help other people every day, especially those at home. The Guide promises duty to God and the queen, helpfulness to other people at all times and obedience to the Guide law. The law requires honesty, loyalty, helpfulness, friendliness, courtesy, concern for animals, obedience, cheerfulness, thrift and purity in thought. word and deed.

Guides are encouraged to be practising members of their own religious denominations.

Origin and Development. — The formation of the Girl Guides association was the result of a spontaneous demand from the girls themselves following the beginnings of the Scout movement (see BOY SCOUTS). In response. Sir Robert Baden-Powell with his sister, Agnes Baden-Powell? devised a scheme of training. and the movement began in 1910. Sir Robert married, in 1912, Olave Soames. who was appointed chief commissioner in 1916. In 1918 she was elected Chief Guide.

From small beginnings the movement grew to include Brownies, aged $7\frac{1}{2}$ to 11; Guides, 11 to 16; Rangers (land. sea and air sections), 14 to 21; and Cadets (Guiders; *i.e.,* officers in training); also through "extensions," "auxiliaries" and "lones" to make guiding possible for handicapped girls, for girls in approved schools or training homes and for those living too far from a company to attend its regular meetings. The Trefoil Guild links those who are no longer active members of the movement but who "are prepared to carry out the Guide ideals in their daily lives and in the community in which they live and work."

Queen Elizabeth II and Queen Elizabeth the queen mother are patrons. Princess Margaret is Chief Ranger of the British Commonwealth and empire. The princess royal is president. In 1923 the association was incorporated by royal charter.

Organization. — A council elects the executive committee and a chief commissioner. Decentralization, through countries' chief commissioners and county, division and district commissioners, enables the training policy to be carried out by the Guiders in companies and packs and also allows the needs of the girls to be represented to the executive committee. Local associations in districts or divisions are groups of interested persons, principally nonmembers, whose support enlists public interest.

Headquarters of the association for Great Britain and the commonwealth are at 17–19 Buckingham Palace Road, London, S.W.1.

Training. — There are headquarters training centres in England at Foxlease in the New forest, Hampshire; Waddow hall. Lancashire; and on M.T.B. (Motor Torpedo Boat, Ex. R.S.) 630 on the Dart river. Scotland, Wales and Ulster also have centres for the training of Guiders.

Citizenship training begins in the pack where the Brownie learns in the "pack pow-wow" to express her views; it continues through the Guide company where Guides in patrols under their girl leaders discuss the affairs of the company and the leaders meet as a company committee. The Kanger organization varies: but it is calculated always to help the girl to an understanding of democratic government and to the carrying of her Guiding into a wider world. A system of tests and badges at all stages encourages girls to widen their interests and develop skills. Special stress on homemaking badges helps to train future wives and mothers. Camping and outdoor activities develop initiative and resource while awareness and often experience of international contacts, together with the underlying motive of both promise and law, emphasize world sisterhood and service.

World Association.— The World Association of Girl Guides and Girl Scouts co-ordinates members in 35 countries. Associations applying for membership must have self-governing organizations representative of the country as a whole and must accept the principles of the promise and law, and also the principle that the movement is open to girls of all races, nations and creeds. Membership must be voluntary and the organization must be strictly nonpolitical. International conferences are held regularly in different countries, and at one of the earliest, in 1930, Lady Baden-Powell was appointed World Chief Guide. At the same time a design for the Guide world flag was agreed upon. The joint birthday of the founder and the Chief Guide, Feb. 22, is celebrated throughout the world as "Thinking day" when the movement's 4,250,000 members join in thought and expression of a common purpose. (B.-PL.)

GIRL SCOUTS is a voluntary organization "dedicated to helping girls develop as happy, resourceful individuals willing to share their abilities as citizens in their homes, their communities, their country and the world. This purpose is achieved through a program that is based on a voluntarily accepted code of living. The program is carried out in small groups under the guidance of adult leadership. It provides a wide range of activities developed around the interests of girls, and offers opportunities for fun, friendship, service and daily practice in living the Girl Scout Promise and Laws" (constitution of the Girl Scouts of the U.S.A.).

Girl Scouting is open to all girls 7 through 17 years old who are willing to subscribe to the promise and laws of scouting, pay annual membership dues and meet other simple requirements. Adult membership is open to both women and men. The Girl Scouts are part of the world-wide Scout movement founded by Sir Robert (later Lord) Baden-Powell in 1910: the organization is a member of the World Association of Girl Guides and Girl Scouts. Juliette Gordon Low of Savannah, Ga., formed the first Girl Scout troop in the U.S. in 1912, following the pattern set up for Girl Guides, sister organization of the Boy Scouts of Great Britain. Mrs. Low was a native of Georgia, but she had lived in Great Britain and had helped to organize Girl Guide troops. She became the first president of the U.S. organization; when she retired from office in 1920 she received the title of founder, and her birthday (Oct. 31) was set aside as a special day for the Girl Scouts. At the time of her death in 1927 the Girl Scouts had troops in every state of the Union and had more than 140,000 members.

The Girl Scout promise: "On my honour, I will try: to do my duty to God and my country, to help other people at all times, to obey the Girl Scout Laws." These laws are as follows:

1. A Girl Scout's honor is to be trusted.
2. A Girl Scout is loyal.
3. A Girl Scout's duty is to be useful and to help others.
4. A Girl Scout is a friend to all and a sister to every other Girl Scout.
5. A Girl Scout is courteous.
6. A Girl Scout is a friend to animals.
7. A Girl Scout obeys orders.
8. A Girl Scout is cheerful.
9. A Girl Scout is thrifty.
10. A Girl Scout is clean in thought, word and deed.

These laws are a simple code for growing girls and are substantially the same in all countries in which Scouting is organized; they have been recognized as a standard of conduct and an expression of friendship regardless of race, nationality or religion. The trefoil emblem of the Girl Scouts, which symbolizes the three parts of the promise, is used in various versions throughout the world-wide movement.

Girl Scouting in the United States is divided into three age groups: Brownie Scouts, 7 through 9 years old; Intermediate Girl Scouts, 10 through 13; Senior Girl Scouts, 14 through 17. Four major areas of interest which carry through the program for the three age levels centre on the home, the arts, citizenship and the out-of-doors. These four areas are subdivided respectively into 11 program fields: agriculture, health and safety, homemaking; arts and crafts, literature and dramatics, music and dancing; community life, international friendship; nature; out-of-doors, sports and games.

Girl Scouting is "girls and adults working together" in basic units called troops, which usually consist of 16 to 32 girls and an adult leader or leaders. Except for the Brownie Scouts, troop business is transacted and decisions arrived at through a representative system of government whereby smaller subunits known as patrols elect their representatives to a "court of honour" which also includes the elected troop officers and the adult leaders.

Activities of girls in Scouting are designed to foster good social attitudes, broadened interests, development of individual capacities, growth of a sense of responsibility. Girls undertake projects which are progressively challenging. Community service is basic to the program, and may range from making simple gifts for invalids or singing Christmas carols to beautifying the grounds of public buildings. Scouts learn to know and appreciate the out-of-doors through games, nature study and camping.

The Brownie Scout learns to get along with her peers and to develop simple skills. She may hem towels for her mother, raise a potted plant for Easter services, help prepare a picnic meal for a troop party for parents.

The Intermediate Girl Scout develops new skills or broadens her talents through a program of progression through ranks, and by work for proficiency badges. She selects her own areas of interest from more than 100 badges, such as Active Citizen, Campcraft, Child Care, Hospitality. Work for badges usually involves practical applications plus community service: *i.e.*, "*Weather*—Know the rules of safe conduct during a thunder storm, out-of-doors and indoors." or "Storyteller—Learn how to select good stories for younger children. Tell them to children in your family . . . at the public library."

The Senior Girl Scout devotes much of her time to community service and vocational exploration, often combining them by working as a volunteer hospital aide or ranger aide, or assisting at a public playground. Many Seniors take part in visits exchanged among girl members of the various associations in the world-wide Scout-Guide movement.

Adapting itself to the changing needs of girls, the organization grew from the first troop of 12 girls to a membership by the latter 1950s of more than 2,000,000 girls and 600,000 adult volunteers. Professional workers in Girl Scouting account for less than 0.5% of adult membership.

The Girl Scout council is the organization which makes Scouting available to girls in the community. It is established, developed, maintained and financed by local volunteers. Clubs, schools, church groups and other private organizations assist local councils by providing meeting places, leadership, financial help, volunteer support and other co-operation. The Girl Scout national organization is financed principally by membership dues of $1 per annum. Governing body is the National council, consisting of delegates elected by local Girl Scout councils and meeting at regular intervals. The national organization publishes *The Girl Scout Leader*, *The American Girl* and various handbooks. The headquarters are in New York city. (For the British equivalent of Girl Scouts, see GIRL GUIDES.) (E. W. CT.)

GIRLS' FRIENDLY SOCIETY, THE. An organization for all girls sponsored by the Protestant Episcopal Church. Founded in England in 1875, it spread to the United States with the establishment of the first branch at St. Anne's Church, Lowell, Massachusetts, in 1877.

Today it has an international membership with branches in forty-four countries. The program of the society, based on the present-day interests and needs of girls, includes worship, study, recreation, and service to the Church and the community. An understanding of the issues of the world today as they affect young people is emphasized. A junior department provides a program for girls under 12 years of age.

Branches may be organized in any parish, mission, or institution of the Episcopal Church, headed by leaders who are communicants of the Church; the membership of the society, however, is inter-denominational.

GIRNAR, a sacred hill in western India, in the peninsula of Kathiawar, 10 m. E. of Junagarh. Five peaks rise about 3,500 ft. above the sea; on them are numerous Jain temples, frequented by pilgrims. At the foot of the hill is a rock, with an inscription of Asoka (2nd century B.C.), and also two other inscriptions (dated A.D. 150 and 455).

GIRODET-TRIOSON (ANNE LOUIS GIRODET DE ROUCY) (1767–1824), French painter typical of the first phase of the romantic movement. known as Girodet-Trioson after his guardian, M. Trioson, was born at Montargis, Loiret, on Jan. 29. 1767. A pupil of J. L. David, his "Joseph reconnu par ses freres" (Joseph recognized by his brothers) won him the Prix de Rome at the age of 22. He submitted to the Salon of 1792 "Le Sommeil d'Endymion" (Endymion sleeping) (Louvre), a cold! sensual, crepuscular work. nearer in feeling to the troubled romanticism of Chateaubriand than to the Spartan ideal of David. Girodet was also a poet, and his interest in literature is given full reign in the curious "Ombres des guerriers français reçues par Ossian dans le palais d'Odin" (Ossian receiving the generals of Napoleon in the palace of Odin), done for Malmaison in 1801, "Fingal" (Leningrad), painted for Napoleon in 1802, and above all, the famous "Atala au Tombeau" (The burial of Atala) (Louvre) of 1808. This. together with his windswept portrait of Chateaubriand meditating in front of the Coliseum (1809. Versailles), is Girodet's most typical work. In "La Révolte du Caire" (The revolt in Cairo) (1810, Versailles), he made a determined etiort to copy the swirling compositions of Antoine Gros, for whom he had a deep affection. His landscape sketches and book illustrations, notably for Pierre Didot's Racine (1801–05), have a freshness that is missing from his more elaborate works. He died in Paris on Dec. g. 1824.

Girodet's poem *Le Peintre* and essays on *Le Génie* and *La Grâce* were published after his death with a biographical notice by his friend M. Coupin de la Couperie (1829); E. J. Delecluze, in his *Louis David, son école et son temps* (1855), gives a briei life. (ha. B.)

GIRONDE, a maritime de'partement of southwestern France, formed from parts of the old province of Guyenne, viz., Bordelais, Bazadais. and parts of Pkrigord and Agenais. Area. 4,141 sq.mi. Pop. (1954) 896.517. It is bounded north by the *département* of Charente-Maritime, east by those of Dordogne and Lot-et-Garonne, south by that of Landes, and west by the Bay of Biscay. The de'partement lies on the east and the west sides of the Gironde estuary formed by union of Garonne and Dordogne. On the west, the Landes consist chiefly of morass or sandy plain, divided from the sea by dunes planted with pines which bind the sand together and prevent it from drifting inland. On the east the dunes are fringed for some distance by large lakes, Hourtin, Carcans and Lacanau, communicating with each other. The Bay of Arcachon forms a vast shallow lagoon, a large part of which has been converted into arable land. The estuary of the Gironde, about 45 m. in length, widens northwards from 2 to 6 miles. Islands and mud banks divide it into east and west channels and make navigation difficult. It is, however, well buoyed and lighted, and has a mean depth of 21 feet. There are wide marshes on the right bank north of Blaye, and on the left low-lying polders protected by dikes and composed of fertile salt marshes. At the mouth of the Gironde stands one of the finest French lighthouses, the tower of Cordouan built 1585–1611, and extended in the late 18th century.

The climate is humid and mild and very hot in summer. Wheat, rye, maize, oats and tobacco are largely grown, but the culture of the vine is by far the most important industry carried on (see WINE), the six vine-growing districts occuping about one-seventh of the surface of the de'partement. The Mitdoc is a region 50 mi. long by about 6 mi. broad, along the left banks of the Garonne and Gironde. The Graves country is a zone 30 mi. long. on the left bank of the Garonne from near Bordeaux to Barsac. The Sauternes country lies south-east of the Graves. The Côtes lie on the right bank of Dordogne and Gironde between Dordogne and Garonne, and on the left bank of the Garonne. The produce of the Palus, the alluvial land of the valleys, and of the Entre-deux-Mers, on the left bank of the Dordogne, is inferior. Fruits and vegetables are largely grown, peaches and pears being especially fine. The Médoc breed of horses, the Bazadais breed of oxen and the Bordelais breed of milch cows are well known. Oyster-breeding is on a large scale in the Bay of Arcachon. Resin, pitch and turpentine are obtained from the pine woods, which also supply vine-props, and there are well-known quarries of limestone. Manufactures and trade are chiefly carried on at Bordeaux (*q.v.*), the chief town, and the third port of France. Pauillac, Blaye, Libourne and Arcachon are minor ports.

Gironde is divided into the arrondissements of Bordeaux, Blaye-et-Sainte Luce Langon. Lesparre-Médoc and Libourne, and has 50 cantons and 5jj communes. The de'partement is served chiefly by the Orlkans and Southern companies. It forms part of the circumscription of the archbishopric, the appeal-court and the *académie* (educational division) of Bordeaux, and of the region of the XVIII army corps (Bordeaux). Besides Bordeaux, Libourne, La Réole, Bazas, Blaye, Xrcachon, St. Emilion and St. Macaire are the most noteworthy towns. Among other places of interest the chief are Cadillac, on the right bank of the Garonne, where there is a 16th century castle, surrounded by fortifications of the 14th century; Labri.de, with a feudal chbteau in which Montesquieu was born and lived; Villandraut, where there is a ruined castle of the 11th century; Uzeste, which has a church begun in 1310 by Pope Clement \-; Mazères with an imposing 14th century castle; La Sauve, which has a church (13th cent.) and other remains of a Benedictine abbey; and Ste. Foy-la-Grande, a bastide created in 1255 and afterwards a centre of Protestantism, which is still strong there. La Teste. pop. (1946) 6,674, was the capital. in the middle ages, of the famous lords of Buch.

GIRONDISTS, the name given to a political party in the Legislative Assembly and National Convention during the French Revolution (1791–93) (Fr. Girondins). The name was first given them because the most brilliant exponents of their point of view—Vergniaud, Gensonné, Guadet—were deputies from the Gironde. In the Legislative Assembly these represented a compact body of opinion which, though not as yet definitely republican, was considerably more advanced than the moderate royalism of the majority of the Parisian deputies. Associated with these views was a group of deputies from other parts of France, of whom the most notable were Condorcet, Jacques Pierre Brissot, Roland and Pétion. On the policy of the Girondists Madame Roland, whose salon became their gathering-place, exercised a powerful influence (see ROLAND); but such party cohesion as they possessed they owed to the energy of Brissot (*q.v.*) who came to be regarded as their mouthpiece. Hence the name Brissotins, coined by Camille Desmoulins. As strictly party designations these first came into use after the assembling of the National Convention (Sept. 20, 1792), to which a large proportion of the deputies from the Gironde who had sat in the Legislative Assembly were returned. For the struggle of the Girondists with the Montagnards and their ultimate downfall, see FRANCE: *History*.

BIBLIOGRAPHY.—Of the special works on the Girondists, Lamartine's *Histoire des Girondins* (1847, new ed. 1902) is rhetoric rather than history, and is untrustworthy; the *Histoire des Girondins,* by A. Gramier de Cassignac (1860) led to the publication of a *Protestation* by J. Guadet, a nephew of the Girondist orator, which was iollowed by his *Les Girondins, leur vie privte, leur vie publique, leur proscription et leur mort* (1861, new ed. 1890); with which *cf.* Alary, *Les Girondins par Guadet* (Bordeaux, 1863); also Charles Vatel, *Charlotte de Corday et les Girondins; pièces classées et annottes* (1864–72); *Recherches historiques sur les Girondins* (1873); Ducos, *Les Trois Girondines* (Madame Roland, Charlotte Corday, Madame Bouquey) *et les Girondins* (1896); Edmond Biré, *La Ltgende des Girondins* (1881, new ed. 1896). Memoirs or fragments of memoirs by particular Girondists also exist; *e.g.,* Barbaroux, Pétion, Louvet, Madame Roland.

GIRTIN, THOMAS (1775–1802), English landscape painter in water colour. He was born in London on Feb. 18, 1775, the son of a brushmaker. He was apprenticed to Edward Dayes, the water-colourist, with whom he later quarreled. While still boys he and J. M. W. Turner were employed by the connoisseur Thomas Monro in copying works by J. R. Cozens. Girtin went on numerous sketching tours, chiefly in the north of England and founded a sketching club for young artists. During 1801–02 he visited Paris and produced a series of etchings of that city. His gigantic panorama of London, the "Eidometropolis," was exhibited just before his premature death, probably from consumption, on Nov. 9, 1802.

Girtin's earlier landscapes are in the 18th-century topographical manner, but in his last years he evolved a bold, spacious and romantic style, in spirit akin to the contemporary poetry of Wordsworth, which greatly influenced English landscape painting. The increasing power of his last works at least tempers the exaggeration of Turner's supposed remark: "If Tom Girtin had lived, I should have starved." The British museum and the Victoria and Albert museum, London, are rich in examples of his work.

See J. Mayne, *Thomas Girtin* (1949); T. Girtin and D. Loshak, *The Art of Thomas Girtin* (1954). (D. Lk.)

GIRVAN, a small burgh and fishing town of Ayrshire, Scot., at the mouth of the Girvan, $54\frac{1}{2}$ mi. S.S.W. of Glasgow and 22 mi. S.S.W. of Ayr by road. Pop. (1951) 5,990. The principal industries — besides catering to visitors — are fishing (mainly herring and whitefish), the manufacture of woolen goods, tweeds and knitwear, the building and repairing of fishing boats and the processing of seaweed. Girvan's mild and equable climate is favourable to early potato crops, and its sandy beaches are an attraction to holidaymakers. It is the port of communication with Ailsa Craig (*q.v.*).

GIRY, (JEAN MARIE JOSEPH) ARTHUR (1848–1899), French historian, who made a considerable contribution to the study of the origins and significance of the urban communities in France. He was born at Trevoux (Ain) on Feb. 28, 1848, and studied at the École de Droit, the École des Chartes and the École des Hautes Études. He held posts at the Bibliothèque Nationale and the Archives Nationales before being appointed lecturer at the École des Hautes Etudes in 1877. He became lecturer at the faculty of letters of the Sorbonne in 1881, and professor at the École des Chartes in 1885. He died at Paris on Nov. 13, 1899.

Giry's works include *Histoire de la ville de Saint-Omer et de ses institutions jusqu'au XIV^e^ siècle* (1877); *Les Établissements de Rouen* (2 vol., 1883–85); *Documents sur les relatzons de la royaute' avec les villes de France de 1180 à 1314* (1885); and *Étude sur les origines de la commune de Saint-Quentin* (1887). His *Manuel de dzplomatique* (1894) secured his election to the Académie des Inscriptions.

GISBORNE, a seaport of New Zealand, in Cook county, provincial district of Hawke's bay, on Poverty bay of the east coast of North Island. Pop. (1956) urban area 22,622; (1958 est.) 23.600 (town, 20,500). The port has rail connection with Wellington. Wool, frozen mutton and agricultural produce are exported from the surrounding district. Near the site of Gisborne, Captain Cook landed in 1769 and gave Poverty bay its name from his inability to obtain supplies because of the hostility of the natives.

GISORS, a town of France, in the *de'partement* of Eure, in the pleasant valley of the Epte, 44 mi. N.W. of Paris on the railway to Dieppe. Pop. (1954) 5,056. In the middle ages Gisors was capital of the Vexin. Its position on the frontier of Normandy caused its possession to be hotly contested by the kings of England and France during the 12th century, when with the fortresses of Neaufles and Dangu it was ceded by Richard Coeur de Lion to Philip Augustus. During the wars of religion of the 16th century it was occupied by the duke of Mayenne on behalf of the League, and in the 17th century, during the Fronde, by the duke of Longueville. Gisors was made a duchy in 1742 and afterwards came into the possession of the count of Eu and the duke of Penthièvre.

Gisors is dominated by an 11th- and 12th-century stronghold of the kings of England. The central tower, the choir and parts of the aisles of the church of St. Gervais date from the middle of the 13th century. and the rest from the Renaissance. Gothic and Renaissance styles mingle in the west façade, adorned with a profusion of sculptures; the fine carving on the wooden doors of the north and west portals is particularly noticeable. Among the industries of Gisors are felt manufacture, bleaching, dyeing and leather dressing.

GISSING, GEORGE ROBERT (1857–1903), English novelist, was born at Wakefield on Nov. 22, 1857. He was educated at the Quaker boarding school of Alderley Edge and at Owens college, Manchester. His life, especially its earlier period, was spent in great poverty, mainly in London, though he was for a time also in the United States. supporting himself chiefly by private teaching. He published his first novel, *U'0rkers in the Dawn,* in 1880. *The Unclassed* (1884) and *Isabel Clarendon* (1886) folloned. *Demos* (1886), a novel dealing with socialistic ideas, was, however, the first to attract attention. Gissing's own experiences had preoccupied him with poverty and its brutalizing effects on character. He made no attempt at popular writing, and for a long time the sincerity of his work was appreciated only by the few. But his unflinching realism, and the minute care of his descriptions of the sordid milieu of shabby London streets left their mark on the English novel. Among his more characteristic novels are: *Thyrza* (1887), *A Life's Morning* (1888), *The Nether World* (1889), *New Grub Street* (1891), *Born in Exile* (1892), *The Odd Women* (1893), *In the Year of Jubilee* (1894), *The U'hirlpool* (1897). Others; *e.g., The Town Traveller* (1901), indicate a humorous faculty, but his novels are mainly concerned with the life of the poorer middle classes, with lonely men and women engaged in a generally hopeless struggle with fate and with the conflict between education and circumstances. The quasi-autobiographical *Private Papers of Henry Ryecroft* (1903) reflects Gissing's studious and retiring tastes. He was a good classical scholar and had a minute acquaintance with the late Latin historians, and with Italian antiquities; his posthumous *Veranilda* (1904), a historical romance of Italy in the time of Theodoric the Goth, was the outcome of his favourite studies. He died at St. Jean de Luz in the Pyrenees on Dec. 28, 1903.

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GIULIO ROMANO: *see* Romano, Giulio.

GIUNTA PISANO (d. 1255–1267), Italian painter, a native of Pisa and according to some critics a pioneer who, coming from Tuscany to Assisi, influenced the development of Umbrian art. It is said that he painted in the upper church of Assisi, notably a "Crucifixion" dated 1236, with a figure of Father Elias, the general of the Franciscans. embracing the cross. This painting no longer exists. Three large Crucifixions are ascribed to the same master, whose signature can be traced on them. One is in SS. Raineri e Leonardo in Pisa and was formerly in the convent of St. Anna; the other, in the Museo Civico at Pisa, is completely overpainted; the third is in Sta. Maria degli Angeli at Assisi. In these paintings Christ is represented with his head leaning on one side with an expression of pain, and his body bending forward in agony — a conception differing from "the triumphant Christ" of the preceding age.

GIURGIU, a town in the region of Bucharest, Rumania; situated amid mud flats and marshes on the left bank of the Danube. Pop. (1956) 32,613. Three small islands face the town, and a larger one shelters its port, Smarda, $2\frac{1}{2}$ mi. E. A railway runs north to Bucharest and northwest to Blejesci and steamers ply to Ruschuk, $2\frac{1}{2}$ mi. S.W. on the Bulgarian shore, whence railways run to Varna, Sofia and South Bulgaria. Thus Giurgiu, besides having a considerable trade with the home ports lower down the Danube, is the headquarters of commerce between Bulgaria and Rumania. It exports timber, grain, salt and petroleum; importing coal, iron and textiles. There are also large sawmills, and pipelines for oil run to Baicoi-Bucharest.

Giurgiu occupies the site of Theodorapolis, a city built by the Roman emperor Justinian (A.D. 483–565). It was founded in the

14th century by Genoese merchants who called the town, after the patron saint of Genoa. San Giorgio (St. George). As a fortified town, Giurgiu figured often in the wars for the conquest of the lower Danube; especially in the struggle of Michael the Brave (1593–1601) against the Turks, and in the later Russo-Turkish wars. It was burned in 1659. In 1829, its fortifications were finally razed, the only defense left being a castle on the island of Slobosia, united to the shore by a bridge.

GIUSTI, GIUSEPPE (1809–1850), Italian poet whose satires on Habsburg rule in Italy in the early years of the Risorgimento are still enjoyed for their literary merits, was born at Monsummano in Tuscany on May 13, 1809. After two periods as a law student at Pisa (1826–29 and 1832–34), he led an inconspicuous life until the revolution of 1848. He then sat as a deputy in the two Tuscan legislative assemblies and in the short-lived constituent assembly (till April 1849). He died in Florence on March 31. 1850.

Giusti's satirical poems were at first circulated only in manuscript; and the first collections of them, Poesie italiane (unauthorized, 1844) and Versi (1845; to be distinguished from the innocuous Leghorn edition, Versi di Giuseppe *Giusti,* 1844), had to be printed outside Italy, at Lugano and at Bastia. without the author's name. His first notable satire, La ghigliottina a *vapore,* dates from 1833. Other satires were Lo stivale ("The Boot," in allusion to the cartographical shape of the Italian peninsula); La terra dei morti, in protest against Lamartine's description of Italy as the land of the dead; *Il* brindisi di Girella; *Gingillino,* denouncing opportunist officials; *Il* dies *irae,* on the death of the Austrian emperor Francis I; and Per *l'incoronazione,* on the coronation of the succeeding emperor. His masterpiece, however, is *Sant' Ambrogio* (1847), a poem describing a company of Austrian soldiers at Mass, in which the poet begins by deriding them but gives way to sympathy and a sense of solidarity with them as they join in a chorus by Verdi. Popular in their day because of their liberal. anti-Austrian ideas, their satire against the Tuscan grand duke and his agents, and their patriotic expression of faith in Italy's resurgence, Giusti's satires can still be read with pleasure for their wit, their humorous turns of phrase and their power of ridicule in characterization.

His complete works, including some previously unpublished material, were edited by F. Martini (1924); selections were edited by P. Carli (1912).

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GIUSTINIANI, the name of a prominent Italian family which originally belonged to Venice, but established itself subsequently in Genoa also; at various times it had representatives in Naples, Corsica and several of the islands of the Archipelago.

In the Venetian line the following are most worthy of mention:

1. LORENZO (1380–1456), the Laurentius Justinianus of the Roman calendar, entered the congregation of the canons of St. George in Alga, and in 1433 became general of that order. About the same time he was made bishop of Venice by Eugenius IV; and on the removal of the patriarchate from Grado to Venice by Nicholas V in 1451, he was promoted to that dignity, which he held for 14 years. He died on Jan. 8, 1456, and was canonized by Alexander VIII, his festival being kept on Sept. 5. The best edition of his works is that of the Benedictine P. N. A. Giustiniani (2 vol., 1751).

2. LEONARDO (1388–1446), brother of the preceding, was for years a senator of Venice, and in 1443 was chosen procurator of St. Mark. He translated into Italian Plutarch's Lives of *Cinna* and *Lucullus,* and mas the author of some poetical pieces, amatory and religious—strambotti and cunzonetti—as well as of rhetorical prose compositions. The popular songs set to music by him became known as Giustiniani. (See *Poésie inédite* di Leonardo Giustiniani, edited by Wiese [1883].)

3. BERNARDO (1408–1489), son of Leonardo, entered the Venetian senate and served on diplomatic missions to France and Rome; about 148j he became one of the Council of Ten. He wrote a history of Venice, De *origine* urbis Venetarum rebusque ab *ipsa* gestis *historia* (1492; Ital. trans. 1545). It is to be found in vol. i of the Thesaurus of Graevius.

4. PIETRO, also a senator, lived in the 16th century and wrote a *Historia rerum Venetarum* in continuation of Bernardo. He also wrote chronicles De gestis Petri Mocenigi and De *bello* Venetorum *cum Carolo* VIII (Script, rer. Ital. vol. xxi).

Of the Genoese branch of the family the most prominent members were the following:

5. AGOSTINO (1470–1536) was born at Genoa and, after joining the Dominicans in 1487, studied Greek, Hebrew, Chaldee and Arabic; and in 1514 began the preparation of a polyglot edition of the Bible. As bishop of Nebbio, Corsica, he took part in the earlier sittings of the Lateran council (1516–17) but, in consequence of party complications, withdrew to his diocese and ultimately to France, where he became a pensioner of Francis I, and was the first to occupy a chair of Hebrew and Arabic in the University of Paris. He became acquainted with Erasmus and More and returned to Nebbio, about 1522. He bequeathed his fine library to the republic of Genoa. Of his projected polyglot only the Psalter was published (Psalterium Hebraeurn, Graecum, Arabicum, *et Chaldaicum,* Genoa, 1616). Besides the Hebrew text, the LXX translation, the Chaldee paraphrase and an Arabic version, it contains the Vulgate translation, a new Latin translation by the editor, a Latin translation of the Chaldee and a collection of scholia. Giustiniani printed 2,000 copies at his own expense, including 50 in vellum for presentation to the sovereigns of Europe and Asia. Besides an edition of Job, containing the original text, the Vulgate and a new translation, he published a Latin version of the *Moreh Nevochim* of Maimonides (Director dubitantiunz *aut perplexorum,* 1520) and also edited in Latin the Aureus *libellus* of Aeneas Platonicus and the Timaeus of Chalcidius. His annals of Genoa (Castigatissimi *annali* di Genova) were published posthumously in 1537.

6. POMPEIO (1569–1616), a native of Corsica, who served under Alessandro Farnese and the marquis of Spinola in the Low Countries, where he lost an arm, and was known by the sobriquet Bras de Fer. He defended Crete against the Turks, and subsequently was killed at Friuli. He left in Italian a personal narrative of the war in Flanders, repeatedly published in Latin (*Bellum* Belgicum, Antnerp, 1609).

7. GIOVANNI (1513–1556), born in Candia, was the translator of Terehce's *Andria* and Eunuchus, of Cicero's In Verrem and of Virgil's Aeneid, viii.

8. ORSATTO (1538–1603), Venetian senator, translator of the Oedipus Tyvannus of Sophocles and author of a collection of Rime, in imitation of Petrarch, was one of the latest representatives of the classic Italian school.

9. GERONIMO, a Genoese (16th century), translated the *Alcestis* of Euripides and three of the plays of Sophocles; he wrote two original tragedies, Jephte and Chrzsto in Passione.

10. VINCENZO, who in the beginning of the 17th century built the Roman palace, made the art collection associated with his name. The collection was removed in 1807 to Paris, and in 1815 all that remained of it, about 170 pictures, was purchased by the king of Prussia and removed to the Berlin royal museum.

GJELLERUP, KARL ADOLPH (1857–1919), Danish poet and novelist who shared the Nobel prize for literature with Henrik Pontoppidan in 1917. Born at Roholte, Zealand, on June 2, 1857, he studied theology, although already an atheist; and, strongly influenced by Georg Brandes and Darwinism, wrote novels expressing optimistic radicalism—En Idealist (1878) and Germanernes Laerling (1882). Travel broadened his outlook and he reacted against naturalism, developing an idealistic philosophy incorporating elements derived from Schiller, Schopenhauer, Wagner and Buddhism. He settled in Germany in 1892 and wrote many of his later works in German, often using Germanic and classical or Indian themes and settings. His works include novels—Die *Opferfeuer* (1903), Pilgrimen *Kamanita* (1906; Eng. trans. by J. E. Logie, The Pilgrim Kamanita, 1911); plays—*Brynhild* (1884). *Wuthhorn* (1893); and verse in Danish. He died at Klotzsche near Dresden, Oct. 11, 1919.

GLACE BAY, a town and port, the chief coal-mining centre of Cape Breton county, Nova Scotia, on the Atlantic ocean. The town is 14 mi. E. of Sydney, with which it is connected by railway. Coal mining dates from 1720 and major operations from 1858. The rich bituminous seams dip seaward for four miles. Pop. (1956) 24,416. Large fishing fleets, particularly for swordfishing, are stationed there. Marconi sent a transatlantic wireless message from Glace Bay in 1902. (C. W. RD.)

GLACIAL EPOCH: see PLEISTOCENE EPOCH.

GLACIER, a body of ice originating on land by compaction and recrystallization of snow and showing evidence of present or past movement. Glaciers occur where snoafall in winter exceeds melting in summer, conditions which prevail only in high mountain areas and polar regions at present. Because they are restricted to cold, remote places, glaciers are less familiar to most persons than are rivers, lakes and other kinds of hydrologic phenomena. Nonetheless, glaciers are extremely important features because of the direct and indirect effects on the earth and its inhabitants resulting from the presence of extensive ice-covered areas.

Glaciers occupy a total of 5,800,000 sq.mi., or 10% of the earth's land surface. an area nearly as large as South America. Of the present area of glaciers 96% is concentrated in Antarctica and Greenland, and the remainder is widely scattered on all continents, except Australia, and on many islands in high latitudes. The exact volume of glaciers is not known, but conservative estimates suggest that there is enough ice to incase the entire earth in a mantle between 100 and 200 ft. thick. Variations in the existing amount of glacier ice are highly critical to man because appreciable changes, either increases or decreases, would adversely affect the distribution of people and their economic relationships. For example, if all existing glacier ice were to melt, the resulting rise in sea level of about 200 ft. would submerge every major coastal city in the world.

Types of **Glaciers.**—*Ice* Sheets.—The largest glaciers, which are called ice sheets or icecaps, cover huge areas and in many cases are thick enough to bury entire mountain ranges except for the highest peaks. Practically all of Antarctica, an area of more than 5,000,000 sq.mi. is covered by an ice sheet locally 8,000 ft or more in thickness. The Greenland ice sheet covers about 650,000 sq.mi. and has a maximum measured thickness of nearly 11,000 ft. Smaller ice sheets occur on Iceland. Spitzbergen and several other arctic islands, and still smaller ones in the highlands of Norway.

Valley Glaciers.—Ice streams which flow down mountain valleys are valley glaciers. The Alps, Rockies, Himalayas and other high ranges of the world contain many glaciers of this kind. The smallest valley glaciers are thin patches of ice covering only a fraction of a square mile. And at the other extreme is Beardmore glacier in the antarctic which is about 120 mi. long and 2j mi. wide. Hubbard glacier in Alaska is about 75 mi. long. Many large valley glaciers are 1,000 to 3,000 ft. thick.

Piedmont Glaciers.—A third and more rare type, intermediate between valley glaciers and ice sheets, are piedmont glaciers. They are valley glaciers which spread laterally over the lowland at the foot of a mountain range. The Malaspina and Bering glaciers in Alaska, each of which covers about 1,500 sq.mi., are splendid examples.

Differences in size between these three types of glaciers depend on climatic factors which determine the amount of snow that accumulates. Differences in form result from the fact that glacier ice flows and thus can mold its form according to the topography.

How Glaciers Form.—Glaciers originate in snow fields. The lower limit of perennial snow fields is called the snow line. The snow line is at sea level in polar regions and rises gradually toward the equator. The maximum altitude of the snow line (about 20,000 ft.) occurs not at the equator but in the dry horse latitudes between 20° and 30° north and south of the equator. Climatic conditions. which are determined by geographic position and altitude, affect both winter snowfall and summer melting, and thus are the major factors affecting locations of snow fields and glaciers. It is for this reason that some very cold but dry areas have no glaciers whereas other warmer areas with abundant snowfall support large glaciers.

As snow fields grow in thickness, solid ice is formed through gradual recrystallization of the accumulated snow. In the first step. which takes place near the surface, melting, evaporation and compaction transform fluffy flakes of new-fallen snow into a porous mass of small, rounded granules called firn. This stage in the change of snow to solid ice can be seen in any melting snowdrift. The weight of snow which accumulates year after year buries the firn of previous years to greater and greater depths. The increasing pressure causes melting and recrystallization at the edges of grains until all air space is gone, and solid crystalline ice is formed.

The thickness of snow, firn and ice can continue to increase only until the strength of ice is exceeded by the pressure exerted by the weight of the accumulation, at which point movement begins. As a result of the pressure from above, ice at the bottom moves in much the same way that cold molasses or tar will flow. Although ice in small pieces is a brittle substance incapable of flowing, ice under sufficient pressure behaves as a plastic material and flows readily though quite slowly. The thickness required to initiate movement varies somewhat depending on slope of the land surface, temperature of the ice and other factors, but some flow occurs in ice masses as little as 50 ft. thick.

Flowage causes a glacier to move downward or laterally into a zone where losses exceed annual accumulation of snow. If the glacier descends below the snow line, losses are due mostly to melting and evaporation, but where a glacier extends into the sea much of the wastage may result from breaking off of icebergs which float away. Thus, the size of a glacier and also variations in its size depend on the degree of balance between accumulation and wastage rates. A glacier which is in equilibrium (a rare condition) does not fluctuate in size because flowage from the zone of accumulation exactly compensates for losses sustained in the zone of wastage.

Glaciers move so slowly that the motion cannot be seen, but the speed of movement can be estimated in various ways. For example. there are many records of the bodies of mountaineers buried by avalanches in the Alps having been carried several miles to a glacier terminus in a few decades. Likewise. the movement of large rocks or other objects on a glacier surface can be determined by successive observations or measurements from some fixed point off the ice. Somewhat more precise ways of measuring glacier speeds include drilling deep holes in the ice and inserting pipes which are progressively deformed, or by setting up rows of stakes and measuring their movement by surveying techniques. Maximum velocities up to 150 ft. per day have been recorded, but a few inches or a few feet per day are more typical.

The various parts of a glacier move at different rates. Movement of a valley glacier is similar to the flow of a river in that velocities are greater in the centre than near the edges, as is shown by the fact that a straight row of stakes soon becomes curved. Ordinarily flow is more rapid in the middle part of a glacier than near its head or terminus. The upper 100 to zoo ft. of a glacier is composed of rigid, brittle ice which does not flow but is carried along by the mobile ice underneath. This brittle zone fractures easily and is characterized by long cracks called crevasses, which are caused by forces that result from different rates of flow in various parts of the underlying ice. Especially at places where the gradient of the bedrock floor changes abruptly, the upper surface of the glacier may be broken into a jumbled maze of ice pinnacles called *séracs*.

Effects of Glaciation.—Glaciers are the most powerful of all erosional agencies and their special effects on land features commonly are both distinctive and spectacular. Glaciated mountains are much more rugged than nonglaciated mountains. Sharp pointed peaks like the Matterhorn in Switzerland and deep, U-shaped valleys like Yosemite in the Sierra Nevada of California owe their form mainly to glaciation. The fiords of Norway, Patagonia and Alaska, are glaciated valleys now partially submerged by the sea.

A glacier abrades and polishes the bedrock floor over which it passes; rocks and sand pushed along by the ice have the effect of a giant rasp or piece of sandpaper. Frost action, landsliding and avalanching carry rock debris onto a glacier surface from the land protruding above it. The material carried by a glacier ranges from house-sized boulders to clay particles. When the glacier melts all of this material is laid down as an unsorted deposit called till or boulder clay. At the terminus of a glacier the melting ice drops its load in the form of mounds and ridges referred to as a terminal moraine. Valley glaciers also commonly have lateral moraines between the edge of the ice and the valley walls, and medial moraines formed by confluence of tributary glaciers which have lateral moraines.

Drumlins are clusters of elongate hills oriented parallel to the direction of ice movement; they are composed of till laid down near the margins of large ice sheets.

Much of the material laid down by glaciers is reworked by melt-water streams, which build outwash plains and outwash terraces composed of stratified sand and gravel. Kettles are depressions on outwash plains formed by melting of ice blocks buried in the outwash deposits. Eskers are winding ridges of stratified gravel and sand believed to have been deposited by subglacial streams.

Former Periods of Glaciation.— Present-day glaciers are in part remnants left over from the Ice Age or Pleistocene epoch (*q.v.*), when the ice-covered area of the earth was three times its present size (see also MAN, EVOLUTION OF: Estimation *of Geo*logical Antiquity). The antarctic and Greenland glaciers were not much larger then than now, but large areas in North America and Europe were covered by ice sheets. Exactly when Pleistocene glaciation began is not known, but probably less than 1,000,000 years ago. Available evidence indicates that there were at least four major glacial periods, separated by intervals when the climate was warmer than at present. So far as can be determined by use of the radiocarbon method for dating wood and other organic matter found in glacial deposits, the last major ice advance in North America and Europe culminated about 18,000 years ago. At this time the snow line was 1,200 to 1,400 ft. lower than at present and mean annual temperature may have been about 14° F. cooler. Final shrinkage of the North American and European ice sheets began about 11,000 years ago, and by 3000 B.C. glaciers were less extensive than at present. After 2000 B.C., glaciers again expanded slightly and in most parts of the world attained sizes slightly greater than during the 17th and 18th centuries. Warmer climate during the last half of the 19th century, and especially the first half of the 20th century, caused extensive shrinkage of glaciers throughout the world. Although recession has been the general rule during this period, a few glaciers have either advanced or remained essentially stable.

Not only are remnants of Pleistocene glaciers still present, but also the landscape over wide areas bears the direct or indirect imprint of glaciation. Areas that were covered by ice are strewn with till and characterized by typical glacial land forms, including moraines, drumlins and eskers. Drainage features reflect influences of glaciation, in that the courses of some rivers, as the Missouri, were determined by the position of the glacier margin; furthermore, the thousands of lakes and swamps in Canada and the northern United States and in northern Europe occupy basins formed by glacial erosion and deposition. Indirect effects of the Pleistocene glacial episode extend far from the areas actually covered by ice. Belts of sand dunes and blankets of wind-blown silt, called loess (*q.v.*) occupy large areas south of the boundaries of the former North American and European ice sheets.

Terraces caused by variations in stream load accompanying glaciation and deglaciation are prominent features in many valleys. Terraces were also formed along the coast as a result of sea level fluctuations during glaciations and interglacial periods. Large lakes developed in regions now arid, as a result of greater precipitation and less evaporation during glacial times; Great Salt lake (*q.v.*) is a remnant of a formerly much larger body referred to as glacial Lake Bonneville (see also UTAH).

Before the Pleistocene ice age, there were two earlier major glaciations. Both of these occupied large areas in belts which are now tropical. One glaciation occurred during late Pre-Cambrian time (about 600,000,000 years ago) and the other during the Permian period (roughly 235,000,000 years ago). Apparently, all three of the known major glacial episodes were rather brief, and during the long intervals between them glaciers were not present even in high mountain and polar regions. This means that we are living during an unusual period, because during most of geologic time climate was considerably warmer than at present, and trees of subtropical types grew even in polar areas that are now covered by ice.

Glaciological Research.— Although an impressive amount is known about glaciers, many important problems await solution. Much remains to be learned about the physical properties and behaviour of glaciers, especially the large ice sheets. Flow speeds of many glaciers have been determined, but there is no satisfactory explanation of the mechanism by which flow of ice occurs. Relations between glacier fluctuations and climatic variations are highly complicated and poorly understood. The ultimate cause of world-wide climatic changes which during geologic time have resulted in three major glaciations is still an unsolved mystery. Variations in astronomic, atmospheric, oceanic and continental tectonic factors have been considered, and recently migration of the poles was suggested. All of these and many other related problems are the subjects of intensive study by glaciologists all over the world. Apart from purely scientific interest, there is a practical aspect to such investigations because of potential effects 'on man that would accompany changes in the present amount of glacier ice. Studies of past behaviour of glaciers have been too limited in scope to be of significant value in forecasting future trends. See also GEOLOGY.

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GLACIER BAY NATIONAL MONUMENT is approximately 100 mi. N.W. of Juneau in southeastern Alaska. Its ice fields terminate in more than 20 glaciers. Muir glacier, the best known, has a face 2 mi. wide and more than 200 ft. high. Glacier bay lies in a basin whose high western boundary culminates in 15,320-ft.-high Mt. Fairweather. Many glaciers funneling into a single narrow channel produce dramatic ice movements.

The region has been known since about 1700. Around 1750 the ice filled practically the entire bay; it had begun to retreat by the time of Capt. George Vancouver's visit in 1794. Since then the ice front usually has been in retreat.

The G.S. naturalist John Muir visited and reported on Glacier bay in 1879 and 1880. Thereafter it was intensively studied by glaciologists, climatologists and plant ecologists.

Glacier bay was made a national monument in 1925; a unit in the U.S. national park system, it comprises about 2,300,000 ac. It may be reached by ship, small boat or air. (J. E. CL.)

GLACIER NATIONAL PARK, in northwestern Montana, C.S., was established in 1910 to protect a highly scenic part of the Rocky mountains. Traversed from north to south by the continental divide, the park is a wilderness of more than 1,000,000 ac.

The mountains constitute a fault-block range. Faulting of the earth's crust along the eastern slope has resulted in rock of ancient origin being forced eastward for 15 mi. on rock of a later geologic period, a formation referred to as the Lewis overthrust.

Mountains, lakes: cirques and U-shaped valleys all show the effect of glacial action that took place during a more recent period, when the region was covered by an ice sheet hundreds of feet thick. A few remnants of the glaciers still cling to the higher peaks.

West of the continental divide, rainfall is heaviest, so that forest growth is more luxuriant there. Characteristic trees are western red cedar, hemlock. larch. white birch. lowland white fir and est-ern white and ponderosa pine. East of the divide, lodgepole pine and Engelmann spruce predominate, while Douglas fir occurs

PHOTOGRAPH, JAMES'S PRESS AGENCY

THE MER DE GLACE

The Mer de Glace, near Chamonix, in the French Alps, is a glacier $3\frac{1}{2}$ miles long, formed by the junction of three others, the Glacier du Géant, the Glacier de Talèfre and the Glacier de Leschaux

BY COURTESY OF (BOTTOM LEFT) W. S. BARCLAY, (BOTTOM CENTRE) THE NEW ZEALAND HIGH COMMISSIONER; PHOTOGRAPHS, (TOP LEFT) E. M. NEWMAN FROM PUBLISHERS PHOTO SERVICE, (TOP CENTRE) THE KEYSTONE VIEW CO., INC., (TOP RIGHT, CENTRE) BRADFORD WASHBURN, (BOTTOM RIGHT) EWING GALLOWAY

VARIOUS TYPES OF GLACIERS

Top left: Monte Rosa glacier seen from Gornergrat, Switzerland. The dark rock on the right is hundreds of feet in height

Top centre: Balmaceda glacier. Last Hope Sound, Chile. Huge blocks of ice stand above the glacier's surface

Top right: Mendenhall glacier near Juneau, Alaska. This glacier is a large, nearly stagnant ice sheet

Centre: Malaspina glacier in the Mt. St. Elias range, Alaska, an excellent example of the piedmont type of glacier

Bottom left: La Romanche glacier, Beagle Channel, Tierra del Fuego, falls directly into the sea

Bottom centre: Franz Josef glacier and Castle rock, Westland, South Island, N. Z., showing crevasses and jagged ice formations on the surface

Bottom right: Tschierva glacier from Alp Ota, near Pontresina, Switzerland. This glacier is an Alpine type showing valley formation and lateral moraines along the margins on both sides. At high elevations, groups of limber pine, whitebark pine and alpine fir grow in meadows that are bright with wild flowers in the summer.

The white mountain goat attracts the attention of visitors by its ability to traverse sheer cliffs. Other mammals of the sanctuary are black and grizzly bear, mountain lion, coyote, elk, moose and deer. Some of the park's birds are Rocky Mountain jay, water ouzel, Clark's nutcracker, white-tailed ptarmigan and grouse.

Adjoining the international border, Glacier is contiguous to Canada's Waterton Lakes National park. The two comprise the Waterton-Glacier International Peace park. (Dx. B.)

GLACKENS, WILLIAM JAMES (1870–1938), U.S. painter and leader of the group known as The Eight, was born in Philadelphia on March 13, 1870, studied at the Pennsylvania Academy of the Fine Arts and at the same time worked as an illustrator for the *Philadelphia Record*, the *Public Ledger* and the *Press*. In 1895 he spent a year in Paris and then settled in New York where he continued as an illustrator for the *New York Herald* and the *New York World*. *McClure's Magazine* sent him to Cuba in 1898 to cover the Spanish-American War. At about the turn of the century he took up painting seriously; "Hammerstein's Roof Garden" (1901) was his first important picture. As an illustrator he had dealt with all aspects of contemporary life; he was a sure draftsman and had a keen visual memory, which gave an authentic quality to his work.

He joined with a group of artists who were also interested in depicting contemporary life, and they united to oppose the stodgy, old-fashioned viewpoint of the National Academy. Robert Henri was the leader, and around him gathered John Sloan, George Luks, Everett Shinn as well as the more romantic painters Ernest Lawson, Maurice Prendergast and Arthur B. Davies. Known as The Eight (later, known as the "Ash Can school" because of their honest rendering of city scenes), they held one memorable exhibition in 1908 at the Macbeth gallery, but, due to diversity of viewpoints, the group did not hold together.

One of Glackens' major early works was "Chez Mouquin" (1905) showing a gay New York restaurant in a vivid and robust manner. Later he became interested in Impressionism and very consciously tried to imitate Renoir.

He died in Westport, Conn., on May 22, 1938.

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GLADBACH, the name of two towns in Germany, distinguished as Bergisch Gladbach and Monchen-Gladbach.

1. BERGISCH GLADBACH is in North Rhine-Westphalia, 8 mi. N.E. of Cologne by rail. Pop. (1950) 32,681. It possesses four large paper mills, and among its other industries are percussion caps, nets, machinery, iron founding and fire clay. Ironstone. peat and lime are found in the vicinity. Near Gladbach is Xltenberg, with a remarkably fine church built for the Cistercian abbey.

2. MONCHEN-GLADBACH, also in North Rhine-Westphalia, 16 mi. W.S.W. of Dusseldorf on the main line of railway to Aachen. Pop. (1885) 44,230; (1950) 124,879. Its industries are the spinning and weaving of cotton, the manufacture of silks, velvet, ribbon and damasks, and dyeing and bleaching. There are also tanneries, machine works and foundries. The beautiful minster has a Gothic choir (1250), a nave (early 13th century) and a crypt of the 8th century. The town is the headquarters of important insurance societies. A Benedictine monastery was founded near Gladbach in 793; so it was called Monchen-Gladbach (Monks' Gladbach). The monastery was suppressed in 1802. Gladbach became a town in 1336 and came into the possession of Prussia in 1815. Its oil tanks, railway yards and airfield were frequent targets for British bombers in World War II.

GLADDEN, WASHINGTON (1836–1918), U.S. Congregational minister and religious journalist. the foremost early advocate of the social gospel (*see* CHRISTIAN SOCIALISM) in the U.S., was born at Pottsgrove, Pa., Feb. 11, 1836. He grew up on a farm and received early newspaper training in a small city newspaper office. He attended Williams college. Williamstown, Mass., and later held pastorates at North Adams and Springfield, Mass. He was religious editor of the *New York Independent* for four years from 1871. In 1882 he became pastor of the First Congregational church of Columbus, O., which he served until his death (becoming emeritus pastor in 1914).

Gladden was attracted to the ministry by "a religion that laid hold upon life with both hands, and proposed, first and foremost, to realize the Kingdom of God in this world" *(Recollections)*. As acting editor of the *Independent* he aided in the exposure of the Tweed ring. He opposed both socialism and classical economic theory and sought to apply the "Christian law" to social problems; he was probably the first U.S. clergyman of note to approve of unionization. A popular speaker, he appeared before universities and theological schools, twice giving the Beecher lectures at Yale.

The titles of his 40 books often conveyed their messages: *Applied Christianity* (1887), *Who Wrote the Bible?* (1891), *Ruling Ideas of the Present Age* (1895), *Social Salvation* (1901). His poem "O Master, Let Me Walk With Thee" became a familiar hymn.

Gladden advocated church union, stimulating the formation of many federations by his fictional account of *The Christian League of Connecticut* (1883). He was a charter member of the American Economic association and served two years on the Columbus city council. In 1904 he was elected moderator of the National Council of Congregational Churches and shortly afterward startled the country with a proposal to reject a $100,000 gift from John D. Rockefeller to the denomination's foreign missions board, on the ground that it was "tainted money." He died at his home in Columbus on July 2, 1918.

See his autobiography, *Recollections* (1909), which contains a bibliography of his works; C. H. Hopkins, *The Rise of the Social Gospel in American Protestantisnz, 1865–1915* (1940). (C. H. Hs.)

GLADIATORS (from Lat. *gladius*, "sword"), professional combatants who fought to the death in Roman public shows. That this form of spectacle, which is almost peculiar to Rome and the Roman provinces, was originally borrowed from Etruria is shown by various indications. The older Roman name for the fighters was *bustuarii*. The first gladiators are said to have been exhibited at Rome in the Forum Boarium in 264 B.C. by Marcus and Decimus Brutus at the funeral of their father. On this occasion only three pairs fought, but the taste for these games spread rapidly, and in 174 B.C. Titus Flaminius celebrated his father's obsequies by a three-day fight in which 74 gladiators took part.

Julius Caesar engaged such extravagant numbers for his aedileship that his political opponents took fright and carried a decree of the senate imposing a certain limit of numbers, but notwithstanding this restriction he was able to exhibit no less than 300 pairs. During the later days of the republic the gladiators were a constant element of danger to the public peace. The more turbulent spirits among the nobility each had his band of gladiators to act as a bodyguard. Under the empire the passion for the arena steadily increased. Augustus, indeed, limited the shows to two a year and forbade a praetor to exhibit more than 120 gladiators; yet 100 pairs were the fashionable number for private entertainments, and in the Marmor Ancyranum the emperor states that more than 10,000 men had fought during his reign. Even the emperor Titus ordered a show which lasted 100 days; and Trajan, in celebration of his triumph over Decebalus, exhibited 5,000 pairs of gladiators.

Domitian at the Saturnalia of A.D. 90 arranged a battle between dwarfs and women. Even women of high birth fought in the arena, and it was not till A.D. 200 that the practice was forbidden by edict.

Gladiators were commonly drawn either from prisoners of war, slaves, or criminals condemned to death. Down to the time of the empire, only greater malefactors, such as brigands and incendiaries, were condemned to the arena; but by Caligula. Claudius and Nero this punishment was extended to minor offenses. For the first century of the empire it was lawful for masters to sell their slaves as gladiators, but this mas forbidden by Hadrian and Marcus Aurelius. Besides these three regular classes, the ranks were recruited by a considerable number of freedmen and Roman citizens who had squandered their estates and voluntarily took the *auctoramentum gladiatorium*, by which for a stated time they bound themselves to the *lanista.* Even men of birth and fortune not seldom entered the lists, and one emperor, Commodus, actually appeared in person in the arena.

Gladiators were trained in schools (ludi) owned either by the state or by private citizens, and though the trade of a *lanista* was considered disgraceful, to own gladiators and let them out for hire was reckoned a legitimate branch of commerce. Men recruited mainly from slaves and criminals, whose lives hung on a thread, must have been more dangerous characters than modern galley slaves or convicts; and, though highly fed and carefully tended, they were of necessity subject to an iron discipline. In the school of gladiators discovered at Pompeii, of the 63 skeletons buried in the cells many were in irons. But hard as was the gladiators' lot (so hard that special precautions had to be taken to prevent suicide), it had its consolations.

A successful gladiator enjoyed far greater fame than any modern prize fighter or athlete. He was presented with broad pieces, chains and jeweled helmets, such as may be seen in the museum at Naples; poets like Martial sang his prowess; his portrait was multiplied on vases, lamps and gems; and highborn ladies contended for his favours.

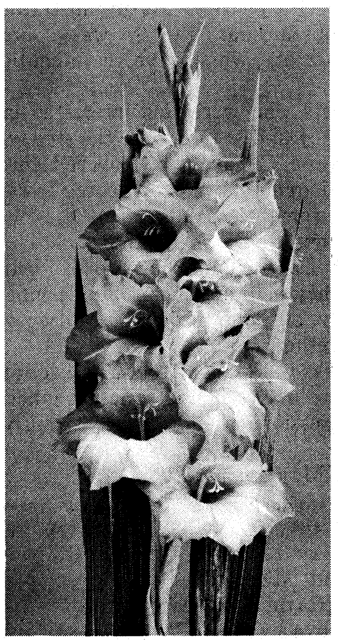
There were various classes of gladiators, distinguished by their arms or modes of fighting. The Samnites fought with the national weapons—a large oblong shield, a visor, a plumed helmet and a short sword. The Thraces had a small round buckler and a dagger curved like a scythe; they were generally pitted against the Mirmillones, who were armed in Gallic fashion with helmet, sword and shield, and were so called from the fish which served as the crest of their helmet. In like manner the Retiarius was matched with the Secutor; the former had nothing on but a short tunic or apron, and sought to entangle his pursuer, who was fully armed, with the cast net *(iaculum)* that he carried in his right hand; if successful, he despatched him with the trident (tridens, *fuscina*) that he carried in his left. There were also the Andabatae, who are believed to have fought on horseback and to have worn helmets with closed visors; the Dimachaeri of the later empire, who carried a short sword in each hand; the Essedarii, who fought from chariots like the ancient Britons; the Hoplomachi, who wore a complete suit of armour; and the Laquearii, who tried to lasso their antagonists.

The shows were announced some days before they took place by bills affixed to the walls of houses and public buildings; copies were also sold in the streets. These bills gave the names of the chief pairs of competitors, the date of the show, the name of the giver and the different kinds of combats. The spectacle began with a procession of the gladiators through the arena, after which their swords were examined by the giver of the show. The proceedings opened with a sham fight *(praelusio, prolusio)* with wooden swords and javelins. The signal for real fighting was given by the sound of the trumpet, those who showed fear being driven on to the arena with whips and red-hot irons. When a gladiator was wounded, the spectators shouted *"habet"* ("he is wounded"); if he was at the mercy of his adversary, he lifted up his forefinger to implore the clemency of the people, to whom (in the later times of the republic) the giver left the decision as to his life or death. If the spectators were in favour of mercy, they waved their handkerchiefs; if they desired the death of the conquered gladiator, they turned their thumbs downwards. (A different account is given by Mayor on Juvenal iii 36, who says: "Those who wished the death of the conquered gladiator turned their thumbs towards their breasts, as a signal to his opponents to stab him; those who wished him to be spared turned their thumbs downwards as a signal for dropping the sword.") The reward of victory consisted of branches of palm, sometimes of money.

Gladiators who had exercised their calling for a long time or who displayed special skill and bravery were presented with a wooden sword *(rudis)* and discharged from service. The first Christian emperor was persuaded to issue an edict abolishing gladiatorial games (325), yet in 404 we read of an exhibition of gladiators to celebrate the triumph of Honorius over the Goths, and it is said that they were not totally extinct in the west till the time of Theodoric.

The tesserae of gladiators were small oblong tablets of ivory or bone, with inscriptions giving the name of the gladiator; the name of the *patronus* or *dominus;* the letters SP (for *spectatus,* "approved"). showing that the gladiator had passed his preliminary trials; a day of a Roman month; and the names of the consuls of a particular year.

GLADIOLUS, (from *gladius,* a "sword," in allusion to the sword-shaped leaves) a numerous genus of showy herbs belonging to the iris family (Iridaceae). They grow from a solid fibrous-coated corm (a bulblike enlargement of the base of the stem) and have long narrow plaited leaves and a terminal one-sided spike of generally bright-coloured irregular flowers blooming from the bottom upward. The segments of the limb of the perianth are very unequal, the perianth tube is curved, funnel shaped and widening upward, the segments equaling or exceeding the tube in length. There are about 250 known species, a large number of which are South African, but the genus extends into tropical Africa, forming a characteristic feature of the mountain vegetation, and as far north as central Europe and western Asia. One species G. *illyricus,* though very rare, is found wild in England, in the New forest and the Isle of Wight. Some of the species have long been cultivated in flower gardens, where both the introduced species and the modern varieties bred from them are very ornamental and popular.



J. HORACE MCFARLAND CO.

A GARDEN GLADIOLUS

The modern varieties of gladioli have almost completely driven the natural species out of gardens, except in botanical collections. The most gorgeous groups are those of hybrid origin, most of which have been derived from G. *blandus,* G. *cardinalis,* G. *dracocephalus,* G. *psittacinus,* G. *gan*davensis, G. *oppositiflorus* and G. *primulinus.* The flowers of the best varieties are of great size and substance, often measuring seven to nine inches across, while the range of colour is marvelous, with shades of gray, purple, scarlet, salmon, crimson, rose, white, pink, yellow, etc., often beautifully mottled and blotched in the throat. The plants are vigorous in growth, often reaching a height of three to four feet.

The beginning of the modern cultivated gladioli was probably the introduction of G. gandavensis (itself a hybrid) in 1841.

A deep and rather stiff sandy loam enriched with well-decomposed manure is the best soil for gladioli. The corms should be planted in succession at intervals of two or three weeks, after warm weather arrives, about three to five inches deep and at least one foot apart.

The gladiolus is easily raised from seeds, which should be sown in March or April in pots of rich soil placed in slight heat, the pots being kept near the glass after they begin to grow, and the plants being gradually hardened to permit their being placed out of doors in a sheltered spot for the summer. The time occupied from the sowing of the seed until the plant attains its full strength is from three to four years. Because few of the seeds come true to type approved sorts are multiplied by secondary corms which form around the principal corm; but in this they vary greatly, some kinds furnishing abundant increase, while others fail to yield offsets.

The rich glowing colours of the modem gladioli render them exceedingly valuable as decorative plants during the summer months. They are, moreover, very desirable and useful flowers for room decoration, for while the blossoms themselves last fresh for several days if cut early in the morning or late in the evening, the undeveloped buds open in succession, so that a cut spike will go on blooming for some time. (N. TR.)

GLADSTONE, HERBERT JOHN GLADSTONE, 1ST VISCOUNT (1854–1930), English statesman, son of W. E. Gladstone (*q.v.*), was born in London on Jan. 7, 1854, and educated at Eton and at University college. Oxford. He lectured on history at Keble college for three years (1877–80) and then entered on a parliamentary career, representing Leeds from 1880 to 1910.

From 1880 to 1881 he acted as private secretary to his father, and in 1881 became a lord of the treasury. His other political offices were financial secretary to the war office (1886); under-secretary at the home office (1892–94); first commissioner of works (1894–95); chief whip to the Liberal party (1899–1906); and secretary of state for home affairs (1905–10). In 1910 he was created a viscount, was appointed the first governor general and high commissioner for South Africa, a post which he held until July 1914. He was created knight of the grand cross of the order of St. Michael and St. George in 1910 and made knight grand cross of the order of the Bath in 1914. He wrote *W. E. Gladstone* (1918) and *Affer Thirty Years* (1928). Lord Gladstone died at Dane End, near Ware. Hertfordshire, on March 6, 1930.

GLADSTONE, WILLIAM EWART (1809–1898), four times prime minister of Great Britain, was born in Liverpool on Dec. 29, 1809. His descent was purely Scottish. His mother, formerly Anne Robertson of Dingwall, came of good Highland family; and his father John (1764–1851) was descended from the Gledstanes of Lanarkshire, once bailies to the earls of Douglas. His father's father had been a corn dealer at Leith; John Gladstone made himself into a merchant prince by trading with the East and West Indies, and became a leading citizen of the great slaving port of Liverpool. He was a Canningite member of parliament from 1818 to 1827, was made a baronet in 1846, and died worth about £600,000. William Ewart Gladstone, named after a friend of his father's, was the fifth of six children. He was sent to Eton, where Arthur Hallam, the subject of Tennyson's *In Memoriam*, was his closest friend. Eton he ever afterward described as the queen of all schools; he did not particularly distinguish himself there. He first displayed his considerable powers of intellect at Christ Church. Oxford, nhere he secured two first classes in 1831, in Greats (classics) in November and in mathematics in December.

His father dissuaded him from his original intention to take orders in the Church of England; and he devoted his life, as he saw it, to serving the principles of the Gospel in politics. As a disciple of Edmund Burke and George Canning, he mistrusted parliamentary reform; his speech against it in May 1831 at the Oxford Union. of which he was president, made a strong impression, and was indeed regarded as the finest so far delivered there. One of his Christ Church friends, son of the duke of Newcastle, persuaded the duke to support Gladstone as candidate for Newark in the general election of Dec. 1832; and the "Grand Old Man" of Liberalism thus began a parliamentary career of more than 60 years as a Tory member for what was little better than a pocket borough.

His abilities were noticed early; his maiden speech on June 3, 1833, defending the treatment of slaves on a plantation his father owned in Demerara, made a decided mark. He held minor office in Sir Robert Peel's short government of 1834–35, first at the treasury under Peel himself. then as undersecretary for the colonies under Lord Aberdeen. After two other women had refused him, in July 1839 he married Catherine (1812-l goo), daughter of Sir Stephen Glynne of Hawarden near Chester. She was a woman of lively wit, complete discretion and exceptional charm, utterly devoted to her husband, to whom she bore eight children. This marriage gave him a secure base of personal happiness for the rest of his life. It also established him in the aristocratic governing class of the time; his wife's mother had been Pitt's first cousin. His first book. *The State* in *Its Relations With the Church*, had been published in 1838. He outgrew while he wrote it its strong and narrow doctrines, to the effect that the Church of England must act as the conscience of the state, which in its turn can distinguish religious truth and falsehood; doctrines already obsolescent when the book appeared.

The Influence of **Peel.**—Macaulay, in a too celebrated afterthought, referred to him in reviewing this work as the rising hope of stern and unbending Tories. His early parliamentary performances were indeed strongly Tory; but time after time actual contact with the effects of Tory policy forced him by the evident justice of each particular case to take a more liberal view. His conversion from the conservatism in which he was brought up to the liberalism which gave him lasting fame was prolonged by stages over a generation. He took his first steps in a liberal direction during Peel's second ministry (1841–46). By 1840 he was attending meetings of what would now be called the shadow cabinet, and had hoped to be included in the new cabinet from the start as secretary for Ireland; but Peel rightly judged that he was too strong an Anglican for immediate contact with a country part Roman Catholic and part Presbyterian. and that the son of so successful a merchant would be useful at the board of trade. Gladstone, made vice-president of the board under the ineffective Lord Ripon, complained privately that "the science of politics deals with the government of men, but I am set to govern packages"; yet the wisdom of Peel's choice was soon apparent. The vice-president's powers ofw application astonished even his hard-working colleagues; Sir James Graham said of him that he could do in four hours what would take any other man 16, and that he worked 16 hours a day.

Under Peel's supervision he embarked on a major simplification of the tariff; in 1842 the duties on no fewer than 750 articles were removed or reduced. While mastering the complexities of this subject Gladstone became indeed a more thoroughgoing free trader than Peel himself. The prime minister felt that Gladstone was outstanding among all the promising young men in the government; said that a more admirable combination of ability, knowledge, temper and discretion had never before been exhibited in parliament; and in May 1843 invited him into the cabinet as president of the board of trade.

Gladstone accepted, after characteristic hesitations about a proposal to amalgamate t o Welsh bishoprics; and continued the work of improving the commercial structure of the country. The Railway act of 1844, prepared under his direction, compelled all lines to carry passengers in covered coaches, once a day at least, at a charge of not more than 1*d.* a mile, and made provision for eventual state purchase of railway lines. Among other useful tasks, he much improved working conditions for coal heavers in the London docks. Early in 1845, when the cabinet proposed to increase the state grant to the Irish Roman Catholic college at Maynooth, Gladstone resigned—not because he did not approve of the increase, but because it went against the views he had published seven years before. Plain men found his reason for resigning pernickety. At the end of the year he rejoined the cabinet as secretary of state for the colonies. This legally involved the resignation of his seat at Newark. As he was by now a convinced free trader, and the duke of Newcastle was a protectionist, he could not win it again; and for various reasons he did not contest any of the half-dozen possible seats suggested to him by the Conservative whip. For six months, till Peel's government fell in June 1846, he was in office, but not in parliament—a position of doubtful constitutional propriety. Absence from the commons had an effect of importance to him; he was unable to make any personal reply to Disraeli's onslaughts on Peel. While he was at the colonial office he was led nearer to liberalism by being forced to consider the claims of English-speaking colonists to govern themselves; but he was there too short a time to make any useful mark on colonial policy.

Private Preoccupations.—The Glynne family estates were deeply involved in the financial panic of 1847. For several years Gladstone was concerned with extricating them, devoting his customary energy to the intricacies of industrial investment and land tenure; dull as this work must have been at the time, it gave him a still fuller insight into practical economics, which helped him later when he was chancellor of the exchequer. In the course of these operations he became the largest landlord in the county of Flint. At about the same time he began, with singular simplicity, a habit of charitable work which was open to a great deal of misconstruction; he often tried, in the streets of London, to persuade prostitutes to enter a home which he and his wife maintained, or in some other way to take up a different way of life. He spent much time and money on these efforts, till well past his 75th birthday. Another private matter that absorbed a great deal of his attention was the conversion of his youngest sister to the Roman Catholic church; this pained him even more acutely than any of the political separations that befell him.

Some of his closest Oxford friends were among the Anglicans who left the Church of England for the Church of Rome under the impact of the Oxford movement and the Gorham judgment (*see* ENGLAND, CHURCH OF. and MANNING. HENRY EDWARD). Gladstone had been brought up by an evangelical mother; he had moved over to. a high Anglican position when in Italy just after leaving Oxford. and once he had reached it he retained it. Neither affection nor argumentative skill could ever persuade him to become a Roman Catholic himself; but the suspicion that he was one dogged him, and was used against him from time to time by political and clerical adversaries. Of these he had many in the University of Oxford, for which he was elected M.P., to his great delight, in Aug. 1847. He scandalized many of his new constituents at once by voting for the admission of Jews to parliament, and many more by his tolerant opposition to Lord John Russell's Ecclesiastical Titles act of 1851.

In June 1850 he made his first weighty speech on foreign affairs, opposing Lord Palmerston in the Pacifico debate. That autumn he paid a private visit to Naples, and called on a learned friend. who turned out to be in prison. The conditions that he found in the Neapolitan prisons so appalled him that when he returned to London next February he could talk of little else. Brushing aside a request to join a protectionist government that was in contemplation, he appealed to Lord Aberdeen, the leader of his Peelite friends and a former foreign secretary, to use his influence to help the many thousands of starving political prisoners Gladstone had seen living chained to criminals in underground dungeons. Aberdeen took time in consulting powerful acquaintances in Vienna; nothing was actually done. So in July 1851 Gladstone published two trenchant *Letters to Lord Aberdeen* which described what he had seen and appealed to all Conservatives to set an iniquity right. The results were far from what he had desired. For the time. the Neapolitan prisoners were treated even worse than before, and most Conservatives, all over Europe, were deaf to his appeal. But Palmerston circulated the *Letters* to all the British missions on the continent, and they delighted every liberal who heard of them.

Financial Policy.—For nine years after Peel's death in 1850 Gladstone's political position was seldom comfortable and sometimes embarrassing. One of the most eminent of the duindling band of distinguished Peelites. he was mistrusted by the leaders of both the main parties, and distrusted some of them—particularly Palmerston and the protectionist Disraeli—in his turn. He refused to join Lord Derby's government in 1852. At the end of that year, by a brilliant attack on Disraeli's budget, he brought the government down; and he took a long stride forward in public estimation as a result, for he joined Aberdeen's coalition as chancellor of the exchequer. His first budget speech on April 18, 1853, gave the country in Greville's words "the assurance of a *man* equal to great political necessities, and fit to lead Parties and direct Governments." In his bold and comprehensive plan he made further large reductions in duties, propounded the eventual elimination of the income tax, and with considerable political courage revived and carried a scheme that Pitt had not been strong enough to carry in 1796, for the extension of the legacy duty to real property. Every other member of the cabinet at first opposed this proposal, and he converted them all. His budget provided the backbone of the coalition's success in 1853, a year in which he spent much time in arranging for competitive entry into the civil service. He was also busy preparing the Oxford University act passed in the following year; this local preoccupation kept him from taking any detailed interest in the events which led up to the Crimean War. He defended the war, then and thereafter, as necessary at its inception for the defense of the public law of Europe; but of course its outbreak deranged his financial plans. He determined to pay for it as far as possible by taxation. and doubled the income tax—from *7d.* to *1s. 2d.*—in 1854. When Aberdeen fell in Jan. 1855 Gladstone agreed to join Palmerston's cabinet, but resigned three weeks later with two other Peelites, Sir James Graham and Sidney Herbert, sooner than accept J. A. Roebuck's committee of inquiry (*see* ROEBUCK, JOHN ARTHUR). This action mas no more readily explicable to ordinary men than his resignation ten years earlier had been, and he was for a time unpopular in the country. He made himself more unpopular still by speeches in parliament in the summer of 1855 in which he held that the war mas no longer justified, as its proper objects had already been attained. Meanwhile his imagination was still haunted by the horrors of Naples. He helped finance a quixotic project, to which Palmerston added £500 from secret service funds. A steamer with an armed crew was dispatched to rescue some Neapolitan prisoners confined on a Mediterranean island. The good, and the harm. that might have come of this voyage were alike averted when the vessel sank on the way.

Gladstone always kept up his reading in classical studies, as well as in theology and Italian poetry; and used his leisure out of office to prepare a long book. *Homer and the Homeric Age* (3 vol.; Oxford, 1858), which suggested that ancient Greek life had been designed by providence to show men how they should behave to each other. He helped to defeat Palmerston in the commons by a speech on China in March 1857; and later that year opposed the Divorce bill on religious grounds with such persistency that he was accused long afterward of having invented parliamentary obstruction himself. He twice refused to join Derby's government in 1858, in spite of a generous letter from Disraeli; but accepted an offer to visit the Ionian Islands protectorate as lord high commissioner in the winter of 1858–59, a journey that produced no useful results.

In June 1859 he gave a silent, unavailing vote for Derby's Conservative government on a confidence motion, and caused surprise by joining Palmerston's Whig cabinet as chancellor of the exchequer a week later. His sole, but overwhelming, reason for joining a statesman he neither liked nor trusted was the critical state of the Italian question. The triumvirate of Palmerston, Russell and Gladstone did indeed help over the next 18 months to secure the unification of almost all Italy; but on other matters the cabinet was much divided.

Gladstone was constantly at issue with his prime minister over spending on defense. By prolonged efforts, he managed to get the service estimates down by 1866 to a lower figure than that for 1859. He took little other part in the government's foreign policy, except for an unfortunate and unauthorized reference to the seceding American states as "a nation" in Oct. 1862. The national economy responded well to his policies at the exchequer. which included the abolition of a further 370 duties by the celebrated budget of 1860. Two other financial measures of that year were important: the Anglo-French trade treaty, a project of Richard Cobden's which Gladstone warmly supported. and which shortly doubled the value of Anglo-French trade; and Gladstone's proposal to abolish the duties on paper, which to Palmerston's ill-concealed delight the house of lords rejected. Next year Gladstone repeated the proposal, this time including it with all the other budget arrangements in a single finance bill which the lords dared not amend, a procedure that has been followed ever since. Another particularly useful step was the creation of the post office savings bank. These measures brought him into increased contact, and increased popularity, with the leaders of working-class opinion; journeys round the main centres of industry did the same. A few words of his in the commons on May 11, 1864, were widely interpreted outside as a declaration of belief in practically universal suffrage; seen in their context, they are not quite so extreme. They are worth quoting, with their context, as an example of his characteristic tendency to qualification: "I venture to say that every man who is not presumably incapacitated by some consideration of personal unfitness or of political danger is morally entitled to come within the pale of the Constitution. Of course, in giving utterance to such a proposition, I do not recede from the protest I have previously made against sudden, or violent. or excessive, or intoxicating change." In the general election of July 1865 Gladstone was defeated at Oxford, but just secured a seat in south Lancashire; the sadness of the defeat was atoned for in some degree by a contact with a popular constituency which he found refreshing. When Palmerston died in October and Russell became prime minister, Gladstone took over the leadership of the house of commons, while remaining at the exchequer. It was not a post for which he was well suited; he was too busy to spend much time in making himself agreeable to backbenchers, and while Whigs distrusted him as a former Conservative, Conservatives distrusted him as a renegade, and radicals as a churchman.

By now quite convinced of the need for a further reform of parliament, he introduced a bill for the moderate extension of the franchise in March 1866. Violently attacked by Robert Lowe. it foundered in committee in June, and the whole government resigned. Next year Disraeli introduced another moderate Reform bill; and this passed, hut not until John Bright and Gladstone had transformed it in committee into a stronger one that gave a vote to most householders in boroughs. Early in 1868 Disraeli became prime minister; Gladstone, two months later, carried against him in the commons three resolutions calling for the disestablishment of the Protestant church in Ireland. and explained that autumn in *A Chapter of Autobiography* the reasons that had led him so far from the conclusions of his first book. Russell had by now resigned from active politics. and it was to Gladstone that the Liberal whips looked for instructions during the general election at the end of the year. Though Gladstone lost his Lancashire seat, he was returned for Greenwich; and the Liberal party won handsomely in the country as a whole. His abilities had made him its indispensable leader; and Queen Victoria called on him to form a government when Disraeli resigned.

First Administration.— Gladstone's first cabinet (1868–74) was one of the most capable of the century *(see* ENGLISH HISTORY: *The Age of Victoria* [1837–1901]). Its prime minister tried, like Peel and unlike Palmerston or Disraeli, to supervise the work of each department. while giving close attention to church appointments and devoting his main efforts to Irish and foreign policy. The Irish church was successfully disestablished in 1869, and a first attempt to grapple with Irish land was made in 1870; but the Land act of that year almost broke up the cabinet, and was emasculated by the lords. Abroad, an attempt to promote disarmament in 1869 failed, as Bismarck refused to consider it: the Franco-German War took the government completely by surprise; and the cabinet would not allow Gladstone to propose to Prussia the neutralization of Alsace and Lorraine. The principal achievements of 1871 and 1872, the London declaration by the great powers that they would not in future abrogate treaties without the consent of all the signatories and the settlement by arbitration of a long-standing claim for compensation by the United States, look well in retrospect, but were thought pusillanimous at the time. The most useful reforms at home mere administrative, except for the Education act of 1870 and the Ballot act of 1872; these measures supplemented the work of parliamentary reform. but antagonized opposite wings of the Liberal party. When an Irish University bill failed by three votes to pass the commons in March 1873, Gladstone resigned, but was forced back into office by Disraeli. In August he had to reshuffle his cabinet, and again took on the chancellorship of the exchequer himself. Fascinated by another plan to abolish income tax altogether, he dissolved parliament suddenly in Jan. 1874; but his party was heavily defeated, and his government resigned. As far back as 1855 he had written: "Public life is full of snares and dangers, and I think it a fearful thing for a Christian to look forward to closing his life in the midst of its (to me at least) essentially fevered activity." So he gave up the Liberal party leadership. though he remained M.P. for Greenwich; and retired to Hawarden. to write pamphlets attacking papal infallibility and articles on Homer.

Bulgarian Atrocities— The indifference of Disraeli's government to the brutality of Turkish reprisals against risings in the Balkans in 1875–76 brought him back to active politics. He had held for many years that the only just solution to Balkan problems was to hand the peninsula over to its indigenous inhabitants. Now, in Sept. 1876, he published a famous pamphlet on *Bulgarian Horrors and the Question of the East* which demanded that the Turkish irregulars should remove themselves, "one and all, bag and baggage, . . . from the province they have desolated and profaned." He took the lead in stirring popular indignation against the government's bellicose eastern policy; but it was uphill work. London society and the London mob were both against him; the queen, under the blandishments of her prime minister, strongly disapproved; the Whiggish elements in his own party were lukewarm or indifferent at first; and only some radicals, with whom he had little in common, supported him hotly. He paid too little attention to the embarrassment he was causing the Liberal party leader, Lord Granville. Yet in the end he triumphed.

He gave up his Greenwich seat, and stood for the Scottish county of Midlothian against a sitting Conservative who was heir to the greatest local magnate. In two tremendous outbursts of oratory, of volcanic force, in Nov. 1879 and March 1880, Gladstone secured his own return to parliament, but he did much more as well; he overthrew a government.

The general election of March and April 1880 had more, and on the whole more ardent, contests than any before; and it was this one man's eloquence that decided the result, and secured a large Liberal majority. The feat is unique. Gladstone was able, by manifest sincerity and skill of argument combined, to convince a majority of the electorate all over the kingdom that recent Conservative policy had been morally wrong, and the Conservative government had to resign.

Second Administration.— In his second administration (1880–85) Gladstone foolishly combined again for two years and a half the duties of prime minister with those of chancellor of the exchequer. Party lines had not yet set firm, and his large apparent majority in the commons was unruly; for example, he was dogged by the tiresome controversy over Charles Bradlaugh (*q.v.*); and it was not till 1884 that he could introduce the measure for which most Liberals had been pressing, a third Reform act that nearly doubled the electorate by giving votes to householders in country districts. This measure was only passed after a stiff quarrel with the house of lords. Gladstone had hoped to settle the eastern question quickly, and then retire. As it was. he and Granville, the foreign secretary, did manage by a brusque naval threat to compel Turkey to cede Thessaly to Greece; but Granville would not let him go on to give up Cyprus, as the government had already been weakened by other questions and had vital work still before it. There was, again, an appearance of weakness in what can now be recognized as Gladstone's magnanimous attitude to the Transvaal Boers after Majuba *(see* SOUTH AFRICA: *History)*; and there were still graver troubles in Ireland, in the throes of agricultural catastrophe. The exceedingly complicated Irish Land act of 1881, largely Gladstone's own work, did promote in the long run the prosperity of the Irish peasant; but violent crime continued, culminating in the murder on May 6, 1882. of Gladstone's close friend and nephew-in-law Lord Frederick Cavendish, who had just been sent to Dublin as chief secretary in the hope that a settlement could be reached. No alternatives were left to strong police powers in Ireland and measures to restrict the freedom of Irish members to obstruct the work of the commons; Gladstone hated both, but had to sanction them.

A third imperial inbroglio came to overshadow the other two, when a series of unavoidable decisions compelled the cabinet to authorize the occupation of Egypt in 1882. Gladstone's settlement of the Egyptian debt question (1885) was honourable to his belief in the concert of Europe, but had the unintended effect of tying British foreign policy to German. The worst mistakes he ever made were to allow Gen. C. G. Gordon (*q.v.*), whom he never met, to go to Khartoum, and then to fail to rescue him; Gordon was killed in Jan. 1885. This cost Gladstone much in popularity. Firm handling of a dispute with Russia over the northern borders of Afghanistan did something to restore his prestige; but when the government was defeated on the budget in June 1885 he was glad to resign. He refused a -gracefully worded offer of an earldom from the queen.

Irish Home Rule.—Though he had only spent three weeks in Ireland in his life (in 1877), Gladstone had historical insight and imaginative sympathy enough to appreciate the full force of Irish nationalism. For many years he had looked favourably on the case for Irish home rule, that is, for a subordinate parliament in Dublin. as his close colleagues knew. In the autumn of 1885 he believed the time for it was ripe; but as a combination of Irish with Conservative votes had defeated him in June, he waited silently to see what an Irish-Conservative combination would produce. Before the general election of Nov.–Dec. 1885 the radical leader Joseph Chamberlain (*q.v.*), whom Gladstone never much liked or understood at all, secured the allegiance of enough of the new voters in the countryside for his "unauthorized program" to produce a paradoxical result: in the new parliament the Liberal M.P.'s exactly equalled the total of Conservatives plus Irish. At this moment an indiscretion by Gladstone's youngest son revealed his father's conversion to home rule, and most Conservatives therefore turned against it. Lord Salisbury's government was defeated when parliament'met, and Gladstone formed his third cabinet in Feb. 1886. His Home Rule bill was rejected in parliament in June by a large secession of Whigs under Lord Frederick Cavendish's brother Lord Hartington (later duke of Devonshire, see DEVONSHIRE. SPENCER COMPTON CAVENDISH, 8TH DUKE OF), and in the country at a general election in July, and Gladstone resigned office.

He had kept his Midlothian seat, unopposed, and carried with him into the neu parliament a personal following 190 strong, supported by the National Liberal federation, the most powerful political machine in the country. He devoted the next six years to an effort to convince the British electorate that to grant home rule to the Irish nation would be an act of justice and wisdom. This policy was abhorrent to the English upper classes, and for the first time a marked class division between the parties opened. At the jubilee of 1887 Gladstone was cheered from the pavements, but hissed from the balconies. The act was symbolic of the position he had now reached, of the great popular hero of the age. His reputation stood higher with Scotsmen, Irishmen and Welshmen than with Englishmen, except for the English nonconformists, to whom his tendency to regard and describe great political questions as moral ones made a strong appeal; portraits of him were far commoner in poor men's cottages than those of any other political leader. He spoke at many great meetings, and co-operated with the Irish leader C. S. Parnell (*q.v.*). But his judgment did not improve as he got older; and in 1890, when he was over 80, momentary excitement led him into a dangerous quarrel with Parnell about the political consequences of the O'Shea divorce. (Gladstone had never believed the rumours about Parnell's liaison, holding that Parnell would never "imperil the future of Ireland for an adulterous intrigue.") He never sought to correct the errors about him which Parnell spread in Ireland. He sanctioned an extensive program of Liberal reforms drawn up at Newcastle in 1891, because it was headed by home rule; and on this platform the Liberals won in the general election of 1892 a majority of 40—if the Irish voted with them.

Gladstone, an "old, wild, and incomprehensible man of 82½," as the queen called him in a letter at the time, formed his fourth cabinet in Aug. 1892. Its members were only held together by awe of him. In 1893 he piloted another Home Rule bill through 85 sittings of the commons; the lords rejected it on Devonshire's motion by the largest majority ever recorded there, 419–41, but the full discussion in the commons brought Ireland eventual benefit. The cabinet rejected Gladstone's proposal to dissolve.

He could not agree with his colleagues that a large increase in the naval estimates mas necessary, and finally resigned—ostensibly because sight and hearing were failing—on March 3, 1894. He was much mortified by the coolness of his last official interview with the queen he had served loyally all her reign; by now she frankly detested him, and had to struggle to conceal the fact in his presence. He retired to Hawarden, and busied himself with a critical edition of the works of Bishop Joseph Butler (2 vol.; Oxford, 1896), whom he used to name with Homer, Aristotle and Dante as his "four great teachers" besides the Gospels. Humanitarian to the end, in his last great speech, at Liverpool in Sept. 1896, he denounced Turkish atrocities in Armenia. After a painful illness, he died of cancer of the palate at Hawarden on May 19, 1898. His body lay in state in Westminster hall for three days, and was buried in Westminster abbey.

Character.—As a young man Gladstone was handsome. As he grew older his face grew more formidable, with deep lines from beside the nostrils to the corners of the mouth, and was much wrinkled in old age. His spare and upright figure, well proportioned. was just below the middle height. His voice was clear, deep and sonorous. with a touch of Lancashire accent; and none who saw it soon forgot the flash of his dark eyes.

His truly extraordinary vigour far exceeded that of other men, and was coupled with no less extraordinary powers of self-control and an iron devotion to duty. Training and natural ability led him to qualify statements and subdivide arguments; his thoughts indeed were often complicated. but his character was fundamentally simple. It was a simple sense of duty that took him into politics, a career in which he never felt really at home and for which he was in some ways unfitted, not least by his tendency to believe that other men's motives were invariably as disinterested as his own, and by his excessive anxiety to maintain the consistency of his own conduct. Political courage and personal magnanimity he had in abundance; and he was the most efficient administrator of his age. His gift for concentration was remarkable; this helped people who did not know him well to think him hard or even hypocritical. But no one who knew him intimately doubted his entire sincerity, or failed to be captivated by his delightful manners, the warmth of his human sympathies and the range of his mind. He was combative by instinct, and combined a magical quickness of apprehension with an unusually retentive memory and an inexhaustible fund of phrase; these qualities made him a fearsome adversary in debate. In his prepared speeches he-was able to communicate to his hearers a full sense of the significance of the subject he was discussing, and of their responsibility for seeing that it was decided aright. Purely as an orator, he had two or three equals in his own day; as a statesman, only Peel came near him. A few British prime ministers—Walpole, Chatham, Pitt, Churchill—have been leaders as great; none has been more inspiring. Lord Acton, indeed, assessing for Gladstone's daughter in 1879 her father's standing among the world's statesmen of the past two centuries, concluded that "in the three elements of greatness combined—the man, the power, and the result—character, genius. and success—none reached his level."

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Among the British Museum Additional Manuscripts are 750 volumes of Gladstone papers which await full research. A little of his correspondence has been published: selected *Correspondence on Church and Religion,* ed. by D. C. Lathbury, 2 vol. (London, 1910); *Gladstone and Palnzerston* (London, New York, 1928) and *The Queen and Mr. Gladstone,* 2 vol. (London, 1933; New York, 1934), both ed. by P. Guedalla; *Gladstone to His Wife, a* selection, ed. by A. Tilney Bassett (London, Toronto, 1936); *The Gladstone-Granville Political Correspondence, 1868–1876,* ed. by Agatha Ramm, 2 vol. (London, 1952). He made two selections himself from his numerous articles in magazines: *Gleaning of Past Years,* 7 vol. (London, 1879) and *Later Gleanings* (London, 1897). Of a projected edition of his *Speeches* by A. W. Hutton and H. J. Cohen only 2 vol. appeared (London, 1891, 1892). A. Tilney Bassett, *Gladstone's Speeches* (London, 1916) contains, besides the texts of 14 of his best speeches, complete lists of all of them and of all his publications. (M. R. D. F.)

GLAGOLITIC ALPHABET. According to tradition, when St. Cyril of Thessalonica undertook his mission to Moravia in the middle of the 9th century A.D., he invented an alphabet for his Slavonic translations of essential religious texts. This alphabet was, almost certainly, the Glagolitic, in which some of the earliest extant manuscripts of Old Church Slavonic are written. After the failure of the Moravian mission, it was quickly superseded among the Orthodox Slavs by the so-called Cyrillic alphabet, and it remained in use principally among those Catholic Croatians who persevered in their loyalty to the Slavonic liturgy. The name of the alphabet is. in fact. probably derived from the Old Church Slavonic *glagola* "(he) said," which would be frequently heard in the chanting of the liturgical Gospels. The origin of the individual letters cannot be said to be well established: despite several, often conflicting, attempts to derive them from contemporary Greek forms or from oriental sources that would have been familiar to such an accomplished linguist as St. Cyril. See ALPHABET.

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GLAISHER, JAMES (1809–1903), English meteorologist and aeronaut. was born in London on April 7, 1809. After serving for a few years on the ordnance survey of Ireland, he acted as an assistant at the Cambridge and Greenwich observatories successively, and when the department of meteorology and magnetism was formed at the latter. he was entrusted with its superintendence. which he continued to exercise for 34 years. until his retirement from the public service. In 1845 he published his well-known dew point tables. which have gone through many editions. In 1850 he established the Meteorological society, acting as its secretary for many years. and in 1866 he assisted in the foundation of the Aeronautical Society of Great Britain. He made a series of balloon ascents between 1862 and 1866, mostly in company with Henry Tracey Coxwell. with the object of carrying out observations on the temperature, humidity, etc., of the atmosphere at high elevations. He died on Feb. 7, 1903, at Croydon.

GLAMIS, a village and civil parish in Angus (Forfarshire), Scotland, 5 mi. S.W. of Forfar. Pop. (1951) 876. The name (pronounced Glaams) is derived from the Gaelic, *glamhus*, "a wide gap," "a vale." In the village is a sculptured stone! supposed to be a memorial of Malcolm II, although Fordun's statement that the king was slain in the castle is now rejected.

Glamis castle. the seat of the earl of Strathmore and Kinghorne, is a fine example of the Scottish baronial style, enriched with certain features of the French chbteau. In its present form it dates mostly from the 17th century, but the original structure was as old as the 11th century, for Macbeth was thane of Glamis. Robert II bestowed the thanedom on John Lyon, who had married the king's second daughter by Elizabeth Mure and was thus the founder of the existing family. Patrick Lyon became hostage to England for James I in 1424. When, in 1537, Janet Douglas, widow of the 6th Lord Glamis, was burned at Edinburgh as a witch, for conspiring to procure James V's death. Glamis was forfeited to the crown, but it was restored to her son six years later when her innocence had been established. The 3rd earl of Strathmore entertained the Old Pretender in 171j and fell on the battlefield at Sheriffmuir. Sir Walter Scott spent a night in the "hoary old pile" when he was about twenty years old, and gives a striking relation of his experiences in his *Letters* on *Demonology and Witchcraft*. The castle was the early home of Lady Elizabeth Bowes-Lyon, who became consort to King George VI. In 1930 it was the birthplace of Princess Margaret Rose, the first royal babe to be born in Scotland for 300 years.

GLAMORGAN (Welsh *Morgannwg;* the name Glamorgan is a corruption of the Welsh Gwlad Morgan. meaning the terrain of Morgan, a 10th-century Welsh prince). A county of southern Wales bounded northwest by Carmarthenshire; north by Carmarthenshire and Breconshire, east by Monmouthshire and south and southwest by the Bristol channel and Carmarthen bay. Area 817.j sq.mi. Economically it is the most important of the Welsh counties containing Cardiff. the capital of Wales. and Swansea, the second biggest town. It is the most densely populated of the Welsh counties. Structurally and physically it may be considered in two sections: (1) the northern upland section of barren moorland, part of the south Wales coal field; (2) the rural southern section including the vale of Glamorgan and the Gower peninsula.

The body of the county forms a sort of quarter circle between the rivers Taff and Neath. Near the apex of the angle formed by these rivers is the loftiest peak in the county, the great Pennant scarp of Craig y Llyn or Cam Moesyn (1,969 ft.). To the south and southeast extends a great coal field. its surface forming an irregular plateau with an average elevation of 600 to 1,200 ft., but with numerous peaks about 1.500 ft. or more, Mynydd y Caerau being 1,823 ft. Out of this plateau have been carved, to the depth of 500 to 800 ft. below its general level, three distinct series of narrow valleys, those in each series being more or less parallel. The Cynon, the Great and Lesser Rhondda (tributaries of the Taff) and the Ely flow to the southeast, the Ogwr or Ogmore (with its tributaries the Garw and Llynfi) flow south through Bridgend, and the Avon brings the waters of the Corwg and Gwynfi to the southwest into Swansea bay at Aberavon. To the east of this high ground and divided from it by a spur of the Brecknock mountains culminating in Carn Bugail (1,570 ft.) is the Rhymney, which forms the county's eastern boundary. On the west other spurs of the Beacons divide the Neath from the Tawe and the Tawe from the Loughor. which, with its tributary the Amman, separates the county on the northwest from Carmarthenshire. The rivers are all comparatively short, the Taff, the chief river, being only 40 mi. long.

To the south of this central hill country. which is wet, cold and sterile, and whose slopes form the coal field's southern edge, there stretches out to the sea the undulating plain known as the vale of Glamorgan, rising in places to more than 400 ft. The floor of the vale is of New Red Sandstone and Lias. On the faces of the almost perpendicular coastal cliffs can be seen the beds of coloured rocks lying nearly horizontally—red and green marls, black shales and blue and yellow limestones. Stretching westward from Swansea is the Gower peninsula of folded Old Red Sandstone and Carboniferous rocks. Cefn-y-Bryn, an anticline of Old Red Sandstone, forms its prominent backbone. The peninsula is a low plateau with some hills rising to 600 ft. Most of the southern part is of Mountain Limestone covered inland by boulder clay. The limestone cliffs are of great beauty. The National Trust owned 171 ac. of the Gower peninsula in 1954.

After the coal measures forming the north of the county had been deposited the southern part was subjected to powerful folding; the resulting anticlines were worn down, and then submerged slowly beneath a Triassic lake in which accumulated the Keuper conglomerates and marls which spread over the district west of Cardiff and are traceable on the coast of Gower. The succeeding Rhaetic and Lias of the coastal plain (the fertile vale of Glamorgan) from Penarth to near Bridgend were laid down by the Jurassic sea. A well-marked raised beach is traceable in Gower. Sand dunes are present locally around Swansea bay, and between the rivers Ogmore and Neath where Kenfig town lies buried. Moraines, chiefly formed of gravel and clay, occupy many of the Glamorgan valleys. and are glacial in origin.

Between the vale and the coal field is a succession of ridges of Old Red Sandstone, Mountain Limestone and gray-green Pennant Sandstones. The uplands of the coal field are of Pennant Sandstone and are bleak, barren moorland. In each of the narrow valleys between run river, railway and road. On either side of the road is a continuous line of gray houses, works, etc., mostly erected in the 19th century. The churches belonging to the old villages are upon the moorland near the ancient trackways.

Early Settlement.—The earliest known traces of man within the county are the remains found in the caves of the south coast of Gower (*q.v.*). These are of Palaeolithic date. Many flint implements have been found on the south coast particularly at the mouth of the Ogmore river. There are many cairns and tumuli on the hills of the north such as those on Garth mountain near Cardiff, Crug-yr-avan and a number east of the Tawe. There is little evidence of a strong Megalithic culture, although there is a well-preserved stone circle at Carn Llecharth near Pontardawe, and fine dolmens at Cefn Bryn in Gomer and at St. Nicholas and St. Lythan's, near Cardiff. Several prehistoric beaker pots have been found in the vale of Glamorgan and the valley ways, especially that of the Taff, have yielded socketed axes of the late Bronze Age. Important sites on the coast and along the inland valleys are guarded by indigenous hilltop forts occupied probably in Romano-British times. In Roman times the country from the Neath to the Wye was occupied by the Silures. a mixture of peoples dominating the moorlands of south Wales. There are Ogham stones at Loughor and Kenfig. The conquest of the Silures by the Romans began about A.D. 50 by Ostorius Scapula and was continued by Sextus Iulius Frontinus. The important station of Gaer on the Usk near Becon was connected by two branch roads, one running from Cardiff through Gelligaer (where there was a strong hill fort) and Penydarren, and another from Neath through Coelbren. An important Roman road ran along the vale from Caerleon through Cardiff to Neath (Nidum).

Glamorgan was an important centre of Celtic Christianity. Llandaff is associated with St. Dubricius and St. Teilo (6th century). To this period also belongs the establishment of the great monastic settlements of Llancarfan, Llandough and Llantwit Major (Llanilltyd Fawr). After the withdrawal of the Romans, the coasts were raided by Saxons. The Scandinavians who came in the 9th and succeeding centuries left more abundant traces both in the place names of the coastal areas and in such camps as that on Sully Island, the Bulwarks at Porthkerry and Hardings Down in Gower. Mean hile the native tribes had been reorganized into a principality known as Glywyssing, till about the end of the 10th century when it acquired the name of Morgannwg (the territory oi Morgan, a prince who died in A.D. 980). Morgannwg was then the whole country from the Neath to the Wye.

The Norman conquest was effected at the end of the 11th century by Robert Fitz Hamon, lord of Gloucester who, in 1080, began the building of Cardiff castle. His followers settled in the vale, which became known as the "body" of the shire, while in the hill country the Welsh retained their customary laws and much of their independence. Glamorgan, whose bounds were contracted between the Neath and the Rhymney, then became a lordship marcher, its status and organization being that of a county palatine. Cardiff, the caput *baroniae,* was granted municipal privileges, and in time Cowbridge, Kenfig, Llantrisant, Aberavon and Neath also became chartered market towns. The manorial system was introduced throughout the vale, the manor often becoming the parish. The religious houses included the Cistercian abbeys of Neath and Margam founded in 1129 and 1147, respectively, the Benedictine priory of Ewenny (1141) and that of Cardiff (1147). Dominican and Franciscan houses were also iounded at Cardiff in the following century. Gower (with Kilvey) had a separate history (see GOWER).

For the first two centuries after Fitz Hamon's time the lordship of Glamorgan was held by the earls of Gloucester, the first earl being Fitz Hamon's son-in-law. The lordship passed by descent through the families of De Clare (who held it from 1217 to 1317), Despenser, Beauchamp and Neville to Richard III. on whose fall it escheated to the crown. Raids from the hills were frequent. Cardiff castle was seized by the Welsh about 1153 and Caerphilly castle was built to keep them in check, but this provoked an invasion in 1270 by Llywelyn ap Gruffydd, who besieged the castle. In 1294 Morgan led a rebellion against Edward I and in 1316 Llewelyn Bren (Llywelyn ap Rhys) again besieged Caerphilly castle and in 1317 was hung, drawn and quartered in Cardiff castle. In 1404 Owen Glendower (Owain Glyn Dwr) swept through the county, burning Cardiff and carrying all before him. By the Act of Union of 1536 the county of Glamorgan was incorporated as it now exists, by the addition to the old county oi the lordship of Gower and Kilvey, west of the Neath. The lordship of Glamorgan, shorn of its quasi-regal status. was granted by Edward VI to William Herbert, afterwards 1st earl of Pembroke, from whom it has descended to the present marquess of Bute. (See CARDIFF.)

The rule of the Tudors promoted the rapid assimilation of the inhabitants of the county, and by the reign of Elizabeth I even the descendants of the Norman knights had largely become Welsh both in speech and sentiment.

In common with the rest of Wales the county was mainly royalist in the Civil War, but later dissatisfaction made it declare for parliament. A subsequent royalist revolt in Glamorgan in 1648 was crushed by Colonel Horton at the battle of St. Fagan's.

Industrial Development. — Down to the middle of the 18th century the county had no industry of importance except agriculture. The coal which underlies practically the whole surface except the vale of Glamorgan and west Gower was little worked till about 1755, when it began to be used instead oi charcoal for the smelting of iron. The iron works were mostly on the northern outcrop of the coal field and by 1811 there were 25 blast furnaces in the county, among them those of Aberdare. Dowlais and Merthyr Tydfil. Down to about 1850 the chief collieries were owned by the ironmasters and were worked for their own requirements. When, in the district north of Cardiff. the suitability of the lower seams for steam purposes was realized, an export trade sprang up and soon assumed enormous proportions. The port of Cardiff (including Barry and Penarth). from which the bulk of the steam coal was shipped, became the first port in the world for the shipment of coal. This remarkable development coincided with the ever increasing demand for railway construction, steamships and navies, but resulted in an absence of by-product industries in the area. In the southwest of the county the triangle formed by Port Talbot, Ystalyfera and Loughor concentrated on the metallurgical industries which focused on Swansea. "the metallurgical capital of Wales." The manufacture of iron and steel was carried on at Dowlais. Ebbw Vale, Merthyr Tydfil and at Port Talbot, Briton Ferry, Pontardawe and other places. During the last quarter of the 19th century the use of the native ironstone was almost wholly given up and the necessary ore was imported. The tinplate industry centred in the Swansea-Llanelly area, though the oldest works in the county are at Melin Griffith near Cardiff. Copper smelting was carried on in the west of the county, at Port Talbot, Cwmavon, Neath and Swansea, and to a smaller extent at Cardiff, the earliest works having been established at Neath in 1584 and at Swansea (*q.v.*) in 1717. There are nickel works at Clydach near Swansea. Swansea has almost a monopoly of the manufacture of spelter or zinc, and lead, silver and other metals or their by-products are treated in or near the town. The development of the anthracite coal field lying to the north and west of Swansea (from which port it is mostly shipped) dates mainly from the closing years of the 19th century.

After World War I there was a big drop in the demand for south Wales steam coal both at home and abroad. (See WALES.) This was due to the increase in the number of modernized power plants using small'coal, and the loss of export markets and of the admiralty coal contract (because of the conversion of naval ships from coal to oil fuel). The result was the serious depression of the 1930s during which many collieries and steel works became derelict. A small area west of Port Talbot suffered considerably less, since it dealt mainly with anthracite coal, for which there was a consistent demand, and it also contained other industries. The coal region was, therefore, scheduled for attention under the Special Areas (Development and Improvement) act of Dec. 1934. The main object of the act was not to organize relief works. but to assist the economic recovery of the areas by attracting new industries to them. A survey of the natural resources and public services in south Wales was completed in 1937 and by the end of 1938 several new establishments had been brought to Glamorgan and other coal areas.

After World War II the industries of Wales were further diversified through the agency of the Distribution of Industries act. By 1954 there were 137,000 people in regular work in new iactories and extensions to factories established after 1937 and the bulk of these were in Glamorgan. Four leading Welsh firms pooled resources and plans to form the Steel Company of Wales which modernized the Welsh tin-plate industry by the establishment of a strip-mill plant at Port Talbot, with complementary cold reduction plants at Trostre near Llanelly and Velindre near Swansea. In Nov. 1953 the Port Talbot plant was in full production employing more than 8,000 men and turning out 3,500 tons of rails and 22,800 tons of steel strip and plate weekly. The National Coal board's long-term development plan in the south Wales coal field included schemes in several Glamorgan valleys.

Agriculture and Fisheries. — Regarded largely as an industrial county, Glamorgan still has an extensive agricultural character. In 1953 there were some 125,000 ac. under rough grazing and 205,000 ac. under crops and grass covering 63% of the total area. The county is roughly divided into two-thirds hill and mountain area and one-third lowland. The hill districts produce mutton, lamb, wool, store cattle and milk.

There were between 4,000 and 5,000 farms in 1953, of which 2,200 were milk producers. Even hill farms naturally suited only for sheep and store cattle produced milk for the densely populated mining valleys—a ready-made market on their doorsteps. The average size of farms is between 60 and 70 ac. with the largest more than 500 ac. In the main they are family concerns with one or two workers to help. In Oct. 1953 there were 3,300 regular and 1,500 casual workers on the land—600 more than in 1939.

The vale of Glamorgan, celebrated down the ages for its high natural fertility, now has a big milk yield as well as high wheat, cattle and sheep production. Since the beginning of World War II notable features of farming in the Gower peninsula have been the high proportion of early potatoes and vegetables and the cultivation of flowers. The progress of agriculture in Glamorgan after World War II is illustrated by these comparative figures (1953, 1939 in parenthesis): total tillage and grass, 40,000 ac. (18,500); total cattle, 78,000 (69,000); sheep, 296,000 (364,000); pigs, 27,000 (20,000); poultry, 350,000 (348,000); horses, 5,500 (12,000).

Forestry developments in the county are increasingly yielding pit props for the south Wales coal field.

Two of the three Welsh fishery centres are in Glamorgan—Cardiff and Swansea. In 1953 Swansea had 11 trawlers and Cardiff had 10. Hake is the main catch but other wet fish and shellfish are also important.

Communications.—The physical features of the county are well suited for communication purposes. The coal trains could run easily from the high ground of the coal field to the vale and thence to the coal exporting ports on the coast, the uphill return journey being done with empty cars. Thus a large number of small private lines ran down from the coal valleys focusing on Cardiff, Barry, Port Talbot and Swansea, which are well supplied with dock accommodation. Gradually the small railway lines became amalgamated and after 1923 they were all run by the Great Western railway. Since 1946 they have been absorbed into the Western Region of the nationalized British railways. The main line, between the highland and the sea, serves Cardiff, Bridgend, Port Talbot, Neath, Swansea and Loughor.

The number of passengers who travelled by air from Cardiff to the west of England in 1953 was 11,000. Between 1948 and 1954 regular services were established between Cardiff and the Channel Islands, Paris, Dublin and Liverpool.

Population and Administration.—The rapid rise of population with the development of its industries and coal mining was one of the most remarkable features in the social-economic life of Glamorgan during the 19th century. In the three decades between 1831 and 1861 the population increased 35.2%, 35.4% and 37.1% respectively, and from 1881–91, 34.4%. In 1901 the population stood at 859,931. In 1931 it was 1,229,065 and in 1951 it was 1,202,581, a decrease of 2.2%. The area of the administrative county with associated county boroughs is 817.6 sq.mi.; that of the administrative county alone is 732.5 sq.mi. The county is divided into seven parliamentary divisions, Aberavon, Barry, Caerphilly, Gower, Neath, Ogmore and Pontypridd, each returning one member. In addition there are three members for Cardiff, two each for Swansea and Rhondda, and one each for Aberdare and Merthyr Tydfil. There are three county boroughs: Cardiff (a city), Merthyr Tydfil and Swansea; five municipal boroughs: Barry, Cowbridge, Neath, Port Talbot and Rhondda; 12 urban districts and seven rural districts.

Glamorgan is in the Wales and Chester circuit, and assizes are held at Cardiff and Swansea alternately. All three county boroughs are quarter sessions boroughs and have their own commissions of the peace and police forces. Two of the municipal boroughs—Neath and Port Talbot—also have their own commissions of the peace. The county is in the dioceses of Llandaff and Swansea and Brecon.

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GLANDERS

GLANDERS or Farcy is primarily a specific infectious and contagious disease of solipeds (the horse, ass and mule). Secondarily, man may become infected through contact with diseased animals or by inoculation while handling diseased tissues and making laboratory cultures of the causal bacillus. As a disease of solipeds, glanders was recognized at an early period. In 425 B.C. it was mentioned by Hippocrates in his writings. In 1797 Erill Viborg, a Danish veterinarian, first published a systematic description of glanders and farcy. He rightly described them as one and the same disease, capable of being transmitted by contact. In 1882 Friedrich Loffler and Johann Schiitz in Germany isolated and identified the causal agent, which they named the *Bacillus mallei*, now designated technically as the *Pfeifferella mallei* or *Malleomyces mallei*. Ordinarily, it is spoken of as the glanders bacillus and described as a gram-negative bacterium, non-spore forming and nonmotile, growing readily in laboratory culture media. In the affected animal, the bacillus is present in the nasal discharges, secretions from pustules and ulcers on the skin and from diseased nodules in the lungs, bronchial and submaxillary lymph glands.

The infection can be disseminated through the medium of both clinical and nonclinical (latent) cases. Close contact between the affected and nonaffected always results in an increasing spread of the disease. Natural infection may take place through one of the following channels: by ingestion into the digestive tract through the consumption of infection—contaminated feed or water; by inoculation through slight abrasions of the skin or mucous membrane, or by inhalation into the respiratory tract. After infection, the disease usually follows a chronic course with a variable period of incubation extending from several weeks to several months. Horses which are kept closely stabled and worked hard or debilitated usually develop clinical symptoms in a shorter period than those kept outdoors on open range. The period of incubation appears to be relatively shorter in the mule and donkey.

Clinical cases are manifested either by a chronic nasal discharge from one or both nostrils, with or without visible ulceration of the nasal septum; chronic enlargement and induration of the submaxillary lymph glands without outward suppuration or the presence of pustules and ulcers (farcy buds) on the skin of the hindlegs or other parts of the body. Nonclinical or latent cases are essentially pulmonary in type and the lesions remain in a concealed state (occult) in the lungs as tubercle-like nodules and suppurating foci. In many latent cases, the affected animal shows slight signs of lung trouble (altered breathing). These occult cases frequently spread infection through the respiratory secretions for a variable period of weeks or months before showing clinical symptoms and can be detected only by the use of the mallein test. The agent used for this test is an extract or toxin produced from pure cultures of the bacillus, and its use as a diagnostic agent for glanders was first demonstrated in 1891 by O. Kalning and C. Helman in Russia and by Leonard Pearson in the U.S. There are three recognized types of mallein test: (1) the subcutaneous mallein test, a hypodermic injection of mallein under the skin on the side of the neck, which in from 10 to 12 hr. produces a definite rise in temperature (thermal reaction) and a distinct painful swelling at the site of injection; (2) the ophthalmic mallein test, in which the mallein is placed in the fornix of the eye and the reaction is manifested in from 6 to 12 hr. by the development of a purulent discharge from the eye; (3) the palpebral intradermic mallein test in which the mallein is injected into the loose fold of skin below the margin of the lower eyelid and the reaction is manifested in from 24 to 48 hr. by marked swelling of the eyelid and a muco-purulent discharge from the eye. In addition to these allergic mallein tests, several laboratory methods can be used, especially in the diagnosis of human glanders: the agglutination, precipitin and complement-fixation tests and laboratory culture examinations.

The post-mortem appearances of glanders comprise one or more of the following gross lesions: skin lesions, consisting of nodules, pustules and ulcers especially of the hindlegs; respiratory lesions, consisting of nodules and ulcers on the nasal septum, turbinated bones, larynx and trachea; pulmonary lesions consisting of tuberclelike nodules embedded in the lungs; lymphatic lesions, involving the submaxillary, bronchial and inguinal lymph glands. Lesions also may occasionally be found in some of the body glands such as the liver. spleen and kidney. The treatment of glanders in animals is not recognized as a cure for the disease.

The only effective policy for the control and suppression of the disease is compulsory notification of all cases, slaughter of all reactors to the mallein test and proper cleaning and disinfection of the affected premises. Under this policy, glanders was completely eradicated in the U.S., Great Britain and Canada. The disease is still known to prevail in some parts of Europe, Asia and Africa.

Glanders in Man.—While glanders as a disease of solipeds was recognized and referred to from an early period (by Hippocrates), no specific description of it as a disease of man was definitely recorded until the year 1830. Since then, many cases of glanders in man have been reported. In 1900 Otto von Bollinger in Germany published an account covering 120 cases. In 1906 George D. Robins in Canada published a report of 156 cases. In 1908 William Hunting in England reported 10 cases which he observed personally. Following World War I (1914–18), the incidence of human glanders in Russia was appallingly high for a time. because of lack of control over the disease in horses.

Glanders most frequently occurs in man through occupational contact with diseased horses, from making an autopsy on a diseased animal or from making laboratory cultures of the *Bacillus* mallei. In man, the period of incubation averages from one to five days. The onset and manifestations of the disease are fairly typical. Within a few days following infection. constitutional disturbances develop manifested by fever, malaise, fatigue. loss of appetite. jaundice, nausea, headache and rheumatic pains. More definite signs develop rapidly in the form of an erysipelaslike swelling of the face and the limbs or a painful nodular eruption which is soon followed by a general pustular eruption. There is also nasal involvement accompanied by a purulent nasal discharge and ulceration of the septum. The final stage of the disease is characterized by profuse suppurating pustules covering the body, intramuscular abscesses. pneumonia, diarrhoea, emaciation and fatal collapse.

The average duration of acute cases is from two to four weeks. In chronic cases, the symptoms are quite similar in character but are prolonged over a period of several months. The treatment of human glanders has included the use of many drugs, largely tonic and palliative. combined with surgical treatment. In selected 'cases, the use of sulfadiazine and other sulfapyrimidines might be indicated. Favourable results nere reported in several cases following the use of serum from hyperimmunized horses. The prevention of glanders in man depends essentially on the eradication of the disease in horses, asses and mules. (C. D. Mc.)

GLANDS. Glands are structures which secrete fluids They are classified according to their mode of secretion, the nature of the secretion, the behaviour of the secretory gland cell and the organization of the gland. The mode of secretion may be toward the outside of the body (exocrine) or toward the blood and lymph vessels (endocrine). The secretion may be characterized as cellular (as in the testis) or noncellular (prostate, thyroid or salivary glands).

During secretion, the gland cells produce their characteristic secretions either through cellular activity without any direct contribution of the protoplasm (merocrine type, as in salivary glands) or through cellular disintegration (holocrine type. as in sebaceous glands, or apocrine type, as in mammary glands). The gland may be composed of a single cell or of a simple or complex organization of cells.

Anatomy.—The unicellular glands in mammals are limited entirely to goblet cells. These secrete mucous, a Iubricating fluid widely distributed especially in the intestinal tract. The multicellular glands consist of four components: (1) secretory gland cells; (2) ducts which convey the secretory product from the gland cells to an external surface; (3) connective tissue elements which provide a framework to maintain the preceding two elements; and (4) blood vessels, lymphatics and nerves which supply the nutrients and raw materials of the secretion, carry away the waste products, and in some places control the activity of the gland cells and blood vessels. All four parts are intimately interwoven anatomically and integrated functionally.

The gland cells may be arranged as a folded sheet (as in the choroid plexuses of the brain). They may be arranged as punched out projections, generally toward the connective tissue framework. These projections may be simple (as in intestinal glands) or branched (as in gastric glands), and each is further subclassified according to whether the projection is tubular (as in the intestine), coiled (as in sweat glands). or acinar or grapelike in shape (as in the sebaceous glands of the skin). In the simple glands. each secretory projection pours out its secretion directly into an unbranched duct. In the compound glands, the ducts are branched and the secretion passes from the secretory portion to a series of progressively larger ducts which finally empty on to an outer surface (as in salivary glands, pancreas, liver).

All compound glands are enclosed in connective tissue capsules. The glands are partly broken up into grossly visible lobes (as the liver, which has five lobes) in relation to major branchings of the duct system. These are further partly separated into smaller units, the lobules, which are also visible with the naked eye. These are in turn further divided into inicrolobules which are visible only with the microscope. All four components of glands (secretory, ductular, connective, and vascular and neural) consist of cells and a cellular cement or binding substance. Embedded in the latter only in the connective tissue are microscopically visible fibres In the connective tissue the cement substance with its fibres is the most prominent feature, the cells being sparse. In the other three gland components, the cells are most conspicuous, the cement substance being small in amount.

Histology.—As stated above, there are four components of glands. secretory portion (whence the secretion originates), the duct system (which conducts the secretion to a surface), the connective tissue (which is the sustaining framework of the gland) and the blood vessels and nerves. The last two components are present in all glands and differ in their microscopic structure in no essential way from their counterparts in nonglandular organs. The ducts may be absent from certain glands in later embryos and foetuses and in adult life. Such organs are endocrine and secrete directly into the circulating blood. Some endocrine glands (the islands of Langerhans of the pancreas, producing insulin) frequently retain a relationship to ducts; the secretion is nevertheless passed directly into the blood just as in other endocrine glands.

There are certain glands which have no ducts which are not endocrine. Their secretion passes directly onto the surface of the organ (as for example. goblet cells. choroid plexus). The ducts are all of the nature of cylinders whose malls consist of cells. These may occur as a single layer of cells which may be flat (as in intercalary ductuli), cuboidal (as in the pancreas), columnar (as in the kidney); or they may be arranged in layers two or more cells thick (as in salivary glands).

It is possible that certain ducts not only conduct the secretion but also alter its composition. Gland cells, like others, consist of a cell membrane, the nucleus and the cytoplasm, including the ground substance, a basophilic substance (called chromophile), mitochondria and Golgi apparatus. In addition, the cytoplasm frequently contains specific granules, watery vacuoles and fat droplets.

The specific granules are believed to contain the specific protein in some form resembling that which is characteristic of the secretion.

Some gland cells show little or no detectable change in structure whether they are secreting or not. Others, both exocrine and endocrine, pass through cyclic morphological changes during strong secretion and then revert to the normal or relatively inactive state. These include: reduction in the number of specific granules. increase in the number of watery vacuoles, increased prominence of the chromophile substance, increased number and size of the mitochdndria, and hypertrophy of the Golgi apparatus. In addition, the nucleus increases in volume with an apparent decrease in stainability of the chromatin, an increase in size and stainability of the nucleolus and a displacement of the nucleus as a whole toward the secretory surface. The cell as a whole becomes smaller. All of these structures revert to normal in the absence of marked secretory activity.

Gland cells, like others, must be considered to be in a state of continual activity. Even "resting" cells are active, performing work in maintaining their integrity and internal organization, and in synthesizing and secreting their specific substances or secretions at minimum levels. *See* also ENDOCRINOLOGY; HORMONES.

(I. GH.)

GLANVILL (or GLANVIL), **JOSEPH** (1636–1680), English philosopher, was born at Plymouth and educated at Oxford. After the Restoration he was successively rector of Wimbush, Essex, vicar of Frome Selwood, Somersetshire, rector of Streat and Walton.

In 1666 he was appointed to the abbey church, Bath; in 1678 he became prebendary of Worcester cathedral, and acted as chaplain in ordinary to Charles II from 1672. He died at Bath on Nov. 4, 1680. Glanvill's first work (a passage in which suggested the theme of Matthew Arnold's *Scholar Gipsy), The Vanity of Dogmatizing,* etc. (1661), shows how philosophical scepticism might be employed as a bulwark for faith.

The endeavour to cognize the whole system of things by referring all events to their causes appears to him to be doomed to failure from the outset. We know isolated facts, but we cannot perceive any such connection between them as that the one should give rise to the other. In the words of Hume, "they seem conjoined but never connected." All causes then are merely the occasions on which the one first cause operates.

Glanvill rejected the scholasticism and Aristotelianism of his own university for the Platonism of Cambridge, writing in 1662 the *Lux Orientalis* which reproduced Henry More's theory of the pre-existence of the soul. In spite of his admission of the defects of our knowledge, Glanvill yielded to vulgar superstitions, and actually endeavoured to accredit them both in his revised edition of the *Vanity of Dogmatizing,* published as *Scepsis scientifica* (1665), and in his *Philosophical Considerations concerning the existence of Sorcerers and Sorcery* (1666). The latter work was based on the story of the drum alleged to have been heard every night in a house in Wiltshire (Tedworth, belonging to a Mr. Mompesson), a story which made much noise in the year 1663, and which is supposed to have furnished Addison with the idea of his comedy *The Drummer*. Glanvill's *Sadducismus Triumphatus,* printed posthumously in 1681, also defends witchcraft; but he supported a more honourable cause in his defense of the Royal society of London, as *Plus Ultra, or the Progress and Advancement of Science since the time of Aristotle* (1668), a work showing his empirical tendencies.

GLANVILLE (GLANVIL or GLANVILL), **RANULF DE** (d. 1190), chief justiciar of England and reputed author of the first classical text on the common law, was born at Stratford, Suffolk, date unknown. In 1180 Glanville, who had served as sheriff of Yorkshire and Lancashire, succeeded Richard de Lucy as chief justiciar. For the remainder of the reign of Henry II he was the king's principal adviser, and during the king's frequent absences was, in effect, viceroy of England. He was removed from office in 1189 by Richard I and imprisoned until, it is said, he paid a ransom of £15,000. He subsequently accompanied King Richard I on the third crusade, dying at Acre, in Palestine, in 1190.

Glanville, a man of great energy and versatile talent. was useful to Henry II in many ways, chiefly in the great legal changes that mark Henry's reign. The common law was greatly strengthened by the re-establishment of the *curia regis,* by the increased use of itinerant justices and ,by new remedies and improved methods of procedure, including the inquest, from which the right of trial by jury was ultimately developed.

Glanville is best known for the *Tractatus de legibus et consuetudinibus regni Angliae* ("Treatise on the Laws and Customs of the Kingdom of England"), the earliest of the classical texts on the common law. This treatise, attrlbuted to Glanville, but probably written by his nephew and secretary Hubert Walter (*q.v.*), was an accurate, lucid description of the procedure in the king's court. It was soon accepted as the authoritative statement of the law of the period and did much to establish and to extend the common law in competition with the canon and the feudal systems of law. Largely because of the *Tractatus* this period in the common law came to be known as the age of Glanville.

Written about 1188. the *Tractatus* was first printed in London in 1554. An annotated edition by George E. Woodbine was published in New Haven, Conn., in 1932. John Beames' English translation of 1812 was reprinted in Washington, D.C., in 1900, with an introduction by Joseph Henry Beale. *See* also ENGLISH *LAW;* COMMON LAW. (S. TT.)

GLAPTHORNE, HENRY (*c.* 1610–*c.* 1643), English poet and dramatist whose poetry resembles that of his "noble Friend and Gossip, Captaine Richard Lovelace," to whom he dedicated his poem, *Whitehall* (1643). He was presumably born in 1610 at Whittlesey, Cambridgeshire, where he was baptized on July 28 of that year. His plays included *Argalus and Parthenia* (1639), a pastoral tragedy, and *Albertus Wallenstein* (1639), his only attempt at historical tragedy. His plays, although undistinguished, contain isolated passages of merit. He also published *Poems* (1639), many in praise of an unidentified "Lucinda," and edited the *Poems Divine and Humane* of his friend Thomas Beedome (1641).

He was living in London in 1643 when he published an unofficial royalist pamphlet, but nothing further is known of him.

GLAREOLIDAE, a family (order Charadriiformes) of old world shore-inhabiting birds comprising the coursers and pratincoles (*q.v.*).

GLARUS, one of the Swiss cantons, the name being taken from that of its chief town. Its area is 264 sq.mi., of which 173.1 sq.mi. are classed as "productive" (forests covering 41 sq.mi.). It is composed of the upper valley of the Linth which rises in the glaciers of the Todi, 11,876 ft., and has carved out for itself a deep valley, with comparatively level floor, occupied by a number of villages.

Glacier passes lead from its head to the Grisons, also the rough footpath over the Kisten pass, but a carriage road over the Klausen pass gives access to the canton of Uri. The Sernf valley or Kleinthal, which joins the Linth at Schwanden, a little above Glarus itself, has a track leading to the Grisons over the Panixer pass and the Segnes pass. Just below Glarus town, another glen (coming from the southwest and leading by the Pragel pass to Schwyz) joins the main valley, and is watered by the Klön. It is separated from the main glen by Glarnisch (9,560 ft.), while the Sernf valley is similarly cut off from the Grossthal by the high ridge running northward from the Haus Stock (10,361 ft.) over the Karpfstock (9,167 ft.).

In the east the Riesetenpass leads to the valley of Weisstannen, and the Widersteinerfurkel leads to the Murgtal, both being valleys of the St. Galler Oberland. There is a sulfur spring at Stachelberg, near Linthal village, and an iron spring at Elm, while in the Sernf valley there are the Plattenberg slate quarries, and just south of Elm those of the Tschingelberg. A railway runs through the whole canton from north to south past Glarus to Linthal village, while from Schwanden there is an electric line (opened in 1905) up to Elm.

In 1950 the population of the canton was 37,663, five-sevenths of which were Protestants and two-sevenths Catholics, all German-speaking. The density per square mile was 142.7. After the capital, Glarus (*q.v.*), the largest villages are Nafels, Ennenda (opposite Glarus, of which it is practically a suburb), Netstal, Mollis and Linthal.

The slate industry existing since the beginning of the 17th century, the cotton spinning introduced in 1714, the cotton printing established in 1740 and the weaving are the most important manufactures. There is little agriculture, while the breeding of cattle is important, for it is a region of mountain pastures which can support thousands of cows. The canton produces green cheese made of skim milk, whether of goats or cows, mixed with buttermilk and coloured with powdered *Melilotus caerulea.* The curds are brought down from the huts on the pastures, and, after being mixed with the dried powder, are ground in a mill, then put into shapes and pressed. The canton forms a single administrative district and contains 28 communes. It sends representatives elected by the *landsgemeinde* to the federal *ständerat* and *nationalrat*. The canton still keeps its primitive democratic assembly or *landsgemeinde* (meeting annually in the open air at Glarus on the first Sunday in May), composed of all male citizens of 20 years of age or more. It acts as the sovereign body, so that no "referendum" is required, while any citizen can submit a proposal. It names the executive of 6 members, besides the *landammann* or president, all holding office for three years. The communes (forming 18 electoral circles) elect for three years the *landrat,* a standing committee of members in the proportion of 1 for every 500 inhabitants or fraction over 250. The constitution dates from 1887.

GLARUS (Fr. *Glaris),* the capital of the Swiss canton of the same name 42½ mi. S.E. by rail from Zürich, is on the left bank of the Linth at the northeastern foot of the Vorder Glarnisch (7,648 ft.); on the east rises the Schild (7,453 ft.). In May 1861 practically the whole town was destroyed by fire. Pop. (1960) 5,852, almost all German-speaking.

The DISTRICT OF GLARUS is said to have been converted to Christianity in the 6th century by the Irish monk, Fridolin, who was the founder of the Benedictine nunnery of Sackingen, on the Rhine between Constance and Basel, that about the 9th century became the owner of the district. The Habsburgs gradually drew to themselves the exercise of all the rights of the nuns, so that in 1352 Glarus joined the Swiss confederation, and gained complete freedom after the battle of Nafels (1388). Zwingli the Reformer was priest there 1506–16 and Glarus early adopted Protestantism, but there were many struggles between the two parties, and to secure peace it was arranged that, besides the common *landsgemeinde,* each party should have its separate *landsgemeinde* (1623) and tribunals (1683). The slate-quarrying industry appeared early in the 17th century, cotton spinning was introduced about 1714, and calico printing by 1750. In 1798; in consequence of the resistance of Glarus to the French invaders, the canton was united to other districts under the name of canton of the Linth. The old system of government was restored in 1814, but in 1836 by the new liberal constitution one *landsgemeinde* only was retained. Pop. (1960) 40,118.

GLAS, JOHN (1695–1773), Scottish minister, founder of the Glasite Church, was born at Auchtermuchty, Fife, where his father was parish minister, on Oct. 5, 1695. He became minister of Tealing, Dundee, and in 1725, in a letter to Francis Archibald, minister of Guthrie, Forfarshire, he repudiated the obligation of national covenants. In the same year his views found expression in the formation of a society "separate from the multitude" numbering nearly a hundred, and drawn from his own and neighbouring parishes. Its members pledged themselves to follow Glas's doctrine. From the scriptural doctrine of the essentially spiritual nature of the kingdom of Christ, Glas in his public teaching drew the conclusions: (1) that there is no warrant in the New Testament for a national church; (2) that the magistrate as such has no function in the church; (3) that national covenants are without scriptural grounds; (4) that the true Reformation cannot be carried out by political and secular weapons but by the word and spirit of Christ only. This argument is most fully exhibited in Glas's *The Testimony of the King of Martyrs* (1729).

Glas was summoned (1726) before his presbytery, and he was in 1728 suspended from the discharge of ministerial functions, and finally deposed in 1730. The members of his society for the most part continued to adhere to him, thus constituting the first "Glassite" or "Glasite" church. The seat of this congregation was shortly afterward transferred to Dundee (whence Glas subsequently removed to Edinburgh), where he officiated for some time as an "elder." He next laboured in Perth for a few years, where he was joined by Robert Sandeman (*see* GLASITES), who became his son-in-law, and eventually was recognized as the leader and principal exponent of Glas's views. Ultimately in 1730 Glas returned to Dundee, where the remainder of his life was spent.

In 1739 the general assembly removed the sentence of deposition which had been passed against Glas. He died in 1773.

A collected edition of his works was published at Edinburgh in 1761 (4 vol., 8vo), and again at Perth in 1782 (5 vol., 8vo). Glas's *True Discourse of Celsus* (1753), from Origen's reply to it, is a competent and learned piece of work. The *Testimony of the King of Martyrs concerning His Kingdom* (1729) is a classic repudiation of erastianism and defense of the spiritual autonomy of the church under Jesus Christ.

GLASER, DONALD ARTHUR (1926–), U.S. nuclear physicist who was awarded the 1960 Nobel prize in physics for his invention and subsequent development of a research instrument known as the bubble chamber (*q.v.*), was born in Cleveland, O., on Sept. 21, 1926. After graduating from Case Institute of Technology, Cleveland, in 1946. he attended California Institute of Technology, Pasadena, where he received his Ph.D. in physics in 1950, specializing in cosmic ray studies and nuclear physics. He conceived the idea for the bubble chamber while at the University of Michigan, where he taught from 1950 to 1959, when he joined the faculty of the University of California at Berkeley. Glaser, who at 34 was one of the youngest scientists ever to be awarded a Nobel prize, received a D.Sc. degree from Case institute in 1959.

GLASGOW, a city, county of a city, royal and parliamentary burgh and port, Lanarkshire, Scotland, situated on both banks of the Clyde 44 mi. W.S.W. of Edinburgh and 396½ mi. N.W. of London by road. Pop. (1961) 1,054,913. Area 60.4 sq.mi. The valley of the Clyde is closely confined by hills, and the city extends far over these. The commercial centre of Glasgow, with the majority of important public buildings, lies on the north bank of the river, which traverses the city from east-southeast to west-northwest, and is crossed by a number of bridges. The uppermost is Dalmarnock bridge, dating from 1891, and next below it is Rutherglen bridge, rebuilt in 1896, superseding a structure of 1775. Next comes King's bridge at Ballater street. St. Andrew's suspension bridge gives access to the Green to the inhabitants of Hutchesontown, a district which is approached also by Albert bridge, leading from the Saltmarket. Above this bridge is the tidal dam and weir. Victoria bridge (1856) took the place of a bridge erected by Bishop Rae in 1345, and demolished in 1847. Then follows the Portland street suspension bridge (1853) by which pedestrians from the south side obtain access to St. Enoch square and, finally, the bridge variously known as Glasgow, Jamaica street, or Broomielaw bridge (1835). Toward the close of the 19th century it was reconstructed and reopened in 1899, but because of its inadequacy to cope with the constantly increasing traffic, George V bridge, a short distance downstream, was opened in 1928. The Richmond park foot bridge was reconstructed in the 1950s. There are two railway bridges.

History. — Some historians hold that the name of Glasgow comes from Gaelic words meaning "dark glen," descriptive of the narrow ravine through which the hlolendinar flowed to the Clyde. But the more generally accepted version is that the word is the Celtic *Gleschu,* afterward written Glesco or Glasghu, meaning "dear green spot" *(glas,* green; *cu* or gku, dear), supposed to have been the name of the settlement that Kentigern found there when he came to convert the Britons of Strathclyde. Kentigern or Mungo ("dear one") became the patron saint of Glasgow. and the motto — "Let Glasgom Flourish by the Preaching of the Word." usually shortened to "Let Glasgow Flourish"—and arms of the city are identified with him. It is not till the 12th century, however, that the history of the city becomes clear. About 1178 William the Lion made the town by charter a burgh of barony, and gave it a market with freedom and customs. At the battle of the Bell o' the Brae, on the site of High street, Wallace routed the English under Percy in 1300; he was betrayed to the English in 1305 in Robroyston. Plague ravaged the burgh in 1350 and 30 years later; the regent Arran, in 1544. besieged the bishop's castle, and there was a subsequent fight at the Butts (now the Gallowgate). Most of the inhabitants were opposed to Queen Mary and many actively supported Murray in the battle of Lnngside — the site now occupied by the Queen's park — on May 13, 1568, in which she lost crown and kingdom. Under James VI the town became a royal burgh in 1636. with freedom of the river from the Broomielaw to the Cloch. The people made common cause with the Covenanters to the end of their long struggle.

Montrose mulcted the citizens heavily after the battle of Kilsyth in 1645, and three years later the provost and bailies were deposed for contumacy to their sovereign lord. Plague and famine devastated the town in 1649, and in 1652 a conflagration laid a third of the burgh in ashes. Even after the restoration its sufferings were acute. It was the headquarters of the Whiggamores of the west and its prisons were constantly filled with rebels for conscience' sake. The government scourged the townsfolk with an army of Highlanders, whose brutality only served to strengthen the resistance at the battles of Drumclog and Bothwell Brig. The union was hotly resented, but marked the dawn of almost unbroken prosperity. By the treaty of union Scottish ports were placed. in respect of trade, on the same footing as English ports, and the situation of Glasgosv enabled it to acquire a full share of the ever-increasing Atlantic trade.

The commerce of Glasgow was already considerable and in population it was now the second town in Scotland. It enjoyed a practical monopoly of the sale of raw and refined sugars, had the right to distil spirits from molasses free of duty, dealt largely in cured herring and salmon, sent hides to English tanners and manufactured soap and linen. It challenged the supremacy of Bristol in the tobacco trade—fetching cargoes from Virginia, Maryland and Carolina in its own fleet—so that by 1772 its importations of tobacco amounted to more than half of the whole quantity brought into the United Kingdom. The tobacco merchants built handsome mansions and the town rapidly extended westward. With the surplus profits new industries were created, which helped the city through the period of the American Revolutionary War. Most, though not all, of the manufactures in which Glasgow has always held a foremost place date from this period. It was in 1764 that James Watt succeeded in repairing a hitherto unworkable model of Thomas Newcomen's fire (steam) engine in his small workshop within the college precincts. Shipbuilding on a colossal scale and the enormous developments in the iron industries and engineering were practically the growth of the 19th century.

Glasgow was an important target for enemy air action in World War II and considerable damage was done, particularly to the large tenement blocks.

Buildings.—The municipal buildings (1888) occupy the eastern side of George square, the civic centre of the city, and many additional blocks have been built or purchased for the municipal staff. A sanitary department was opened in 1897, including a bacteriological and chemical laboratory. Added buildings, connected with the older ones by two bridges, were completed in 1923. Up till 1810 the town council met in a hall adjoining the old tolbooth. It then moved to the structure at the foot of the Saltmarket, now used as courthouses, and, after two further moves, the present quarters were occupied. On the south side of George square is the head post office.

On the west side stand the Bank of Scotland (1869) and the Merchants' house (1874–77), the head of which (the dean of guild) along the head of the Trades' house (the deacon convener of trades), has been ex officio member of the town council since 1711, an arrangement devised with a view to adjusting the frequent disputes between the two guilds. The Trades' hall (1794) is the oldest public building in the city. The Royal exchange, a fine Corinthian building, is used as a public library. Argyle street, the busiest thoroughfare, leads to Trongate, where a few remains of the old town are carefully preserved. On the south side of the street, spanning the pavement, stands the Tron steeple, a stunted spire dating from 1637, all that is left of St. Mary's church, burned down in 1793. On the opposite side, at the comer of High street, stood the ancient tolbooth, or prison, a turreted building, five stories high, with a Jacobean crown tower. The only remnant of the structure is the tower known as the Cross, or Tolbooth, steeple.

The old Royal infirmary, designed by Robert Adam and opened in 1794, adjoining the cathedral, occupied the site of the archiepiscopal palace, the last portion of which was removed toward the close of the 18th century. It was rebuilt in 1912, and later extensions demolished the block containing the ward in which Joseph Lister first applied his discovery of antisepsis. On the northern side are the buildings of the medical school attached to the institution.

Hutcheson's hospital, founded by George and Thomas Hutcheson in the 17th century for poor old men and orphan boys, and adorned with statues of the founders, is situated in Ingram street. By the increase in the value of its lands the hospital has become a very wealthy body and is able to subsidize schools apart from the charity.

St. *Mungo's* Cathedral.—The cathedral stands in the northeast quarter of the city 104 ft. above the Clyde. It is a beautiful example of Early English work, impressive in its simplicity. Its form is that of a Latin cross, with imperfect transepts. At the centre rises a fine tower, with a short octagonal spire. The choir, locally known as the High church, serves as one of the city churches, and the extreme east end of it forms the Lady chapel. The chapter house, which projects from the northeastern corner, was built in the 15th century and has a groined roof supported by a pillar. The crypt beneath the choir is borne on 65 pillars and lighted by 41 windows. The sculpture of the capitals of the columns and bosses of the groined vaulting is exquisite and the whole is in excellent preservation. Strictly speaking, it is not a crypt, but a lower church adapted to the sloping ground of the right bank of the Molendinar burn. St. Mungo's well in the southeastern corner was considered to possess therapeutic virtues, and in the crypt a recumbent effigy, headless and handless, is reputed to be the tomb of Kentigern.

In 1115 an investigation was ordered by David, prince of Cumbria, into the lands and churches belonging to the bishopric, and from the deed then drawn up it is clear that at that date a cathedral had already been endowed. When David ascended the throne in 1124 he gave to the see of Glasgow the lands of Partick besides restoring many possessions of which it had been deprived. Jocelin (d. 1199), made bishop in 1174, was the first great bishop, and is memorable for his efforts to replace the cathedral built in 1136 by Bishop John Achaius, which had been destroyed by fire. The crypt is his work, and he began the choir, Lady chapel, and central tower. The new structure was sufficiently advanced to be dedicated in 1197. James Beaton or Bethune (1517–1603), the last Roman Catholic archbishop, fled to France at the Reformation in 1560, and took with him the treasures and records of the see, including the Red Book of Glasgow dating from the reign of Robert III. The documents were deposited in the Scots college in Paris, were sent at the outbreak of the Revolution for safety to St. Omer, and were never recovered. This loss explains the paucity of the earlier annals of the city. The Reformers threatened to mutilate the cathedral, but the prompt defense of the craftsmen was the means of saving it.

Excepting the cathedral, no Glasgow church possesses historical interest. This is due largely to the long survival of the severe sentiment of the Covenanters. There are several fine modern churches.

Art Galleries, Libraries and **Museums.**—Glasgow merchants and manufacturers have been constant patrons of art, and their liberality may have had some influence on the younger painters who, toward the close of the 19th century, broke away from tradition and, stimulated by training in the studios of Paris, became known as the "Glasgow school."

In 1944, Sir William Burrell presented the magnificent collection of paintings, tapestries, *objets d'art,* etc. which bears his name, to be housed at the estate of Dougalston extending to 360 ac. just north of Glasgow. The art gallery and museum, the finest in Great Britain outside London, was opened in 1901 in Kelvingrove park. Opposite is the huge Kelvin hall burned down in 1926, but rebuilt in the following year. The Institute of Fine Arts, in Sauchiehall street, is mostly devoted to periodical exhibitions of modem art. There are also museums in the People's palace on Glasgow green and at Camphill.

The faculty of procurators possesses a valuable library which is housed in its hall in West George street. In Bath street there is the Philosophical Society's library and the Physicians' library is in St. Vincent street. The Mitchell library was moved to North street in 1911 and extended in 1953. It is the chief public library in the city. The Stirling library in Miller street has an extensive commercial reference library and is particularly rich in tracts of the 16th and 17th centuries. The Athenaeum in St. George's place is occupied by the Royal Scottish Academy of Music and the College of Dramatic Art.

University and Schools.—The university, founded in 1450 by Bishop Turnbull under a bull of Pope Nicholas V, survived in its old quarters till far into the 19th century. The *paedagogium,* or college of arts, was at first housed in Rottenrow, but was moved in 1460 to a site in High street, where Sir James Hamilton of Cadzow, first Lord Hamilton (d. 1479), gave it four acres of land and some buildings. Queen Mary bestowed upon it 13 ac. of contiguous ground, and her son granted it a new charter and enlarged the endowments. Before the Revolution its fortunes fluctuated, but in the 18th century it became very famous. By the middle of the 19th century, however, its surroundings had deteriorated, and in 1860 it was decided to rebuild it elsewhere. The ground had enormously increased in value and a railway company purchased it for £100,000. In 1864 the university bought the Gilmore hill estate and adjacent property and the new buildings (1870) were placed on the ridge of Gilmore hill—the finest situation in Glasgow. On the south the ground falls in a series of terraces toward Kelvingrove park and the Kelvin. On the west stand the houses of the principal and professors. The third marquess of Bute (1847–1900) gave £40,000 to provide the Bute or common hall, divided by a screen from the Randolph hall, named after another benefactor, Charles Randolph (1809–1878). The library includes the collection of Sir William Hamilton, and the Hunterian museum, bequeathed by William Hunter (*q.v.*) the anatomist, is particularly rich in coins, medals, black-letter books and anatomical preparations. Exhibitions were founded by John Snell (1629–79), a native of Colmonell in Ayrshire, for the purpose of enabling students of distinction to continue their careers at Balliol college, Oxford. The governing body includes the chancellor, elected for life by the general council, the principal, also elected for life, and the lord rector, elected triennially by the students voting in "nations" according to their birthplace (*Glottiana,* natives of Lanarkshire; Transforthana, of Scotland north of the Forth; Rothseiana, of the shires of Bute, Renfrew and Ayr; and Londoniana, all others). There were 67 professors and some 6,100 students in 1952. By an act of 1889, women were permitted to enrol as students and to graduate.

A faculty of engineering was instituted in 1923 and after World War I chairs were founded in languages and branches of chemistry, law, physics, engineering, medicine and theology, besides accountancy and music. During the period 1899–1903 the buildings were much extended and a further large extension was opened in 1907. In 1927 a new range of buildings in the west quadrangle provided additional accommodation for teaching and in 1930 a union for men students was opened. A memorial chapel was dedicated in 1929. Among other additions have been a new observatory, the Gardiner Institute of Medicine, a new reading room with accommodation for 565 readers (opened in 1939) and further buildings for chemistry and research into nuclear physics. Four halls of residence for men and one for women are under the control of the university.

The Royal Technical college in George street originated in the foundation (1796) by John Anderson (1726–96), professor of natural philosophy in the university, who opened a class in physics for working men, provided for the instruction of artisans and others unable to attend the university. It was the first technical college in the United Kingdom. In 1799 George Birkbeck (1776–1841) succeeded Thomas Garnett (1766–1802) and began in the following year those lectures on mechanics and applied science which, continued elsewhere, ultimately led to the foundation of mechanics' institutes in many towns. In 1886 the foundation was amalgamated with the college of science and arts (1823), the successor of the mechanics' institution; the "Young" chair of technical chemistry; the Atkinson institution (1861) and Allan Glen's school (1853) being named the Glasgow and West of Scotland Technical college. It received its present name in 1912 and was affiliated with the university in 1913. The Glasgow schools of architecture and art are in part maintained by the college. In 1912 Allan Glen's school was transferred to the Glasgow school board.

The Anderson College of Medicine was instituted in 1799; it became one of the most important in the United Kingdom and in 1886, when it was separated from the original Anderson foundation, was placed under a separate governing body. St. Mungo's college, which developed from an extramural school in connection with the Royal infirmary, was incorporated in 1889, with faculties of medicine and law. Both colleges are with the veterinary college now under the control of the university. The school of art, the agricultural college and the schools for the training of teachers are institutions with distinctly specialized objects. The high school in Elmbank is the successor of the grammar school (long housed in John street) which was founded in the 14th century as an appanage of the cathedral. Other secondary schools include Glasgow academy, Kelvinside academy and the girls' and boys' schools endowed by the Hutcheson and other educational trusts.

Parks and **Open** Spaces.—Of the 52 parks and 770 minor open spaces and playgrounds, comprising 4,007 ac., the oldest is the Green (136 ac.), on the right bank of the river, adjoining a densely populated district. It once extended farther west, but a portion was built over at a time when public rights were not vigilantly guarded. It is a favourite area for popular demonstrations. The Kelvin flows through Kelvingrove park (87 ac.), in the west end, and the ground is naturally terraced, while the situation is beautified by the adjoining Gilmore hill with the university on its summit. The park contains the Stewart fountain erected to commemorate the labours of Lord Provost Stewart and his colleagues in the promotion of the Loch Katrine water scheme, statues of Lord Lister, Lord Roberts and Carlyle, and a war memorial. The other parks on the right bank are, in the north, Ruchill (53 ac.), acquired in 1891, and Springburn (77 ac.), acquired in 1892, and, in the east, Alexandra park ($98\frac{1}{2}$ ac.), in which is laid down a nine-hole golf course, and Tollcross ($83\frac{1}{2}$ ac.), acquired in 1897. Victoria park (654 ac.), at Whiteinch, contains a remarkable grove of fossilized trees.

On the left bank Queen's park (148 ac.), occupying a commanding site, was considerably enlarged in 1894 by the enclosure of the grounds of Camphill. The other southern parks are Richmond (44 ac.), acquired in 1898, Maxwell (21 ac.), which was taken over on the annexation of Pollokshields in 1891; Bellahouston (172 ac.), acquired in 1895; and Cathkin Braes ($72\frac{1}{2}$ ac.), presented to the city in 1886 by James Dick, a manufacturer, containing "Queen Mary's stone," a point which commands a view of the lower valley of the Clyde. In the northwestern district of the town 40 ac. between Great Western road and the Kelvin are devoted to the royal botanic gardens. Other acquisitions include 200 ac. of the Balloch castle estate (Loch Lomond park), the Rouken Glen (288 ac.), Linn (206 ac.), Newlands and Glenconner (14 ac. each), Dawsholm (79 ac.), Knightswood (148 ac.) and King's (68 ac.) parks. The corporation owns, besides, the Ardgoil estate of 14,740 ac.

Government.—By the Local Government (Scotland) act, 1889, the city was placed entirely in the county of Lanark, the districts then transferred having previously belonged to the shires of Dunbarton and Renfrew. In 1891 the boundaries were enlarged to include six suburban burghs and a number of suburban districts, the area being increased from 9.5 sq.mi. to 18.5 sq.mi. In 1912 Govan, Partick, Pollokshaws and several suburban districts were included in the city, making the total area 29.9 sq.mi. Further extensions were made in 1925, when parts of Renfrewshire, Dunbartonshire and Lanarkshire, including the Yoker district, were added, raising the area to 44.8 sq.mi. Extensions in 1931 and 1937 brought Glasgow to an area of 62.1 sq.mi. In 1893 the municipal burgh was constituted a county. Glasgow is governed by a corporation consisting of 113 members, including 20 bailies and the lord provost.

As a county Glasgow has a lieutenancy (successive lords provost holding the office) and a court of quarter sessions, which is the appeal court from the magistrates sitting as licensing authority. In 1859 water was conveyed by aqueducts and tunnels from Loch Katrine to the reservoir at Mugdock, a distance of 27 mi., whence after filtration it was distributed by pipes to Glasgow. In 1914 works were completed to raise Loch Katrine 5 ft. and to connect with it by tunnel Loch Arklet (455 ft. above the sea), with storage for 2,050,000,000 gal. The two lakes together possess a capacity of 12,000,000,000 gal. The entire works between the lake and the city mere duplicated over a distance of $32\frac{1}{2}$ mi., and an additional reservoir, holding 694,000,000 gal., was constructed and a dam built $1\frac{1}{4}$ mi. west of the lower end of Loch Arklet, designed to create a sheet of water $2\frac{1}{2}$ mi. long and to increase the water supply of the city by 10,000,000 gal. a day. In 1919 power was given to raise Loch Katrine a further 5 ft., making 17 ft. that could be drawn upon. This work was finished in 1926 and provides storage equivalent to six months' supply to the city at 70,000,000 gal. a day. The water committee supplies hydraulic power to manufacturers and merchants. Huge gas works opened at Govan in 1921 and a large electric generating station at Dalmarnock bridge in 1920, are now vested in national boards. A large refuse electric power works was opened at Govan in 1929.

By lapse of time and congestion of population, certain quarters of the city, in old Glasgow especially, were slums and rookeries of the worst description. The municipality obtained parliamentary powers in 1866 to condemn for purchase overcrowded districts, to borrow money and levy rates. The work was carried out, and when the act expired in 1881 whole localities had been recreated. Under the amending act of 1881 the corporation began in 1888 to build tenement houses and lodging houses. The powers of the improvement trustees were practically exhausted in 1896, when it appeared that the funds showed a deficiency of £423,050. Assessment of ratepayers for the purposes of the trust had yielded £593,000, and it was estimated that these operations had cost the citizens £24,000 a year. In 1897 an act was obtained for dealing in similar fashion with insanitary and congested areas in the centre of the city, and on the south side of the river. The drainage system was entirely remodelled, the area being divided into three sections, each distinct, with separate works for the disposal of its own sewage. Housing conditions and unemployment were again very bad after World War I, and led to a "rent strike." Under the various Housing (Scotland) acts, 89,571 houses were completed by March 1953, but overcrowding continued to be as great a problem as slum clearance. In May 1930 the corporation, under the Local Government (Scotland) act, 1929, became the local education authority.

Throughout the 19th century the population grew prodigiously. Only 77,385 in 1801, it was nearly doubled in 20 years, being 147,043 in 1821, already outstripping Edinburgh. In 1901 it stood at 761,709, in 1931 at 1,088,461 and in 1951 at 1,089,555. Since 1918 Glasgow has returned 1j members to parliament, one each for Bridgeton, Camlachie, Cathcart, Central, Gorbals, Govan, Hillhead, Kelvingrove, Maryhill, Pollok, Scotstoun, Shettleston, Springburn, Tradeston and Woodside.

Communications, — One railway terminus is situated in Queen street, and consists of a high-level station (main line) and a low-level station for Balloch, etc., used in connection with the city and district line, largely underground, serving the northern side of the town. The central station terminus for Carlisle, Edinburgh, etc., in Gordon street, comprises a high-level station for the Cathcart Circle railway and a low-level station for Balloch, and for the connection between Maryhill and Rutherglen, which is mostly underground. Both the underground lines communicate with certain branches of the main line, either directly or by change of carriage. The older terminus in Buchanan street now takes the northern and eastern traffic and the station in St. Enoch square serves the southwest of Scotland and Carlisle. The Glasgow subway—$6\frac{1}{2}$ mi. long, worked in two tunnels and passing below the Clyde twice—was opened in 1896 as a cable line. It was bought in 1923 by the corporation and was converted to electric traction, the new system being inaugurated in 1935.

There are at certain points free steam ferryboats or floating bridges for conveying vehicles across the harbour. The corporation has obtained powers to construct twin tunnels under the river at Whiteinch. Steamers, carrying both goods and passengers, constantly leave the Broomielaw quay for the piers and ports on the river and firth, and the islands and sea lochs of Argyllshire.

The Port. — The Clyde navigation trustees are responsible for 18 mi. of the River Clyde, from Port Glasgow to Glasgow. The harbour occupies 368 ac. of water space. For the most part it is lint l by quays and wharves, which have a total length of just over 12 mi., and from the harbour to the sea vessels drawing 26 ft. can go up or down on one tide. In the middle of the 18th century the river was fordable on foot at Dumbuck 12 mi. below Glasgow and $1\frac{1}{2}$ mi. S.E. of Dumbarton. The earliest shipping port of Glasgow was Irvine in Ayrshire, but lighterage was tedious and land carriage costly, and in 1658 the civic authorities endeavoured to purchase a site for a spacious harbour at Dumbarton. Being thwarted by the magistrates of that burgh, however, in 1662 they secured 13 ac. on the southern bank at a spot some 2 mi. above Greenock, which became known as Port Glasgow, where they built harbours and the first graving dock in Scotland. Sixteen years later the Broomielaw quay was built, but it was not until the tobacco merchants appreciated the necessity of bringing their wares into the heart of the city that serious consideration was paid to schemes for deepening the waterway.

In 1768 John Golborne advised the narrowing of the river and the increasing of the scour. By the building of numerous jetties, the constant use of steam dredgers and the blasting of rock, the channel was gradually deepened and much land reclaimed. By 1900 it had a minimum depth of 22 ft., and, as already indicated, the largest vessels make the open sea in one tide, whereas in 1840 it took ships drawing only 15 ft. two and even three tides to reach the sea. From 1812 to 1820 Henry Bell's "Comet," 30 tons, driven by an engine of 3 horsepower, plied between Glasgow and Greenock, until she was wrecked, being the first steamer to run regularly on any river in the old world. When the quays and wharves ceased to be able to accommodate the growing traffic, the construction of docks became imperative. In 1867 Kingston dock on the south side, of 43 ac., was opened but soon proved inadequate, and in 1877 Queen's dock (two basins) at Stobcross on the north side, of $33\frac{3}{4}$ ac., was opened. In 1897 Prince's dock (three basins) on the opposite side, of 35 ac., was opened, fully equipped with hydraulic and steam cranes and all the other latest appliances. The Rothesay dock ($20\frac{1}{2}$ ac.) at Clydebank, opened in 1907, and the wharf at Renfrew, are included in the harbour.

The railway has access to the harbour for goods and minerals at Terminus quay to the west of Kingston dock, and a mineral dock has been constructed by the trust at Clydebank, about $3\frac{1}{2}$ mi. below the harbour. The King George V dock at Shieldhall, which added another 20 ac. of water space and over a mile of quays to the harbour, was opened in 1931. It is connected by railway lines and a road joining the new trunk road of the Glasgow corporation scheme. There are also five graving docks, the Partick dry dock, and two patent slips. The shipping attains to colossal proportions. The imports consist chiefly of grain and flour, leather, tobacco, timber, oil, iron ore, bacon and other foodstuffs; and the exports principally of cotton, jute and linen goods, yarn, coal, machinery and spirits.

Industries. — Natural causes, such as proximity to the richest field of coal and ironstone in Scotland and the vicinity of hill streams of pure water, account for much of the great development of trade in Glasgow. It was in textiles that the city showed its earliest predominance, which, however, was not maintained, though several cotton mills are still worked. The leading feature in the trade has always been in the manufacture of light materials. Thread is made on a considerable scale. Carpets are woven and some factories are exclusively devoted to the making of lace curtains. The allied industries of bleaching, printing and dyeing have prospered. The use of chlorine in bleaching was first introduced in Great Britain at Glasgow in 1787, on the suggestion of James Watt, whose father-in-law was a bleacher; and it was a Glasgow bleacher, Charles Tennant, who first discovered and made bleaching powder (chloride of lime). Turkey red dyeing was begun at Glasgow by David Dale and George Macintosh, and the colour was long known locally as Dale's red. A large quantity of gray cloth continues to be sent from Lancashire and other mills to be bleached and printed in Scottish works. These industries gave a powerful impetus to the manufacture of chemicals, and the works at St. Rollox developed rapidly.

There are several breweries and distilleries and Glasgow is the centre of the whisky blending, bottling and casing industry. Many miscellaneous industries are carried on such as the making of glass, paper, clothing, confectionery, cabinets, biscuits, boots and shoes, pottery and rubber goods. Since the days of the brothers Robert Foulis (1705–76) and Andrew Foulis (1712–75), printing, both letterpress and colour, has been identified with Glasgow, though less than with Edinburgh. The discovery of the value of black-band ironstone, till then regarded as useless "wild coal," by David Mushet (1772–1847), and Neilson's invention of the hot-air blast threw the control of the Scottish iron trade into the hands of Glasgow ironmasters; the furnaces themselves were mostly erected in Lanarkshire and Ayrshire. The expansion of the industry was such that in 1859 one-third of the total output in the United Kingdom was Scottish. Mild steel is manufactured and some crucible cast steel is made. In addition to brass foundries there are works for extraction of copper and smelting of lead and zinc. Locomotive engines are built, all kinds of builder's ironwork is forged, and the sewing machine factories in the neighbourhood are important. Boilermaking and marine engine works, in many cases being directly connected with the shipbuilding yards, are numerous.

Shipbuilding, indeed, is the greatest of the industries of Glasgow. Excepting a trifling proportion of wooden ships, the Clyde-built vessels are made of steel, the trade having owed its immense expansion to prompt adoption of this material. Every variety of craft is turned out, from battleships and great liners to dredging plant and hopper barges. In the 20th century many new industries were established, among them the manufacture of motor trailers, welding machinery, electrodes, electric lamps and batteries, electric household appliances, silk and synthetic fibre garments, seamless containers, etc. The Great British Empire exhibition of 1938 was held from May to October in Bellahouston park.

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GLASITES, a Christian sect, founded in Scotland by John Glas (*q.v.*). It spread into England and America, but is now practically extinct. The name Glasites or Glassites was generally used in Scotland; in England and America the name Sandemanians was more common. Glas dissented from the Westminster Confession only in his views as to the spiritual nature of the church and the functions of the civil magistrate. But his son-in-law Robert Sandeman added a distinctive doctrine as to the nature of faith which is thus stated on his tombstone: "That the bare death of Jesus Christ without a thought or deed on the part of man is sufficient to present the chief of sinners spotless before God." In their practice the Glasite churches aimed at a strict conformity with the primitive type of Christianity as understood by them. Each congregation had a plurality of elders, pastors or bishops, who were chosen according to what were believed to be the instructions of Paul, without regard to previous education or present occupation, and who enjoy a perfect equality in office. In all the action of the church unanimity was considered to be necessary; if any member differed in opinion from the rest, he must either surrender his judgment to that of the church, or be shut out from its communion. The Lord's Supper was observed weekly; and between forenoon and afternoon service every Sunday a love feast was held at which every member was required to be present. Mutual exhortation was practised at all the meetings for divine service, when any member who had the gift of speech (χάρισμα) was allowed to speak. The practice of washing one another's feet was at one time observed; and it was for a long time customary for each brother and sister to receive new members, on admission, with a holy kiss. The lot was regarded as sacred; the accumulation of wealth they held to be unscriptural and improper, and each member considered his property as liable to be called upon at any time to meet the wants of the poor and the necessities of the church. Churches of this order were founded in Paisley, Glasgow, Edinburgh, Leith, Arbroath, Montrose, Aberdeen, Dunkeld, Cupar, Galashiels, Liverpool and London, where Michael Faraday was long an elder. Their exclusiveness in practice, neglect of education for the ministry, and the antinomian tendency of their doctrine contributed to their dissolution. Many Glasites joined the general body of Scottish Congregationalists, and the sect may now be considered extinct. The last of the Sandemanian churches in America ceased to exist in 1890.

See James Ross, *History* of *Congregational Independency in Scotland* (Glasgow, 1900). (*D.* M.)

GLASS, CARTER (1858–1946), American politician, was born at Lynchburg, Va., on Jan. 4, 1858. He received his education in the Lynchburg schools and learned the printer's trade, which he followed for several years, eventually becoming proprietor of the Lynchburg *Daily News* and *Daily Advance*. He was elected to the Virginia State Senate for two terms (1899–1903) and was a member of the Constitutional Convention in 1901. He was elected in 1902 to the national House of Representatives, and thereafter was continuously re-elected until his resignation in 1918. As chairman of the House banking committee he was active in framing and passing the Federal Reserve Bank law. In 1918 he entered President Wilson's cabinet as secretary of the Treasury. Under his guidance the fifth Liberty Loan was floated in April, 1919. In Nov. 1919 he resigned after his appointment to the U.S. Senate, where he remained by election until his death, on May 29, 1946.

GLASS. The attributes of a glass are transparency, uniformity of properties at all points in its substance, hardness, brittleness and conchoidal or shell-like markings on fractured areas. Until the 20th century a glass was always regarded as a transparent product resulting from the fusion of mineral substances. In 1903 Gustav Tammann defined a glass as a supercooled liquid, thus including as glasses many organic substances, such as glycerol. betol and sugar, which after being melted could be cooled to yield clear, rigid products. Further, some of the high polymer organic substances, described in England as plastics (*e.g.*, pollopas, polystyrene, etc.), possess transparency and uniformity of properties and have been moulded into lenses and other transparent objects. They have been described, especially in continental Europe, as organic or polymeric glasses.

The definition accepted in the United States, however (American Society for Testing Materials), recognizes as glasses only those of inorganic origin. While for scientific classification it must be insisted that many organic substances can be converted into glasses, for purposes of description in this article it is convenient to accept the limitation in this American definition, of which the following is a slight variant:

> Glass is an inorganic product of fusion, which has cooled to a rigid condition without crystallizing. Masses or bodies of glass may be colourless or may be made coloured, translucent or opaque by the presence of dissolved material or of amorphous or crystalline substances in suspension.

The inorganic substances convertible into glasses by fusion and cooling include single elements, such as selenium, and the oxygen, sulphur. selenium and tellurium compounds of silicon, boron, phosphorus. germanium, arsenic, antimony and bismuth. Nitrates, sulphates and fluorides can also form glasses. These glass-forming substances, within certain limits of composition, also bestow glass-forming characteristics on their compounds with the oxides of sodium, potassium, lithium, calcium, magnesium, lead, barium, zinc, aluminum, iron, cobalt, nickel. copper, manganese, etc. The most frequently used glass-forming substances are the oxides of silicon, boron and phosphorus. that of silicon dominating all others. The production of fused silica glass (from rock crystal or quartz sand) has for many years been a large-scale industry.

In 1932 the terms "glass network former" and "glass network modifier" were introduced by W. H. Zachariasen, the first to designate those compounds (in particular the oxides of silicon, boron, etc.) which favour the production of a glass, the latter to define the function exercised by the oxide of the metallic elements.

According to his views, confirmed experimentally by B. E. Warren (1934), both crystals and glass have a three-dimensional network structure built from a certain group of atoms constituting a repeatable unit in the network. In crystalline silica and the silicates the unit is comprised of an atom of silicon linked to four oxygen atoms so spaced as to conform to the shape of a tetrahedron. It is assumed that in silica-containing glasses this same unit controls the formation of the network; but whereas in crystals the cells in the network produced from these units are repeatable and symmetrical, in glasses they are random. nonrepeating and nonsymmetrical. (See CRYSTALLOGRAPHY.) The elements from the basic oxides (sodium, potassium. calcium, barium. etc.) are regarded as occupying a position within the cell and to have a greater freedom of movement. (For a fuller exposition see, for example. J. E. Stanworth's Physical Properties of Glass, Oxford, 1950.)

Most commercial glasses contain at least three major constituents, some six or more, comprised of one or more of the glass-forming oxides (silica. boric oxide, etc.) together with one or more of the oxides of the metallic elements (sodium. potassium. calcium, etc., as above); and each constituent has its own specific function to discharge in modifying the ease of melting and the physical properties of the glasses. (For typical compositions used for different purposes see Properties, Manufacture and Uses, below.)

A large proportion of the known chemical elements have been embodied as constituents in glasses, bestowing on them the most diverse range of colour and physical properties—optical, electrical, heat and radiation transmitting, mechanical and chemical—so that commercial glasses can now be produced for the most diverse of purposes. The density can be varied between fourfold and fivefold; the thermal expansion thirtyfold; and the electrical resistance ten thousand millionfold. The variety and number of commercial glasses of different compositions and properties is very great. Of the highest-quality optical glasses alone some makers produce more than 100 varieties. But limitations on the range of commercial glasses are imposed by physicochemical and economic conditions. For example, although from the three most commonly used constituents alone, silica (sand), soda and lime, a very large number of glasses could be prepared by varying the proportions, certain of them cannot be cooled under manufacturing conditions without the deposition of crystals of one component or of compounds produced on fusion—SiO_2 as tridpmite, $CaSiO_3$ as wollastonite and $Na_2O.3CaO.6SiO_2$ as devitrite. This phenomenon of devitrification still has to be guarded against in the chambers from which sheet glass is drawn at about 1,000° C. Optical glass compositions are also limited by devitrification because of the slow rate of cooling given. The other physicochemical condition is that not all compositions yield glasses sufficiently resistant to weathering or chemical attack. On the economic side it is obvious that the more expensive lead oxide and potash, which increase refraction and brilliance, will be reserved for the special objects for which adequate prices can be expected. Sheet glass, plate glass, bottles and jars and much common domestic ware are made from sand, soda and lime because of their cheapness. The use of continuous automatic glassmaking machines also tends to a standardization of compositions employed.

The shaping of glass drawn from the furnace in the fluid condition at 1,000°–1,200° C. depends on its continuous increase of viscosity in cooling from the highest melting temperatures (1,300°–1,600° C.) down to the rigid state already reached at 450°–650° C., according to the glass. Glassmaking is therefore unique in that it consists not only in the production of the glass itself but also in its conversion directly from the furnace into the fully shaped articles, whereas metals, because they have a sharp freezing point, must first be poured and converted into ingots.

Except for the introduction at St. Gobain in France in the last decade of the 17th century of a new invention for rolling large plates of glass, the processes for shaping glass remained much the same in principle from the early Christian era (see History, below) until nearly the end of the 19th century, when the development of machines. at first semiautomatic, began in England and in the United States. In the 20th century epoch-making advances took place. especially in the U.S. but also in Belgium and England, in the invention of fully automatic machinery for shaping glassware required in great numbers or quantities. At least 95% of the total weight of glass manufactured in the U.S., Great Britain and several other countries is by automatic machinery. The Corning ribbon machine can make more than 1,000,000 electric light bulbs a day.

As just before the opening of the Christian era when the blowpipe came into use, so with the development of glassmaking machines, the output of glassware increased enormously and the uniformity and general quality of the articles greatly improved. Modern glassmaking has become largely a branch of engineering. In consequence, the glass industry, no longer dependent on skilled glass blowers for utilitarian glass. so spread after 1915 that by 1954 there were few countries outside the arctic and antarctic where it had not been established. Both the importance of the industry and its great expansion during the 20th century are illustrated by the data shown in Table I for the three largest producing countries (U.S.S.R. unknown).

TABLE I.—Glass Production, *1900* and *1950*

Country	1900		1950	
	Population	Production (tons)	Population	Production (tons)
United States . . .	76,000,000	1,000,000	152,000,000	5,460,000
Great Britain . . .	38,000,000	220,000	50,000,000	1,230,000
West Germany . . .	39,000,000	400,000	48,000,000	800,000

The great advances made were rendered possible by clever inventors backed up by systematic scientific research and control. The first university department for research and teaching in glass technology was established in 1915 at Sheffield, Eng , and the first Society of Glass Technology, in 1916, also in Sheffield. Similar institutions soon followed in the U.S., then in 1922–23 in Germany and later in several other countries. In glass as a decorative material. notable advances were made after 1920 in purity, range of colouring, form and decorative surface treatment. These advances were pioneered mainly by individual glassworks or by individual artists; but to the old established schools for training in glass craftsmanship at Zwiesel in Bavaria and at Steinschonau (Kamenicky Senov) and Haida (Novy Bor) in Czechoslovakia there were added another at Zelezny Brod in Czechoslovakia, one at Rheinbach in Germany and three in Great Britain (London, Edinburgh and Stourbridge). There is an International Commission on Glass which maintains contact with all institutions engaged in promoting the study of glass in all its aspects.

For a readable and accurate general account of glass and glassmaking the reader may be referred to Glass, The Miracle Maker, by C. J. Phillips, and ed. (New York, 1948). (W. E. S. T.)

PROPERTIES, MANUFACTURE AND USES

The simplest glass and one with excellent properties in most respects is fused silica (SiO_2). By fusing silica with alkali (soda) a glass is obtained at a much lower temperature and therefore more cheaply, but it is not resistant to the weather. Indeed, one range of such alkali-silica glasses constitutes the commercial water glass or sodium silicate. Additions of a suitable amount of one or more further constituents (*e.g.,* lead oxide or lime) gives much-improved chemical stability while maintaining the relatively low temperature of glass formation and so results in commercially usable glasses. The alkali-lead oxide-silica glasses are used for producing best-quality cut crystal ware, while the alkali-lime-silica type, modified often by the introduction also of a little magnesia and alumina, is used for the commoner glasses such as containers, flat glass and cheap domestic glassware. Where considerable resistance to thermal shock and great chemical resistance is needed, as in cooking ware and chemical apparatus, a borosilicate glass is used in which the alkali content is largely replaced by boric oxide. Of these glasses the Pyrex brand is most widely known (W. C. Taylor, United States patent 1,192,474).

For special optical purposes the silica may be wholly or largely

TABLE 11.—*Percentage Compositions of Typical Commercial Glasses*

Glass type	Flat glass window glass: Colburn type	Flat glass window glass: Fourcault type	Plate glass	Container glass: British	Container glass: American, 1950	Container glass: Amber	Container glass: Amber	Dark blue	Dark green	Cheap tumbler and electric lamp bulb
Silica	71.7	71–72.5	72.2	72–74.5	72.1*	70.5†	67.8	71–72	67.2	70.1
Boric oxide				0–0.2	0.2	..	1.1			0.7
Alumina } Iron oxide }	0	1–2	0.14	0.4–1.5	1.9	2.1	2.3	1.1; 0.1	2.4	2.6
Lime	9.7	7–9	112	'8.8–9.4	8.4	8.9	8.6	11.5–12.5	8.1	5.4
Magnesia	4.3	2.5–4.5	2.1	trace–0.4	2.0	1.4	1.3	1.1	1.5	3.6
Soda	13.0	14.5–15.5	13.7	14.1–15.5	14.4	16.0	13.9	11.5–12	14.8	16.8
Potassia	..	0.2–0.8	..	0–0.2	0.4	0.6	0.4	0.3–0.8	1.0	0.3
Manganese dxide'	..	..		..	(Fluorine = 0.2)	..	3.8	..	2.5	..
Cobalt oxide		..	..				..	0.1–0.3		..
Chromium oxide	..	..					..	..	0.5–0.8	..

	Tubing: For electric lamp stem assembly	Tubing: Soda for lamp working	Tubing: Ampoule: Colour-less	Tubing: Ampoule: Amber (Fiolax)	Tubing: Gauge glass	Tubing: Clinical thermo-meter bulb	Sealing to Fernico alloy	Sealing tungsten
Silica	56.6	70.0	67.2	69.4	71–77‡	55.78	67–67.5‖	77.0
Boric oxide	0.2	0.6	5.0	3.4	7–12		10–20	15.4
Alumina	0.8	} 2.5	3.7	1.8	3–9	0.2	5–10	} 1.1
Iron oxide	0.05	}	0.07	2.3	0.1	0.02	..	}
Lime	..	5.3	6.5	9.2	0.2–0.5	0.2	..	0.4
Magnesia	..	3.5	0.1	2.2	0–1.5		..	..
Zinc oxide	..		..	(Manganese oxide 3.1)	0–5	..	..	..
Lead oxide	30.2	..	..		..	31.4	(Lithia below†)	..
Soda	5.1	17.2	10.85	8.2	1.2–5.1	0.1	o—below§	4.6
Potassia	7.2	0.2	6.0		0.8–5.2	12.0	below‖	1.9

	Tableware: Lead crystal (pot-melted)	Tableware: Lime (pot-melted)	Tableware: Ma-chine-made	Chemical and heat-resisting glass: Fused silica	Chemical and heat-resisting glass: Vycor (American)	Chemical and heat-resisting glass: Pyrex brand	Chemical and heat-resisting glass: Monax	Chemical and heat-resisting glass: "Top of stove"¶	Special illuminating glasses: Mercury-vapour lamp (H.P.)	Special illuminating glasses: Sodium-vapour lamp	Special illuminating glasses: Projec-tor lamp
Silica		71–73	*See*	100	96.3	80.1	76.7	57.5	58.7	21.50	75.0
Boric oxide	*See*	0–1.5	Cheap	..	2.9	12.0	11.1	5.7	3.0	42	18.2
Alumina	Clini-	c–1	tumbler	..	} 0.4	3.1	} 2.7	{ 19.4	22.4		1.0
Iron oxide	cal	app. 0.03	and	..	}	0.08	}	{ 0.1	0.1		0.1
Lime	thermo-	5–8.5	electric	..	..	0.2	0.4	6.5	5.9	10	0.3
Magnesia	meter	0–3.5	lamp	..	..			9.2	8.4	..	..
Zinc oxide	bulb	..	bulb	..	..		2.4	..	..		
Lead oxide	glass,	..	glasses,	..	..	..	..	..	..	..	..
Soda	this	14–18	this	..	0.02	3.9	4.8	1.1	1.1	6.5	3.4
Potassia	table	0–2	table	..	0.02	0.3	1	..	0.2	..	1.9
Arsenicoxide:	above	0–0.2	above	..	0.005	0.3	..				

*Average of numerous compositions, from survey of trends over several years. †With carbon and sulphur added to the batch. ‡Also Pyrex brand glass. §Practically English lead crystal glass for tableware. ‖U.S. patent 2,392,314; with in addition calcium fluoride or baryta not more than 3%. ¶British patents 447,460; 447,585; 447,593; 479,173. All of June 30, 1936. ♀Approximate composition from batch formula.

replaced by boric oxide (borate glasses) or phosphoric oxide (phosphate glasses). Many of these are deficient in chemical stability and can be used only in protected positions. The range of these was extended after 1939 by the use of rare-earth oxides (*e.g.*, U.S. patent 2,150,694). One phosphate glass (British patent 585,257 of Feb. 3, 1947) has remarkable resistance to hydrofluoric acid solution, which rapidly attacks all ordinary glasses.

Table II sets out a number of typical glass compositions. To these may here be added that of glass fibres used for electrical insulating braids and the like. The great surface area per unit weight possessed by such fibres makes the chemical attack by moisture or acids proportionately far greater than that suffered by the same glass in lump or vessel form. For insulating fibre the very durable glass of percentage composition (approximately) SiO_2 54, B_2O_3 10, Al_2O_3 14, CaO 17, MgO 4 is used. (See Glass *Fibres*, below.)

PROPERTIES

Since chemical and physical properties are controlled largely by composition, it follows that these also can be varied over a wide range. Indeed it has been claimed that in the making of glass-to-metal seals, when the expansion characteristics of glass and metal must be matched quite closely, it is easier for the glass manufacturer to adjust his glass to match a given alloy than for the alloy maker to produce his alloy to match a given glass. In the case of such an ancient craft as glassmaking, trial and error has resulted over the centuries in the development of certain glass compositions which are particularly suited to certain processes (*e.g.*, lead crystal glass for lengthy hand forming operations), but the introduction of mechanical methods of forming and the need for glasses for electrical and other special purposes resulted in demands that could scarcely have been met without the systematic research on the effect of composition on glass properties that has been carried out in the 20th century.

Properties that are particularly important are the following:

Chemical durability, or resistance to attack by weather or by any solid, liquid or gaseous substances which the glass vessel may contain. In a very broad sense the alkali content of the glass controls this property, high alkali imparting poor durability. This is not, however, the only factor. Boric oxide, alumina, zinc oxide and zirconia all help to give increased durability in certain circumstances. Table III indicates the relative effects of some oxides on the attack of water on various simple three-component glasses of the same general type. The order of attack varies with the nature of the reagent and the temperature as well as the composition of the glass. Since the weathering and chemical corrosion of commercial glasses are usually extremely slight and noticeable only after a considerable time interval, the methods of testing durability exaggerate the severity of the conditions either by reducing the glass to the form of small grains of controlled size, thus greatly increasing the surface exposed to attack, or by raising the temperature; or both methods may be united in one test. Table IV shows the percentage losses sustained by various types of glass in the form of grains of 20–30 mesh when heated for one hour in boiling water or the reagents indicated.

In view of the effect on solutions for injections, etc., of small amounts of alkali dissolved out of the containers (ampoules), it is of paramount importance that such articles be made of really durable glass. The same applies to containers for blood storage.

Viscosity and, particularly, the rate at which viscosity changes with temperature, has an important effect on the forming of glass

TABLE 111.—*Action of Boiling Water in Three Component Glasses of General Type* $6\ SiO_2\ (2\text{-}x)\ Na_2O\ x\ RO$ *(or* R_2O_3 *or* RO_2*)*

Mols. oxide per 100 mol. silica	CaO % Loss	CaO % Na_2O	BaO % Loss	BaO % Na_2O	PbO % Loss	PbO % Na_2O	MgO % Loss	MgO % Na_2O	ZnO % Loss	ZnO % Na_2O	Al_2O_3 % Loss	Al_2O_3 % Na_2O	ZrO_2 % Loss	ZrO_2 % Na_2O
2	23.0	8.2	43.7	17.6	17.0	6.7	..	..	10.8	7.2	..	..	2.6	1.8
4	2.4	2.3	13.0	5.5	2.0	1.8	2.3	1.4	1.3	1.6	0.7	0.6	0.6	0.4
6	0.9	1.0	3.0	1.9	0.7	0.6	0.9	0.8	0.4	0.3	0.4	0.2	0.2	0.2
8	0.5	0.5	0.8	0.7	0.4	0.3	0.4	0.3	0.2	0.2	0.2	0.1	..	
10	0.3	0.25	0.4	0.2	0.3	0.1	0.3	0.1	0.16	0.1	0.17	0.03	..	
14	0.21	0.05	0.34	0.06	..	..	0.12	0.05	0.10	0.04	..			..
18	0.17	0.02	..		..	..	0.06	0.02	..	..	..	..	..	

Percentage loss in weight, and Na_2O (soda) extracted

TABLE IV.—*Comparative* Durabilities (Powder Method)

Glass	Water % loss	Constant boiling hydrochloric acid % loss	Approximately 2.5% sodium carbonate solution % loss	Approximately 2% caustic soda % loss
Bottle glass good . .	0.09	0.08	0.53	1.40
Bottle glass: bad . .	0.27	0.18	1.78	1.99
Leadcrystalglass (22% PbO)	0.31	0.37	2.10	3.36
Leadcrystalglass (28% PbO)	0.16	0.26	1.98	3.20
Chemical ware . . .	0.02–0.06	0.06–0.11	0.22–0.6	1.6–3.9
Gauge glass tubing . .	0.01–0.02	..		
Ampoule tubing . . .	0.01–0.05	..	..	
Soft soda tubing . .	0.1	..	..	

while hot and plastic. Since such operations often proceed step by step, it is necessary that the glass remain soft enough to yield to formative pressure over a considerable range of temperature, ending at a viscosity high enough to retain the final shape. Alteration of the forming process thus means quite often alteration of composition in order to secure the required viscosity. The lead crystal glass used for hand working remains soft over much too wide a range of temperature to suit an automatic bottle-forming machine, and the glass suitable for the latter again would not be suitable for flat glass-drawing machines. Viscosities of 10^3 c.g.s. (centimetre-gram-second) units (poises) (furnace working temperature), 10^6 c.g.s. units (lower limit of working range) and 10^{13}–10^{14} c.g.s. units (T_g or transformation point) are important in glassworking.

Softening Point.—The softening of glass is a time-temperature phenomenon. Useful data, however, result from finding the temperature at which a rod of standard dimensions, heated in a standard apparatus at a standard rate, begins to elongate at a defined rate under its own weight. Such a temperature is the Littleton softening point. Values range from 500°–1,100° C. It corresponds with a viscosity of 4.5×10^7 poises.

Annealing Point.—This is defined as the temperature at which strain will be relieved in 15 minutes, corresponding with a viscosity of 2.5×10^{13} c.g.s. units.

Surface tension plays an important part in forming operations. It closes the ends of tubes when heated, draws in the skirt of an electric bulb envelope to seal to the flare of the stem and prevents glass from penetrating into minute crevices in moulds. Values for silicate glasses are around 300 dynes per centimetre.

Density.—Ordinary bottle and window glasses have densities in the region of 2.5. That of lead crystal glass is approximately 3.1, of "densest flint" optical glass 7.2 and of fused silica 2.2. Factors enabling density to be calculated from composition have been applied with partial success.

Thermal expansion is important as a factor in the resistance of glass to heat shock and in determining the stresses set up in windows under alternating heating (solar radiation) and coding (rain). A very powerful factor is alkali content, since both sodium and potassium oxides markedly increase the expansion. Values range from 56×10^{-7} to 140×10^{-7} cm. per centimetre per degree centigrade. (Silica glass 5.6×10^{-7}, Vycor glass 8×10^{-7}, Pyrex glass 32–36×10^{-7}, bottle glass 82–88×10^{-7}, lead crystal glass 88×10^{-7}.) In glass-to-metal seals the expansions of glass and metal must match closely over the range of temperature in which glass cannot yield to stress.

Thermal Endurance.—Thermal expansion, mechanical strength, the dimensions of the article and the rate at which heat is spread affect thermal endurance. Glass rods of Pyrex type in one test withstood, when dropped into cold water, a shock of 325° C., while soft lamp-working glass withstood only 112° C. and a commercial soda-lime glass 131° C. Tests of this property are routine practice in many glassworks to detect faulty ware as it is very sensitive to departures from normal technique.

Thermal Conductivity.—Values range from 0.0078 to 0.0028 cal. per centimetre per degree centigrade per second. High soda, potash and lead oxide contents decrease thermal conductivity, while high silica and boric oxide increase it.

Mechanical Properties.—Glass is very strong in compression. When it breaks it does so in tension. Compressive strength ranges from 90,000 to 180,000 lb. per square inch, tensile strength from 4,000 to 1,500,000 lb. per square inch (depending on cross-sectional area of specimen), Young's modulus 6,500,000 lb. per square inch, Poisson's ratio (σ) 0.14–0.271 (ordinary glass about 0.22). The true strength of glass is never realized in tests. Reduction in diameter of a test piece results in higher and higher values, thought to be a result of the reduction of the number of chance flaws in the glass surface from which fracture begins.

Considerably greater strength is obtained from simple shapes by a controlled sudden chilling instead of the normal annealing. Such "toughened" glass used as an automobile window will withstand an impact roughly eight times that needed to break ordinary glass of the same thickness.

Containers such as milk bottles make many trips between factory and consumer. The improvement in mechanical and thermal properties achieved is illustrated by the fact that whereas 20 trips was regarded as average in the 1920s, the figure in 1954 was nearer 60. Improved design of containers also helped.

Electrical Properties.—Conductivity of glass varies with composition and increases with temperature; therefore, though glass is a good insulator at room temperature, it is possible when it is raised to red heat to pass sufficient current through the mass to raise the temperature to 1,400° C. and continue melting by electrical energy. High alkali content gives (relatively) high conductivity or low resistivity. Resistivity ranges from 10^8 to 10^{18} ohms per cubic centimetre. Lead glasses of good working properties have high resistivity and so are used in electric lamps to support the filament.

Dielectric constant depends on composition and on the temperature and the frequency. It varies from 3.7 to 16.5. Pyrex-type

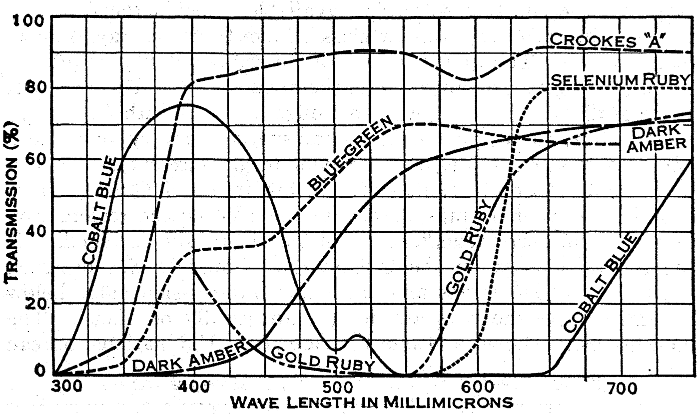


FIG. 1.—TRANSMISSION OF VARIOUS COLOURED GLASSES FOR LIGHT OF DIFFERENT WAVE LENGTHS

glass has the low value of 4.1–5.0. Dielectric loss varies with frequency. For Pyrex-type glass the value changes from 1.9×10^{-2} to 4×10^{-2} as frequency falls from 10^6 cycles to 10^3 cycles. Values for most glasses are around 1–2×10^{-2}.

Optical Properties.—Refractive index (for sodium D line) varies from 1.458 (fused silica) through 1.478 for Fluor Crown, 1.517 for Hard Crown, 1.613 for Dense Barium Crown, 1.613 for Dense Flint, 1.668 for Dense Barium Flint to 1.717 for Double Extra Dense Flint.

Dispersion (difference between refractive indexes for wave lengths in different parts of the spectrum) varies between (Fraunhofer lines C–F) 0.007 for fused silica and 0.024 for Double Extra Dense Flint glass.

Stress Optical *Coefficient.*—Under stress glass behaves as a uniaxial optically negative crystal (Brewster); that is, it rotates the plane of polarization of light passing through it. On this depends the working of the strain viewer used to test whether an article is properly annealed or not.

Absorption and Transmission.—Of the "white" light falling on a glass plate at right angles to the surface, some is reflected, some is absorbed and some emerges at the other surface. The absorption is not the same for all wave lengths, so the emerging light is relatively stronger in some wave lengths than others in comparison with the incident light. Instead of now being ordinary white light it is coloured. The extent of the absorption in the various wave lengths depends upon the glass composition, the thickness and the temperature. Fig. 1 shows the behaviour of a number of glasses. Specially interesting are (1) glasses very low in iron content, which transmit ultra-violet light (quartz glass is best); (2) glasses of high ferrous iron content, which cut off both ultra-violet and heat radiation, as spectacles for furnace workers; and (3) glasses containing nickel oxide, which transmit ultra-violet but no visible light.

Ultra-Violet Ray Transmitting Glass.—Glasses having the property of transmitting radiations of shorter wave length than occur in the visible spectrum (that is, shorter than 400 $m\mu$, the sign $m\mu$ representing 1 millimicron or $\frac{1}{10,000,000}$ cm.) have been known for many years. Fused silica or quartz provides a glass transmitting rays down to 190 $m\mu$. In 1907 E. Zschimmer prepared in small quantities a number of glasses having transmission limits varying from 186 $m\mu$ to 280 $m\mu$. As the most active rays which affect a photographic plate are those of short wave length, lenses which transmit well in the ultra-violet are advantageous in camera work. O. Schott, at Jena, introduced such a glass under the name of "Uviol." Good ultra-violet transmission is important especially for stellar photography.

The stimulus to the development of ultra-violet transmitting sheet glass was the study by Bernard at Samaden and Auguste Rollier at Leysin, Switz., of the beneficial effect of high alpine sunlight on tuberculosis patients, and the employment of electric arc lamps having a high output of ultra-violet rays for combating rickets. The rays of therapeutic value are confined to a small region from about 297 to 307 $m\mu$. Because of atmospheric absorption, the shortest solar rays available, even in the Alps, are 295 $m\mu$, but ordinary window glass seldom transmits rays shorter than 310 $m\mu$. The question arose as to the possibility of preparing window glass to transmit the therapeutic rays. This was first successfully done by F. E. Lamplough in 1925 with Vita-glass. Like quartz, fused boric oxide is transparent to very short rays, and Vita-glass resembles ordinary window glass except that it contains about 2% boric oxide and is of low iron and titanium oxide content. For high transparency in the ultra-violet region, iron oxide in the ferric condition must be rigorously excluded. Of the several glasses on the U.S. market, Corex D was designed primarily for sun lamps and has a low transmission value below 290 $m\mu$ where the rays are not therapeutically beneficial. The measurements shown in Table V, made at the U.S. national bureau

TABLE V.—*Ultra-Violet Ray Transmission, at 302 $m\mu$*

Glass	New	After stabilization	Glass	New	After stabilization
Corex D . .	64	62	Holvi . .	40	36
Neuglas . .	63	49	Vita . .	48	23
Uviol . . .	70	51	Sanalux .	48	26
Helio . .	58	40			

of standards on samples two millimetres thick, indicate the transmission in the region of therapeutic value of a number of specimens of glasses available. After short service the transmission of most such glasses diminishes considerably and then remains constant. The amount of the decrease is indicated in the third column, which shows transmission values after stabilization. (*See* also LIGHT; SPECTROSCOPY.)

MANUFACTURE AND USES

Raw Materials.—The oxides shown in the conventional expressions of glass compositions are not always present as such in the mixture, known as "batch," charged into the melting furnace. In many cases the material furnishing them to the glass is a carbonate; sometimes it is a nitrate or sulphate or possibly a hydroxide. In Table VI are set out a number of oxides which take part in glass formation, with the usual raw materials employed to introduce them into the batch.

Materials may be chosen for their cheapness or for some property in addition to their capacity to yield a desired constituent. Thus alkali nitrates, much more expensive than the carbonates per

TABLE VI.—*Chief Raw Materials Used in Making Glass*

Glass constituent	Formula	Raw material	Per cent of raw material remaining in glass: Material	Per cent
Aluminum oxide .	Al_2O_3	Hydrated alumina		65.4
		Calcined alumina		100
		Felspar	Al_2O_3	18
			$K_2O(Na_2O)$	13*
			SiO_2	68
		Lepidolite	SiO_2	53
			Al_2O_3	27
			K_2O	10
			Li_2O	4%*
			F_2	4
		Cryolite	NaF	(Some loss of F as SiF_4)
			AlF_3	
Arsenic oxide . .	Sb_2O_3, As_2O_3, As_2O_5	Arsenious oxide	As_2O_3	(Some loss by volatilization)
Barium oxide . .	BaO	Barium carbonate	$BaCO_3$	77.7
		Barium sulphate	$BaSO_4$	65.7
Boric oxide . . .	B_2O_3	Boric acid	H_3BO_3	56.3
		Borax (hydrated)	B_2O_3	36.5
			Na_2O	16.3
		Borax (anhydrous)	B_2O_3	69.2
			Na_2O	30.8
Calcium oxide . .	CaO	Limestone	$CaCO_3$	56.0
		Burnt lime	CaO	100
		Hydrated lime	$Ca(OH)_2$	75.7
		Dolomite (raw)	CaO	30.4
			MgO	21.8
		(burnt)	CaO	58.2
			MgO	41.8
Lead oxide . . .	PbO	Litharge	PbO	100
		Red lead	"Pb_3O_4"	97.7
Magnesium oxide	MgO	Magnesium carbonate	$MgCO_3$	47.6
		Dolomite (see above)		
Phosphorus pentoxide	P_2O_5	Aluminum phosphate	Al_2O_3	41.8
			P_2O_5	58.2
		Calcium phosphate (bone ash)	CaO	54.1
			P_2O_5	45.9
		Sodium phosphate .	Na_2O	43.6
			P_2O_5	50.0
Potassium oxide . .	K_2O	Potassium carbonate calcined		68.1
		Potassium nitrate		46.5
Silica	SiO_2	Sand (quartz)	SiO_2	100 less impurities
Sodium oxide . .	Na_2O	Soda ash	Na_2CO_3	58.5
		Salt cake	Na_2SO_4	43.7
		Soda nitre	$NaNO_3$	36.5
		Borax (*q.v.*)		
		Sodium silicofluoride	Na_2SiF_6	
		Soda felspar (*q.v.*)		
Zinc oxide . . .	ZnO	Zinc oxide		100

*Approximate figures.

unit of oxide contributed to the glass, are sometimes employed because they assist melting and provide an oxidizing atmosphere which is desirable when melting lead glasses and certain coloured glasses. Sundry fluorides are used not for their alkali or calcium contents but because they contribute fluorides which opacify the glass if in sufficient amount or speed up melting and refining when used in small quantities. The colours produced by various materials are indicated in Table VII. Such colours are either "solution" colours or owe their action to finely divided particles dispersed through the main glass mass; *e.g.*, gold and other ruby glasses.

Sand is a most important material. It must possess a reasonably uniform grain size with no large grains and little dusty material and for colourless glass must contain very little iron oxide (0.04% maximum for good-quality containers, 0.02% for lead crystal tableware and not more than 0.006% for optical glass; window-glass sands may contain as much as 0.10% obtained by blending good sands with poorer ones); other colouring oxides should not be present in amount to give rise to detectable colour.

Batch Preparation.—The raw materials are stored in bins, "silos" or sacks and are weighed out, mixed and sent to the furnace. In large installations the weighing may be automatic, material being fed in predetermined sequence to a weighing machine so interlocked that further use is impossible until correct weight is shown. When weighed out, the batch is tipped into a mixer, frequently of the well-known concrete-mixer type. and is discharged to a hopper which holds one "mixing" or is elevated and conveyed to a storage bin. Very special batches (*e.g.*, for optical or coloured glass not made in quantity) are sometimes mixed by hand and shovel in wooden tubs. Conveying of batch is by bucket or belt conveyor, by "unit mix" hopper on a monorail or by compressed air along a tube. Segregation by vibration or

TABLE VII.—*Colouring Materials*

Glass constituent	Per cent present in glass	Batch material	Colour produced	Melting conditions
Copper	0.03–0.1	Cuprous oxide	Ruby	Reducing
Copper oxide	0.2–2	Cupric oxide, Copper carbonate, Copper sulphate	Blue-green	Oxidizing
Cadmium sulpho-selenide	0.03–0.1	Cadmium sulpho-selenide; Cadmium sulphide+ selenium	Ruby	Reducing
		Cadmium sulphidef selenium+ sulphur	Orange	Reducing
Cadmium sulphide	0.03–0.1	Cadmium sulphide+ sulphur	Yellow	Reducing
Ferric oxide	up to 4	Ferric oxide	Yellow-green	Oxidizing
Chromium oxide	0.05–0.2	Chromium oxide; Potassium bichromate or chromate	Green to Yellow-green	Oxidizing
Ferrous oxide		Ferrous oxalate	Blue-green	Reducing
Gold	0.01–0.03	Purple of cassius; Gold chloride	Ruby	Slightly reducing, (best in lead glass)
Carbon and sulphur compounds		Carbon and sulphur; Carbon and salt cake	Amber	Reducing
Iron oxide; Manganese oxide	1–2; 2–4	Ferric oxide; Pyrolusite	Amber	Oxidizing
Uranium oxide	0.1–1	Yellow uranium oxide	Yellow with green fluorescence	Oxidizing
Selenium		Selenium in potash lime glass	Pink	Slightly oxidizing
Selenides		Selenium in had glass	Amber	"
Manganese oxide	0.5–3	Pyrolusite	Pink-purple	Oxidizing
Nickel oxide	0.05–0.5	Nickel oxide, hydroxide or carbonate	In soda glass brown; In potash glass purple	Indifferent
Neodymium oxide	up to 2	Neodymium oxide	Pink	Oxidizing (best in lead glass)
Cobalt oxide	0.001–0.1	Cobalt oxide; Smalt	Blue with high red transmission	Sot markedly affected

"free fall" is of course a danger, and briquetting of mixed batch is claimed as a solution to such segregation troubles. It is customary and in general beneficial to include in the mixing a proportion of broken glass of the same composition as that to be made. This comes naturally from waste glass incidental to manufacture and is called cullet. It should be of small-sized pieces.

Batch Feeding.—To large furnaces this is generally automatic by screw or pusher feeding device or by discharging a thin stream across the furnace to form a "blanket" of batch. When melting is done in pots, hand filling with shovels is the rule except in some plate-glass works where power-operated ladles are used.

Glass Melting Furnaces.—Meltings in early times were carried out in clay pots heated by wood. The process, on more modern lines, still persists, but producer gas from coal or lignite, oil, coke-oven gas and natural gas are the common fuels. Electric heating is employed where power is cheap and other fuels expensive (Switzerland) or as a boost to other methods. Special glasses and those made in small quantity are generally melted in pot furnaces containing 1–20 pots (most often 8–12). The pots may be open or "closed"—*i.e.*, covered with a hooded side opening which abuts on a hole in the furnace wall so that the flame gases have no access and cannot affect the glass. Their capacity ranges from a few pounds to 30 cwt., and shapes vary. A common one has an egg-shaped horizontal section so that the maximum amount of floor space of a circular furnace may be used. The clay mixture contains raw clay with a percentage (30 or more) of carefully graded prefired clay ("grog"). Sometimes so-called sillimanite is used as grog. The making is either by hand from rolls of plastic mixture or by casting a fluid slip in plastic moulds as in the pottery industry. Drying must be slow and very carefully controlled and, before being placed in the melting furnace, pots are heated in a "pot arch" to a temperature in excess of 1,000° C. and are transferred hot. A ring of clay is placed in each to define a clean area from which molten glass will be gathered. The flames come from ports, generally in the floor of the furnace but sometimes in the end walls in the case of rectangular furnaces (pots in two parallel rows), and, circulating over the pots, pass out by flues in the pillars supporting the crown or by a port at the opposite end as the case may be. Larger amounts of glass are melted in tank furnaces, based on the invention of Friedrich and William Siemens, in which the walls define the glass-melting area and the flame passes over the surface of the glass.

Those of small size, 2–10 tons' capacity, may be "day tanks" in which glass is melted overnight and worked out during the day, or melted one day and night and then worked out. Bigger tanks are continuous, batch being charged at one end into a "doghouse" and removed as reasonably homogeneous glass at the other for feeding to forming machines. Such tanks (see fig. 2) are divided into melting and working ends by a bridge wall. Communication is either through a "doghole" in the bridge or by a submerged "throat" which connects holes in the floor of each compartment. The flames may pass from side to side (cross-firing) or, entering at the back wall, pass down to the bridge and return (horseshoe firing) or, in small tanks, pass down from the back walls and out through ports at either side of the bridge. In yet another form the furnace crown is hollow and the flame from the back wall returns from near the bridge between the false crown and the outer one to pass to a heat recovery system. Such systems may be (1) regenerative, in which the waste gases heat stacks of brickwork which then, by reversal of flame direction, are used to preheat the combustion air and fuel gas, or (2) recuperative, in which the gas flow through the system is constantly in one direction and the waste gases pass over tubes through which the combustion air is led for preheating. Large tanks of the window-glass type are 136 ft. long and 28 ft. uide and hold approximately 5-ft. depth of glass; *i.e.*, approximately 1,000 tons. Gas consumption for such a tank is about 50,000,000 cu.ft. per month.

During melting, carbonates, sulphates, nitrates. etc. in the batch decompose, with evolution of the corresponding acid gases (CO_2, SO_3, etc.). In addition, water is driven off from wet sand

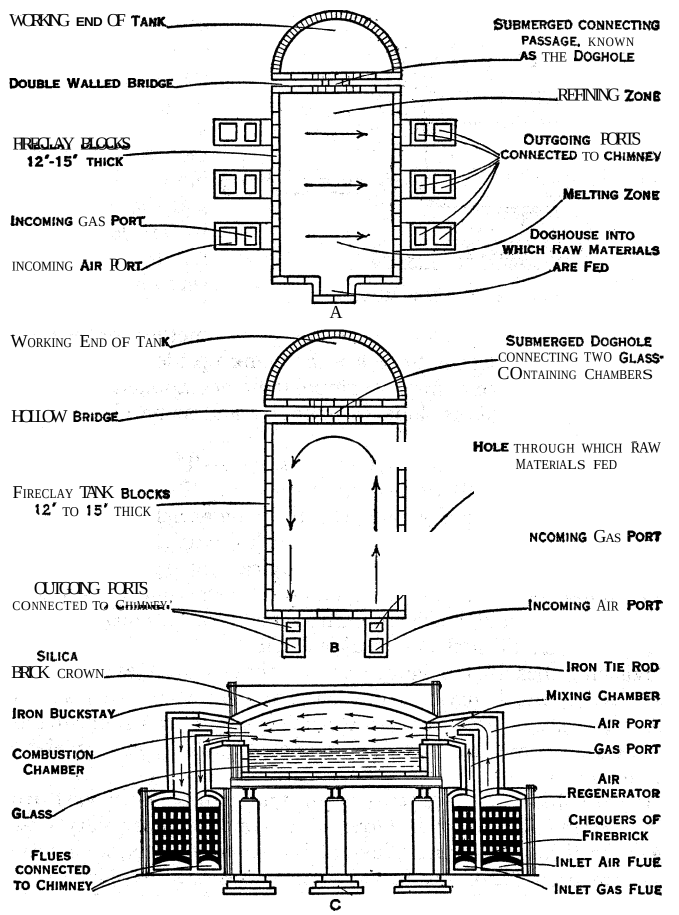


FIG. 2.—PLANS OF TWO TYPES OF TANK FURNACES FOR MELTING GLASS

A. Plan of cross-flame furnace. B. Plan of horseshoe-flame furnace. C. Cross section of oross-flame furnace and from some crystalline salts; *e.g.*, borax. The more easily fusible materials form a glaze. which speeds up reaction by increasing surface contact. and the proportion of molten matter increases at the expense of undissolved grains (mostly silica). Finally the last trace of batch disappears but the melt is full of bubbles ("seedy"). The temperature is now raised somewhat to reduce viscosity and to complete decomposition so that the bubbles disappear, after which the temperature is slowly reduced from the 1,400°–1,500° C. (1,600° for Pyrex-type glass) at which melting is carried out to the working temperature of around 1,250°–1,400° C., depending on the composition. This temperature gradient from end to end of the tank is achieved by proper location and size of burners and by screening the working end in some cases by a "shadow wall" built on the bridge.

Glass Forming Processes.—Hand Processes.—These are generally applied to pot-melted, good-quality glass, frequently lead crystal because its working properties suit the leisurely sequence of manipulations involved. After the glass within the ring in the pot has been skimmed clean, an amount of glass is gathered on the blowpipe and withdrawn, the tail of glass being dropped at the instant of separation outside the ring so that it does not contaminate the next gather. By blowing. rolling on a polished iron plate (marver). swinging, etc.. the glass is formed into a hollow, pear-shaped bulb. The blowpipe may be rolled up and down the long arms of the glassmaker's chair while he works on it with shearlike tools (pucellas or procellas) to constrict it, draw it out, flatten the base with a wooden "battledore" and so on. Extra glass may be cast on to form stems, bases, handles, etc. The glass is then attached at the base to a rod (punty) and is cracked off the pipe so that the other end of the article may be finished, using the rod as axis of rotation. Production can be speeded up by blowing the body of the article in a mould and then finishing at the chair. Large articles such as illuminating globes are mouth-blown in moulds, and the excess glass is cracked off by heating at a diamond scratch after annealing. An alternative method of removing the waste cap of glass is to rotate the blank upside down and melt off the waste by very intense pinpoint flames applied at the line of separation. This is done for tumbler and some electric lamp blanks.

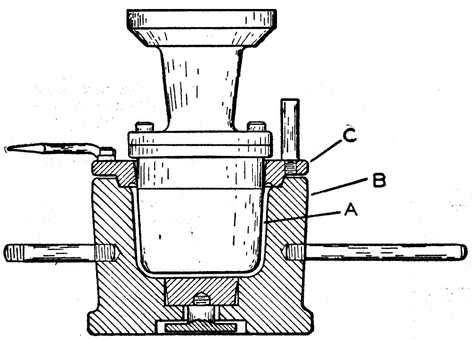


FIG. 3.—PRESS MOULD
A. Plunger. B. Mould body. C. Ring

Lamp Working (Bench Glass Blowing).—This is carried out using tubing and rods of various diameters. They are heated in the flame of a gas-air blowpipe, the air being enriched with oxygen when borosilicate glass is worked. The articles made include chemical and other scientific and surgical apparatus (*e.g.*, glass eyes, ampoules, syringes, thermometers), egg timers, decorative figures and animals, beads and Christmas tree ornaments.

The making of such items as electric lamps, radio valves and television tubes is a development of these processes, but it has been largely mechanized, while massive components of glass pipe lines and heavy chemical apparatus are handled by semimechanical processes. Some use has been made of high-frequency electric welding.

Moulds for glass are mostly of fine-grained gray cast iron. When extra-high polish is required or conditions are very exacting, special heat-resisting alloys of the stainless steel or nichrome type are used. Moulds for most purposes are used hot, sometimes at temperatures approaching 600° C.; but for thin-walled hollow ware they are used wet and are coated with a paste (comprising carbonizable material with a binder) to retain the water, which provides a cushion of steam between glass and mould when the former is rotated. Usually the moulds are of two or more sections in the body, together with a base and in some cases (for example, for pressing) a ring (fig. 3) to define the upper edge of glass and to locate the plunger in proper relation to the mould body.

Moulds used for automatic machines present problems in cooling. This factor largely controls the rate of working.

Mechanical Methods.—These involve pressing, blowing, drawing, casting, rolling. individually or in combinations of two or more processes. Thus bottles may be made by press and blow or blow and blow (or suck and blow) methods as described in BOTTLES.

Feeding Glass to Machines.—This is done by hand in the semi-automatic processes which are still operated to deal with special shapes. The glass is gathered on an iron rod with a ball-shaped end and is allowed to run off the latter into the mould The machine operator shears through the stream when sufficient glass has been supplied. Fully automatic container-forming machines either gather their own mould charges by suction from a pool of glass or receive separate charges extruded from a feeder channel running from the working end of a tank furnace and cut off by mechanically or pneumatically operated shears Very accurate control of glass level, glass homogeneity, temperature and feeder mechanism is needed to deliver charges of constant weight to make articles of constant capacity.

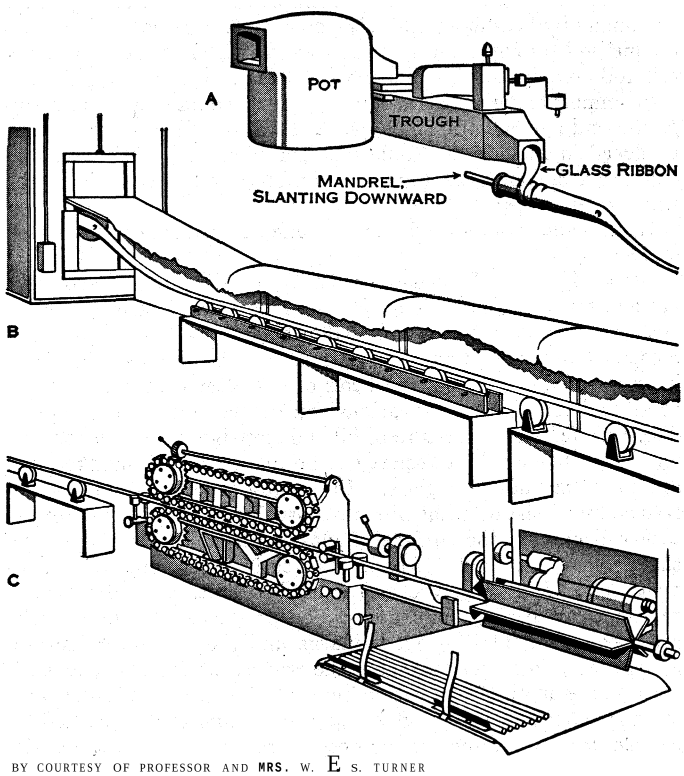
Pressed Glass.—The moulds may be "block" (*i.e.*, body in one piece), with a movable base to eject the pressed article, or, for heavily decorated pieces, the body may be in three, four or more sections hinged to swing open to clear projections. For ware of precise dimensions or when a number of articles are desired at one pressing, font moulds are used, with cavities fed from a central reservoir at which the pressure is applied by plunger and in which excess glass remains to form a means for removing the pressing from the mould. Automatic presses carry a number of moulds on a circular table, rotated step by step to bring each in turn below a charging device (feeder), then to a pressing station and, after a sufficient interval for cooling, to a take-out point. Pressure in automatic machines is generally exerted by compressed air through a cylinder and piston and a toggle linkage. Hand presses operate as a rule by lever and crank Glass blocks for light-transmitting walls are made by welding together at the edges two rectangular cup-shaped pressings. They have good thermal- and sound-insulating properties. and when prismatic ribs are formed on the inside surfaces considerable spreading of the transmitted light results.

Light-Blown Hollow Ware.—Blanks for making tumblers, electric lamp envelopes and the like are made on \Vestlake-type machines or on the Corning ribbon machine. The former machine follows to a considerable extent the motions of a hand worker but uses shorter pipes and gathers by suction. The Corning machine takes a continuously rolled ribbon of glass bearing thickened hot portions spaced by thinner cold ones and from the hot "blobs" blows the blank, using blowheads on one continuous belt above the ribbon and moulds on another belt below it. Speeds of up to 1,000 or more bulbs per minute are attainable.

Drawing Processes.—Tubing.—In drawing tubing by hand, a parison of suitable shape, generally thick-walled, is attached at the free end to a punty and is then drawn out. The drawn tube (or rod if not blown out) is rested on a ladderlike rack and is cut up into lengths. There is much waste glass attached to both pipe and punty.

In mechanical drawing, a stream of glass flows as a flat ribbon onto a revolving, hollow, downwardly inclined mandrel, blends thereon to a uniformly thick coating and is drawn off the lower end as a tube if air is blown into the upper end at relatively low pressure (up to 18 in. water gauge). The size of mandrel nose, temperature and rate of feed and removal of glass together with the pressure of air determine tubing dimensions. Drawing speeds range from about 20 to 850 ft. per minute. Removal is controlled by a drawing device, located 100–200 ft. away, consisting of two endless caterpillar belts whose asbestos-faced shoes engage the tubing or rod which is by that time almost cold. Various devices on the machine are used to cut the glass into lengths depending on its thickness and diameter. This is the Danner process (fig. 4), which is much used.

Precision-Bore Tubing.—Suitable tubing is caused to pass over



BY COURTESY OF PROFESSOR AND MRS. W. E. S. TURNER

FIG. 4—THE DANNER MACHINE FOR DRAWING GLASS TUBING

A. Molten glass is delivered at a controlled rate from pot (charged from a separate furnace) through trough onto rotating mandrel. B. Runway, furnace end; the glass tubing is drawn away from the mandrel end over heat-insulated pulleys. C. Runway, tractor end; the glass tubing is drawn rapidly by tractor mechanism at end of runway into a length-cutting machine

a sizing mandrel while hot and plastic, and is collapsed upon it to produce a very accurate bore by exhausting the air within the portion of tube adjacent to the mandrel. The tubing is then used to form, *e.g.,* barrels for hypodermic syringes, without need for internal grinding—a process which would much reduce its strength and increase its liability to attack by chemicals and sterilizers in use.

Glass *Fibres.*—*See* below.

Sheet Glass.—Early sheet glass was hand-made (1) by blowing a large parison, attaching to a punty, cracking off from the pipe, reheating and spinning the pipe so that centrifugal force caused the glass to spread out to form a disk attached at its thickened centre to the pipe; (2) by blowing and swinging the parison so that it elongated to form a long cylinder which was then, after cracking off the ends, split longitudinally and opened out while heated in a flattening kiln till it lay on a smooth refractory "stone" hearth. The first step in mechanization, attributable to J. H. Lubbers, was production of glass cylinders approximately 40 ft. long by 30 in. in diameter which were similarly treated. Present methods are in principle two. The first is upward drawing from a pool of glass, the line of draw being located either by a slot in the bottom of a long fire clay boat (Fourcault process) or by a cooling bar placed a little below the surface (Slingluff or Pittsburgh process). When the sheet is a few feet above glass level it is rigid enough to be engaged by the first of a series of pairs of asbestos-faced rollers which continue to draw it upward (fig. 5). The ribbon is cut into sheets which are removed as they emerge and are stored after washing in dilute acid to remove surface deposit. The second method is horizontal drawing (Colburn or Libbey-Owens process). Here, although the sheet is drawn vertically from the pool in the drawing chamber or trough, it is then bent over a nichrome roller (fig. 6) and passed between two endless belts which draw it forward to proceed into a 200-ft.-long roller annealing furnace (leer or lehr), at the cold end of which it is cut into sections. The speed depends on the thickness of the sheet and is of the order of 100 in. per minute for thin glass. The process may be applied to furnish glass for grinding and polishing as plate glass. Production per machine is much greater with the Colburn than with the Fourcault process.

Rolled Glass.—Originally the demarcation between sheet and plate glass was sharp. One was blown, the other cast, rolled and (generally) ground and polished to a flat surface on each side. The demarcation is not so clean-cut nowadays. The first cast and rolled plate is ascribed to Lucas de Nehou in 1688. A process of casting molten glass onto an inclined table feeding a pair of rolls was developed by Chance Brothers and E. F. Chance in 1890 to produce figured (*i.e.,* patterned surface) glass. The discontinuous processes reached peak development in the Bicheroux process (1918), in which the glass rolled from the teemed contents of a pot is received on a train of cars moved past the inclined rolling table, shears cutting between the cars to enable each in turn to be hauled away to the annealing leer. Continuous methods for making polished plate are typified by those of the Ford Motor company and Pilkington Brothers Limited. In the first the glass passes from the melting furnace through a channel under close control of temperature and quantity and flows in a widening stream down an inclined spout to feed a large-diameter bottom roll working with a small-diameter top roll. The 40-in.-wide rolled ribbon passes directly into a leer 440 ft. long, which it traverses in about $2\frac{1}{2}$ hours. The glass is then cut into lengths and ground and polished. In the Pilkington process, the width of ribbon may be much wider, and in one form it passes directly without cutting from the leer to the grinding and polishing section in which it is operated upon on both upper and lower surfaces at once (twin plate process).

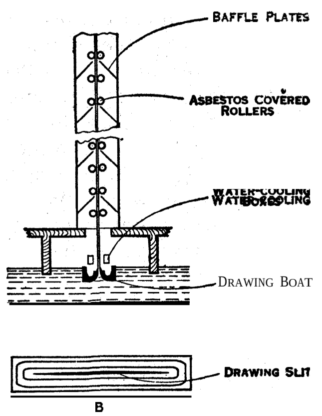


FIG. 5.—PRINCIPLE OF THE FOURCAULT SHEET-GLASS DRAWING PROCESS

Grinding and Polishing of Plate Glass.—The old discontinuous process involved setting sheets of glass in plaster on huge 30-ft.-diameter circular cast-iron tables. Spaces between sheets were filled with waste glass. The tables were then taken to the motor and rotated below a "spider" carrying a number of cast-iron "tools," which had on their under surfaces "nogs" to engage the glass, with spaces between through which sand or emery could be carried by water as a slurry to do the abrading. Starting with fairly coarse sand, the size of abrasive was reduced stage by stage until a very smooth gray surface was obtained. The tools were then changed for polisher disks faced with felt charged with rouge and water. This brought about the final polish (see LENS). It was the irregularity of surface of cast and rolled rough plate, which

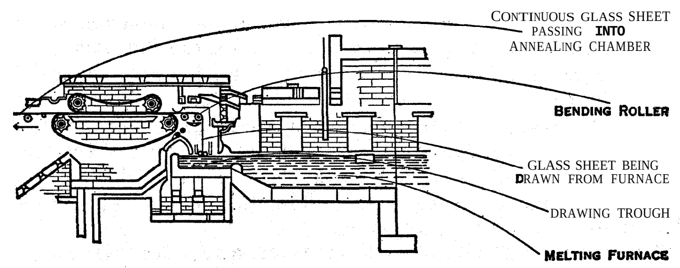


FIG. 6.—PRINCIPLE OF THE COLBURN (OR LIBBEY-OWENS) SHEET-GLASS DRAWING PROCESS

made necessary the removal of so much material, that encouraged the development of later methods using pairs of rollers instead of a casting table and "rolling pin." The continuous grinding and polishing methods of Ford and others involve bedding the glass on fabric on carefully levelled cars passing down a track to bring their contents in turn below a series of independent motor-driven heads operating tools supplied with successively finer abrasive and. after a space for cleaning and inspection, under similarly driven polishing heads supplied with rouge paste. Elaborate arrangements for collecting, regrading and returning abrasive to the system may be provided. The glass, polished on one face, is rebedded and the process repeated, on a second line, on the opposite face. The Pilkington twin plate process saves cars and double track.

Foam Glass.—The insulating value of glass fibre is well established. A sort of vitreous "sorbo" has been made which in addition to possessing good insulation properties will carry some load and can be dressed to dimensions without special tools. This is produced by packing into moulds crushed glass grains mixed with a substance (*e.g.,* carbonaceous material or limestone) which. at a temperature at which the grains become soft enough to sinter together, will produce bubbles of gas. The moulds are passed through a furnace and the product in large slabs is sawed into suitable blocks. It is used for partition walls in building and as thermal insulation. It is light enough to float in water, has a very low absorption of the latter (2%) and, being rotproof and verminproof, may be considered as a substitute for cork.

Annealing.— The free cooling of glass from the molten state results in solidification first on the outside. Such material, being rigid, resists the inward pull of the hotter glass inside, which. in cooling down to room temperature, needs to contract more than that on the surface. Such a piece of glass is left with the surface in compression if of simple shape (*e.g.,* a sphere). As such it is strong against mechanical shock. Surfaces with sudden changes of contour, on the contrary, are in similar circumstances very prone to disruption by the application of slight additional stress, mechanical or thermal. To make commercial glassware safe in use it must, after receiving its final shaping, be cooled very slowly from a temperature at which it is soft enough for stresses to be relieved in a few minutes to a lower temperature, below which it is not possible to introduce permanent stress by sudden cooling. From that point the limit to the rate of cooling is the ability of the article to withstand the temporary stresses set up by the thermal gradient at the moment. The process may be carried out (1) batchwise, in kilns uhich are charged, heated and cooled (optical glass and certain very thick-walled goods), or (2) most often, by passing the ware on a conveyor belt down a tunnel leer, 2 ft. 6 in. to 11 ft. wide and 30 ft. to 440 ft. long, in which a suitable temperature gradient is established. The atmosphere in the leer may be controlled to affect the surface of the glass and improve durability. Heating is by gas, oil or electricity. Modern leers. because of good insulation and rapid transfer of ware from machines, need little additional heat above that taken in by the hot glass itself. The time to anneal depends upon the wall thickness of the article. Very thin ware, such as electric lamp bulbs, needs only a few minutes; containers generally need one to two hours in leers 65–75 ft. long. Rolled plate glass needs very long leers because of the speed with which the ribbon is produced and fed forward. A slow speed in a roller conveyor or leer would allow the ribbon to sag between the rollers and destroy its flatness.

Processes Applied After Formation and Annealing.—Removing Waste Caps From Blanks.—This is done by (1) cracking off, either by making a crack in the plane of separation and then heating in this plane with needle-point flames, or by heating first and then scratching; or (2) melting off as described earlier.

Edge Grinding.—Dishes, globes, illuminating bowls, tumblers, etc. are held down on a horizontally rotating iron disk fed with abrasive and water. Alternatively, a fine grit sandstone wheel is used.

Fire Finishing.— The ground edges are heated first in a soft flame and then in a high-intensity flame till fusion rounds them and removes the grayness. Slow cooling follows. With tumblers less bead is produced this way than by melting off.

Decorative *Cutting* (Grinding).—The design is roughed out on the article in a water-resistant paint and is then cut on an abrasive wheel. Formerly this was an iron disk with mitred edge fed with sand and water. The process, repeated with emery and water, gave a smoother finish which was further improved by powdered pumice and finally by brushing with putty powder (tin oxide). The modern method employs first a silicon carbide wheel of, say, 80 to 100 grit followed by an alumina wheel of, say, 150 to 180 grit and then immersion in an acid polishing bath containing strong sulphuric and hydrofluoric acids, worked warm. Cheap ware, mass-produced in moulds to standard dimensions, may be cut in machines which index the ware step by step and present it to the wheel at each step.

Hand-made articles would not be sufficiently regular to suit such a process.

Other Abrasive Processes.—Intaglio is similar to decorative cutting, but the spindle is overhanging and the wheels are much smaller. The depressions are shallower and the process is intermediate between cutting and engraving. The last uses an overhanging spindle with copper wheels of diameter from pinhead size to around four inches, of various thicknesses and edge contours. These are fed with a mixture of oil and abrasive (emery generally) and in the hands of the expert can be made to turn out the most artistic "drawings" on glass. In sandblasting, sand grains entrained by a blast of air at pressures usually of 2–25 lb. per square inch will obscure the surface of glass with a pattern rather like that given by grinding. If paper backed by a resilient sticky substance (*e.g.,* glue and glycerine) is used to protect the portions to remain clear. designs may quickly be produced Metal stencils are used in sandblasting trade-marks and the like on glassware. Sandblasting in stages, changing the pattern of the resist at each stage as the depth of excavation increases. has produced some very striking relief effects. In glass *sculpture,* hand tools operated by flexible drive or a motor of the bosch type are used to execute designs in *situ* on large sheets of glass.

Ice-Flower Patterns.— A sandblasted glass surface is coated with strong glue and slowly dried. At the proper stage the glass is placed in a warm enclosure and the shrinkage of the glue drags glass from the surface to produce a system of shallow conchoidal fractures which is considered decorative.

Etching.—Hydrofluoric acid attacks most glasses readily. The effect varies according as the material removed remains in solution or is left in the surface, which depends in part on the acid strength and also on what other substances are present in the etching mixture. Clear etching is produced by either dilute hydrofluoric acid alone, or in some cases (*e.g.,* lead glasses and some low silicates) by strong acid used with strong sulphuric acid. In the case of lead glass there is a deposit but it brushes off in warm water. In other circumstances a rough mat or translucent surface is produced; *e.g.,* with potassium fluoride and a mineral acid a delicate satin finish, with ammonium bifluoride mixtures a "white" finish. The internal surface of a "pearl" electric light bulb is produced in two stages: first a coarse etch from an internal spray with a strong ammonium bifluoride mixture, then a spray rinse with a more dilute one which smoothes the too-sharp contours of the first etched surface and largely restores the original strength of the bulb. Ammonium bifluoride is the active constituent of inks for writing on glass and of pastes for badging glassware through a wax resist (see Enamelling, below).

Enamelling.—(I) A design cut in a brass or glass plate is charged with a mixture of enamel colour and medium; *e.g.,* lithographic varnish and a sheet of transfer tissue paper is gently applied and then peeled off from one corner to bring with it the design in enamel. This is applied to the clean glass surface and the paper is damped and peeled off. leaving enamel only on the glass, which is then heated carefully till the enamel fuses to it. The same transfer method is used for applying wax resists to glass to be etched. (2) A silk or other mesh screen carries light-sensitive material that has been exposed behind a negative and developed to produce a design in open apertures (the background is of closed ones). Enamel mixture is brushed over this by a squeegee to force it through the apertures and so print the design on the glassware held beneath. In the case of circular containers provision is made for rotating the ware as it is moved below the screen.

Silvering, *Coppering,* Gilding.—Mirrors, once made with tin amalgam, have since the discoveries of Michael Drayton and Justus von Liebig been made by chemical reduction of silver-ammonia compounds to metallic silver. Modern developments include processes in which the solutions meet in a spray above the cleaned glass, passing on a conveyor, and deposit the silver immediately the spray falls on the glass. Copper and gold may also be deposited by chemical reduction. Gold films of controlled thickness may be obtained by heating an organic gold compound. Dark-coloured mirrors are obtained by depositing films of lead sulphide. In addition to chemical deposition, films may be produced by "sputtering" (high-voltage discharge between electrodes) in *vacuo* or by evaporating in vacuo—the latter process yielding aluminum or rhodium mirrors, and. with certain fluorides, the "bloomed" lens which has a very high light transmission. Films which permit the passage of sufficient electric current to warm the glass are of two kinds: first, the rather thick sprayed aluminum grid which enables the glass plate to be used as a radiator, and, second, the film which can be heated to preserve clear vision through a glass screen in vehicles. Staining of glass by silver or copper compounds produces the yellow or red colours seen in windows. (See STAINED GLASS.) A somewhat similar treatment has been applied to glass coming hot from the forming process to give a surface which may be soldered to metal. "Lustres" are produced by painting with organic sulpho-compounds of gold, platinum or other precious metals, in an essential oil (*e.g.,* lavender). Gentle heating smokes off the medium and decomposes the sulpho-compound, leaving a bright metallic mirror surface on the glass.

Photosensitive Glass.—Certain glasses (U.S. patent 2,515,275 of July 18, 1950) containing small amounts of gold. silver or copper are sensitive to light. When exposed to ultra-violet radiation no obvious change occurs until the glass has subsequently been heated to a temperature a little below that at which it softens. The characteristic colour (yellow or ruby) then develops. Some of the glasses are so controlled in composition that the "nuclei" produced initiate devitrification and produce an opal effect. By exposure to the radiation behind a negative or stencil, very decorative effects may be produced. (M. PN.)

In addition to the many uses of glass referred to in the foregoing, attention may be directed to its employment as the basis of four substantial branches of industry: namely, optical instruments (see LENS), electric lamps and radio valves, safety glass and glass fibres. Of these two last-named industries the following special accounts are given.

Safety Glass.—This has been defined as glass so treated or combined with other materials as to reduce the likelihood of injury to persons by objects from exterior sources or by the glass itself when it is cracked or broken. Such glass is made in one of two ways. The first consists in laminating a sheet of plastic between two sheets of glass, and the second in heat-treating a single layer of glass.

Laminated Glass.—The invention of this type of glass, popularly and romantically ascribed to Edouard Benedictus of France, was actually anticipated by John Wood of England, who was granted a patent for making such glass in 1905. After the first commercially successful Triplex glass made under the Benedictus patents, several important developments took place. First. celluloid (a cellulose nitrate plastic) was replaced by cellulose acetate plastic, which is inherently more stable than celluloid. A contemporary development was the use of ultra-violet-absorbing glass to protect the celluloid plastic from the damaging light rays. In 1943 by far the major portion of the world's production of laminated glass was made with a polyvinyl acetal plastic, which replaced the older cellulose plastics because of its greater flexibility at low temperatures.

A description of the operations involved with the vinyl type of plastic will indicate the principles on which all these processes have been based. The panes of glass to be reinforced can be either flat or curved: and although drawn sheet glass is sometimes used, the best type is prepared from thin, polished plate. the panes normally employed varying in thickness from $\frac{1}{16}$ in. to $\frac{3}{4}$ in., depending upon the purpose for which the lamination is to be used. After cutting to the proper size, the panes of glass are thoroughly cleaned and dried and then sheets of vinyl plastic, also thoroughly cleaned and cut to the proper size, are placed between the panes of glass and the resulting sandwich is bonded together by the application of heat and pressure. The vinyl plastic is self-bonding and very resistant to water penetration. Hence, no additional adhesive and edge sealer are needed, as was the case in the older processes. The vinyl laminated glass is more resistant to impact than the celluloid lamination, and its strength is more uniform over the range of temperatures normally encountered out-of-doors.

When such a laminated glass is struck heavily, the cracks radiate from the centre of attack, but the splinters remain firmly adhering to the intermediate plastic layer. It is, therefore, used in the glazing of motorcars and aeroplanes to reduce injuries should the glass become broken. Bullet-resisting glass is a laminated glass generally $1\frac{1}{2}$ in. thick and made of several layers of glass interspersed with several layers of plastic.

Heat-Treated Glass.—The principle on which this glass is manufactured is the same as that on which Rupert's drops are made. A sheet of glass is heated to just below its softening point and then is uniformly and rapidly cooled with a blast of air. This rapid cooling puts the outside surfaces of glass under compressional strain and, since glass generally fails under tension, this product is much stronger than untreated glass to bending, twisting and tensional stresses but is susceptible to the impact of sharp objects capable of puncturing the surface. When it fails. cracks develop throughout the whole body of the glass and it breaks into a large number of comparatively small and harmless pieces. In America it is generally used for the back light glazing in motorcars; in Great Britain it is used for windshields, side windows and back lights to a very large extent. Also, it is extensively used in places where glass is subjected to pressures uniformly distributed over the surface. (G. B. WA.; A. C. WE.)

Glass Fibres.—Probably the first form of glass produced was a fibre drawn quite unintentionally when a mass of molten glass was manipulated. These fibres were coarse, but finer fibres that could be woven were produced by melting the end of a glass rod, attaching the droplet to a rotating wheel and thus drawing, or spinning, a fibre. René de Réaumur, in 1713, in a report to the Paris Academy of Science, submitted glass fabric woven by the Venetian Carlo Riva. In 1893 Edward Drummond Libbey set up a glass fibre producing unit at the Columbian exposition and, by weaving the fibres together with silk threads, made various curios including lamp shades, neckties and a gown for Georgia Cayvan, a celebrated actress. The infanta Eulalia of Spain was presented with a glass gown of similar design. These gowns. though dramatic, were impractical because the fibres were too coarse to permit the fabric to be folded. Efforts to industrialize glass fibre manufacture are reflected in numerous patents issued prior to 1914, mainly in Europe. Most of these concerned improvements to the rod-drawing process such as the Venetians' or Libbey's process. The spinning wheel was replaced by revolving drums and a multitude of fibres was drawn simultaneously. In 1908 W. Pacsinsky produced glass silk fibres by drum-winding threads dra n from the perforated bottom plate of a ceramic glass melting chamber. Before and during World War I Germany thus produced coarse glass fibres to replace imported asbestos and other high-temperature insulation materials.

In 1929 F. Rosengarth invented a process in which a stream of molten glass impinges on the centre of a fast-rotating ceramic disk with radial serrations. In these the glass divides into small streams and is whipped off the edge of the disk into fibres. Rosengarth, together with the Hager brothers, industrialized this process. It is still much used in Europe because of the low installation cost of the process when small to medium production is required. Centrifugal processes were also being developed in the U.S. by Harford and Stafford in the 1920s, and many variations and refinements of the early versions were later proposed and introduced. In the U.S. also, P. O. E. Friedrich and F. L. Dimmock began production of glass fibres by the drum-winding process about 1923 and before 1927 had established a market for their fibres for use in electric storage batteries, in ornamental applications and for various other purposes. The Owens-Illinois Glass company took up the search for industrial glass fibre processes in 1931 and was followed by the Corning Glass works in 1935. The two companies combined their efforts in 1938. forming the Owens-Corning Fiberglas corporation. In this period Games Slayter, John H. Thomas and several associates were successful in developing new processes suitable for large-scale industrial manufacture. The first was a process for the production of relatively short interfelted glass fibres, or "glass wool." The other two were textile fibre processes which came into production in 1935 and 1936.

Glass Wool.—In this process, fibres with diameters ranging from about 0.00035 in. to 0.00080 in. are produced and form a resilient, white, fleecelike mass which is known as glass wool. (The term "spun glass" is not appropriate to these products.)

Production begins with the accurate formulation of the batch of silica sand, limestone and other selected mineral ingredients as in standard glass manufacturing operations. The batches are melted in large gas-fired glass-melting tanks or furnaces. At the forehearth end of the tank the glass drains down through small orifices formed in bushings of temperature-resistant metal. As the streams of molten glass pour down, they are caught by jets of high-pressure air or steam. The action attenuates the glass into fibres that may be long or short, coarse or fine, according to the accurate control exercised over the glass temperature, the size of the orifices and the pressure of the jets. The fibres pass downward through a forming hood to a travelling conveyor, on which they gather in the desired thickness. Glass mineral wool thus formed has a density of 1½ lb. per cubic foot, compared with the density of about 14 lb. common to the "spun glass" wool produced by earlier European processes.

The fibres are customarily lubricated with a microscopic film of an inert mineral oil, or they may be treated with a thermosetting binder and carried through compression rolls and ovens to produce semirigid to rigid sheets or "boards." The basic wool may be processed and fabricated to form bats, blankets, boards, blocks, pipe insulation and cements for many uses as thermal insulation and for sound absorption purposes.

Glass Textiles.—The second and third of the three U.S. processes produce fibres or filaments suitable for textile uses. Both begin with the formation of virgin glass into small marbles (about ⅝ in. in diameter) that are inspected to eliminate impurities that might interfere with subsequent operations. The glass marbles are then remelted in small electric furnaces which have perforated metal bushings through which the molten glass flows in fine streams. From this point on, the two textile fibre processes differ.

The staple fibre process is substantially the same as the wool process, in that the streams of glass are attenuated into fibres by jets of steam or air. The fibres are gathered as a thin webbing on a revolving drum immediately below. The webbing is drawn off the drum, gathered as a loose strand of fibres known as sliver and immediately wound on a tube. The strand or sliver may then be further drafted, twisted and plied to form a yarn resembling a cotton or worsted yarn. The term "staple fibre" is given to this process and material because the individual fibres are of limited length (9 in. to 12 in.) as contrasted with the other textile fibre, known as "continuous filament," the length of which is limited only by packaging requirements and may be measured in miles.

Bonded Mat or Staple Tissue.—A modification of the staple fibre process is used to produce bonded mat or staple tissue. a thin sheet of fine glass fibres held together with a binding agent such as starch or resin. The fibres are gathered as a webbing on a continuous conveyor instead of a drum and are treated with the selected binding agent, calendered and dried The sheets are rolled and trimmed and are widely used, as a pipe-wrapping material holding a bituminous coating, round oil. water or gas pipes in position as a corrosion protective. The sheets form an inorganic base for roofing felts and, cut into small sizes, are used as retainer plates in batteries. Mat thicknesses range from 0.010 in. to 0.050 in. according to their intended use.

In the continuous filament process the bushings in the electric furnaces are provided with 100, zoo or more small orifices. As the molten glass flows downward in parallel streams, the operator gathers the strands and feeds them over a size applicator to a high-speed winder. The tension created by the minding unit mechanically draws each filament to a diameter considerably smaller than the orifice diameter.

Both textile fibres are exceedingly fine and correspondingly flexible. The normal fibre diameter is 0.00022 in. A strand of 100 filaments is still too fine for commercial weaving; customarily, two to four strands are twisted and plied to produce a fine yarn. Yarns and fabrics made from staple fibres resemble cotton or worsted; they have a rough texture produced by the free ends of the individual fibres Continuous filament textiles resemble natural silk or rayon; they have a high lustre and a sleek surface. Coloured glass yarns and fabrics were introduced in 1940 in a limited range of blue and tan shades by incorporating suitable mineral pigments in the glass itself. In 1954 it was preferred to dye the fibres by resin-carried pigments.

Properties of Glass Fibres.—Glass fibres are inorganic, incombustible, nonabsorbent, nonhygroscopic and chemically stable. The diameter of textile and "wool" fibres is so small in relation to their individual mass and length that they bend freely and do not break until bent to a radius several times the diameter of the fibre. Thus, in a yarn composed of fibres so fine that several hundred filaments are required to construct it, there is little likelihood that any individual filament will ever be bent to the breaking point, even when the fabric into which the yarn is woven is folded upon itself.

The tensile strength of fine glass fibres substantially exceeds that of any other commercial fibre. Individual fine glass fibres produced in the laboratory have shown breaking strengths of 350,000–500.000 lb. per square inch. In actual bulk production, figures of around 200.000 lb. per square inch are regularly obtained. The lower strength is explained through damage of fibres by abrasion during the manufacturing processes. The stretch of glass fibres is less than 2%.

Glass fibres have a vastly greater surface area than an equivalent weight of glass in solid form; hence, their chemical durability is related not only to the inherent resistance of the glass itself but also to the fibre diameter and the service conditions encountered. Accordingly, various glass compositions are used. Glass fibres for general thermal insulating and acoustical work are produced from highly durable, low-alkali glass compositions. For electrical applications, a glass containing no alkali metal oxides is used. Glass wool has a unique density-conductivity relationship. At its natural density of 1½ lb. per cubic foot. the conductivity "k" (British thermal units/hour/square foot/inch/°F.) at 70° F. mean temperature is 0.27. When the density is increased by compressing the wool to about 9 to 12 lb. per cubic foot, the conductivity is lowered to approximately 0.24. Further increases in density show a gradual rise in conductivity. There is a gradual increase in conductivity with rising mean temperatures and a fall with decreasing fibre diameters.

In textile yarns and fabrics, the intimate contact of fibre to fibre and the lack of entrapped air spaces increase the conductivity materially. Thus, in electrical applications, where the internal heat induced in motor windings must be rapidly dissipated, glass fibre insulation shows desirable heat-conduction properties. Both wool and textile forms of fibrous glass have high heat resistance and can be used in all temperature ranges to approximately 1.000° F. By adding refractory clays in the production of insulating blocks and cements, the temperature limit can be raised to 1,200° or 1,400° F.

Glass has long been recognized as an excellent electrical insulation material. When made flexible by conversion to fibres or fabrics, the inherent electrical properties are retained, but leakage and moisture penetration can occur through the interstices of the fabrics. Therefore, glass electrical insulation materials, like cotton or asbestos, must be used with suitable electrical varnishes and impregnants. The temperature resistance of glass considerably exceeds that of standard electrical varnishes and impregnants but permits the use of those capable of withstanding greater heat than organic fibres and thus has enabled engineers to design equipment tolerating higher operating temperatures than are practical for cotton and with less bulk than is practical for asbestos. The introduction of resins with temperature resistance substantially above previously available varnishes extended opportunities for utilizing the strength, space factor and heat resistance of glass insulation. The resistance of glass to all acids except hydrofluoric, its electrical insulation value and the high porosity of mats of glass fibres early suggested its use in electric storage batteries to help retain the active ingredient on the positive plates. Glass fibre mats were used in storage batteries for heavy industrial applications as early as 1925. The proper use of glass retainer mats made it possible to increase the service life of automotive batteries by more than 100%.

Uses *of* Glass Fibres.—The unique combination of properties possessed by glass fibres and the variety of sizes and forms made commercially practical by the development of the U.S. processes resulted in the development of many uses.

Glass wool and products made therefrom are used as building insulation, as thermal insulation in domestic equipment (ranges, refrigerators, water heaters, etc.), as industrial insulation (cold-storage and refrigerated equipment, boilers, retorts, ovens, process equipment, piping, duct work, etc.), as marine insulation in merchant and naval ships of all types and as thermal insulation in aircraft, railroad passenger, freight and tank cars, buses, trucks and military vehicles. It is also used for sound-absorption and acoustical purposes in buildings and equipment.

Glass fibre mats are used as a reinforcement for bitumen in pipe wraps and roofing felts, as storage battery retainer mats, as a strainer-type air-filtering medium and in some electrical, acoustical and light-diffusing applications. Coarse glass fibres are used to produce impingement-type replaceable air filters, eliminator mats in air washers and contact or diffusion mats in rectifying towers used in alcohol distillation and in other types of fractionating processes.

Glass electrical textiles are used as sliver or yarns in the insulation of wires and cables, as cords for binding coils in magnetic equipment, as braided sleeving for the insulation of lead wires and as plain or varnished cloth or tape for wrapping coils and other parts. The cloths are also used to form laminated sheet materials and glass-mica insulations.

Glass service fabrics are used in various military and naval applications, as pipe lagging cloths and tapes. as chemical filtration fabrics, in filters for blood plasma and oils and wherever an incombustible, nonshrinking and nonstretching fabric is needed.

After World War II a vast new field of application was found for glass fibres in plastics reinforcement, particularly with resins of the polyester type, which require little or no pressures during their cure. Very large articles, such as boats (up to 50 ft.), motor-car bodies, aircraft parts (radomes, ducts), corrugated translucent roofing sheets and fishing rods can be formed, all with a high strength for weight ratio, excellent impact strength and weathering resistance.

In the U.S., glass decorative fabrics were produced as drapery materials, shower curtains and marquisettes. Glass threads also found use in surgery as a suture material for certain types of work. Medical research established that glass fibres cannot be inhaled into the lungs and are innocuous both in the intestinal tract and in the blood stream. Workers handling glass fibre products. particularly in wool form, may experience a transitory skin irritation of purely mechanical character, which produces no allergic reaction and soon passes as they become accustomed to the material. No physiological reactions of the body to glass fibres have been demonstrated.

(T. S. R.; A. DE D.)

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HISTORY

ANCIENT TIMES TO 19TH CENTURY

Early Glass.—Little is known of the earliest phases of glass-making. It is not even certain in which of the riverine civilizations of the ancient near east glass was first made. The earliest wholly glass objects (as opposed to objects of other materials covered with glaze) from Egypt are beads that date from some time after the 6th dynasty; that is, after about 2500 B.C. Possibly earlier than these are a green glass rod that may go back as early as 2600 B.C., found at Eshnunna in Babylonia, and a small piece of blue glass found at Eridu, dating from before 2200 B.C. Whether glass was actually made earlier in Mesopotamia or not, however, there can be little doubt that the first vessels of glass were manufactured in Egypt under the 18th dynasty (15th and 14th centuries B.C.), particularly from the reign of Amenhotep II (1448–20) onward. These vessels are distinguished by a peculiar technique. The shape of the vessel required was first formed of clay (probably mixed with sand) which was fixed to a metal rod. On this core the body of the vessel was built up, usually of opaque blue glass. On this, in turn, were coiled threads of glass of contrasting colour, which were pulled by a comblike instrument in an upward and downward direction to form feather, zigzag or arcade patterns. These pattern threads, usually yellow, white or green in colour, and sometimes sealing-wax red, were rolled in (marvered) flush with the surface of the vessel. Finally, if desired, handles—often of translucent glass and sometimes of patterned "canes"—were added. The vessels so made were nearly always of small size and were in most cases made for toilet use, to contain unguents and the like. Occasionally glass was decorated with designs cut on the lapidary's' wheel. Glass is known to have been made on the palace site of Tel el Amarna, the residence of Ikhnaton (c. 1375–54 B.C.), and the number of fragments found in and near the palace of Amenhotep III (*c.* 1408–1375 B.C.) at Thebes suggests that it was made there also. This great period of activity seems to have died down after the 14th century B.C., and after the 21st dynasty (about 1000 B.C.) appears to have ceased altogether.

Little is known of the glass made at this time in Mesopotamia, but the Nineveh tablets of the reign of Assur-bani-pal (668–c. 626 B.C.) and the remains of glass in various forms excavated by M. E. L. Mallowan at Nimrud (Kalakh) afford practically certain proof that glassmaking was carried on there during the 8th to the 6th centuries B.C. It is possible that certain vase-shaped vessels of palish green glass, cut from the solid mass as if the glass had been stone, may be Mesopotamian and date from as early as the 2nd millennium B.C., although none has been found in controlled excavations. A vase of this technical type, however, is known which bears the cartouche of the Assyrian king Sargon (722–705 B.C.), and it is possible that glass treated in this way, and thus contrasting completely with the core-wound glasses of Egypt, was manufactured over a long period in Mesopotamia.

Glass mas made in Greece in Mycenaean times, usually in the form of small moulded architectural details, but a few vessels of forms abnormal to Egypt suggest that perhaps some vessel glass also was made in the Egyptian technique. The glasses of this period found in the greater part of the Aegean area are probably imports from Egypt.

In general, glass which may be dated to the first half of the 1st millennium B.C. is scarce and displays little homogeneity. Some of it may have been made in Mesopotamia and exported through the Phoenician traders to countries farther west, while some of it may even have been manufactured at sites in the eastern Mediterranean or Aegean of which nothing is at present known. From the 6th century B.C., however; glass begins to appear in great quantities once again, particularly on the Greek-inhabited islands of the Aegean, in Greece itself, Italy, Sicily and even farther west. This profusion of specimens contrasts with the poverty of finds on Egyptian soil, and, although the technique of manufacture of these glasses is the same as that of the core-wound Egyptian glasses of the 18th–21st dynasties, it is probable that they were made elsewhere—possibly in Syria or some part of the Greek world. The vessels made were still small, serving mainly for toilet purposes, but the shapes are quite different from those of the earlier Egyptian dynastic glass. They were in the main decorated with the light-coloured threads on a dark (usually blue) ground familiar from the Egyptian 18th dynasty, but a notable variation is to be found in pieces decorated with dark-purple threads on a white ground. In the Hellenistic period (roughly from the 4th century B.C.) the shapes of these vessels tend to degenerate. The technique of decoration, however, remained the same throughout, although new colour combinations were used, and was indeed continued right into the era of blown glass.

The Roman Empire.—In Egypt in the course of the Ptolemaic period (323–30 B.C.) Alexandria seems to have come to the fore as a glassmaking centre, and in the crucial period about the 1st century B.C., which saw the beginnings of glass as it is known today, it had become pre-eminent in certain branches of glassworking. Most directly connected with the antecedent sand-core techniques was the manipulation of coloured glass rods to make composite canes which, when cut across, revealed a design, much as in the Brighton rock of modern times (mosaic glass). Slices cut from such canes could be arranged side by side to produce repetitive patterns. When, as often happens, the canes are of circular section and with starry or flowerlike designs, the resultant glass is called millefiori (thousand flowers). The technical advance most fraught with possibilities for the future, however, was that of mould pressing, by which glass could be pressed down into a mould by means of a plunger, thus producing vessels of open shapes, such as bowls, dishes, etc. (See Manufacture and Uses, above.) A combination of this technique with the millefiori technique enabled bowls to be produced with variegated designs in infinite variety. Sometimes glass of various colours was irregularly compounded. to give the effect of a natural veined stone, and occasionally enclosures of gold leaf in the glass simulated the glitter of natural pyrites (aventurine glass). Bowls were often finished round the rim with a cordon made of a clear glass thread twisted with one of opaque white; sometimes such cable threads were themselves coiled round and round from a centre to make a bowl of lacy appearance, with the opaque-white glass threads apparently set in a clear colourless matrix. All these pieces might be finished with a fire-polish by returning them to the furnace, but many mould-pressed glasses were, in fact, given a rotary polish, either by means of a spinning wheel fed with abrasives or by a process akin to lathe turning, where the object spins and the tool is stationary. Similar equipment probably was used for the numerous pieces which give every appearance of having been cut from a solid block of glass or at least from a thick blank prepared by the mould-pressing process. The pieces made in this way (usually flat dishes or two-handled cups) follow in shape the current forms of pottery and metalwork. Wheel engraving appears to have become an Alexandrian specialty in the 1st century B.C. and probdbly continued to be so throughout the two succeeding centuries. The Alexandrian engravers produced not only the cut-from-the-block effects already described but also wheel-cut designs both in intaglio and in raised relief, the latter being achieved by the laborious process of grinding back the whole surface of the glass to form the ground of the design. Simple motifs such as lotus buds or lotus flowers were produced in this way. but occasionally also more elaborate figural compositions. Other Alexandrian specialties appear to have been enamel painting (by which pigments mixed with a glassy flux were fused with the surface of the glass vessel in a separate firing in a muffle kiln) and a technique whereby a leaf of gold etched with a design was sandwiched between two layers of colourless transparent glass.

The mould-pressing process described above seems to have given the cue for the most important innovation in the whole history of glass manufacture—blowing. Perhaps by a pure stroke of inventive genius it was perceived that glass on the end of a hollow metal tube could be blown into a mould as easily as it had been hitherto pressed in. The next stage was to make mould-blown forms such as flasks, which could not be made by the pressing technique. Finally, it was realized that the glass bulb on the end of the blowpipe could be shaped freehand to any form desired, and handles, feet and decorative elements added at will. This crucial discovery, probably made during the 1st century B.C., lies behind the astonishing growth of the glass industry in Roman imperial times. It has been said with truth that never before the modern era was glass so widely used as under the Roman empire. Not only were luxury vessels of the types already described produced with an elaboration of skill which astonishes, and often baffles, the modern technician, but commercial containers for a variety of products were mass-produced in common greenish glass on a scale unmatched before the 19th century.

The discovery of glass blowing may well be credited to the Syrian glassworkers, since the first mould-blown glasses bear the signatures of Syrian masters, and since the readily ductile Syrian soda glass was especially apt for this purpose. The Syrian glassworkers. however, seem always to have been willing to migrate where demand promised a ready market, and some of the masters of mould blowing already mentioned appear to have moved to Italy already early in the 1st century A.D.; in the course of this century Italy probably became one of the chief glass-producing areas of the empire. In particular, the art of glass engraving seems to have been transplanted there, and one branch of that art—grinding through an opaque-white layer of glass to the darker ground on which it is superimposed (cameo glass)—appears to have flourished on Italian soil. The most famous example of this exacting technique is the Portland vase. in the British Museum, London. The capacity of the Italian cutter to surpass his masters in work of the most complex character is seen in the so-called cage-cups (diatreta), on which the design—usually a mesh of tangent circles with or without a convivial inscription—is so undercut that it stands completely free of the body of the vessel, except for an occasional supporting strut. These cups were perhaps made at Aquileia and date from the 3rd and 4th centuries A.D.

By an economic process paralleled in the pottery industry, glassmaking soon spread from Italy to the northern province of Gaul and in particular to the valleys of the Rhône and the Rhine. It seems certain that glass was manufactured in Britain, too, but little is known of the industry there and it was probably not of great importance. The Rhineland, however, became one of the great glassmaking areas of the Roman world, and although (in part no doubt because of successive migrations of near eastern workers) Rhenish glass is always recognizably Roman, several types of decorated glass were specialties of the district. Of these, glasses decorated by threads trailed on in serpentine patterns and then pressed flat and notched are perhaps the most important and characteristic (Schlangenfadenglaser). A considerable school of glass engraving also seems to have flourished, probably centred on Cologne. Although some of the engraving is in an impoverished

BY COURTESY OF THE VICTORIA AND ALBERT MUSEUM

ENAMELLED AND GILT GLASS BOTTLE OF SYRIA

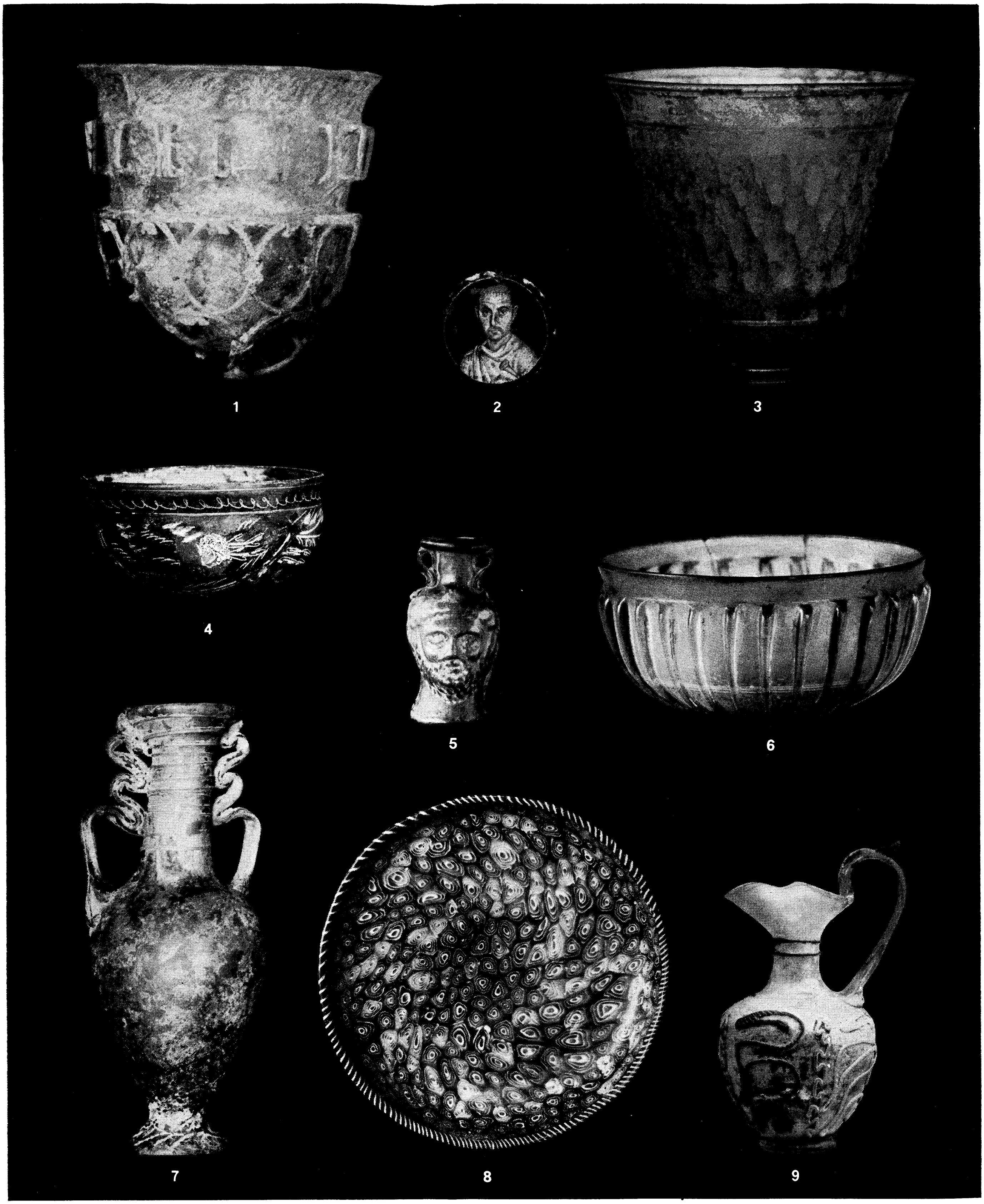
Dating from the late 13th or early 14th century, the bottle was probably made at Aleppo. 17½ in. high

GLASS

BY COURTESY OF (TO? LEFT, TOP CENTRE) THE DIRECTOR OF THE VICTORIA AND ALBERT MUSEUM. (OTHERS) THE TRUSTEES OF THE BRITISH MUSEUM

ANTIQUE AND MEDIAEVAL GLASS OF EUROPE AND THE EAST

Top left: Fragment of mosaic glass. Roman; 1st century A.D.
Top centre: Enamelled "Humpen" with representation of the cooper's trade. Bohemian; 1616
Top right: Toilet jug. Probably Egyptian; 3rd-1st centuries B.C.
Centre left: Goblet. green glass enamelled and gilt. Venetian; about 1500.
Centre right: Bowl of millefiori glass. Roman; 1st century A.D.
Bottom left: "The Portland Vase," blue glass cased with white and carved. Roman; 1st century B.C. or A.D.
Bottom right: Pilgrim bottle, enamelled and gilt glass. Syrian; about 1250–60.



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ROMAN GLASS

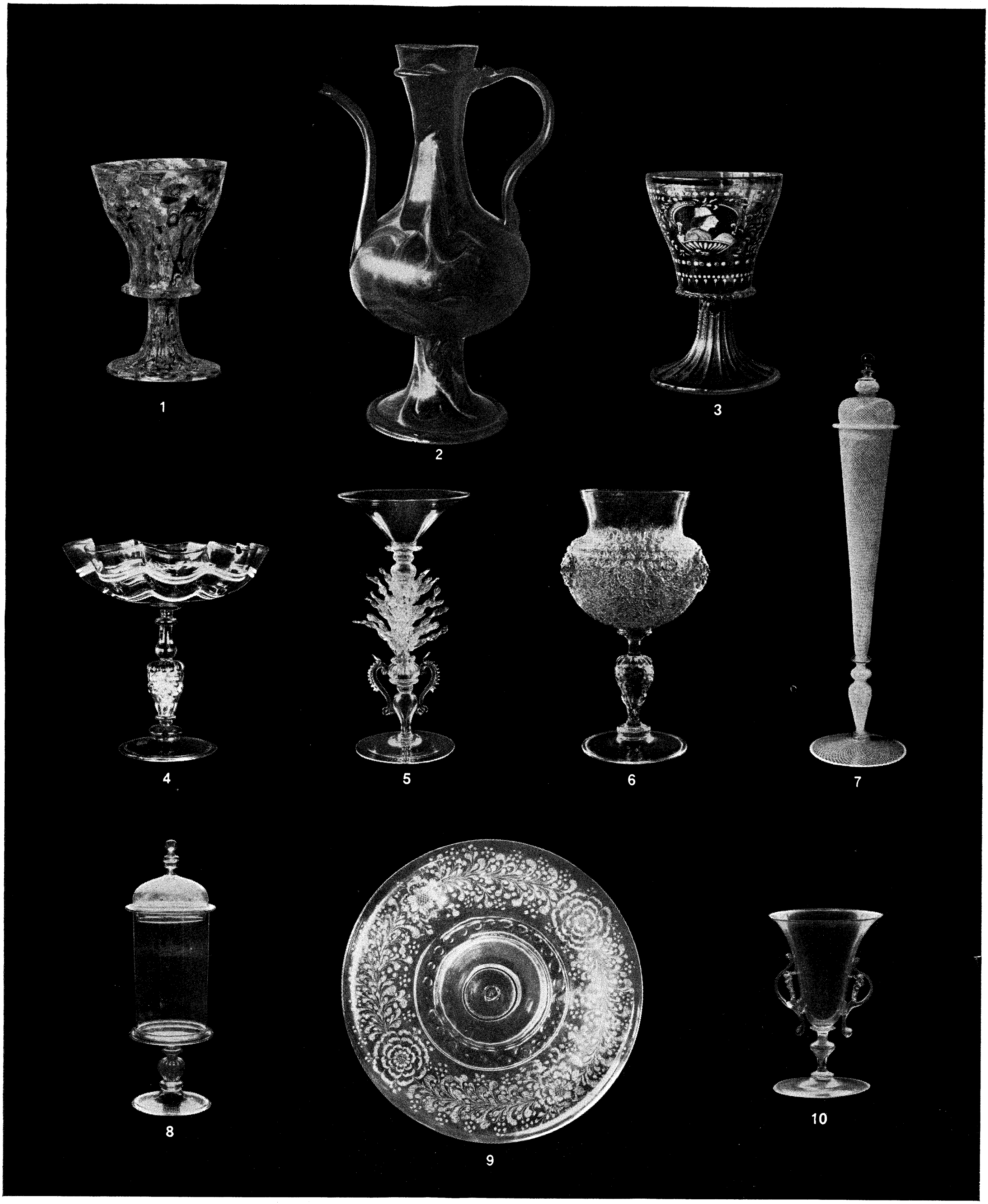
1. Cage-cup, or ***diatreton:*** 3rd century A.D.
2. Portrait head, etched gold leaf between layers of glass; 2nd or 3rd century
3. Faceted beaker; probably 2nd century
4. Bowl engraved with scene from the Actaeon legend, Rhenish; 3rd century
5. Mould-blown bottle, probably Syrian; 2nd or 3rd century
6. Pillar-moulded bowl; 1st century
7. Bottle with plastic decoration, probably Syrian; 4th or 5th century
8. Mosaic-glass dish; 1st century
9. Jug with coloured applied threads ***(Schlangenfadenglas),*** Rhenish; probably 3rd century

GLASS

BY COURTESY OF (1, 3, 7–10) VICTORIA AND ALBERT MUSEUM, (2) STAATLICHE MUSEEN, BERLIN. (4, 5) NATIONAL MUSEUM, STOCKHOLM. (6) RIJKSMUSEUM, AMSTERDAM

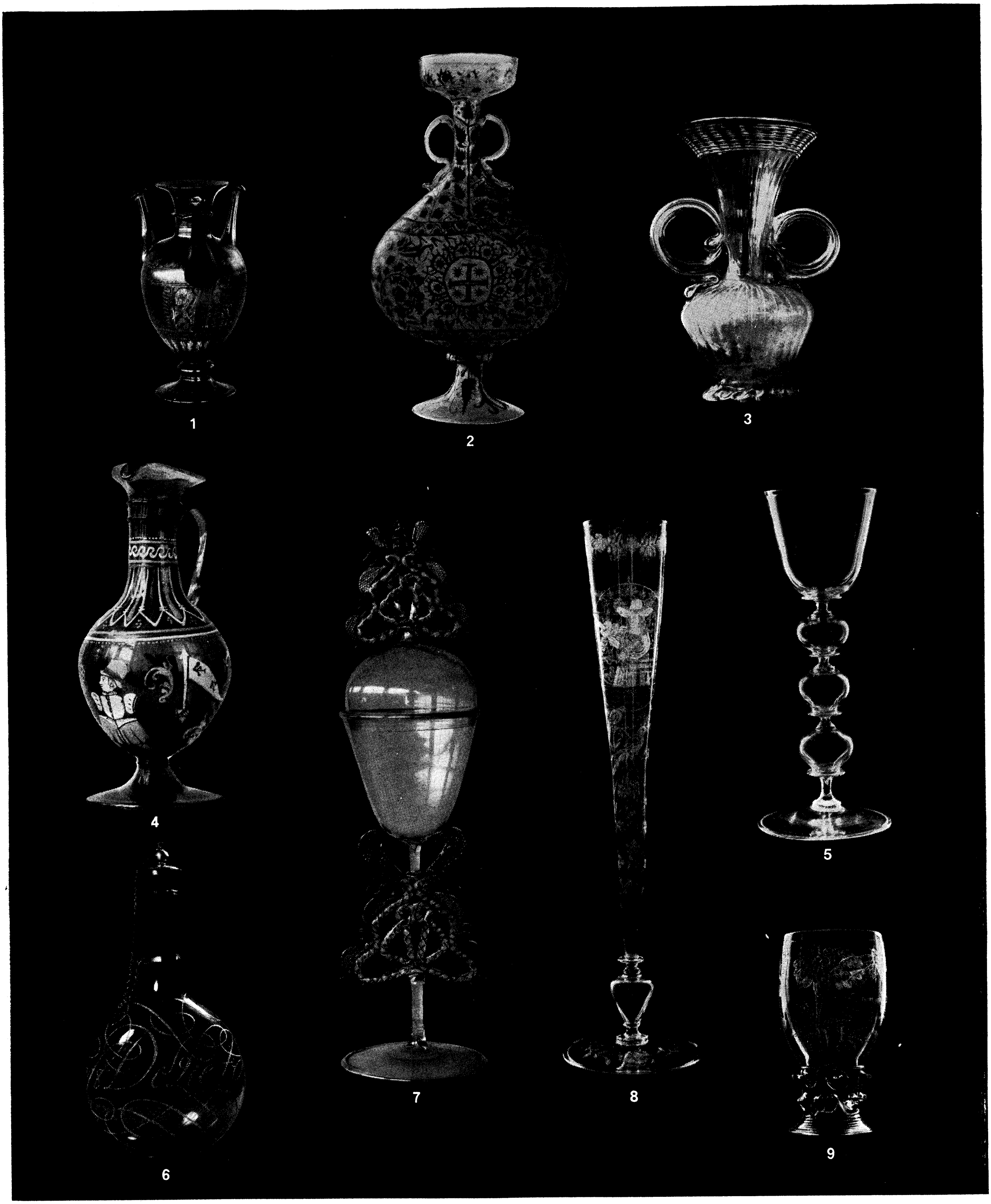
TEUTONIC AND ISLAMIC GLASS

1.–3. Frankish glass; 5th–7th centuries
4. Mould-blown emerald glass jug, near eastern; 12th-14th centuries
5. Beaker, crystal glass cut in relief, probably Mesopotamian; 9th or 10th century
6. Beaker of smoky topaz-coloured glass, cut in relief ("Hedwig" glass), Egyptian; 11th or 12th century
7. Sprinkler, Persian; 17th or 18th century
8. Mosaue lamp, enamelled and gilt glass, Syrian; about 1300–10
9. "Lustre" painted bowl, Egyptian; 10th or 11th century
10. Bottle, enamelled and gilt glass, Syrian: late 13th-early 14th century



VENETIAN GLASS AND GLASS OF THE FAÇON DE VENISE

1. Millefiori goblet, Venice; about 1500
2. Ewer of agate glass (*calcedonio*), Venice; about 1500
3. Goblet of enamelled and gilt glass, Venice; about 1500
4. Stand, with gilt stem and white threaded bowl, probably Venice; 16th century
5. Wineglass with plastic decoration, probably Venice; 17th century
6. Goblet, "ice glass" with gilt stem and applied masks, Netherlands (?); late 16th or early 17th century
7. Wineglass with latticinio decoration, probably Venice; 17th century
8. Reliquary, Venice; probably late 16th century
9. Dish engraved with diamond point, Venice; 17th century
10. Wineglass, Venice; early 17th century



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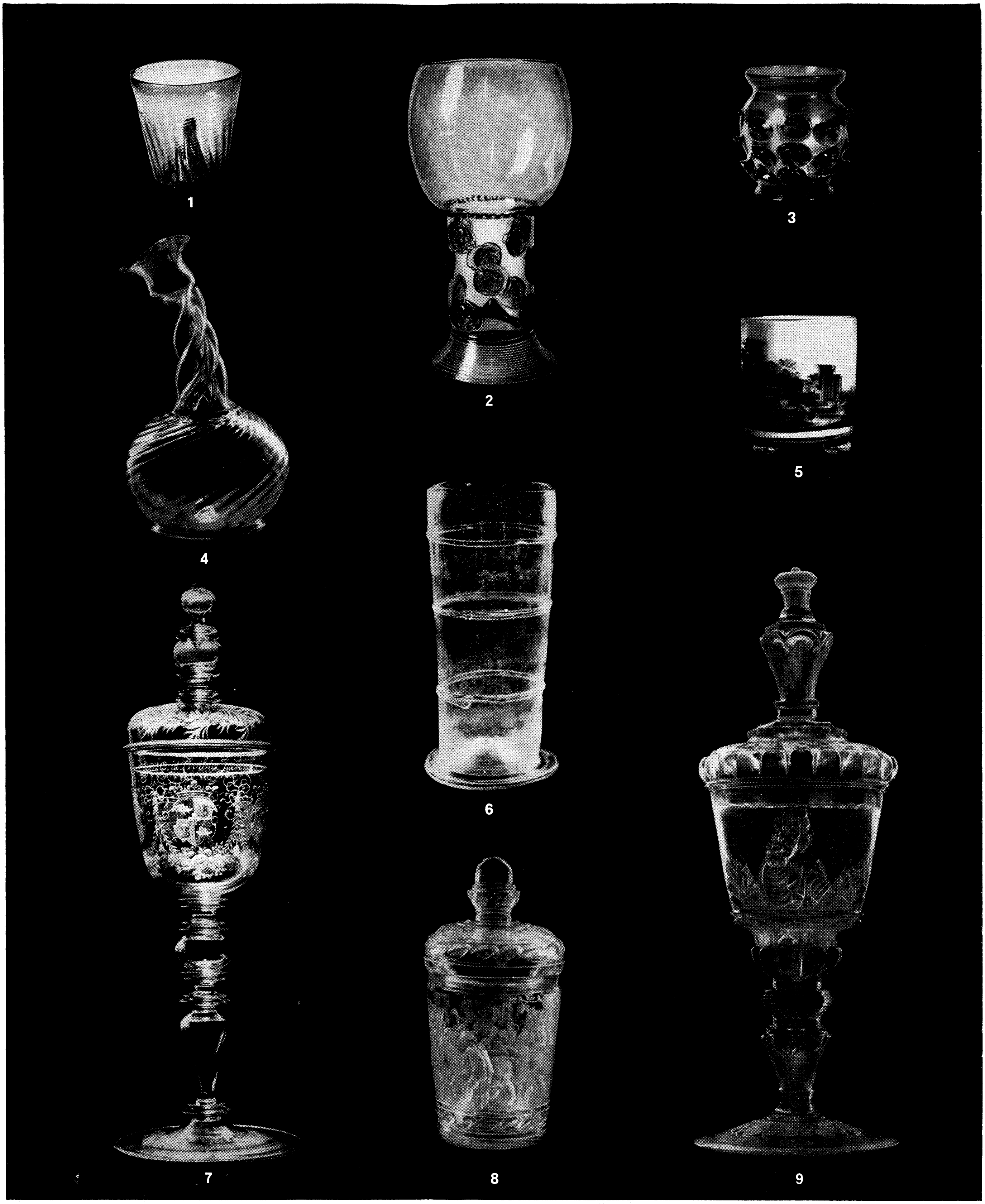
GLASS OF THE FAÇON DE VENISE

1. Blue glass vase engraved with diamond point, Hall in the Tirol, Aus.; second half of the 16th century
2. Vase of enamelled glass, Barcelona, Sp.; early 16th century
3. Vase, Spanish (Andalusia or Castril); 17th century
4. Blue jug enamelled in colours, France; 16th century
5. Goblet, Netherlands; middle of the 17th century
6. Blue glass bottle engraved with diamond point by W. van Heemskerk. Dutch; late 17th century
7. Covered goblet with serpentine stem, probably Netherlands; 17th century
8. Flute glass engraved with diamond point, Netherlands; about 1660
9. *Römer*, engraved with diamond point by Anna Roerners Visscher, Dutch; 1621



BY COURTESY OF (1–8) VICTORIA AND ALBERT MUSEUM, (9) SCHMIDT, "BRANDENBURGISCHE GLÄSER" (VERLAG FÜR KUNSTWISSENSCHAFT)

GERMAN GLASS: LATE MEDIAEVAL TO 17TH CENTURY

1. *Maigelein* of green glass spirally ribbed; second half of 15th century
2. *Römer* of green glass with applied lions' masks; middle of 17th century
3. *Römer* of green glass; late 15th or early 16th century
4. Kuttrolf of clear glass; probably 16th century
5. Beaker decorated in black enamel (*Schwarzlot*) by Johann Schaper, Nurernberg; about 1660–70
6. Pasglas of clear glass, perhaps Rhenish; 16th century
7. Goblet and cover, wheel-engraved by Hermann Schwinger, Nuremberg; 1681
8. Beaker and cover, wheel-engraved by Gottfried Spiller, Berlin; about 1695
9. Goblet and cover, wheel-engraved in relief by Franz Gondelach, Cassel; about 1700

GLASS

BY COURTESY OF VICTORIA AND ALBERT MUSEUM

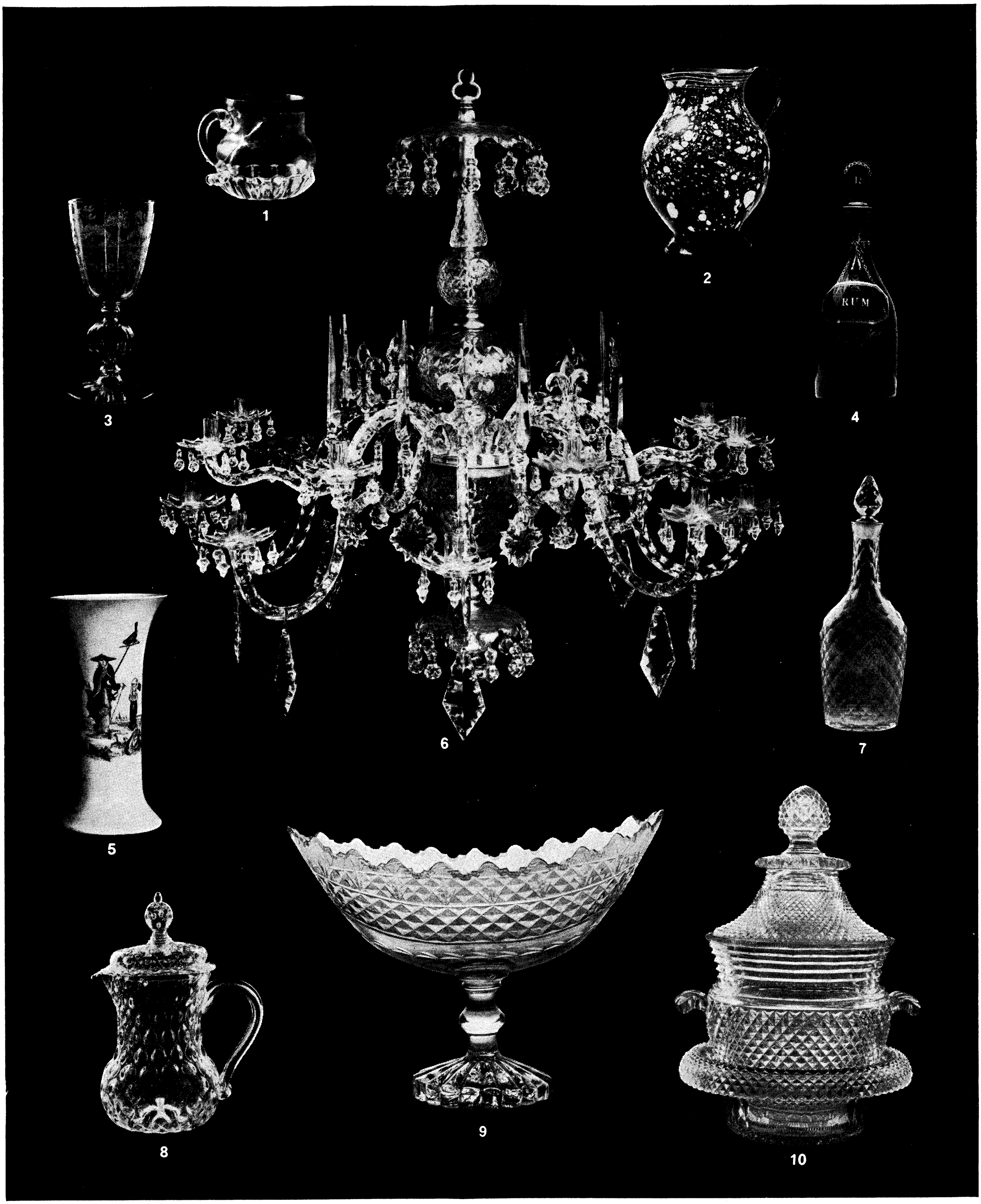
EUROPEAN GLASS OF THE 18TH AND EARLY 19TH CENTURIES

1. Goblet and cover, engraved on the wheel, Silesia: about 1740
2. Beaker with inset medallion in red and gold by J. J. Mildner, Gutenbrunn, Aus.: 1792
3. Beaker, wheel-engraved through a red "flashing," Bohemia; about 1840
4. Sweetmeat glass, San Ildefonso, Sp.: second half of 18th century
5. Double-walled beaker decorated with etched gold leaf (*Zwischengoldglas*), Bohemia: about 1730
6. Beaker enamelled by Anton Kothgasser, Vienna: about 1815
7. Goblet (English) stipple-engraved with diamond point by Frans Greenwood, Dordrecht, Neth.: 1728
8. Dish of opaque-white glass (*lattimo*) painted in enamel colours. Miotti glasshouse, Venice: about 1730
9. Sweetmeat glass and cover, engraved on the wheel. Bohemia; about 1750

BY COURTESY OF VICTORIA AND ALBERT MUSEUM

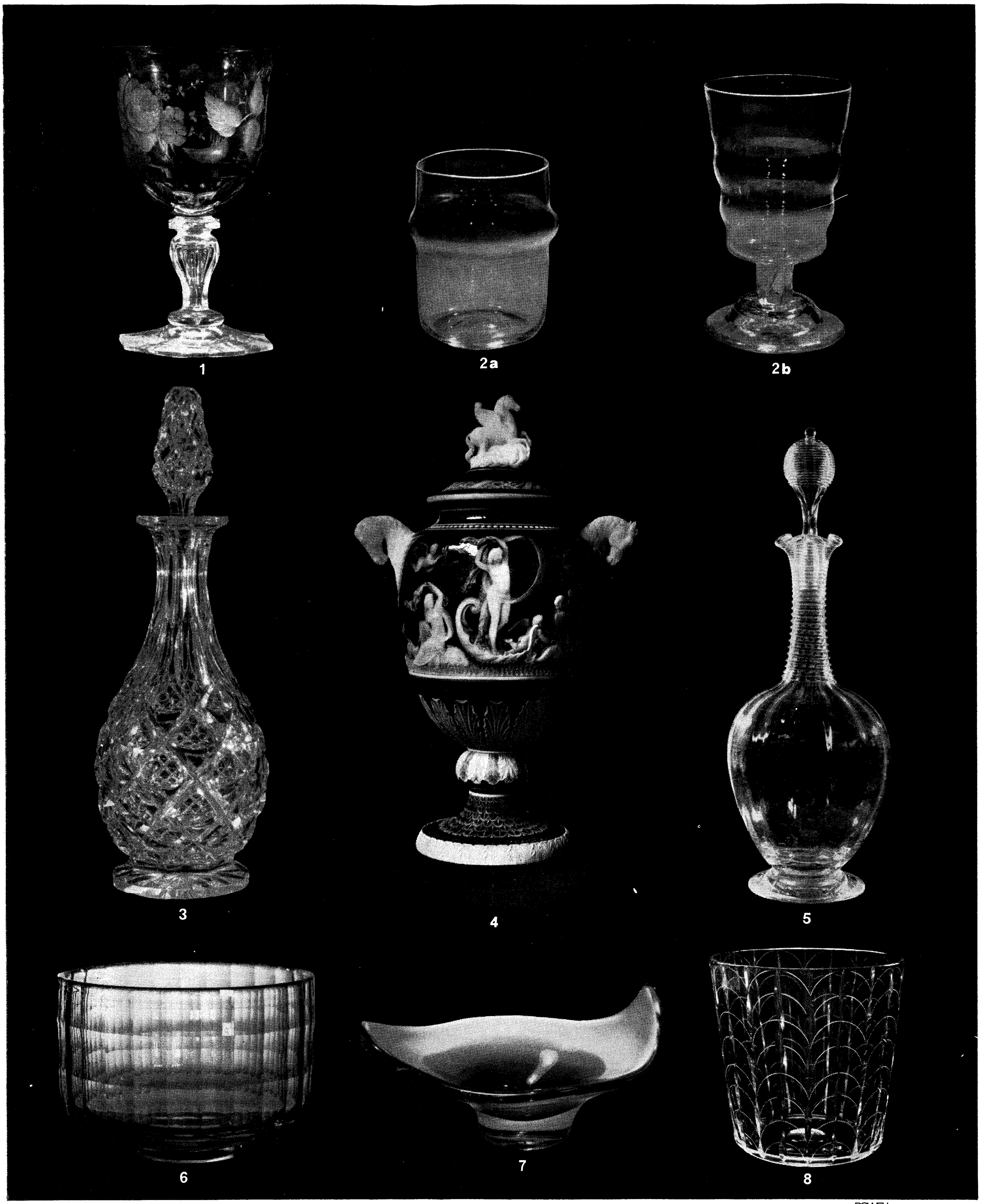
ENGLISH GLASS: LATE 17TH TO EARLY 19TH CENTURIES

1. Goblet containing in the stem a coin of 1684; about 1685
2. Goblet with baluster stem; early 18th century
3. Goblet containing in the stem a coin of 1690; late 17th century
4. Wineglass with shouldered stem and moulded inscription, "God Save King G"; about 1715
5. Wineglass with drawn stem and early type of engraving: about 1730
6. Wineglass with air-twist stem, engraved with Jacobite motives; about 1745–55
7. Wineglass with enamel-twist stem, engraved and inscribed "Success to the Eagle Frigate John Knill Commander," Bristol; 1756–60
8. Wineglass with faceted stem and bowl; about 1760
9. Sweetmeat glass with cut decoration; about 1750–60
10. Rummer with engraved decoration; 1821
11. Wineglass enamelled by a member of the Beilby family, Newcastle upon Tyne; about 1770



ENGLISH GLASS: 16TH TO EARLY 19TH CENTURIES

1. Tankard, bearing the raven's-head seal of George Ravenscroft; about 1675
2. Jug of bottle glass with incorporated white specks (Nailsea type); early 19th century
3. Goblet engraved with diamond point, probably made in the London glasshouse of Jacopo Verzelini: 1581
4. Rum decanter of blue glass with gilt decoration; about 1780
5. Beaker of opaque-white glass painted in enamel colours; about 1755–60
6. Chandelier, cut glass; about 1765
7. Decanter decorated with faceted cutting; about 1760
8. Jug of mould-blown glass, with air bubbles in the cover knob; first half of the 18th century
9. Fruit or salad bowl, English or Irish; late 18th century
10. Wine cooler; about 1825



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BRITISH GLASS AFTER 1850

1. Ruby-cased goblet, made by the firm of Richardson, Wordsley near Stourbridge, with engraving designed by W. J. Muckley; about 1851
2a and 2b. Drinking glasses designed by Philip Webb for William Morris in 1859 and made by James Powell and Sons, London
3. Cut-glass decanter made by the firm of Richardson; about 1851
4. The "Pegasus" vase, made in the "cameo" techniaue by John Northwood of Stourbridge between 1876 and 1882
5. Decanter with blue-glass trailing, made by James Powell and Sons, London; last quarter of the 19th century
6. Cut-glass bowl designed by Keith Murray for Stevens and Williams, Brierley Hill near Stourbridge: 1935
7. Bowl of partly coloured glass designed by William J. Wilson at James Powell and Sons, Wealdstone; 1955
8. Cut and engraved vase designed by Clyne Farquharson at the firm of John Walsh Walsh, Birmingham; 1934

GLASS

BY COURTESY OF (1) J. AND L. LOBMEYR, VIENNA, (2, 7, 9) VICTORIA AND ALBERT MUSEUM, (3) GLASSEXPORT, PRAGUE, (4) PEILL UND PUTZLER, (5) ORREFORS GLASBRUK, (6) METROPOLITAN MUSEUM OF ART. NEW YORK. (8) MRS OILI MAKI. HELSINKI. AND WERNER SODERSTROM OSAKEYHTIO. HELSINKI

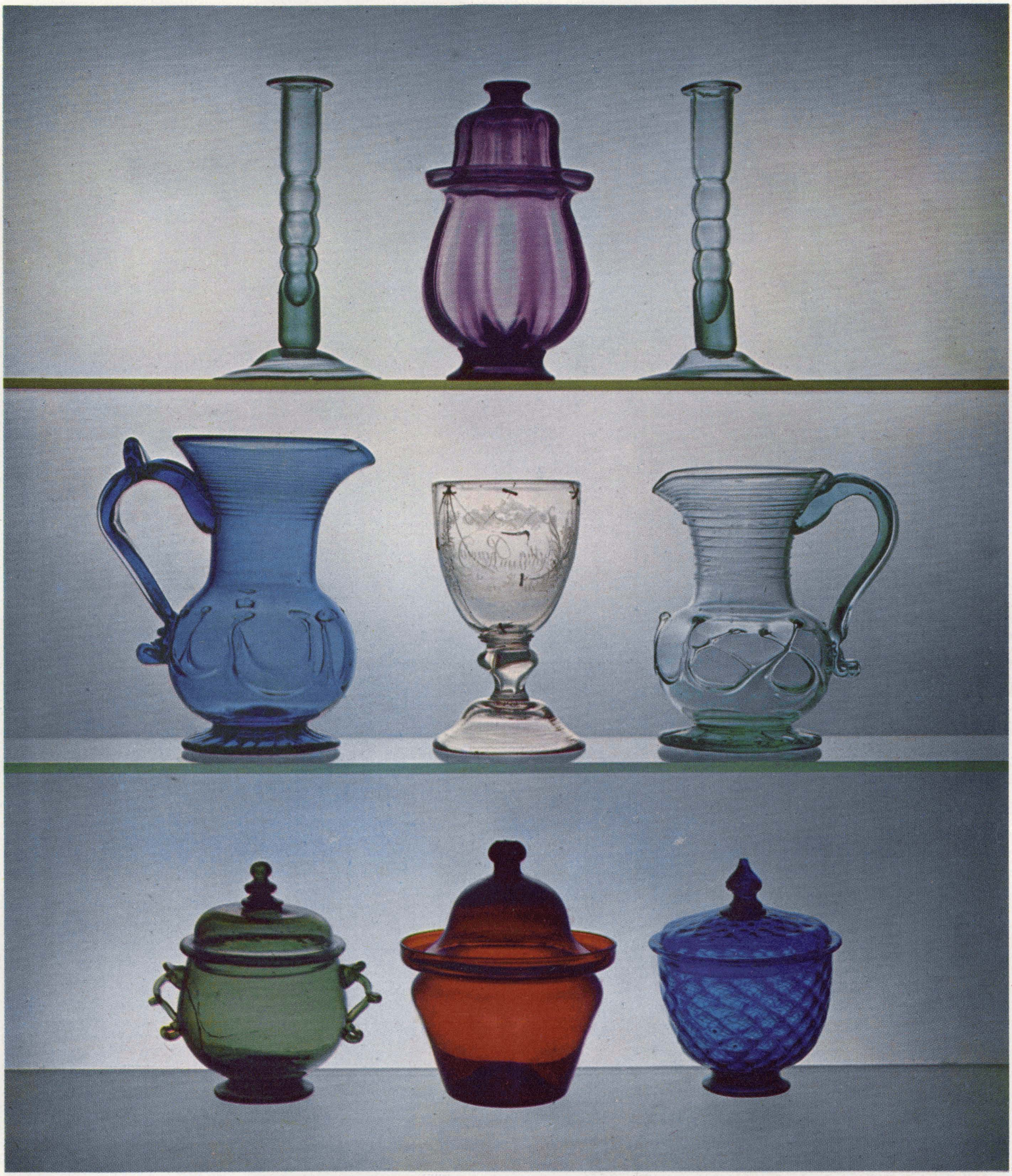
CENTRAL EUROPEAN AND SCANDINAVIAN GLASS AFTER 1850

1. Bowl designed by August Kühne and Josef von Storck and engraved by Carl Pietsch of Kamenicky Senov (Steinschonau), Bohemia, for J. and L. Lobmeyr, Vienna; 1875
2. Lustred glass vase made by the firm of J. Lotz' Witwe, Klastersky Mlyn (Klostermiihle). Bohemia, and shown at the Paris exhibition of 1900
3. Vase engraved with "Hamlet" motifs designed by Jaroslav Horejc and engraved by A. and K. Bischoff at the Lobmeyr studio, Kamenicky Senov. Czech.; 1955
4. Wineglass desianed by Wilhelm Wagenfeld for Peill und Putzler, Duren, Ger.; 1954
5. Engraved bowl designed by Edward Hald at Orrefors glassworks, Sweden; 1925
6. Vase with decoration of internal colour and bubbles designed by Edvin Ohrstrom at Orrefors glassworks, Sweden; 1939
7. Vase with semiopaque white decoration designed by Vicke Lindstrand at Kosta glassworks, Sweden; about 1954
8. Vase of partly bubbled glass designed by Gunnel Nyman for Nuutajarvi (Notsjo) glassworks, Finland; about 1947
9. Vase with engraved decoration, from a series originally designed about 1946 by Tapio Wirkkala for the firm of Karhula-Iittala, Finland

BY COURTESY OF (1) CONSERVATOIRE NATIONAL DES ARTS ET MÉTIERS, PARIS, (2, 6 7) VICTORIA AND ALBERT MUSEUM, (3) METROPOLITAN MUSEUM OF ART, (4) DAUM, NANCY, (5) VENINI VENICE (8) KONINKLIJKE NEDERLANDSCHE GLASFABRIEK, LEERDAM

FRENCH, ITALIAN AND DUTCH GLASS AFTER 1850

1. Cased vase made by Cristallerie de Baccarat, France; about 1851
2. Vase of coloured glass with relief decoration made by Émile Gallé, France; probably about 1895
3. Vase made by René Lalique, France; 1930
4. Bowl designed by Michel Daum, France; 1953
5. Stemmed bowl made by the firm of Venini, Venice, It.; 1920s
6. Vase with figured decoration designed by Ercole Barovier at the firm of Barovier e Toso, Venice; 1951
7. Covered goblet made by the firm of Salviati, Venice; 1869
8. Vase designed by Andries D. Copier at the Leerdam glassworks, Netherlands; mid-20th century



OBJECTS ASSEMBLED BY COURTESY OF THE CORNING MUSEUM OF GLASS, CORNING GLASS CENTER; PHOTO BY JOHN KALINICH

EARLY GLASS OF THE UNITED STATES

Top row: Left and right, pair of candlesticks, probably from glassworks of Caspar Wistar, Wistarberg, N.J., about 1740–80. Centre, sugar bowl, probably from Bakewell glasshouse, Pittsburgh, Pa., first half of the 19th century

Second row: Left and right South Jersey style pitchers with "lily pad" decoration, probably Lockport or Lancaster glassworks, New York, about 1840–60. Centre, engraved goblet from the New Bremen (Md.) glass manufactory of John F. Amelung, dated 1792

Bottom row: Left, sugar bowl, Wistarberg or Glassboro, N.J., probably last quarter of the 18th century; centre, sugar bowl, probably from Zanesville, O., glassworks, about 1815–30; right, sugar bowl possibly from Manheim, Pa., or Henry W. Stiegel glassworks, about 1765–74

BY COURTESY OF (1, 2, 4) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (3) FREDERICK K. GASTON, (5, 8) J. HERBERT WEST, (6, 14) EARL J. KNITTLE, (7) THE TOLEDO MUSEUM OF ART, (9, 11) GEORGE S. MCKEARIN, (10) ARTHUR SUSSEL, (15) FRANCES M. NICHOLS, (16) MRS. E. E. STEINHART; FROM (12, 13) KNITTLE, "EARLY AMERICAN GLASS" (THE CENTURY CO.)

AMERICAN BLOWN, MOULDED AND PRESSED GLASS; 1765–1865

1--4. Attributed to Stiegel: prototypes Continental: 1. Engraved and panelled flint lip glass. 2. Vitreous enamelled flint canister. 3–4. Flint suoar bowl and oitcher showino Venetian diamond technique

5. Swirled, expanded, double-domed Ohio type sugar bowl, 1820–40

6. Swirled and fluted, expanded, reamed edged amber bowl, Pennsylvania-Maryland-Ohro type; 1784–1840

7. Paper-weight made by Wm. T. Gillinder, Philadelphia; 1850–60

8. Amber flower "off-hand" blown by Zanesville, Ohio, artisan; 1840–50

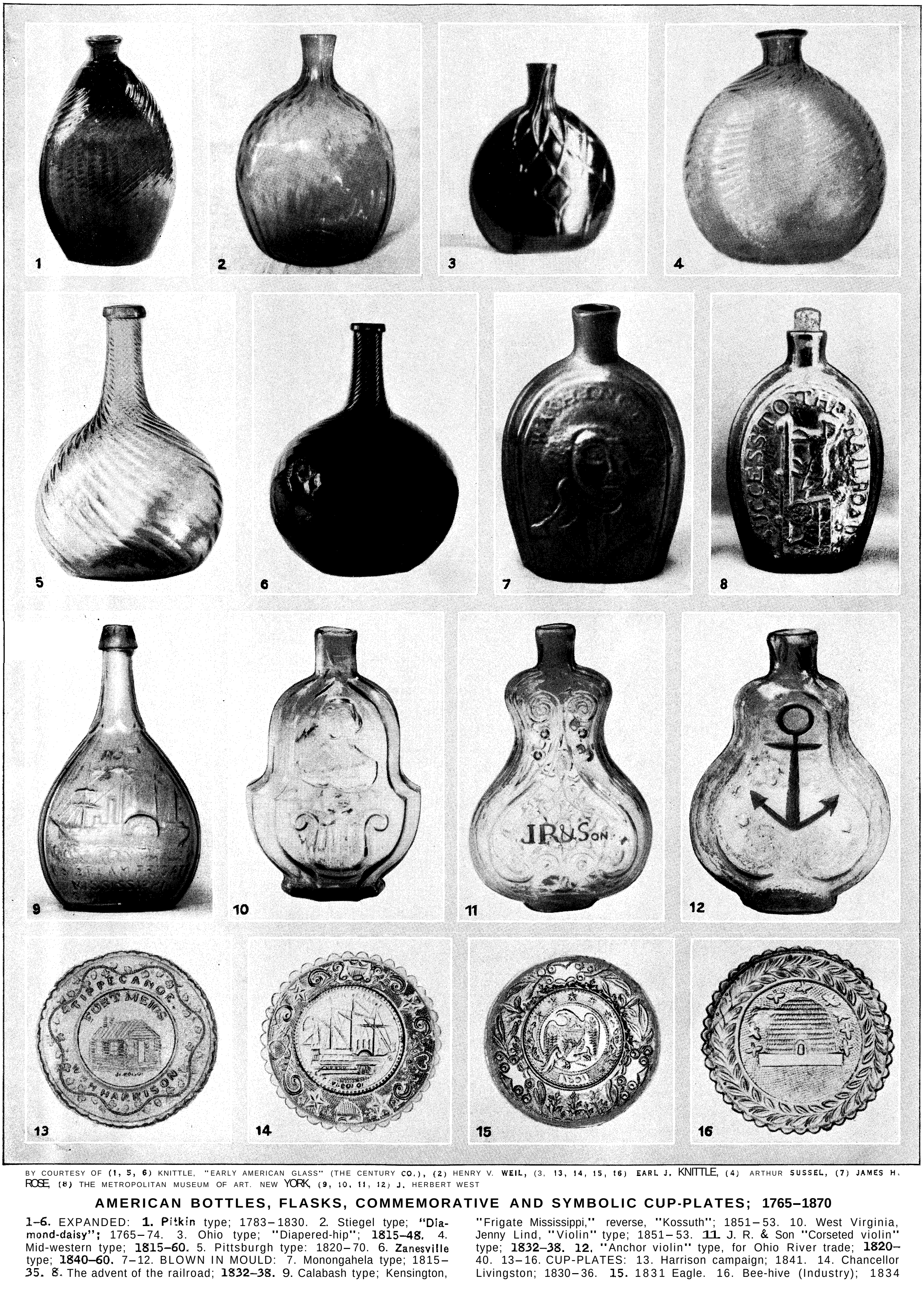
9–13. Insufflated or contact blown-mould technique, 1790–1864: 9. Four-mould pitcher. 10. Three-mould celery holder. 11. Three-mould baroque patterned decanter. 12. Three-mould vase. 13. Three-mould opalescent pitcher

14. Swirled and fluted expanded Ohio pitcher; 1816–26

15. Lacy pressed glass, New England Glass Co., Cambridge, Mass.; 1840–50

16. Crude early pressed glass, Boston and Sandwich Glass Co., Mass., and Providence, R.I.; 1828–38

GLASS



BY COURTESY OF (1, 5, 6) KNITTLE, "EARLY AMERICAN GLASS" (THE CENTURY CO.), (2) HENRY V. WEIL, (3, 13, 14, 15, 16) EARL J. KNITTLE, (4) ARTHUR SUSSEL, (7) JAMES H. ROSE, (8) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (9, 10, 11, 12) J. HERBERT WEST

AMERICAN BOTTLES, FLASKS, COMMEMORATIVE AND SYMBOLIC CUP-PLATES; 1765–1870

1–6. EXPANDED: 1. Pitkin type; 1783–1830. 2. Stiegel type; "Diamond-daisy"; 1765–74. 3. Ohio type; "Diapered-hip"; 1815–48. 4. Mid-western type; 1815–60. 5. Pittsburgh type: 1820–70. 6. Zanesville type; 1840–60. 7–12. BLOWN IN MOULD: 7. Monongahela type; 1815–35. 8. The advent of the railroad; 1832–38. 9. Calabash type; Kensington, "Frigate Mississippi," reverse, "Kossuth"; 1851–53. 10. West Virginia, Jenny Lind, "Violin" type; 1851–53. 11. J. R. & Son "Corseted violin" type; 1832–38. 12. "Anchor violin" type, for Ohio River trade; 1820–40. 13–16. CUP-PLATES: 13. Harrison campaign; 1841. 14. Chancellor Livingston; 1830–36. 15. 1831 Eagle. 16. Bee-hive (Industry); 1834

BY COURTESY OF (1) MISS MARY LEIGHTON, (2) BROOKLYN MUSEUM, (3) ADPRINT LTD., (4) TOLEDO MUSEUM OF ART, (5, 7) THE METROPOLITAN MUSEUM OF ART, (6) SMITHSONIAN INSTITUTION, (8) MAURICE HEATON

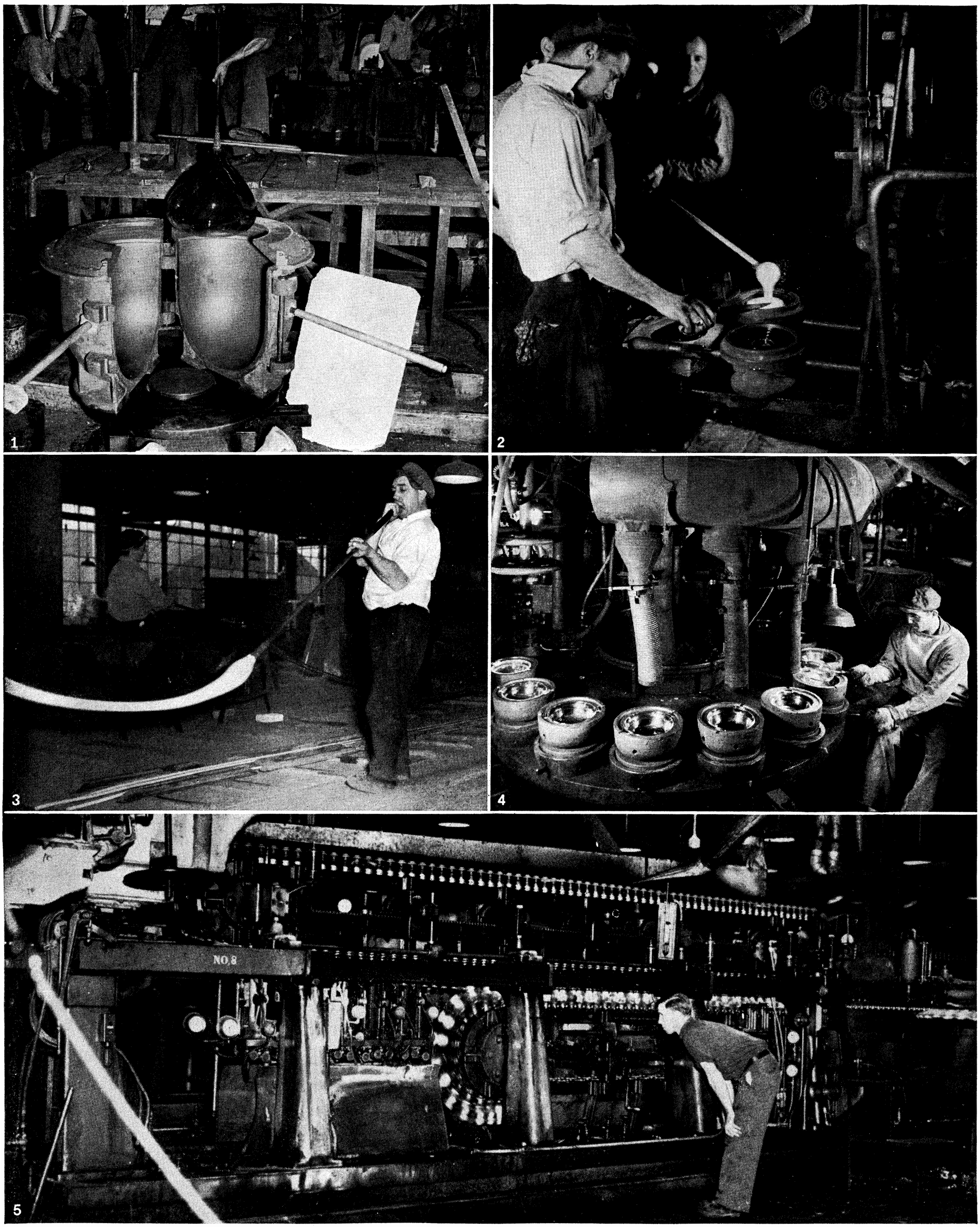
UNITED STATES GLASS AFTER 1850

1. Blue-cased toilet bottle, probably made by the New England Glass company, Cambridge, Mass., in the 1850s
2. Ruby-cased wineglass engraved by Louis Vaupel at the New England Glass company; third quarter of the 19th century
3. Pitcher in "peachblow" coloured glass made by the New England Glass company in the 1880s
4. Cut-glass plate made by the Libbey Glass company, Toledo, O.; 1890–93
5. Vase of Favrile glass made by Louis Comfort Tiffany, New York; end of the 19th century
6. Plate with intaglio cutting made by the T. G. Hawkes Glass company, Corning, N.Y.; early 20th century
7. Vase made by the Steuben Glass company, Corning, N.Y. Engraving designed by Sidney Waugh; 1937
8. Bowl with coloured pattern made by Maurice Heaton, West Nyack, N.Y.; 1955

BY COURTESY OF CORNING GLASS WORKS

OFFHAND GLASS MANUFACTURE

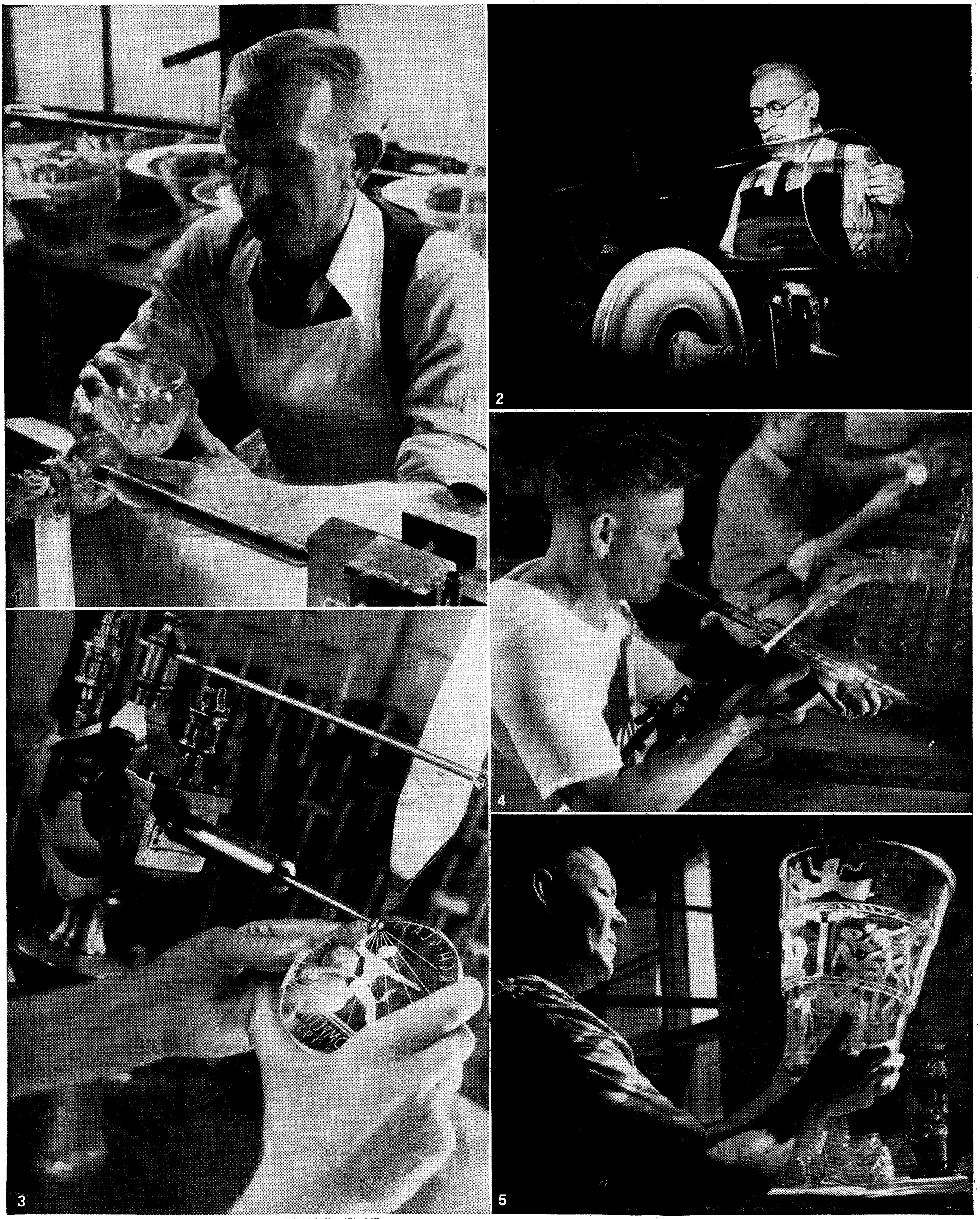
1. Tools used in offhand glass manufacture
2. Gathering glass from a pot for offhand manufacture
3. Offhand blowing to shape the bowl of a goblet
4. After fastening to a punty, the unfinished goblet is reheated and the excess glass is sheared off



BY COURTESY OF CORNING GLASS WORKS

OPERATIONS IN THE MANUFACTURE OF GLASS

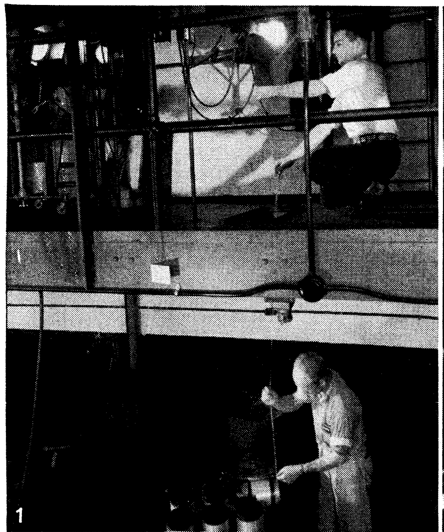
1. An "open and shut" hot-iron blow mould
2. Dropping molten glass into a "block" mould, after which it is pressed into a railroad signal lens
3. Drawing tubing by hand
4. Automatic press for manufacture of baking ware
5. The Corning "ribbon machine" in operation

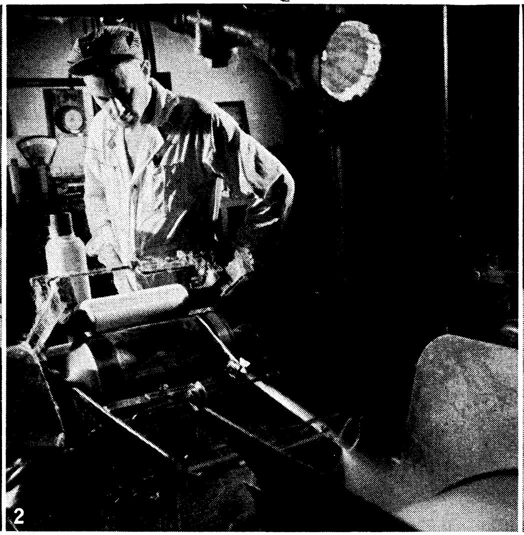


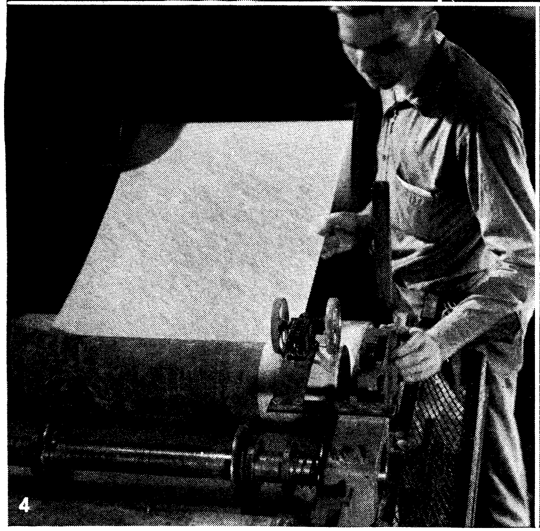
BY COURTESY OF (1-4) CORNING GLASS WORKS; PHOTOGRAPH, (5) PIX

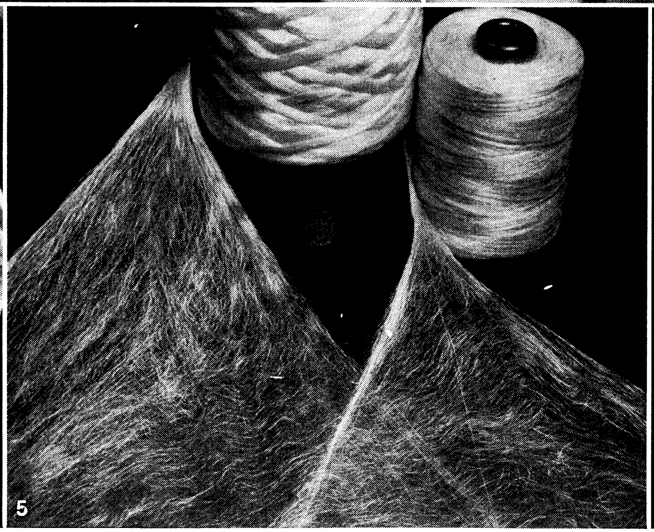
FINISHING AND ENGRAVING GLASS

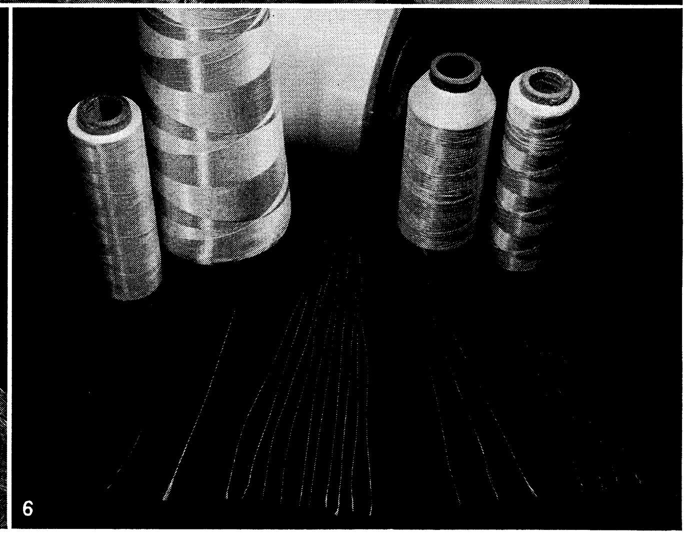
1. An engraver making a hollow cut on a Steuben goblet
2. Polishing a blueprint cylinder
3. Copper wheel engraving
4. Lampworker fabricating a bulb-type condenser
5. Foreman in a Finnish glass factory examining an engraved vase











BY COURTESY OF OWENS-CORNING FIBERGLAS CORPORATION

THE MANUFACTURE OF GLASS FIBRE

1. Manufacturing continuous filament glass fibres for textile use. Glass cullet in the form of marbles is melted in the electric furnace shown at the top of the picture. Bushings with multiple openings at the bottom of the furnace allow 100 to 400 individual filaments to be drawn simultaneously and gathered as a single strand. The man below is supervising the winding of filament. This process of manufacture is one of the four basic types; the other three are illustrated in figs. 2, 3 and 4
2. Production of glass in the form of staple fibre. Fibres are drawn by steam or air pressure from an electric furnace above the drum at the extreme right. They pass by a drying and tempering flame and gather as a web on a wide revolving drum. The web is drawn from the drum to form a sliver (pronounced *sly'-ver*) from which rovings or yarns may be subsequently formed
3. Production of glass mineral wool. Molten glass is drawn from large melting tanks or furnaces through small orifices and torn into shreds by steam or air pressure. The fibres gather on a conveyor as a white fluffy material having a natural density of 1½ lb. per cubic foot. This is the basic form of glass mineral wool and is used to fabricate many types of thermal and acoustical products
4. Forming glass fibre "bonded mat," a wafer-thin sheet of glass fibres. The fibres are produced by the staple fibre process except that the web is treated with a suitable binder and is gathered in sheet form. This product is used for storage battery retainer mats and air filters and to provide a paintable surface for glass mineral wool used in acoustical applications
5. Two forms of glass staple fibre. At the left is the plain form spread out to show the interlacing of many individual fibres. This form can be drafted and twisted for constructing moderately fine to heavy yarns. The type at the right contains a double strand of continuous filament in the centre of the staple fibres so that they may be handled without further drafting to form a high bulking material for electrical cable insulation and other purposes
6. Forms of glass yarn used for electrical insulation purposes. Left: a tube and cone of yarn suitable for weaving into fabrics. Centre background and right: various packagings of yarn, multiple wound to provide several strands in parallel arrangement. These forms are used for serving on magnet wires or cables to form an electrical insulation

linear style, often eked out by lines scratched with a hard-stone point, some of it is executed by means of wheels sufficiently thick to permit rounded cuts corresponding to the relief modelling of the human figure and simulating it when the piece is seen against the light. Both these types of decoration flourished in the 3rd and 4th centuries A.D.

In Egypt in the later (3rd–jth) centuries of the Roman epoch glass was in frequent use for tableware. but the artistic standards of manufacture did not stand very high. Plain dishes, cups. bowls and lamps are frequently met with, the glass metal of the tablewares ranging from an almost colourless material of good quality to a greenish-brownish substance full of bubbles and impurities. Decoration in this late period is mainly restricted to a few rough-cut lines. an occasional group of coloured glass blobs on. for instance) the lamps. or a zigzag trail of glass thread running between the lip and the shoulder of a vase. In Syria during the same period. however. this trailing technique. which was particularly suitable to the ductile Syrian material, was carried to extreme lengths, circuits of threads round the body or neck of a vessel, zigzags—either on the body or festooned between lip and shoulder—and fantastically worked handles being much favoured. Here too the quality of the material degenerated and .the finer types of glass ceased to he made.

With the breakdown of the Roman empire glassmaking fared differently in different parts of the world. In the east. urban life continued relatively undisturbed, and glassmaking evolved in an unbroken progress into Islamic times. In the northern provinces, however, from being a centralized industry, glassmaking became an affair of small glasshouses working in comparative isolation in the forests that supplied them with fuel. There relatively simple shapes were made in an impure greenish or yellowish material, their decoration being restricted to simple trails of thread. Considerable virtuosity. however, was displayed in the manufacture of the elaborate and fantastic "claw beakers" (*Rüsselbecher*) from about A.D. 500 onward. On these, two superimposed rows of hollow trunklike protrusions curve down to rejoin the wall of the vessel above a small button foot.

In the eastern parts of the empire, Syria appears to have continued with its predilection for trailed and applied ornamentation, which became in the 5th–7th centuries sometimes fantastically elaborate. In Egypt the art of glass seems to have suffered a catastrophic decline. only small rough vessels of impure green or blue material being manufactured, with no more decoration than a few coloured blobs of glass or circuits of trailed thread. In Byzantium itself the position of glassmaking is obscure. A distinction made between *vitriarii* (glassmakers) on the one hand and *diatretarii* (glass cutters) on the other; in edicts of Constantine the Great, Theodosius and Justinian. suggests that cutting played an important part in Byzantine glass decoration. This is borne out by the fact that the greater part of the glass brought back from the sack of Constantinople by the crusaders, and placed in the treasury of St. Mark's in Venice. is in fact cut. Apart from the few pieces of obviously Roman glass which had presumably been kept as heirlooms in Byzantium, these glasses are decorated either with tessellated patterns of overlapping round or oval facets or with round bosses cut in the relief technique. These same two broad divisions of cutting technique are observable in the glass of the 5th century excavated at Kish in Mesopotamia, and it is a fair assumption that here, as in some of the other arts. Byzantine taste was strongly influenced by the east. It is probable, however. that some enamelled and gilt glass also was made in the Byzantine provinces (*e.g.,* in Corinth). if not in Byzantium itself. The position of glassmaking in Italy during this period is obscure.

Islam.—In the course of the 7th century A.D. the whole near east was overrun by the Arabs. Although the original political unity of this invading force was soon split by faction, and a number of rival dynasties were established in different parts of the conquered territory, an Islamic cultural area was created which was comparable with the area of Graeco-Roman culture existing under the Roman empire. In these conditions there evolved a glass style which is as distinctively Islamic as that of the Roman empire was Roman. Although it often is not possible to say where a particular glass mas made, the different parts of the Islamic world seem to have shown a predilection for one or another type of glassmaking. In Syria the native bent for plastic work seems to have continued to find its outlet both in pieces more or less heavily decorated with trailed threads or applied blobs and in pieces blown is moulds patterned with ribs or with honeycomb or other all-over designs. In Mesopotamia glassmaking seems to have flourished especially under the Xbbasid caliphate (A.D. 750–1258), which, particularly in the 9th century. appears to have attracted to its service many of the best artists in the Islamic world. In particular, a great school of glass engraving appears to have been established in Mesopotamia. Not only were the earlier modes of facet and boss cutting continued. but (perhaps deriving from them) two splendid new styles were created. the one of linear engraving in intaglio. the other a method of relief cutting in which the outlines of the design were left standing in relief by the cutting back of the ground and were then enlivened by crosshatching. In this technique were produced bowls. bottles and ewers of remarkable sumptuousness, decorated with figures of running animals and with plant scrolls, the leaves of nhich were formed by semipalmettes. The number of fragments of this latter type of cut glass found in Persia after World War II suggests that such work may also have been done there, and the fine linear style referred to above was probably also practised in the more easterly provinces of the Xbbasid caliphate.

In Egypt there was both innovation and, after the decay of the post-Roman period, a notable revival of earlier techniques. Among the innovations mas the device of stamping a glass by means of tongs, one jaw of which was patterned; and many fragments of vertical-sided bowls decorated by this means have been found in Egypt. The technique, however. probably spread to other lands. and one extension of it. by which the upper and lower halves of bottles were made separately in contrasting colours, decorated by the tongs and then joined together, was probably a Syrian innovation. Of greater importance was the Egyptian invention of lustre painting. In its simplest forms it consists of no more than painting in a pigment containing silver, which, when fired in a reducing atmosphere. produced a thin metallic film on the glass varying in colour from pale yellow to brown. Intact bowls and a bottle decorated by this technique are known. but whole classes of far more elaborate lustre-painted wares are represented only by fragments. They present a very wide variety of polychrome surface effects, many of which are probably not produced by lustre pigments properly so-called and the technical secrets of which are not yet understood. The vessels decorated by these techniques must have been sumptuous in the extreme.

The Egyptian archaizing revivals of this period included the reintroduction of millefiori glass, mainly in plaques for wall decoration, and of white fern and feather patterns produced on dark glass vessels by combed and imbedded glass threads. Glass cutting was also practised in Egypt but probably was confined mainly to the production of deeply incised small perfume bottles of square section. the bases of which were often cut into four tapering feet—a conformation nhich has earned for them the name of molar-tooth bottles. Egypt probably also perfected the technique of gilding. which was decisive for the next phase in Islamic glassmaking. It seems possible that it was glassworkers with a knowledge of this technique, migrating from Egypt to Syria on the fall of the Egyptian Fatimite dynasty in 1171, who laid the foundation of the Syrian art of enamelled and gilt glass.

Although the earlier phases of this art are incompletely understood, the first group of enamelled and gilt glasses seems to be one in which thick enamels are used (particularly white and turquoise blue), often in series of beadlike drops. This class is associated with the town of Rakka in Syria. but the association is far from certain. X similar uncertainty surrounds the origins of the two broad families into which the mature Syrian glass of the 13th century is divided. One class. characterized by the use of thick, jewellike enamels, is connected with the town of Aleppo; the other, notable for its exquisitely painted small-scale figural decoration, is attributed to Damascus. Both these cities were famous for their glass at this epoch, but it is far from certain what each produced. Wherever made, the glass of this type represents one of the high lights in the history of the art. whether one considers the rich polychromy of the enamels—green, red, yellow, white and turquoise blue—of the "Aleppo" group, or the masterly drawing in red outline of the "Damascus" group. Toward 1300 Chinese influences, infiltrating to the near east by way of the Mongols and Tatars, makes itself felt in the decoration of these glasses and is apparent in the great series of mosque lamps which from about this time began to be made for the rulers and great officers of state in Egypt. From a peak point of excellence at the beginning of the 14th century, a decline set in which was greatly precipitated by Timur's sacking of the chief Syrian cities at the end of the century. Damascus fell finally in 1400, and it is recorded that the glass-workers of that city were carried into captivity in Samarkand. Nevertheless, some enamelled glass, of inferior quality. continued to be made in the 15th century, perhaps in Egypt. By the end of that century. however, there is evidence that mosque lamps were being made in Venice for the oriental market, and the great near eastern tradition of enamelled and gilt glass was clearly moribund.

Venice and the **Façon de Venise.**—A glass industry was already established in Venice in the 11th century, and it is evident that vessel glass was being made there by the third quarter of the 13th century. In 1291 the glass furnaces were removed to the neighbouring island of Murano in order to obviate the risk of fires. in the city. Although Venice had constant contact with the east, there is no evidence that it was indebted to that source for its skill in glassmaking, and when the first Venetian enamelled glasses appear in the second half of the 15th century, although their technique is essentially similar to that of the Syrian glasses just mentioned, it is clear that they are of independent development. Little is known of the vessels made before this period, but it is evident from representations in pictures that they were mainly footed flasks and low beakers. The Venetians themselves attributed the introduction of enamelling to a member of the glassmaking family of Barovier, and the earliest pieces known, commencing with a goblet referable to the year 1465, certainly show no signs of outside influence. These, like most Venetian glass of this and the immediately succeeding period, show that their makers were inspired with the ideals common to the artists of the Italian Renaissance. The subjects of the enamelled glasses are drawn probably from contemporary woodcuts and *nielli,* and represent triumphs, allegories of love, grotesques and so forth. with decorative borders formed of dots of enamel laid on a ground of gold etched in a scale pattern. Many of these pieces were of richly coloured glass, mainly blue, green and purple. The Venetians were keenly aware of the Roman achievement, in glassmaking as in the other arts, and not only did they reproduce the earlier mosaic, millefiori and aventurine glass, and the glass made of blended colours resembling those of natural layered stones (calcedonio, sometimes miscalled Schmelzglas), but they even copied the Roman form of bowl with vertical external ribs. All these types of coloured glass were Venetian specialties and had probably been evolved as a part of the extensive local bead industry. The greatest achievement of Venice, however, and that upon which its great export trade came to be based, was the manufacture of clear. colourless glass, the secret of which had probably been lost during the middle ages. From its resemblance to the natural crystal, this material was called *cristallo,* although in fact it often has a brownish or grayish cast which is not unpleasing. This glass, which was fluxed with soda. was very ductile and cooled quickly. It therefore demanded of the workman great speed and dexterity, and this in turn affected the nature of the glasses made. Although in the first half of the 16th century the Venetian glass blowers produced glasses of an austere simplicity of form, as the century drew on (and more markedly still in the 17th century) there was a tendency to produce elaborate and fantastic forms which in the end overreached itself. Enamelling went out of fashion in Venice (except on pieces for export) in the first half of the 16th century, its place being taken to some extent by the use of opaque-white glass threads for decorative purposes (*latticinio* or *latticino*). This form of decoration became progressively more complex, opaque threads being embedded in a matrix of clear glass and then twisted into cables which were themselves used to build up the wall of a vessel. The height of complexity was reached when a bulb of glass decorated with cables or threads running obliquely in one direction was blown inside a second bulb with threads writhen in the other direction, the composite globe thus formed being then worked into the desired form. This gave a vessel completely covered with a lacy white pattern (vetro di trina). Other methods of decoration at this time were mould blowing, and dipping a vessel while hot into water, or rolling it on a bed of glass fragments, to produce a crackled surface (ice glass). Cristallo was also found suitable for engraving with the diamond point, which produced spidery opaque lines especially suitable for. delicate linear designs. Most Venetian work of this type was devoted to scrolling leafy designs which run round the rims of dishes and plates. The technique seems to have come in about 1560.

The glassworkers of Murano were governed by stringent laws, which forbade them to leave Venice or to teach their secrets to outsiders, under dire penalties both to themselves and their families. Such was the demand for Venetian glass in the rest of Europe, however, and such the desire of kings and nobles to have the making of glass in their own hands, that many Venetian workmen in the course of the 16th century were tempted to abscond to other countries, where they helped to set up glassworks. Furthermore, there was at L'Altare, near Genoa, a second great centre of glassmaking, where glass was made so like the Venetian in style and material that it is nowadays impossible to distinguish the two. The glassworkers at L'Altare, moreover. were governed by no such laws as the Venetians and rather made it their policy to supply their men and teach their methods wherever there was a demand for them. By these two agencies, therefore, the Italian art of glass spread to the rest of Europe, and glasshouses were established in France, Spain, Portugal, Austria and Germany, while in the north Antwerp seems to have been a source of secondary diffusion. Italian glassworkers were to be found as far north as England, Denmark and Sweden. Their labour was necessarily diluted by that of native workmen, to whom they were often required to teach their methods; while changed sources of raw materials often modified the quality of the glass they made. But even allowing for this and for the adjustments imposed by local taste on form and ornament, it remains true to say that in the late 16th and the 17th centuries there was an international style in glass, wholly Italian in origin and inspiration. This is the so-called *façon* de Venise.

Although there was everywhere a family likeness among glasses of the *façon* de Venise, certain countries developed types peculiar to themselves which are worthy of mention. Thus, in Spain, not only were fantastic and even bizarre shapes evolved in a local green metal, both in the south and in Catalonia, but in Barcelona a characteristic kind of enamelled decoration was developed, the peculiarities of which include a light leaf-green colour and a singular and constantly recurring lily-of-the-valley motif (late 15th-16th century). At Hall, in the Tirol, a characteristic type of decoration with the diamond point, often supplemented by cold painting, was favoured. This consisted of usually alternating broad and narrow upright panels containing symmetrical scroll-work or coats of arms and other devices. Almost equally stiff and formal diamond-point work is to be seen on the glasses probably made at the London glasshouse of Jacopo Verzelini (examples dated between 1577 and 1590). A far more promising development of diamond-point engraving occurred in the Netherlands. There too the work of the 16th century was relatively formal and perhaps slightly stiff. Like the work done in other countries, however, it is marked by a linear character and a clarity achieved by the use of simple hatching, in one direction only, as a filling pattern. In the succeeding century, however, fresh developments occurred which, while having the initial result of making diamond-point engraving more supple and pleasing, contained in themselves the seeds of decay. At this epoch diamond-point engraving was practised not only by professional glass decorators but also, possibly to an even greater extent, by talented amateurs, among whom were numbered members of the humanistic intellectual elite of the time, such as Maria Tesselschade Roemers Visscher (1595–1649), her even more famous sister Anna Roemers Visscher

(1583–1651) and Anna Maria van Schurman (1607–78). The tuo last-named decorated their glasses with flowers and insects drawn with a gossamer touch and often accompanied by epigrams in Latin or Greek capitals scratched with severe precision or in the free scrolled style of the Italianate writing masters of the time. A similar calligraphy was practised on its onn at a later date by the amateur Willem Jacobsz van Heemskerk (1613–92), with notably beautiful results. The subject engraving of the Erst half of the 17th century shows a gradual abandonment of the clarity of the older linear handling. in favour of a system of close hatching and crosshatching to produce chiaroscuro effects, the high lights being formed by sometimes completely opaque spots. Of the many artists working in this manner, only two are worthy of special mention. One was an accomplished engraver signing C. F. M., whose earliest dated glass is of 1644. and the other Willem Mooleyser, of Rotterdam, who worked in the last two decades of the 17th century and whose work has a scribbled freedom and vigour which raise it above the average. By the end of the century this type of diamond-point work was superseded in popularity by wheel engraving.

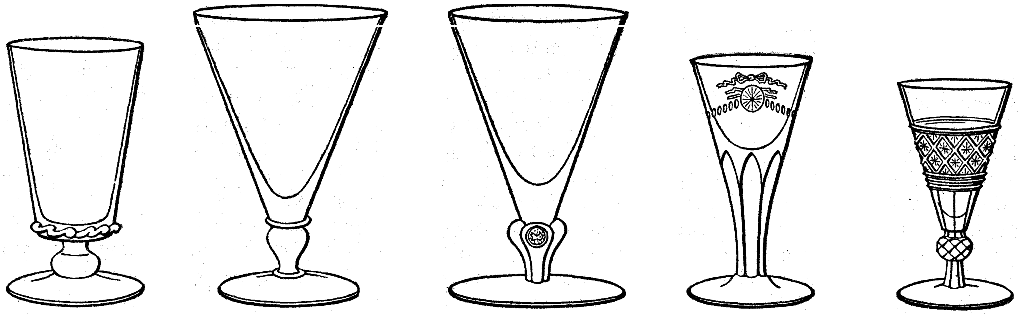


FIG. 7.— A. MANSELL GLASS; ABOUT 1660. B. JOHN GREENE FORM; ABOUT 1660. C. RAVENSCROFT GLASS, IDENTIFIED BY SEAL BEARING RAVEN'S HEAD; ABOUT 1675. D. WINEGLASS WITH STEM CUT IN FLUTES AND BOWL ENGRAVED: MID-18TH CENTURY. E. ELABORATELY CUT WINEGLASS; EARLY 19TH CENTURY

Germany. — In Germany, toward the end of the 17th century, a reaction to Venetian glass styles seems to have set in. In that country there had been a continuous survival; probably from late Roman times, of a local type of green glass. made in forest glass-houses and fluxed with potash obtained by burning forest vegetation, and called therefore *Waldglas* (forest glass). In this material. often of great beauty of colour, were made shapes peculiar to Germany, notably a cylindrical beer glass studded with projecting bosses (*Krautstrunk* or "cabbage stalk") and a wineglass (*Römer*) with cup-shaped or ovoid bowl set on a similarly prunted hollow stem. This became the classic German shape of wineglass, survived into the 18th century and survives, with modifications, to the present day. Apart from these indigenous forms, made in a native metal, German glass made in Venetian-type *cristallo* developed, in the latter part of the 17th century, local characteristics of its own. This was especially true of Nuremberg, where the Italianate tall-stemmed goblet underwent a transformation into a severe glass with stem composed of no more than a baluster-shaped element and a bulb, joined together by a number of disk-shaped *mereses* and attached to foot and bowl by the same means. On these goblets is to be seen some of the most accomplished glass engraving ever practised. Leader and founder of the Nuremberg school of engravers was one Georg Schwanhardt (1601–67), a pupil of Caspar Lehmann. Lehmann had been gem cutter to the emperor Rudolph II in Prague and had there taken the decisive step of transferring the art of engraving from the decoration of precious stones to that of glass. His first dated work is a beaker of 160j. and in 1609 he obtained an exclusive privilege for engraving glass. It is nevertheless virtually certain that, although he is the first great personality in glass engraving. he was not the first to practise the art in the German area. On Lehmann's death in 1622, Schwanhardt inherited his patent and moved to his own native city. Nuremberg, where a whole school of glass engraving grew up around him and his family. Schwanhardt's own work is characterized by a delicate handling of tiny landscapes, often accompanied by contrasting bold formal scrollwork. His son Heinrich, too, excelled in rendering minute landscapes but also engraved inscriptions of fine calligraphic quality. Other notable Nuremberg engravers of the late 17th century were Paul Eder, Hermann Schwinger (1640–83), whose mastery of calligraphy is reminiscent of Heinrich Schwanhardt's, H. W. Schmidt and G. F. Killinger, both of whom are chiefly notable for the delicacy with which they rendered landscape. Work somewhat similar to that of the Nuremberg engravers was done at Frankfurt-on-Main by members of the family of Hess.

After Lehmann's death, little engraving of high quality was done in Bohemia for a while. Just before 1700, however, thanks to the perfection of a massive, crystal-clear, potash-lime glass which allowed cuts of considerable depth, the engravers of the Bohemian-Silesian area came into prominence. A powerful aid to economic working was the harnessing of water power in the mountainous districts of the Riesengebirge, and this enabled the engravers (those of the Hirschberger Tal in particular) to practise the art of relief engraving, which demands an immense output of energy in grinding down the ground on which the design stands. In this technique were produced massive covered goblets decorated with powerful acanthus scroll designs in the contemporary Baroque taste. Relief engraving (*Hochschnitt*) was only occasionally used by itself in the Bohemian-Silesian area in the 18th century, being more often employed in conjunction with intaglio engraving (Tiefsclznitt) on Silesian glasses. By the turn of the 18th century the engravers of this area—almost always anonymous workmen who were obviously regarded rather as artisans than as artists—had acquired immense technical skill, and this enabled them to adapt to glass decoration all the changing fashions of the 18th century in the decorative arts. Their work, however, although striking for its virtuosity, is seldom of great artistic value. Glass engraving, often of fine quality, was also practised in many parts of Germany—notably Thuringia, Saxony and Brunswick—but the most significant work of the late 17th and early 18th century was that done in Brandenburg. There, the glassworks at Potsdam (moved to Zechlin in 17.36) produced massive goblets and beakers which were engraved—usually to order for the court—in Berlin, where a water-powered engraving shop had been installed in 1687. Both Hochschnitt and *Tiefschnitt* were practised, the former being to some extent subordinated to the latter. This workshop, indeed. produced perhaps the greatest of the German intaglio engravers, Gottfried Spiller (d. after 1721), whose deep cutting on the thick Potsdam glass has seldom, if ever, been surpassed in the history of glass engraving. A notable engraver from the same shop, although overshadowed by Spiller, was Heinrich Jaeger (working from before 1694 until after 1701); and later! in the 1730s and 1740s, work of high quality was done by Elias Rosbach (d. 1765). Another workshop of great significance was that set up toward the end of the 17th century at Cassel, in Hesse. There worked perhaps the greatest of all the Hochschnitt engravers, Franz Gondelach (b. 1663, still working 1716), who handled his material with a truly sculptural feeling.

In the second half of the 18th century engraving as a means of decorating glass declined in favour! although the technical skill required for its production never died out in the Bohemian-Silesian area. It experienced a great revival in the second quarter of the 19th century, when the taste of the newly prosperous bourgeoisie favoured elaborate decoration. The engraving of this period is often skilful in the extreme! although marred by excessive naturalism. Striking innovations of the period were the use of a casing (normally ruby red or opaque white) through which the design was cut down to the colourless glass. A yellow coating (the silver stain of the stained-glass artist) was often used in the same way. Notable engravers of this epoch were Dominik Bimann (1800–57), August Bohm (1812–90), A. H. Pfeiffer (1801–66) and members of the Pelikan and Simm families.

Second in importance only to engraving as a method of decorating glass in Germany was enamelling. Germany had proved a profitable market for enamelled Venetian glass during the 16th century, and in the latter part of that century glass enamelling began to be practised in the Germanic lands themselves, the most notable centre being Bohemia. This enamelling, in bright opaque colours, was much favoured throughout the 17th century, chiefly on the cylindrical drinking glasses, often of great size. known as *Humpen*. The glass of which they were made was frequently impure and of a greenish or yellowish cast, while the painting itself was rather the simplified repetitive work of artisans than that of original artists. Nevertheless, the gaiety of colour of these glasses, and a certain naïveté in their painting, give them an authentic unsophisticated charm. The most-favoured types of decoration include a representation of the imperial double-headed eagle with the coats of arms of the imperial hierarchy displayed on its wings (Reichsadlerhumpen); representations of the emperor with his seven electors, either seated or mounted on horseback (Kurfurstenhumpen); subjects from the Old and New Testaments; and allegorical themes such as the Eight Virtues and the Ages of Man. These were painted between borders of multicoloured or white dots or intersecting ellipses, often on a gold ground. This general style continued into the 18th century, but in the course of that century the levels of artistic and technical competence sank, and the tumblers and spirit bottles which were the main types produced can be regarded only as objects of peasant art.

A far more sophisticated type of enamel painting was carried on during the third quarter of the 17th century at Nuremberg. Here, painting in black or sepia (*Schwarzlotmalerei*)—a technique borrowed from the stained-glass artist—was used to decorate the small cylindrical beakers (often resting on three hollow ball feet) which were a locally favoured shape. Other colours, notably red used in touches with the black, were also occasionally employed. The greatest and most original artist of this school was Johann Schaper (1621–70), who painted delicate architectural and landscape compositions in which use was made of a fine point to etch in details through the black enamel to the colourless glass. The best of Schaper's followers were J. L. Faber, Hermann Benkert (1652–81+), Johann Keyll and Abraham Helmhack, but none of them equalled him in artistic competence. Comparable work appears to have been done, although on a more restricted scale, in the Rhineland, notably by Johann Anton Carli (d. 1682) of Andernach. At the beginning of the 18th century Schwarzlot painting, often with touches of gold, was practised in Bohemia and Silesia and reflected the changing fashions in the decorative arts. Daniel Preissler (1636–1733) and his son Ignaz are known to have done this work, but it has not certainly been identified.

In the first half of the 19th century the decorators of vessel glass once again borrowed from the stained-glass artist. Samuel Mohn (1762–1815), his son Gottlob Samuel Mohn (1789–1825) and Anton Kothgasser (1769–1851) painted the straight-sided beakers typical of this "Biedermeier" period in transparent enamels and yellow stain.

A technique peculiar to Bohemia in the 18th century was that of the "gold sandwich glasses" (Zwischengoldglaser). These were beakers, or less often goblets, made of two layers of glass, exactly fitting one over the other, between which was sandwiched a gold leaf previously etched with a steel point to the desired design. The earliest work in this technique was anonymous, but at a later date J. J. Mildner (1763–1808) employed it with notable success, making gift tumblers decorated with medallions of etched gold or silver leaf (often backed with red pigment), and sometimes also engraved on the wheel or with the diamond point.

England.—Glass was certainly made in England during the later middle ages, but most of it was used for church windows. (See STAINED GLASS.) The vessel glass of the period has not been much studied and is only imperfectly understood. It is only when the 16th century is reached, and particularly the second half of it, that the picture becomes clearer. Two lines of development may be traced in this period. On the one hand is the glass of German *Waldglas* type, made in the woods which supplied the furnaces with fuel and a source of potash. These glasses were made by glassworkers whose traditions were those of Lorraine and of Flanders. Much of their production was of window glass, but they also made vessels in a modest variety of shapes and modes of decoration. Chief among the forms made was a tumblerlike drinking glass with a low doubled foot rim produced by pushing in the bottom of the bulb from which the glass was made; this might be decorated either by mould-blown diaper designs, or by swirled ribbing imparted by mould blowing and subsequent twisting, or by a zone of trailed threading beiow the neck. Applied notched ribbons or small circular motifs were also used. Small bottles of mould-blown hexagonal section or of flattened ovate form with diagonal ribbing were also made. The second line of development was that of the international Venetian style brought by immigrant Italians (see above); this, however, in time acquired an English idiom. This work was done mainly in London.

In the 17th century these two traditions were welded into one, the main factor in the process being the proclamation of 1615 forbidding the use of wood in glass furnaces. Thenceforth coal was the sole means of fusing glass, and glasshouses tended to fix themselves where coal measures (and the frequently concomitant fire clays for making glass pots) were abundant. These areas tend to be those where industrial development has been continuous ever since (*e.g.*, the Stourbridge area and Tyneside), and excavation on these sites has seldom been practicable. Little, therefore, is known of provincial glassmaking in England in the 17th century, but it may be taken as certain that *Waldglas* disappeared (even if some of its forms survived) and that an Anglicized form of the 17th-century *façon* de *Venise* became the national style. Some idea of this style may be gained from the fragments of glasses often excavated in London and other cities. It is frequently difficult to distinguish between an English glass and an imported continental one, although a certain coarseness may be taken as symptomatic of local make. During the first half of the 17th century, English glassmaking was dominated by a series of monopoly holders, the greatest of them being Sir Robert Mansell (1593–*c.* 1656), who effectively controlled the industry from 1623 until his death. After the Restoration, although some monopolies were granted for certain categories of glasswares, an increasingly important role in the English industry was played by the Worshipful Company of Glass Sellers (reincorporated in 1664), which was able to keep closely in touch with the needs of the English market. Its members seem to have laid stress on simplicity of shape and durability of material as appears from the correspondence of one of them, John Greene, with his suppliers in Venice (fig. 7, B). Dissatisfied with the quality of glass supplied to them, and no doubt anxious also to make England independent of foreign sources of both finished glass and raw materials, they commissioned George Ravenscroft (1618–81) to make experiments with native materials, in the hope of evolving a more solid metal than the Venetian and one which more closely resembled rock crystal. A similar change of taste was taking place in Germany about the same time (see above). Ravenscroft was completely successful, his crucial discovery being the use of lead oxide as a flux. His "glass of lead," evolved about 1675, was perfected toward the end of the century and set a standard for the rest of Europe. It was solid and heavy and more durable than the Venetian-type glass which it progressively displaced. It was also characterized by brilliance and dark shadow paradoxically combined. It was slower to work than the Venetian glass, and gradually the Venetian idioms were dropped from English glassmaking in favour of a genuine native style. This style is best seen in the drinking glasses which, at the end of the 17th century and beginning of the 18th, constitute the chief glory of the English industry. These often massive baluster glasses were composed of a usually funnel-shaped bowl and a stem compiled of any of a large variety of pear-shaped and bulbous knops. In their simplicity and the harmony of their proportions, they rank among the classics of the Queen Anne style.

Toward the middle of the 18th century, taste in the arts generally inclined to lighter forms, and in the case of glass this tendency was given additional impetus by the passing in 1745–46 of an excise levied on glass by weight. Drinking glasses became slighter, the bowls smaller and the stems taller and more slender. The loss in architectural values was often offset by extraneous decoration. At first this tended to be concentrated in the stem. Bubbles of air had sometimes previously been enclosed in a knop forming part of the stem of a wineglass! and these bubbles were now drawn out and twisted so that they formed a cable of air ribbons inside a cylindrical stem. Stems of this type were popular for about zo years before and 10 years after the middle of the century. Just before 1750 a stem came into favour which was decorated with threads of opaque-white glass instead of the air twists. These stems were made by much the same techniques as the Venetian latticinio glass (*see* above). They remained in fashion during the third quarter of the century, their lapse from favour being perhaps hastened by the second Glass Excise act in 1777, which imposed a tax on the opaque-white "enamel" glass, previously exempt.

These forms of ornament had been restricted to the stems of glasses, but other methods of decoration were simultaneously evolved which could be used to embellish the whole glass. First of these was engraving, which had been sporadically practised in England as early as the end of the 17th century. This work and the inscriptions. coats of arms and arabesque borders in German style which were engraved during the first 20 years or so of the 18th century were undoubtedly the work of immigrant (probably German) artisans. By 1735, however, at least one English engraver was capable of executing such commissions, and from about this time engraving on glass begins to take on a more English character. An artless use of floral motifs, *chinoisevies* and scenes from country life is typical of the engraving of the third quarter of the 18th century. and in this period also falls the frequent representation on glasses of Jacobite themes—portraits of the Old and Sew Pretenders. the rose with buds. the honeysuckle and the other flowers used in the symbology of the Stuart cause, together with the mottoes of such "loyal" societies as the Cycle club. Engraving never reached great heights in England. but English glasses were in demand by engravers on the continent, particularly in the Netherlands, where the work of at least one notable artist—Jacob Sang, of Amsterdam—was almost exclusively done on imported English drinking glasses. English lead glass seems also to have been particularly sympathetic to the Dutch diamond-point engravers, whose work in this period was executed almost exclusively in stipple. The chief masters of this delicate art, in which the design seems no more than a bloom on the surface of the glass, were Frans Greenwood (1680–1761) of Dordrecht, the originator of the style, and David Wolff (1732–98) of The Hague, whose work, if uninspired, is of high technical accomplishment.

The second decorative technique of foreign inspiration to be used on English glass in the 18th century was enamelling. It was used for embellishing opaque-white glass in ,imitation of china about the middle of the century—a type of work usually associated with the name of Michael Edkins (1734–1811), a Bristol artist, but in fact done in many parts of the country. Perhaps the most original work in this medium was done on clear glass by members of the Beilby family of Sewcastle upon Tyne, during the 1760s and 1; 70s. Their rendering in pink- or blue-toned white enamel of ruins, trophies of arms and rural pastimes, often framed in scrollwork of the utmost delicacy, is one of the best things in English rococo glass. Gilding mas also used at this time to decorate glasses, usually with simple designs of vine and grapes.

These ornamental techniques, however, were of ephemeral growth in England. Far more significant than any of them, because more firmly rooted in the very nature of English glass, was the art of cutting. Although literary references to cut glass occur before 1720, the earliest known pieces extant can hardly be dated much before 1730. On them the cutting is mainly confined to brims and feet, which are scalloped or notched; or, in the case of wineglasses, to the thicker parts of the glass, such as the stem. which might be fluted or cut in an all-over pattern of flat diamonds. Throughout the period from about 1745 to 1770, shallow cutting was the normal, diamonds, hexagons, flutes and scale pattern being combined with segmental lunate cuts (produced by holding the glass at an angle to the cutting wheel) and with triangular and diamond motifs in very low relief. These elements could be combined to produce designs of great complexity and richness, and this period is the golden age of English cutting. About 1770 a plainer style, employing mainly flutes, responded to the rising neoclassical fashion in the other arts. The flutes were sometimes combined with diamonds in relief, and when further taxes were imposed on glass in 1777 and 1781. and in 1780 trade between England and Ireland was freed, it was this relief-diamond style which was taken up in the latter country by the glasshouses founded under these favourable economic conditions. The Irish glassworkers could afford to be more lavish with their metal, and on this thicker glass increasingly deeply cut diamonds and other relief motifs could be produced. About the turn of the century the diamonds began to be reduced in size and to be used as a diaper design covering whole areas. often alternating with fields of larger truncated diamonds. the surfaces of which were themselves diversified with cut crosshatching. Such designs were often used in combination with deeply cut horizontal grooves. These styles. which were subsequently followed in England as well as in Ireland. finally led to a complete breaking up of the face of the glass into points and ridges, with increased prismatic effect but with a disastrous loss of that surface quality which is one of the peculiar beauties of glass. The prismatic brilliance was enhanced by the progressively greater purity and whiteness of the glass made during the second quarter of the 19th century, and the temptation to cut ever more deeply and with greater complexity finally seduced the glassmakers into producing the "prickly monstrosities" of the Great exhibition of 1851.

Throughout the 18th century there was great admiration on the continent for English lead "crystal," and in the second half of it some of the continental glasshouses. by the use of lead oxide, had contrived to produce a comparable material. English cut glass was admired and exported, and the styles of cutting of the late 18th and early 19th centuries were much imitated abroad.

The Far East.—Glass has never been truly at home in China. Records suggest that it was brought there from the west as early as the 3rd century A.D.. but finds of small glass objects of typical Chinese shapes dating from as early as the Han dynasty (206 B.C.–A.D. 220) suggest that, even if the material was brought from the west, it could be worked on the spot to conform to Chinese usage. It was no doubt regarded as a cheap substitute for jade. The Chinese themselves do not claim to have made glass before the 5th century A.D., and even then it is very doubtful if they knew more than how to make beads and other similar small objects. The vessels of glass occasionally found in burials of the T'ang (A.D. 618–906) and later dynasties may be assumed to have been imported. Of the extant glass vessels typically Chinese in form, none can be shown to be of a date earlier than the reign of the emperor K'ang Hsi (1662–1722), and there is every likelihood that glassmaking mas in fact introduced in this period, when, through the Jesuits. China became vividly aware of western culture. To this period probably belongs a series of bowls and vases of which the blown character is manifest. They are often of a decayed metal which appears to suffer from the same deficiencies as European glass of the same epoch. During the reigns of the emperors Yung Chêng (1723–35) and Ch'ien Lung (1736–96) the emphasis on blown forms is subordinated to the desire to make glass a surrogate for natural stones. Although the colours used are often not such as are found in nature, the glass is handled as though it were jade, the foot in particular being fashioned as though cut from stone. This lapidary treatment is further emphasized in the cased glass bottles cut on the wheel in such a way that the design stands in one or more colours on a ground of a contrasting tone.

(R. J. C.)

United States. — Glassmaking was apparently the first industry to be transplanted from Europe in the wake of the Spanish conquerors. As early as 1535 glass was being made at Puebla de los Angeles in Mexico, and in 1592 a glasshouse was located in the territory of the Rio de la Plata in the town of Córdoba del Tucumán, Arg. Broken glass, undoubtedly of European origin, was remelted at the latter and fashioned into various objects including thick. semitransparent flat glass.

The London company of Virginia set up a glasshouse in Jamestown in 1608 for the manufacture of "glasses" and beads. A "tryal of glasse" was sent off to England before the winter of 1609, the "starving time" during which 440 of the colony's 500 inhabitants died. In 1621 the company tried again, and although the second attempt was more carefully planned, it too failed. Excavation of the site has revealed that glass was melted in considerable quantities though no evidence of bead manufacture has been found.

For more than a century after Jamestown. there is little American glass to speak of. The earliest successful glasshouse was begun in 1739 by Caspar Wistar. The fact that his works produced only humble utilitarian vessels and windowpanes saved him from extermination by the "lords of trade." Wistar died in 1752, after which the factory was operated by his son Richard. It was offered for sale in 1780. Although few, if any, objects exist which can be assigned to the Wistar Glass works with certainty, it is important as the cradle of the American glass known today as South Jersey type. Glass so-called is the work of individual glass blowers using ordinary bottle or window glass to make objects of their own design. Applied glass and. occasionally, pattern moulding were the only feasible means of decoration. and the resultant loopings and threadings are typical of continental traditions. One decorative device, the lily pad, is of particular importance as no European prototype is known. A hot gather of glass applied to the base of the bowl is pulled up around the sides in a series of projections in which the bowl appears to rest.

The second great name in early American glass is Henry William Stiegel. In 1763, 13 years after his arrival in America and after several years in the iron business, he built his first glasshouse. Like Caspar Wistar, Stiegel was concerned with the manufacture of bottles and windowpanes, but, with the founding of his second house at Manheim, Pa., in 1765. he ventured into the table glass business. No longer beneath the notice of the "lords of trade," he reported to them in 1767 that the glass he made was both inconsiderable in quantity and ordinary in quality. This report is in sharp contrast to the many advertisements in which he favourably compares his wares with English imports. Encouraged by the patriotic adoption of the nonimportation agreement, Stiegel built a third glasshouse, the American Flint Glass works, also located at Manheim and completed in 1769. Adverse economic conditions. caused by approaching war and colonial preference for imported tablewares, brought final failure in 1774.

Few pieces can be attributed with confidence to the Stiegel factories and, like that of Wistar, his name survives as the founder of a tradition. Stiegel-type glass is characterized by the use of clear and artificially coloured glasses; by extrinsic decoration, such as engraving, enamelling and pattern moulding; and, in general, by two distinct styles, one involving English and tlie other German techniques and decorative devices. Certain mould-blown patterns, such as the diamond-daisy and daisy-in-hexagon, are believed to have been originated at the Stiegel houses, no European prototypes having been identified.

Before the turn of the century, several other glassworks were founded, but few survived the Revolution. These houses were devoted largely to the manufacture of bottles and window glasses and, with the notable exception of the New Bremen Glassmanufactory, most of the off-hand pieces which can be tentatively assigned to them are of the South Jersey tradition. Three of these enterprises are of particular importance: First, the New Bremen Glassmanufactory, founded by John Frederick Amelung and company, is of special interest as many of its presentation pieces are both signed and dated as well as being among the finest produced in the U.S. before 1800. Originally from Bremen, Ger., Amelung was persuaded to come to America, Maryland in particular, for the express purpose of founding what he believed to be a much-needed industry. By 1785 his works offered green and white hollow ware for sale; by 1795 the glassworks themselves were offered for sale. One of the most famous pieces in the history of American glass is the Bremen Pokal, blown and engraved in 1788 and sent back to Amelung's German financiers in Bremen. probably the only return they ever received on their investment.

The second factory of importance, later known as the Olive Glass works. was completed in 1781 by former employees of the Wistar Glass works, the Stanger brothers. In addition to the many fine South Jersey pieces attributed to this house, it is of interest because of its long history, eventually becoming part of the Owens Bottle company, a forerunner of the Libbey-Owens-Ford Glass company.

The third notable venture begun before 1800 is the well-known works associated with the name Pitkin. Erected near the Connecticut river in 1783, it was intended for the manufacture of crown window glass, but need and foresight converted it in 1788 to a manufactory of bottles and flasks. The factory thrived until 1830 and is best known for the half-post ribbed flasks in natural browns, ambers and greens. Today the word "Pitkin" denotes a type of flask and not a specific glassworks.

The few houses which survived the 1790s and the depression following the War of 1812 multiplied to more than 90 by 1830. This high rate of increase is partially explained by the false prosperity which preceded the War of 1812, and later by the employment of a special sales agent, extensive paid advertising and the adequate tariff regulations, finally achieved in 1824 For convenience, they are divided into three geographical groups: New England, the middle Atlantic states and the midwest.

Until about 1830 American glasshouses produced little more than simple imitations of European glasses, at best interesting and often very handsome combinations of various decorative devices and traditions. The big change occurred between 1830 and 1840 with the production of fine lead glass, the use of the full-size incised mould and. finally, the pressing machine.

The glasshouse known as Bakewell's was synonymous with the finest achievements of the revived industry. Originally established in 1808 in Pittsburgh, Pa., the first city to use coal for fuel in glassmaking, the company survived under several different firms until 1882. Glass cutting, introduced to Pittsburgh by William Peter Eichbaum, glass cutter to Louis XVI, was an important part of Bakewell's operation. In addition to being the first American company to supply the White House, serving Pres. James Monroe in 1817, Bakewell's produced such specialties as lead glass tumblers with sulphides in the bases portraying the marquis de La Fayette, Andrew Jackson, George Clinton, Benjamin Franklin and George Washington. This company also had the distinction of holding the first patent on mechanical pressing, granted in 182j for a device to make knobs.

Fine lead glass was first successfully made in the New England area in the south Boston works of the Boston Crown Glass company. Thomas Cains, first employed by this firm in 1812, was making flint glass there in 1813. He left the firm in 1824 to found the Phoenix Glass works, which survived until 1870. One particular device usually associated with the Boston manufactories of this period is the guilloche or chain, employed in the decoration of a large variety of tableware.

The New England Glass company, founded in 1818, maintained the same high standards as Bakewell's, even to the point of making glass for President Monroe. This factory held the second patent on a device for mechanical pressing, granted in 1826, and produced quantities of pressed glass of all types before it was moved to Toledo, O., in 1888. The New England Glass company was also famous for its very fine free-blown and engraved glass. In addition vessels were made there in the so-called blown-three-mould technique in which decorative designs adapted from cut glass patterns of the period were impressed in the glass by blowing in moulds hinged in two, three or more sections. More than

400 different moulds have been determined and grouped according to pattern under three primary headings: geometric, arch and baroque. By 1830 this type of production was being replaced by the much more efficient pressing machine.

Deming Jarves. one of the founders of the New England Glass company, founded the Boston and Sandwich Glass company in 1825. Because of his "Reminiscences," extensive advertisements and thorough excavations of the factory site, more is known about this particular factory than any other of the period. Consequently, "Sandwich" has become a generic term for pressed glass even though many other factories used identical machinery and, in cases. identical moulds. Jarves' first patent on a pressing device, the fifth to be granted. was received in 1828 after the Boston mould maker Hiram Dillaway entered his employ. Before the fires were drawn at Sandwich in 1888, Jarves had founded the Mount Washington Glass works in 1837 and the Cape Cod Glass works in 1857.

Among the outstanding makers of fine lead glass in the middle Atlantic states were the Brooklyn Flint Glass works of John L. Gilliland and company and the Dorflinger Glass works. Gilliland, a partner in the Bloomingdale Flint Glass works, sold out in 1823 and founded his own works in Brooklyn. In 1864 two members of the Houghton family acquired controlling interest, and in 1868 the works was moved by barge to Corning, N.Y., to form part of the now famous Corning Glass works.

Perhaps the most fascinating aspect of American glass is that series of pictorially moulded bottles known as historical flasks, produced between 1815 and 1870. Three hundred and ninety-eight different examples have been divided into the following groups: (1) Masonic, (2) emblems and designs related to economic life. (3) portraits of national heroes and designs associated with them and their deeds and (4) portraits of presidential candidates, emblems and slogans of political campaigns. In the second group are a number of interesting designs encouraging the American system of better internal transportation and high protective tariffs. Among the 16 celebrities portrayed in the third and fourth groups are Jenny Lind. the Swedish singer; Lajos Kossuth. the Hungarian patriot; the marquis de La Fayette; and the notorious Thomas W. Dyott, a patent-medicine vendor and bottle manufacturer. These containers were also used as propaganda during political campaigns. William Henry Harrison is pictured in this connection with other impedimenta relative to the log cabin and hard cider campaign of 1840.

The first 25 years of pressed glass, 1825 to 1850, are referred to by collectors as the "lacy period." A milestone within this brief span occurs in 1830 with the development of the cap ring, a device which ensured uniform thickness at the edge of each piece regardless of the amount of glass forced into the mould. Before this date most impressed designs are inspired by Anglo-Irish cut glass. often coupled with popular American devices such as the sheaf of wheat. Between 1830 and 1840 the objects are thinner and more lavishly decorated, often including elaborate motifs based on the classic and Gothic revivals. Because of the unpleasant surface left by the mould and in an effort to imitate the brilliance of cut glass. unstippled areas were filled in with over-all lacelike patterns; hence the term "lacy." About 1840 economic conditions forced glassmakers to revert to cheaper moulds and simpler geometric forms and to abandon the stippled patterns. During this period the mechanical press became firmly established. and by 18jo glassmaking was one of America's new mass-producing industries. (T. S. B.)

MODERN GLASS FROM 1850

The modern history of glass can be said to begin in the middle of the 19th century with the great exhibitions and with the new self-consciousness in the decorative arts which they expressed. Glassmare was being publicly discussed in art journals and collected in museums, and this new spirit of awareness led to a greatly increased borrowing of ideas among the leading glass centres and to the borrowing of ideas from the past.

Gnderlying these complexities of the modern period, however, are still distinguishable certain fundamental methods of using glass which are associated with particular centres. The English style of deeply cut crystal, which had established its supremacy in the early 19th century, has continued to represent a greai part of the production of most of the European and U.S. glass centres. The demand for it, however. has been mainly of a popular nature and until comparatively recent times it attracted little of conscious artistry. Engraved glass. and to a lesser extent coloured and painted glass. have been given the greatest attention in the central European glass-producing area. The Venetian glasshouses at Murano have continued to be the leading exponents of furnace-manipulated glass.

But alongside these traditional methods of using and decorating glassware can be discerned the development of a renewed interest in the beauty of the material itself which, expressed in various ways, in the use of thick masses and in internal figuring and patterning, has been the keynote of the most significant modern contributions to the art of glass.

Pressed glassware, which was first made in the United States with great promise in the first half of the 19th century, had already by the middle of the century assumed the role of a cheap imitation of cut crystal. As such it was of little aesthetic interest. Only in comparatively recent times did pressed glass begin to appear which had been designed expressly in relation to its process of manufacture and which made no attempt to imitate the effects of other processes.

Great Britain. — The Great exhibition of 1851 was the culmination of a period of intense activity in the British glasshouses. The excise duty on glass had been removed in 1845, and the British glassmakers were determined not only to excel in their traditional deeply cut crystal but also to rival the Bohemians in coloured, cased and enamel-painted wares. Probably the most enrerprising of the English glassmakers of the period was Benjamin Richardson, of Wordsley near Stourbridge. and surviving pieces which were shown by him in the exhibition include opal vases with admirable flower painting by Thomas Bott. a ruby-cased goblet with delicate engraving designed by W. J. Muckley, and crystal wares deeply cut in elaborate and sometimes curvilinear patterns.

Probably in reaction against the banality of pressed-glass imitations of cutting, the most sophisticated work in crystal during the later 1850s and 1860s was decorated by engraving. The London firm of Apsley Pellatt (which had been known earlier for its "cameo incrustations") mas prominent in this phase. Much of the engraved work for London dealers was carried out by emigrant Bohemian craftsmen, and in Edinburgh J. H B. Millar, a Bohemian, established in the late '50s an important engraving firm which was initially staffed largely by his fellow countrymen.

The Venetian style of furnace-manipulated glass was also exerting a strong influence. It can be seen, for instance, in the wares of George Bacchus of Birmingham in the early '50s and of Isaac Barnes of Birmingham around 1870. In some degree the Venetian style was a source of inspiration for many of the fancy wares that were made in Great Britain, as in the United States and elsewhere, during the '80s and '90s. These were mostly in coloured glass and were identified by such names as "Burmese" (apparently of American origin and made by Thomas Webb and Sons of Stourbridge), "chameleon" (Hodgetts, Richardson of Stourbridge) and "crushed strawberry" (John Walsh Walsh of Birmingham).

A striking form of mid-Victorian virtuosity was the cameo glass which was produced by Stourbridge glassworkers. This work, which was inspired by the Portland vase, consisted in a lengthy process of etching and carving. normally through a white glass casing, to leave a white carved design in relief on a dark-coloured glass body. The first important pieces were produced in the '70s by John Northwood. He was followed by other glassworkers, and in the '80s a considerable amount of semicommercial cameo glass was produced in the Stourbridge factories, particularly under George Woodall for Thomas Webb and Sons and under John Northwood for the firm of Stevens and Williams.

The influence of the arts and crafts movement was toward the use of plastic forms and furnace decoration, which John Ruskin had advocated in a strongly worded passage (*Stones of Venice*, vol. ii [1853]). In 1859 Philip Webb designed for William Morris some simply formed tableware which was made at the London glassworks of James Powell and Sons. From about 1880 this glassworks was under the control of Harry J. Powell, who, working until World War I, developed a simple, dignified style of handmade blown glass, both clear and coloured and sometimes delicately cut and engraved, which represents probably the finest achievement of modern British glasswork. The spirit of his work was subsequently continued by the firm in the designs by Barnaby Powell, James Hogan and others, with an increasing tendency to exploit the effect of thick glass with waving surfaces.

During the 1930s and after World War II other firms produced work in which a restrained and distinctively modem approach was made to the cutting of faultless crystal glass. Particularly outstanding in this respect were the designs which were produced shortly before World War II by Keith Murray for Stevens and Williams and by Clyne Farquharson for John Walsh Walsh. New and appropriate designs for pressed glass were used by firms such as Chance Brothers and United Glass Bottle Manufacturers, and at the opposite pole of glasswork an amount of interesting engraved work on glasses was carried out by independent artists such as Laurence Whistler.

United States.—By the middle of the 19th century American pressed glass was already a disturbing influence on the design of the finer wares. Its decoration was by that time mostly designed in imitation of cut glass, and the process of fire polishing was being used to give a surface almost as smooth as that of blown glass. During the succeeding decades pressed-glass designs became increasingly complicated, and this tendency was accentuated in the soda-lime glass which William Leighton began to use for pressed work at Wheeling, W.Va., in the 1860s and which was later widely used in the western glasshouses for the cheapest coloured wares.

In general the finer wares of the early part of the period were similar to those of the Biedermeier and later styles of Europe. The New England Glass company at Cambridge, Mass., was employing many European craftsmen and was producing a wide variety of richly decorated cased and engraved wares. At the Boston and Sandwich Glass company cased glass was extensively used for large kerosene lamps. The effect of the competition of pressed glass on cut-crystal work can be seen in the appearance of fine-line cuttings, and during the period up to the Philadelphia Centennial exhibition of 1876 the most significant crystal work was decorated by engraving. Louis Vaupel and Henry S. Fillebrown were two notable engravers employed by the New England company from 1856 and 1860, respectively.

At the time of the Centennial exhibition cut-crystal work began to revive and by 1880 a considerable boom in its production had developed—a boom which was to continue throughout the '80s and '90s. New industrial methods contributed to the production of crystal glass of flawless quality and to its deep cutting with mathematical accuracy in elaborate designs. Among many others, a noteworthy producer of this type of glass in the '90s and later was the Libbey Glass company, which was the successor to the New England Glass company in Cambridge and had moved in 1888 to Toledo, O. Later, about the early years of the 20th century, intaglio cutting in crystal became popular, and work in this expensive process was carried out in a number of cut-glass factories such as the T. G. Hawkes Glass company at Coming, N.Y.

As in Great Britain and elsewhere a great amount of glass was made in fancy forms and colours which although undisciplined and often tasteless nevertheless preserves perhaps more than any other glass the flavour of the period. In the '60s, and later, typically Victorian epergnes were often inspired by the furnace-decorated methods of Venetian glass; and in the '80s and '90s there was a spate of wares in fancy colours which were given specific names such as peachblow, amberina, pomona and Burmese and were made by such firms as the New England Glass company, the Mount Washington Glass company at New Bedford, Mass., and the Hobbs, Brockunier company at Wheeling.

Although belonging essentially to the category of the fancy glasses, the Favrile glass of Louis Comfort Tiffany represented an altogether higher level of achievement both in its shapes and in the colouring and figuring of the glass. It was first shown to the public in 1893, and in pieces which were produced a few years later Tiffany achieved an outstanding expression in glassware of the *art nouveau* style. Much of his work was in a heavily lustred glass which was considerably admired abroad, especially in central Europe where it created a new fashion.

During the 1930s and after World War II new forms of pressed glassware appeared in simple, satisfying designs appropriate to their purpose and the process of manufacture, such for instance as the Pyrex ovenware shapes of the Corning Glass works. In fine glassware the work of the Steuben company of Corning was outstanding. In 1933 this company was reorganized by Arthur Amory Houghton, Jr., and with the help of John Monteith Gates and the sculptor Sidney Waugh he deliberately aimed to produce original works in an impeccable material which would rank as fine art. The most typical work was in simple forms decorated with sculpturesque intaglio engraving by Sidney Waugh; and the interesting experiment was made, not without success, of commissioning designs for engraving from a number of internationally known painters and sculptors. Other noteworthy modern American work included simple designs in blown glass by the Blenko Glass company of Milton, W.Va., and enamel patterned bowls by the independent artist Maurice Heaton.

Czechoslovakia, Austria and Germany.—In the middle of the 19th century the glasshouses of central Europe were producing a great variety of the cased and coloured wares which had become particularly associated with Bohemia in the preceding Biedermeier period. They were also producing a great amount of cut crystal glass in the deeply cut English style, and indeed work of this nature continued with little change throughout the modern period.

A revival of the indigenous art of engraving was initiated by Ludwig Lobmeyr, who from 1864 was in control of the Viennese firm of J. and L. Lobmeyr. His first opportunity was at the Paris exhibition of 1867, and his reputation was firmly established at the Vienna exhibition of 1873. He commissioned designs for his glasses from the leading Viennese architects and painters of the time, and his work was carried out by the finest craftsmen in Bohemia and Austria. Lobmeyr's taste was based upon a deep study of the 18th-century Bohemian and Silesian engraved glass, and the work he commissioned was mostly in the style of a past period. His fame rests mainly on engraved glass, but he also produced glasses of other types such as the Old German enamelled glass which was made for him around 1878 by A. A. Egermann in Novy Bor (Haida).

The *art nouveau* style, which went under the name of *Jugendstil* in central Europe, made a deep impression on central European glassware. The work which was made around the turn of the century abounds in slender shapes and flowing organic motifs. Glasses designed by Karl Koepping in Berlin, with long, waving stems and tuliplike bowls, were perhaps the extreme instance of *art nouveau* style applied to glassware. In 1897 an exhibition of glass by the American Louis Comfort Tiffany was shown at several of the museums in the area. Not only the forms of the Tiffany glasses but also their figured and heavily lustred material attracted great interest. Several factories started making a similar heavily lustred glass, and the firm of J. Lötz' Witwe of Klostersky Mlyn (Klostermiihle) won a *grand prix* at the Paris exhibition of 1900 with glassware in this type of material.

From around 1900 onward a movement toward a modern purist approach to glass was largely fostered by the work of designers connected with the Vienna Kunstgewerbeschule. Men such as Kolo Moser and Josef Hoffmann, who were also closely associated with the Wiener Werkstatte, were designing glasses in simple rational forms, and much initiative in this movement was shown by the firms of E. Bakalowits Sohne of Vienna and J. Lotz' Witwe. This was the period in which the glass-teaching schools achieved a remarkable influence on glass design and came to work in close collaboration with the factories. The most important of these in the years before World War I were the schools at Kamenicky Senov (Steinschonau) and Kovy Bor (Haida) in Bohemia and at Zwiesel in Bavaria.

After World War I the outstanding figure in Czech glass art was Josef Drahonovsky. who was professor at the Prague School of Industrial Art. He was essentially a sculptor and most of his glass designs were for sumptuously engraved glass of a monumental quality. His colleague in Prague, Jaroslav Horejc, designed for engraved work of a broadly similar character, some of it for the Lobmeyr firm of Vienna. In 1920 a new glass school was founded at Zelezny Brod with the intention of encouraging a specifically Czech spirit in glassware. After World War II this school was one of the principal centres for much successful work in the design of thick-walled and figured glasses and of elegantly proportioned tablewares.

In Austria after World War I the Lobmeyr firm under the control of Stefan Rath produced many admirable engraved and relief-carved pieces designed by artists such as Ena Rottenberg, Lotte Fink and Vally Wieselthier. Lobmeyr also produced some of the best designs of Michael Powolny, who had his own workshop and had designed for the firm of J. Lötz' Witwe.

In Germany the outstanding engraver and glass carver of the period after World War I mas Wilhelm von Eiff, who was professor at the Stuttgart Kunstgewerbeschule. Bruno Mauder of the school at Zwiesel was a strong influence for the use of natural and appropriate glass forms; and some fine tablewares were made in bloun and pressed glass both before and after World War II—such as those designed by Wilhelm Wagenfeld for the Vereinigte Lausitzer Glaswerke and for Peill und Putzler of Düren, and by Richard Sussmuth for Glashiitte Immenhausen of Cassel.

France. — In France, as in central Europe and in England, the production of the factories in the middle of the 19th century was mainly divided between cut crystal and coloured wares. The "opalines," the opaque-white and coloured wares, often with elaborately painted and gilt decoration. were especially popular. The larger factories, particularly Baccarat and St. Louis, continued to participate in the international fashions of the rest of the century and beyond. But in France, perhaps because the tradition of industrial glassmaking was comparatively weak, inventive genius manifested itself mainly in the work of individual artists, and thereby a new spirit was introduced into the modern conception of glass.

In the late '60s and '70s three individual artists were experimenting in glasswork, and all of them were represented in the exhibition of 1878. The first was Joseph Brocard. who was studying the enamelling of glass and whose main ambition was to reproduce mediaeval Syrian glass. The second was Eugène Rousseau. a commissioning dealer in ceramics who had turned to glasswork at the end of the '60s, and mas at the height of his achievement in the '80s. Typically his glasses were thick-walled and translucid, often with interior crackling and shot with random streaks of colour. In 1885 he associated with himself E. Léveillé, who continued to work in a similar style after Rousseau's death in 1891. The third of the individual artists at the 1878 exhibition, and the most significant of them, was Emile Gallé of Nancy, who had been experimenting in glasswork since about 1867. His earliest work was in clear glass, lightly tinted and decorated with enamel and engraving; but he soon developed toward the use of deeply coloured, almost opaque glasses, which he used in heavy masses often cased in several thicknesses and carved or etched away to form plant motifs. His inspiration undoubtedly reflects the prevailing interest in Japanese art, and some of his methods must have been suggested by those of Chinese glass. His forms were frequently asymmetrical and of an organic inspiration, and as such his work contributed largely to the art nouveau style of the end of the century. In this period much of Gallé's manner was reflected in ranges of industrial glassware made by the firm of Daum Frères of Nancy.

In later times the leader of French glass art was René Lalique, who was producing his most typical work around the 1920s. Lalique's mork is characterized by his use of clear glass, by his return to symmetrical forms and by his relief decoration produced by blowing into moulds or by pressing. He was a leading advocate for the use of glass in architecture. and much of his work was in the form of lighting equipment and other details of interior decoration. The work of his contemporary Maurice Marinot was more in the tradition of Rousseau, with heavy. thick-walled vessels in strong forms often with boldly cut-away abstract decoration; and Henri Kavarre in the 1930s was producing work of a similar monumental nature.

A number of French artists also explored with success the use of *pâte de verre,* which is powdered glass fired in a mould. The pioneer in the use of this material was Henri Cros. who was working toward the end of the 19th century. In the 20th century important work in the material was carried out by Albert Dammouse and François Décorchement. The most significant work of Jean Luce and Marcel Goupy, designers of glass and pottery, was in the production of elegant tablewares. Aristide Colotte used glass as a sculptor in large, hewn pieces. Jean Sala worked mainly in coloured bubbled glass. André Thuret produced glasses in thick plastic forms and with colour effects. In the industrial field after World War II the firm of Daum was distinguished by its thick clear-glass vessels manipulated into random shapes.

The Scandinavian Countries. — Tip to the time of World War I the Swedish glass industry produced little original work. The sudden development of modern Swedish glass in the 1920s was attributable mainly to the initiative of the Swedish Arts and Crafts society which resulted in the employment of the painters Simon Gate and Edward Hald by Orrefors glassworks and Edvin Ollers by Kosta glassworks from the years 1916–17. The first results were exhibited in Stockholm in 1917 and consisted of hand-blown, undecorated tablewares, together with the luxury "Graal" glass with internal stained decoration which had been so rapidly developed under Gate's inspiration at Orrefors. It was. however, engraved glasswork, chiefly that designed by Gate and Hald at Orrefors, on which the reputation of Swedish glass was established in the 1920s and particularly at the Paris exhibition of 1925.

In the 1930s there came a change of direction whereby the Swedish factories took less interest in engraving and followed the initiative of the French artists in making thick-walled glasses, usually tinted or patterned with internal colour. In this mode they found their greatest success, and this can be attributed largely to their having achieved a system of intimate association between their artists and their glassmaker craftsmen.

At Orrefors additional artists were added to the establishment from 1929 onward. including Vicke Lindstrand, Sven Palmqvist, Nils Landberg, Edvin Ohrstrom and Ingrid Lundin. Each of them worked in an individual style, and in addition to decorative pieces many of them designed tablewares for the subsidiary Sandvik factory. At Kosta important mork was produced by Elis Bergh and later by Vicke Lindstrand. Gerda Stromberg designed for both Eda glassworks and for Strombergshyttan, while other outstanding work was produced by Hugo Gehlin for Gullaskruf and by Monica Bratt for Reijmyre.

In Denmark the Holmegaard glassworks and in Norway the Hadeland glassworks both followed in some respects the example of Swedish glass. At Holmegaard the movement began in the late 1920s with the appointment as art director of Jacob E. Bang, whose designs included an amount of striking engraved work. and was continued in the interestingly shaped wares of his successor, Per Lutken. At Hadeland some distinctively formed glass was designed by a number of artists including Sverre Pettersen, Herman Bongard and Willy Johansson.

In Finland a modern style of glasswork appeared which is of the greatest significance in the development of modern glass. The work is frequently asymmetrical, modelled in heavy masses and in graceful, tall shapes. These characteristics were defined particularly in the work of Gunnel Nyman (d. 1949), and later in the work of Tapio Wirkkala and Timo Sarpaneva for the firm of Karhula-Iittala and of Kaj Franck for the Nuutajarvi (Notsjo) glassworks.

Belgium and the Netherlands. — In Belgium, the Val St. Lambert factory was an important producer of heavily cut crystal throughout the period. It is also associated with cased work, and it was particularly prominent with original work of this nature around 1900. Later Charles Graffart designed for it wares made in a variety of techniques, some of them with engraved decoration.

The Dutch glassworks at Leerdam played an important part in the modern movement, and it followed a line of development distinct from that of the Scandinavian factories. In 1915 the decision was made to invite designs from artists, and by the early '20s excellent simple tablewares were being made to designs by the architects K. P. C. de Bazel and H. P. Berlage and by the decorative artist C. de Lorm. Also in the early '20s the making of special pieces called Unica was begun by C. Lebeau, and these were subsequently continued by the art director Andries D. Copier. Among the later decorative work of the factory the graceful designs by Floris Meydam are outstanding.

Italy.— The revival of Italian glassmaking dates from the early 1860s when the Museo Vetrario was founded at Murano (Venice) and Antonio Salviati began to make, in addition to mosaic tesserae, the glasses which subsequently attracted great attention at the Paris exhibition of 1867. These were in variations of the traditional Venetian style with elaborate furnace decoration, and the production of glasses of this nature continued at Murano throughout the remainder of the 19th century and beyond.

The early 1920s saw the beginning of a more conscious spirit of artistry in Italian glasswork. The decorative artist Vittorio Zecchin was influential in this movement. Paolo Venini began to produce glass in simple elegant forms, and G. Balsamo Stella was designing engraved work for the firm of Cappellin. In later times, and particularly after World War II, much research was made into new methods of colouring and figuring glass, and the results of this were seen especially in the glasses designed by Ercole Barovier for the firm of Barovier e Toso. Work of a similar nature mas designed by Giulio Radi for the firm Arte Vetraria Muranese; and from the Venini firm, presided over by Paolo Venini, came many interesting innovations such as vases decorated with areas of vividly coloured glass which were designed by Fulvio Bianconi. Some of the work, such as a series of vases designed by Flavio Poli for Seguso Vetri d'Arte, showed some influence from the thick-glass techniques of the north, but the modern Italian glass mostly retained a distinctly Venetian volatile character which stood in contrast to the more deliberately calculated work of Sweden and Finland.

Spain and Argentina.— In Spain the Catalan José Maria Gol decorated glasses with bold, enamel-painted designs of floral and other motifs in a highly personal style; while glassware with furnace decoration in a consciously impure material was made in the Balearic Islands. From Argentina, glassware of a distinctive style was seen in the productions of the Cristalerias Rigolleau, which included thick-walled manipulated shapes with random colour decoration. (H. W.)

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GLASS CLOTH: *see* Glass.

GLASSES (EYE): *see* Eyeglasses.

GLASSHOUSE: *see* Greekhouse; Horticulture.

GLASS PAPER. An abrasive material much used for smoothing the surface of wood manufactures. It consists of thick cartridge paper coated with powdered glass. The paper is coated with liquid glue and the glass particles powdered over the surface before the glue has set. *See* also Emery; Sakd-Paper.

GLASS PICTURES AND PRINTS. Glass transfer pictures were essentially English and in vogue from about 1690–1790, when colour prints started to replace them and their quality deteriorated. Famous engravers, such as J. and J. R. Smith, J. McArdell and J. Simon, were closely associated with transfer picture production. A moistened mezzotint was stuck face downward on a piece of crown glass previously coated with adhesive turpentine. The paper of the mezzotint was carefully rubbed away with the finger leaving the outline of the print on the glass, and the picture was then brilliantly coloured from behind. Line engravings and aquatints were also used.

BY COURTESY OF J. A. ROSE

"A MAN DRINKING A GLASS OF PUNCH," A GLASS TRANSFER PICTURE MADE FROM A PRINT BY H. VANDER MYN

Glass prints, or as the French call them, *clichés-verre*, somewhat resembled etchings, in the making of which the Barbizon school of artists, J. B. Corot, C. F. Daubigny, T. Rousseau and J. F. Millet, experimented occasionally betneen 18jj and 1860. In this technique a piece of glass is covered with a white opaque varnish, and in this covering the artist draws the lines of his subject with an etching needle, allowing the light to show through these lines when the glass is held up to the lipht. The artist then places a sheet of sensitized paper close to the back of the glass, so that, when the glass is exposed to the lipht, the lines of the design print off, as a photographic negative does, on the sensitized paper. The resulting print is therefore in the nature of a photograph, which, in fact, it closely resembles. Corot nas perhaps the most successful maker of these *cliche's-verres*.

BY COURTESY OF *THE* METROPOLITAN MUSEUM OF ART NEW YORK

'WOMAN EMPTYING A PAIL" A GLASS PRINT BY JEAN FRANÇOIS MILLET (1814–75)

Bibliography.—H. G. Clarke, *The Story of Old English Glass Pictures, 1690–1810* (1928); L. Loewenthal, *Georgian Glass Pictures and Needlework Pictures* (1934) For glass prints, *see* G Hediard, "Les 'Procédés sur verres'" in *Gazette des Beaux-Arts*, vol xxx (Nov 1, 1903); L H Delteil, *Peintre-graveur illustre*, vol v, sec iv (1910); J. A Rose, "English Glass Pictures, or the Art

of Painting Mezzotinto circa 1690–1790," Paper No. 113, Circle of Glass Collectors, London (1959). (J. A. RE.)

GLASSPORT, a borough of Allegheny county, Pa., U.S., 10 mi. S.E. of Pittsburgh, on the Monongahela river. The leading industries are glassmaking. steel manufacture and oil refining. Glassport was settled about 1900.

For comparative population figures *see* table in PENNSYLVANIA: *Population.*

GLASSWORT, a group of about a dozen species of leafless seashore herbs belonging to the genus *Salicornia* of the Chenopodiaceae family. They are annual or perennial, tender or hardy fleshy herbs that are native in salt marshes of North America, Europe and Asia. They and other members of the family which grow in large quantities in the Mediterranean region were formerly used in making soap and glass, as a large percentage of soda was yielded on burning them. The ashes of these plants were known to the trade as barilla, especially those from S. *herbacea.* (J. M. BL.)

GLASTONBURY, a market town and municipal borough in the Wells parliamentary division of Somerset. Eng., 6 mi. S.S.W. of Wells and 26 mi. S.W. of Bath by road. Pop. (1951) 5,081. Area 7.8 sq.mi. The abbey of St. Mary was perhaps the oldest and certainly one of the richest in England. In the neighbourhood lake villages of the later Iron Age have been excavated. The town lies on the slopes of a group of orchard-clad hills that rise abruptly from the level meadowland of the Brue valley and culminate in the Tor, a green conical height crowned by the tower of St. Michael's church *(c* 1400).

The chief buildings, apart from the abbey ruins. are the churches of St. John the Baptist. Perpendicular nith a fine west tower *(c.* 1470); St. Bencdict, earlier; St. Benignus (*c.* 1500); the George hotel, built by the abbey to house pilgrims (c. 1470); the Tribunal, the abbot's law court *(c.* 1510); and the Abbey barn (14th century), a beautiful cruciform building still used for its proper purpose. The town hall, built in the early 19th century and extended in 1930, also houses the Glastonbury Antiquarian society museum. Sharpham park, where the last abbot. Richard Whiting, was arrested in 1539, and nhere Henry Fielding the novelist was born in 1707, is now a farmhouse.

The Lake Villages.—The low meadowland running northwest from Glastonbury toward the Bristol channel was once a peat bog with winding watercourses, reedy pools and oak, willow and alder thickets. In 1892 low mounds in a field $1\frac{1}{2}$ mi. N. of Glastonbury were found to contain remains of dwellings of the prehistoric Iron Age; these were excavated by A. Bulleid and H. St. George Gray between that date and 1907, and their results published. In 1908 they began work on two groups of similar mounds at Meare, $3\frac{3}{4}$ mi. N.W. of Glastonbury; their report on the excavation of part of the western group of mounds was in course of publication, and work on the eastern group was still continuing in 1956. At the Glastonbury lake village the peat has a depth of 15 ft. A substructure of timber and brushwood was laid and held in position by sharpened piles driven down into the peat, and on this foundation a floor of clay was spread and a circular hut built with a hearth of baked clay; these floors tended to sink in the soft peat and new floors and hearths were laid over them. Some huts had only one floor, but one had as many as ten.

At Meare some of the huts were built without the timber substructure, the peat being drier. and there are fewer traces of the postholes of circular huts, suggesting that many may have been of lighter construction. A few huts at Meare were built on a rectangular mortised framework, and fragments of similar timbers at Glastonbury suggest that rectangular huts preceded the round ones. The Glastonbury village was surrounded by a timber palisade, a feature not found at Meare.

The types of pottery found indicate occupation from about 60 B.C. At Glastonbury the village ended. possibly with a massacre, a few years before the Romans came; at Meare the village continued a few years longer and part of the site was reoccupied in the 4th century. Otherwise the pottery types were similar in the lo–er and higher levels and in the Glastonbury and Meare villages.

The discovery of parts of wooden looms. loom weights and many weaving combs and spindle whorls show that the manufacture of cloth was important. The people were skilled uorkers in wood, the peat having preserved many wooden objects, and their cutting tools were of iron. Many bronze objects were found, fibulae (of the La Tène III type). finger rings, brooches, harness parts and, at Glastonbury, a bowl of excellent design ornamented uith rounded rivets. The discovery of similar rivets. crucibles and slag show that this bowl was actually made in the village. Wheat, barley, peas and beans were grown and cattle, sheep, pigs, horses and dogs kept. Dugout canoes have been found and a broken axle shows that they used wheeled carts. Their trade goods included amber from the Baltic, jet from Whitby, Kimmeridge Shale for bracelets from Dorset and tin from Cornwall.

Pottery of the same types have been found in Wookey Hole cave and in excavating Ponters Ball, an earthwork protecting the high land at Glastonbury from the east. Several timber causeways crossing the peat marsh are similar in construction to the substructure of the lake village huts. The objects from the Glastonbury village are exhibited in the Glastonbury museum, and those from Meare at Taunton.

The Benedictine Abbey of St. Mary.—William of Malmesbury wrote his *De Antiquitate Glastoniensis Ecclesiae* between the years 1125 and 1130, when he was staying at the abbey, basing his work on the documents and other evidence that he was able to study there. His book has been added to by later Glastonbury writers, but the original sections can be distinguished. He says that "annals of good authority" state that the old church of the Blessed Virgin was built by missionaries sent from Rome at the request of King Lucius in A.D. 166; he would not commit himself to earlier stories of which he was auare. This little wattle church, which had later been enclosed in wood. was still in existence when William wrote; on either side of the altar were the tombs of St. Patrick and St. Indract.

King Lucius is a myth and other places claim the tomb of St. Patrick, but-there is no doubt that there was a Celtic monastery with strong Irish associations at Glastonbury before the time of the Saxon conquest. The burial ground of this period. lying to the south of St. Mary's chapel, was excavated in 1953 and 1954 by Ralegh Radford. At Beckery, on a little island 1 mi. W. of the town, excavations in 1891 proved the existence of a pre-Norman chapel of St. Bridget, standing in a Christian burial ground in use before the chapel was built; the name Beckery is Irish, meaning "Little Ireland."

The Saxons were already Christians when their advance after the battle of Pen in 658 brought Glastonbury within the Saxon kingdom and resulted in the introduction of the Benedictine rule in the monastery. Among the many grants of land to the abbey, two may be mentioned: in 678 King Centwine granted Glastonbury to Hemgisl the abbot, free of all service, 6 hides; and in 681 Baldred gave Hemgisl 6 hides on Pennard hill.

These two grants made up Glaston XII hides, the manor in which later abbots established wide privileges. None of the early charters granting land to the abbey has survived in the original, and many are only knonn in much altered copies made in the 13th century or later; nevertheless William of Malmesbury was able to extract a consistent story from the charters, nhich has been confirmed in many points from other sources.

Ine, king of Wessex from 688 to 726, is said by William of Malinesbury to have built the church of St. Peter and St. Paul as an appendix to the old church. Excavations carried out between 1927 and 1929 by C. R. Peers and A. W. Clapham revealed the foundations of Ine's church and its later enlargements, beneath the west end of the 13th-century nave. The proportions of the aisled plan correspond with churches at Canterbury, Rochester and Reculver built a few years earlier. At some date before the time of St. Dunstan (909–988) a narthex or porch was built joining the old church to the new.

Dunstan was made abbot of Glastonbury by King Edmund about 943, and was chief minister of state under Edred; exiled in 955 by Edwig, he returned to power as archbishop of Canterbury under Edgar. He extended Ine's church eastward with a tower and chapels. The importance of the abbey at this time was shown by the burial there of three kings, Edmund, Edgar and Edmund Ironside.

As a result of the Norman conquest, Glastonbury abbey lost several estates, but Domesday Book shows that it remained one of the wealthiest churches in the country, holding rich manors in Somerset, Wiltshire, Dorset. Gloucestershire and Berkshire. Turstin (Thurstan), the first Norman abbot, was active in recovering lost properties and began rebuilding the church of St. Peter and St. Paul, but he fell foul of the monks. who refused to change their Gregorian chant in favour of new music attributed to Abbot William of Fécamp. Turstin called in archers who shot arrows from an upper gallery at monks clustered round the altar, killing 3 and wounding 18. The long and vivid account in the Anglo-Saxon Chronicle under the year 1083 shows how deeply the English resented this incident.

Herlewin (1101–20) pulled down Turstin's partly built church and began afresh on a grander scale. In 1184 a disastrous fire destroyed his church (lead melted from the roof was found by the excavators between its reddened paving stones) and with it were burned most of the monastic buildings, whatever was left of the Saxon church and the old church of St. Mary.

King Henry II appointed Robert Fitz-Stephen to rebuild the abbey, and the new chapel of St. Mary, of the same dimensions as the old church and on its site, was dedicated by Bishop Reginald of Bath in 1186. The archaic style of the building, with round-headed windows and interlaced arcading, which contrasts with Bishop Reginald's work then in progress at Wells with pointed arches, may have been due to the venerable antiquity of the old church it replaced. The rebuilding of the church of St. Peter and St. Paul on a vast scale, in a Gothic style that retained some features of Romanesque, and in particular the free use of the chevron ornament, began before St. Mary's chapel was completed.

Savaric, an able and ambitious cleric who took part in the negotiations for the ransom of Richard I, was rewarded with the bishopric of Bath, to which was joined by papal edict the abbacy of Glastonbury. In 1193 Savaric became bishop of Bath and Glastonbury; the monks refused obedience, and a costly struggle continued with varying fortunes. In 1205 Jocelyn succeeded him as bishop of Bath and Glastonbury, and made a settlement with the monks in 1218; four manors were surrendered to the bishop, and the monks were allowed to choose an abbot. Building was resumed 20 years later, but the church of St. Peter and St. Paul was not completed for another 80 years. The galilee, linking the nave with St. Mary's chapel, mas built before the end of the 13th century in a mature Early English style.

Abbot Monington (1342–74) extended the choir, built the retrochoir, using the chevron ornament over the windows to harmonize with the earlier work, and refaced the interior of the choir with panelling in stone (as at Gloucester, 1337–40). Abbot Richard Bere (1493–1525) built the Edgar chapel east of the retrochoir, and holiowed out a crypt under St. Mary's chapel and part of the galilee, probably to provide a shrine for St. Joseph of Arimathaea; in so doing the floor of the chapel was raised.

Excavations south of the nave have revealed the foundations of the later monastic buildings: traces of walling and remains of a small glass furnace of the Saxon period and postholes of an earlier timber structure. The abbot's lodging was pulled down in the 18th century, but the abbot's kitchen stands. Probably early 14th century, but based on the design of the Romanesque kitchen at Fontevrault, it is square in plan with huge corner fireplaces making the square an octagon; the stone roof rises to a central louvered octagon containing a ventilating shaft.

Richard Whiting (abbot from 1525 till 1539) signed with his monks the declaration of royal supremacy in 1534. In 1539, however, he refused to surrender the abbey and was arrested and convicted of treason on a trumped-up charge of concealing the abbey treasure. He was executed on Tor hill with two monks; the abbey was iorfeited to the king.

The annual value of the abbey estates in 1536 was £3,509; a more detailed inquiry by the king's surveyors increased this to £4,228. A comparison between the values in Domesday Book and in 1536 shows the extent to which the abbey had improved land drainage near Glastonbury. A process which began with straightening and deepening watercourses led to the deposit of flood soil over new areas, and the conversion of peat bogs and alder thickets into rich meadows.

In 1550 the duke of Somerset installed a party of French and Flemish weavers in the abbey buildings, but as Protestant refugees they were forced to leave the country on Mary's accession. Her government considered restoring the monastery, but the difficulties were too great. From that time the abbey was used as a quarry for building and road stone; today the beautiful ruins of St. Mary's chapel remain, with enough of the galilee and of the choir, nave and transepts of the church of St. Peter and St. Paul to give some idea of the whole. Since 1909 the abbey has been the property of the Church of England.

King Arthur and **Avalon.**—William of Malmesbury, who was fully aware of Glastonbury records and traditions as they were known in 1135, refers to the many fanciful tales told of King Arthur, and adds that his burial place is unknown. His contemporary, Geoffrey of Monmouth, in his romantic *History of the Kings* of Britain, describes Arthur's many victories. After the last he retired to Avalon, the "Island of the Blest" of Celtic tradition, to cure his wounds. In 1191 a grave said to be that of Arthur and Guinevere his queen was discovered between two pyramids in the cemetery at Glastonbury; they were reinterred in the great church before the altar in the presence of Edward I. From that time the Isle of Avalon has been identified with Glastonbury.

St. Joseph **of Arimathaea.**—The earliest mention of the legend that St. Joseph of Arimathaea (*q.v.*) came to Glastonbury is in a mid-13th-century addition to William of Malmesbury's book. The story was fully told by John of Glastonbury before the end of that century. A shrine in the crypt of St. Mary's chapel, which itself came to be known as St. Joseph's, was a place of pilgrimage where miracles occurred in the early 16th century. Although John of Glastonbury quoted from a book called the "Holy Grail" in his account of St. Joseph, the monks completely ignored the Grail legend. The Glastonbury thorn (*Crataegus praecox*), which flowers at Christmas, is first mentioned in a poem of 1502, but the legend asserting that it sprang from the staff of St. Joseph must have appeared even later. It is probably a perpetual sport from the common thorn obtained by grafting; trees raised from its seeds revert to type.

The Town.—The name of Glastonbury has been the subject of philological speculation from Saxon times. A. G. C. Turner rejects previous theories and derives the name from Old Cornish, *glastann,* "an oak."

Until 1539 the town was the centre of the manor of Glaston XII hides, in which the abbot had judicial powers to the exclusion of the sheriff. In 1319 Glastonbury received a writ of summons to parliament, but made no return and has not since been represented. Tor fair: held on the second Monday in September, dates from 1127. The town declined after 1539; silk spinning and stocking knitting struggled on into the 19th century, when further improved land drainage increased agricultural prosperity. The borough was incorporated in 1705. The chief local industries today, apart from dairy farming, are dressing and dyeing woolled sheepskins (sheepskins dressed with the wool on), the manufacture of sheepskin rugs and gloves and of sheepskin-lined boots and slippers. The sheepskin industry dates from 1866.

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GLATIGNY, JOSEPH ALBERT ALEXANDRE (1839–1873), French minor poet of the Parnassian school, whose adventures as journalist, playwright and strolling actor earned him a legendary reputation, was born at Lillebonne (Seine-Inférieure), May 21, 1839. He was apprenticed to a printer, but, inspired by reading Théodore de Banville's *Odes funambulesques,* began to write poetry. Verses written in 1857 were published as *Les Vignes folles* in 1860; later collections included *Les Flèches d'or* (1864) and *Gilles et Pasquins* (1872). Specializing in little poems of satirical comment on current affairs and personalities, he became a regular contributor to *Le Rappel.* For a time he exploited his talent for extempore composition by giving public recitals and then joined a traveling company of actors with whom he went to Corsica. There a misunderstanding with the police led to temporary imprisonment: he used his experiences in a one-act comedy in verse, *L'illustre Brizacier* (1873) ; the hero, a disillusioned actor, is a self-portrait. Other plays were *Le Singe* and *Les Folies-Marigny* (both 1872). He died at Sèvres, April 16, 1873. His life formed the subject of a book and a play, *Glatigny, drame funambulesque* (1906), by Catulle Mendès. (R. DL.)

GLATZ (Slav. Kladzko), a town in Wroclaw province, Pol., formerly in the Prussian province of Silesia, Ger., on the left bank of the Neisse, 58 mi. S.W. of Breslau. Pop. (1950) 17,200. The town with its narrow streets winds up the fortified hill which is crowned by the old citadel.

Across the river, on the Schäferberg, lies a fortress built by the Prussians about 1750. Before the town on both banks of the river there is a fortified camp by which bombardment from the neighbouring heights could be hindered and which afforded accommodation for 10.000 men. The inner ceinture of walls was razed in 1891, and their site is now occupied by new streets. There are a Lutheran and two Roman Catholic churches, one of which, the parish church, contains the monuments of seven Silesian dukes. Among the other buildings the principal are the Royal Catholic gymnasium and the military hospital.

Glatz existed as early as the 10th century, and received German settlers about 1250. It was besieged several times during the Thirty Years' War and during the Seven Years' War and came into the possession of Prussia in 1742. In 1821 and 1883 great devastation was caused there by floods. The county of Glatz was long contended for by the kingdoms of Poland and of Bohemia. Eventually it became part of the latter country, and in 1534 was sold to the house of Habsburg, from whom it was taken by Frederick the Great during his attack on Silesia.

GLAUBER, JOHANN RUDOLF (1604–70), German chemist, who because of his wide knowledge, has been proposed as the German Boyle (father of chemistry). Born at Karlstadt, Bavaria, he resided successively in Vienna, Salzburg, Frankfurt and Cologne before settling in Holland, where he made his living chiefly by the sale of secret chemical and medicinal preparations. His well-equipped laboratory in Amsterdam was described as magnificent. Though his writings abound in universal solvents and other devices of the alchemists, he made many real contributions to chemical knowledge. He clearly described the preparation of hydrochloric acid by the action of sulfuric acid on common salt, the manifold virtues of sodium sulfate—sal *mirabile,* Glauber's salt; and he noticed that nitric acid was formed when nitre was substituted for the common salt. He prepared many substances, including salts of lead, tin. iron, zinc, copper, antimony and arsenic. He also made a number of useful observations on dyeing and gave a clear description of the preparation of tartar emetic. One of his most notable works was his *Teutschlands Wohlfarth* in, which he urged that the natural resources of Germany should be developed for the profit of the country, giving various instances of how this might be done. He died on March 10, 1670.

The titles of his 40 books are Latin, but the text is German. The more important are contained in *Opera Omnia,* which appeared in German (1661), in French (1659) and English (1689). A reissue under the title *Glauberus concentratus* appeared in 1715. These writings had a great effect on both his contemporaries and successors.

Biographical details given by W. Brieger in *Geschichtsbl. Technik, Industrie und Gewerbe* (1918) ; *Chemisch Weekblad* (1918). *See* also Eva Armstrong and C. Deischer, *Journal of Chemical Education* (1942) ; P. Walden, Essay in Bugge's *Das Buch der grossen Chemiker* (1930). (R. E. O.)

GLAUBER'S SALT, the decahydrate of sodium sulfate, was named for the alchemist,. J. R. Glauber, who first described its medicinal properties. It occurs native as the mineral mirabilite in Spain, the western United States and the Caucasus, but much that is used today is manufactured from salt cake. *(See* ALKALI MANUFACTURE.) The chemical formula for Glauber's salt is $Na_2SO_4.10H_2O$.

The solubility of the Glauber's salt, which increases sharply with a rise in temperature, reaches a maximum value at 32.384' C. where the decahydrate is in equilibrium with the anhydrous salt. Below that temperature the Glauber's salt is stable and may be crystallized in colourless monoclinic prisms which effloresce in ordinary air. Above the trahsition temperature it changes to the anhydrous salt whose solubility decreases as the temperature rises. Glauber's salt readily forms supersaturated solutions in which crystallization may be initiated by adding a small particle of the solid hydrate. In medicine it is used as a cathartic and is the active principle in some mineral waters. (J. B. Ps.)

GLAUCHAU, a town of Germany, in the district of Karl-Marx-Stadt, on the right bank of the Mulde, 7 mi. N. of Zwickau and 17 mi. W. of Chemnitz by rail. Pop. (1950) 35,387. It has important manufactures of woollen and half-woollen goods. There are also dye-works, print-works and manufactories of paper, aluminum, thread and machinery. Glauchau possesses a weaving school. Some portions of the old castle date from the 12th century; the Gottesacker church contains objects of this period. Glauchau was founded by a colony of Sorbs and Wends, and belonged to the lords of Schonburg as early as the 12th century.

GLAUCOMA is a term applying to a group of diseases of the eye characterized by an abnormal elevation of the pressure within the eyeball. This is usually due to partial blocking of the channels through which the aqueous humour normally leaves the eye. The glaucomas of the human eye differ profoundly in their subjective and objective symptoms, their course and their final outcome. Some glaucomas are mild, transient and easily curable; others are characterized by dramatic, acute, painful attacks, and still others take the course of a gradual, insidiously progressive and entirely painless loss of vision. In almost all glaucomas medicinal or surgical treatment offers a good chance of arresting the disease and of thereby preventing further visual damage. For a broader discussion of glaucoma, *see* EYE, HUMAN: *Diseases of the Eyes;* EYE, SURGERY OF. (P. C. K.)

GLAUCONITE is a green, fine-grained crystalline mineral, a hydrous silicate of iron and potassium found in marine sedimentary rocks of all geologic ages since the Pre-Cambrian, and still in process of formation. Glauconite occurs commonly as globular to lobate bright green grains or pellets a millimetre (0.03937 in.) or less in diameter. It may also occur as irregular grains or flakes, or as clay. It may be confused with the minerals chamosite, celadonite, chlorite and greenalite. Some glauconite has natural bleaching qualities and can be used as a fuller's earth *(q.v.)* and glauconite marls, because of their base-exchange properties, have been used in water-softening units *(see* MARL).

Glauconite is composed of clay minerals and the name has been used interchangeably both as a mineralogic and a morphologic term. It has been defined as a specific micaceous mineral, although it is commonly described as small green pellets of heterogeneous mineral content. It forms in waters of normal salinity on continental shelves, swells and banks off coasts of crystalline land areas that lack important rivers. It is not known to form in fresh water deposits. Glauconite formation takes place principally in the upper part of the 10–400 fathom interval. The temperature range of formation is apparently wide but markedly warm water is not favourable. Very slow or interrupted sedimentation in more or less agitated water, and at least slightly reducing conditions, which may be facilitated by decaying organic matter, are conducive to glauconite formation. Source materials are principally bottom muds and clays of terrigenous origin, although biotite, feldspars, volcanic glass and other materials may contribute. Under the necessary physiochemical environmental conditions, glauconitization occurs as a marine alteration of terrigenous matter to glauconite. Formation of glauconite from a colloidal state may also occur, as this process tends toward the same crystallochemical equilibrium as that obtained in the alteration of clay. Common coagulation of all these amorphous and cryptocrystalline products with selective adsorption of potassium from the sea water leads to the formation of grains of glauconite.

Glauconite grains are common in calcareous sediments but rare in pure clay rocks, pure quartz sandstones or chemically precipitated carbonates. Glauconite is commonly found associated with remains of fecal pellets of sediment-ingesting organisms or as internal fillings of foraminifera. It is rare or absent in beds rich in algae, corals or bryozoans.

Sediments rich in glauconite grains are known as greensand (*q.v.*). (H. D. G.)

GLAUCOPHANE, a group of rock-forming minerals consisting of the iron-free sodium amphiboles (see AMPHIBOLE). The glaucophane group have all the characteristics of, but are distinguished from, the rest of the amphiboles by their distinct blue colour, especially in thin slices.

Glaucophane occurs exclusively in certain metamorphic schists. These schists present a problem in petrology. They contain sodium-rich amphiboles which form in a rock not especially enriched in sodium. In short, the sodium is present in the amphiboles rather than in the plagioclase feldspars where it is usually concentrated (see FELDSPAR). Because of this peculiarity and because they are dense rocks and associated with other dense minerals. glaucophane schists have been thought to represent high pressure mineral assemblages. Other workers have shown that localized introduction of sodium, magnesium and iron into sedimentary rocks has caused the formation of glaucophane without the presence of relatively high pressures. Thus, glaucophane schists might form at high pressures and, on the other hand, might represent a peculiar sequence of sodium introduction into pre-existing mineral assemblages. Glaucophane schist is used by some writers as a separate metamorphic facies. Glaucophane schists are widely distributed over the coast range of California but are unusual elsewhere in the United States.

The members of the glaucophane group vary in composition from $Na_2Mg_3Al_2Si_8O_{22}(OH)_2$ to $Na_3Mg_3Al_2Si_8O_{22}O(OH)$ to $Na_2CaMg_3Al_2Si_8O_{22}O_2$.

See also METAMORPHISM. (G. W. DEV.)

GLAUCUS, a word meaning "bright," and the name of several figures in Greek mythology, the most important of which are the following:

1. GLAUCUS, surnamed *Pontius,* a sea divinity. Originally a fisherman and diver of Anthedon in Boeotia, having eaten a certain magical herb, he leaped into the sea, where he was changed into a god, and endowed with the gift of unerring prophecy. According to others he sprang into the sea for love of the sea-god Melicertes, with whom he was often identified. He was worshipped in most parts of the Greek world by fishermen and sailors. In art he is depicted as a merman covered with shells and seaweed. Various legends, none very important, connect him with the saga of the Argonauts and other cycles. He was famous for his amours, especially those with Scylla and Circe. *See* especially Athenaeus, 296, 297.

2. GLAUCUS, of Potniae near Thebes, son of Sisyphus by Merope and father of Bellerophon. According to the legend he was torn to pieces by his own mares (Virgil, Georgics, iii. 267; Hyginus, Fab., 250, 273).

3. GLAUCUS, the son of Minos and Pasiphaë. When a child, while playing at ball or pursuing a mouse, he fell into a jar of honey and was smothered. His father, after a vain search for him, consulted the oracle, and was referred to the person who should suggest the aptest comparison for one of the cows of Minos which had the power of assuming three different colours. Polyidus of Argos, who had likened it to a mulberry (or bramble), which changes from white to red and then to black, soon afterwards discovered the child; but on his confessing his inability to restore him to life, he was shut up in a vault with the corpse. Here he killed a serpent which was revived by a companion, which laid a certain herb upon it. With the same herb Polyidus brought the dead Glaucus back to life. According to others, he owed his recovery to Asklepios.

4. GLAUCUS, son of Hippolochus, and grandson of Bellerophon. mythical progenitor of the kings of Ionia. He was a Lycian prince who, along with his cousin Sarpedon, assisted Priam in the Trojan War. When he found himself opposed to Diomedes, his guest friend, they ceased fighting and exchanged armour. Since the equipment of Glaucus was golden and that of Diomedes bronze, the expression "gold for bronze" (Iliad, vi. 236) came to be used proverbially for a bad exchange. Glaucus was afterward slain by Ajax, son of Telamon.

GLAZE: see GLAZING; POTTERY AND PORCELAIN.

GLAZING. In its simplest context, glazing means the fitting of panes of glass into suitable frames in order to form a window which will admit light into a building. In the middle ages and up to the end of the 17th century this meant the use of leaded lights, small areas of glass fastened together with specially formed strips of lead ("calms") and held in a frame of wood or wrought iron. From the end of the 17th century until the end of the 19th century this principle was followed, but developing skill in the making of large sheets of glass saw a gradual increase in the size of the panes and window areas, while the leaded light was replaced by sashes of wood in which the glass was held with wood beads or putty Until the end of the 19th century the architectural conception of a window was that of a comparatively small area of glazing placed in a thick load-bearing wall and restricted to the provision of daylight in a building, but the development of cast-iron buildings in the 19th century and the extensive use of steel and reinforced concrete framing in the 20th century considerably altered this. In framed structures the loads of floors and roof are concentrated on to comparatively slender columns, thus leaving large areas of walling which can as well be filled by glazing as by the more traditional materials such as brick or stone. Further technical development in the glass industry provided the means to fill these large areas, so that glazing is not only concerned with the transmission of light into a building but can also provide the whole external surface.

Method. — The normal process of glazing small windows into wooden or metal frames has changed little. The tools generally used are the diamond for cutting, laths or straight edges and tee square for accurate measurement and setting out, glazing knife. hacking knife and hammer. The materials used in addition to the glass are putty, priming or paint, glaziers' sprigs (small headless nails). wash leather or synthetic rubber strip. Putty is made of whiting and linseed oil and it should be stored so that it is kept moist and workable. Wood sashes must be primed before glazing, *i.e.,* given a thin coat of paint usually containing red lead; this enables the putty to adhere to the sash. When each square of glass is cut to size, allowing about $\frac{1}{16}$ in. tolerance all round, the glazier runs the putty round the rebate in the frame into which the glass is to fit with his hands pressing it firmly against the wood. He then beds the glass into it by pressing it down firmly on all the edges and the glass is further secured by the glaziers' sprigs, knocked in on the rebate side. He then trims off the protruding putty and fills the remainder of the rebate, beveling it off on the outside of the sash with the putty knife. When a broken pane is to be replaced the hacking knife is employed to cut out the old putty and remaining broken glass. Metal sashes are glazed in a similar way, although the putty used is usually modified by the addition of a dryer to enable it to set satisfactorily, as there is no absorption of the oil by a metal sash. Proprietory glazing compounds are manufactured for this purpose also and some sashes incorporate spring clips and other devices for securing the glass. In glazed doors and sashes used internally the panes of glass are generally fixed with wood beads, held in place with screws. In doors subject to vibration or slamming the panels are usually bedded in wash leather or synthetic rubber strip and secured by wood beads.

Types of Glass. — For all common glazing in small sizes sheet glass is used. It is available in several qualities and thicknesses and in sizes depending on the thickness up to 80–100 in., length and width combined. For larger areas and for work where a high degree of transparency is required, polished plate glass is used. This can be supplied in sues up to 98 in. wide and 300 in. long, but the practicable size for any particular job is governed more by problems of cutting, transporting and fixing than by manufacturing difficulties. For work requiring specially strong glass armour plate is used. This glass is specially toughened by heat treatment after cutting to size and is therefore supplied by the manufacturers ready for fixing and must not be subsequently cut. Where resistance to fire or danger of breaking makes ordinary glass a potential hazard, mired glass is used. A wire mesh is rolled into the glass during manufacture and even if large areas are shattered the glass adheres to the wire and is not broadcast. This makes it suitable for roof glazing and skylights, where generally the building regulations make its use obligatory. Prismatic glass, designed to refract light, is of use in increasing the light to rooms overshadowed by adjacent buildings. Anti-sun glass, which absorbs heat without reducing unduly the light transmission, is used in the glazing of schools, offices and airport control towers and where unusual climatic conditions make it especially suitable. An amber tinted anti-fly glass is an effective deterrent against houseflies and is therefore used for glazing the windows of buildings storing or manufacturing food.

Special Problems. — The design tendency for the elimination of the load-bearing wall in favour of a framed construction and the introduction of ever growing window areas presents some special glazing problems. The highest standards of heat insulation are demanded in modern buildings to save both in cost of heating and in actual fuel consumption, but large areas of thin sheet or plate glass cannot satisfy these conditions because large windows mean high heat loss and consequential problems such as excessive condensation. The solution is the use of double glazing, in which two sheets of glass are fixed instead of one so that there is a confined space between them. This may be done either by fixing the two sheets of glass in one frame or by having each in a separate frame. The use of two windows in double glazing has been practised for many years particularly to improve sound insulation, but it is cumbersome and expensive. However, manufacturers are now offering factory-made double glazed window units, simply fixed into a single frame, which consist of two sheets of glass separated by a suitable spacer at the edges, usually metal or plastic strip. This unit is hermetically sealed against the external atmosphere, the cavity being filled with clean dry air at the time of sealing. Experiment has shown that an interspace of $\frac{3}{4}$ in. gives the best insulation but that an efficiency of 90% can be obtained if the space is as little as $\frac{1}{4}$ in. The smaller spacing is therefore generally used as the resulting unit is more easily accommodated in a sash of normal dimensions. The operation of assembly and sealing calls for skill and accuracy, so that such units made under factory conditions are relatively expensive, but the extra cost is soon offset by the saving in fuel consumption and there are a number of additional advantages such as the fact that condensation is eliminated, there is no "misting" of the glass and there is a significant reduction in sound transmission.

Where large areas are to be lighted, particularly in industrial buildings, it is usually necessary to provide areas of glazing in the roofs. Although it is not easy to measure the relative amount of light obtained from a unit of roof glazing as compared with the same area in a vertical plane, it is probably as much as three times. Almost all roof glazing, or patent glazing as it is more usually called. is of special design and patent manufacture. There is a wide range of types but basically the systems consist of a bar, usually of steel or aluminum of special section which incorporates fixing clips on the upper part to hold the glass and condensation channels at the bottom. Steel bars are usually covered with a thin lead sheathing to protect them against rusting. The bars are normally placed at about 2 ft. centres and spans up to about 10 ft. can be obtained without extra support. Special devices are incorporated in each design to ensure that the roof remains watertight in spite of widely varying atmospheric conditions and most systems can be fixed at any desired angle.

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(A. RD.)

GLAZUNOV, ALEXANDER CONSTANTINOVICH (1865–1936), Russian composer, was born in St. Petersburg (Leningrad), Aug. 10, 186 j, the son of a publisher and bookseller. He showed an early talent for music, and studied, on the advice of Mily Balakirev, with Nicolas Rimsky-Korsakov. At the age of 16 he composed a symphony (afterward elaborated and published as op. 5), but his *opus* 1 was a quartet in D. followed by a pianoforte suite on *S-a-c-h-a*, the diminutive of his name Alexander. In 1884, helped to some extent by Liszt, he began to make a name outside Russia. His first symphony was played that year at Weimar, and he appeared as a conductor at the Paris exhibition in 1889. In 189; he conducted his fourth and fifth symphonies in London. In 1900 he became professor at the St. Petersburg conservatoire, and in 1906 director. Glazunov was a leading representative of the modern Russian school. His ballet, *Raymonda*, shows that he also shared to the full the Russian love for oriental splendour and movement. Of his many compositions, the most famous are perhaps, among the orchestral works, the sixth symphony, in C minor (op. 58): among those for solo instruments, the theme and variations for pianoforte (op. 72), and the fine violin concerto in A minor (op. 73); and among those for the stage (very few in number) the ballet *Raymonda* (op. 57), already mentioned.

GLEAVES, ALBERT (1858–1937), U.S. naval officer, born in Nashville, Tenn., Jan. 1, 1858, was graduated from the U.S. Naval academy and commissioned an ensign in the navy on Jan. 1, 1881. During the Spanish-American War he commanded the torpedo boat "Cushing," was promoted through the grades with sea and land duty, being much interested in light naval craft, and established the first government torpedo factory in 1908. On July 29, 1915, he became a rear admiral, and he commanded the destroyer force of the Atlantic fleet until the beginning of World War I. Placed in charge of all convoy operations, with the temporary rank of vice-admiral, Gleaves safely shepherded the first American expeditionary force to France in June 1917. From July 16, 1917, to Sept. 1, 1919, he was in command of the cruiser and transport force, Atlantic fleet. being directly responsible for placing 2,000,000 men in France and for bringing the United States army home afterward. This achievement won him the distinguished service medal and the victory medal with star. He commanded the Asiatic fleet in 1920–21 and retired in 1922 with the rank of admiral. For four years, 1928–31, he was governor of the United States naval home, Philadelphia, Pa. He died Jan. 6, 1937, in Haverford, Pa. (W. B. CK.)

GLEBE, in ecclesiastical law the land devoted to the maintenance of the incumbent of a church. In English law the fee simple of the glebe is said to be in abeyance. that is, it exists "only in the remembrance, expectation and intendment of the law." But the freehold is in the parson, although at common law he could alienate the same only with the consent of the bishop and patron. The disabling statutes of Elizabeth (Alienation by bishops, 1559, and Dilapidations, etc., 1571) made void all alienations by ecclesiastical persons, except leases for the term of 21 years or three lives. By an Act of 1842 glebe land and buildings may be let on lease for farming purposes for 14 years or on an improving lease for 20 years. But the parsonage house and ten acres of glebe situate most conveniently for occupation must not be leased. By the Ecclesiastical Leasing acts of 1842 and 1858 glebe lands may be let on building leases for not more than 99 years and on mining leases for not more than 60 years.

In Scots ecclesiastical law, the manse now signifies the minister's dwelling house, the glebe being the land to which he is entitled in addition to his stipend.

GLEDITSIA, a genus belonging to the pea or pulse family (Leguminosae, *q.v.*), embraces 12 species of thorny shrubs and trees. These are widely distributed through the warmer regions of Asia and America. Fierce, branched thorns feature the twigs and even the bole of certain forms which, when planted in hedgerows, form an impenetrable barrier. Two trees of secondary importance, the honey locust (G. triacanthos) and the water locust (*G. aquatica*) are indigenous to the eastern and southern United States,

GLEE, a musical term signifying, broadly speaking, a piece of concerted vocal music, generally unaccompanied, and for male voices, though exceptions are found to the last two restrictions. The number of voices ought not to be less than three. As regards musical form, the glee has affinities with the madrigal (*q.v.*) though the two forms are by no means identical. Thus, while the madrigal does not show a distinction of contrasted movements, this feature is absolutely necessary in the glee. The originator of the glee in its modern form was Dr. Thomas Arne (1710–1778), and among other leading glee writers, all Englishmen, may be mentioned Webbe (1740–1816), Horsley (1774–1858), Callcott (1807–1882) and Stephens (1821–1892).

GLEIM, JOHANN WILHELM LUDWIG (1719–1803), German poet. was born on April 2, 1719, at Ermsleben, near Halberstadt. He studied law at Halle, where he founded the so-called *Anacreontik,* with other young poets. "Father Gleim" was the title accorded to him throughout all literary Germany because of his generosity to young poets. He looked with some suspicion on their revolutionary tendencies, but helped them none the less. Gleim himself wrote feeble imitations of Anacreon, Horace and the minnesingers. a dull didactic poem entitled *Halladat* oder das rote *Buch* (1774) and collections of fables and romances. Of higher merit are his *Preussische Kriegslieder von einem* Grenadier (1758), inspired by the campaigns of Frederick II. Gleim died at Halberstadt on Feb. 18, 1803.

GLEIWITZ (GLIWICE), a tomn in Katowice province, Pol., formerly in the Prussian province of Silesia, on the Klodnitz. and the railway between Oppeln and Cracow, 40 mi. S.E. of the former town. Pop. (1950) 119,968.

Gleiwitz is the centre of the mining industry of Cpper Silesia. There are also foundries with which are connected machine manufactories and boilerworks, and manufactories of wire, chemicals. glass, cement and paper.

GLENALMOND, a glen of Perthshire, Scot., southeast of Loch Tay. It comprises the upper two-thirds of the course of the Almond, a distance of 20 mi., For the greater part it follows a direction east by south, but at Newton bridge it inclines sharply to the southeast for 3 mi., and narrows to such a degree that this portion is known as the Small (or Sma') glen. At the end of this pass the glen expands and runs eastward as far as the well-know11 public school of Trinity college. where it may be considered to terminate. In Sma'glen is Ossian's stone, the traditional grave of Ossian, the Gaelic warrior and bard.

GLENCAIRN, EARLS OF. The 1st earl of Glencairn in the Scottish peerage was ALEXANDER CUNNINGHAM (d. 1488), a son of Sir Robert Cunningham of Kilmaurs in Ayrshire. Made a lord of the Scottish parliament as Lord Kilmaurs not later than 1469, Cunningham was created earl of Glencairn in 1488; and a few weeks later he was killed at the battle of Sauchieburn while fighting for King James III against his rebellious son, afterward James IV. His son and successor, ROBERT (d. *c.* 1490), was deprived of his earldom by James IV, but before 1505 this had been revived in favour of Robert's son, CUTHBERT (d. *c.* 1540), who became 3rd earl of Glencairn, and whose son WILLIAM (*c.* 1490–1547) was the 4th earl. This noble, an early adherent of the Reformation, was during his public life frequently in the pay and service of England.

William's son ALEXANDER, the 5th earl (d. 1574), was a more pronounced reformer than his father, whose English sympathies he shared, and was among the intimate friends of John Knox. He anticipated Lord James Stewart, afterward the regent Murray, in taking up arms against the regent, Mary of Guise, in 1558. When in Aug. 1561 Mary, queen of Scots, returned to Scotland, Glencairn was made a member of her council; he changed sides more than once, and was found fighting against Mary at Carberry hill and at Langside. The earl, who was a violent iconoclast, died on Nov. 23, 1574. His short satirical poem against the Grey Friars is printed by Knox in his History of *the* Reformation.

JAMES, the 7th earl (d. *c.* 1622), took part in the seizure of James VI, called the raid of Ruthven in 1582. WILLIAM, the 9th earl (c. 1610–64), was a somewhat lukewarm royalist during the Civil War. In March 1653 Charles II gave him temporary command of the royalist forces in Scotland, and the insurrection of this year is generally known as Glencairn's rising. After its failure he was betrayed and imprisoned; when Charles 11 was restored, he became lord chancellor of Scotland. He died at Belton, Haddingtonshire, on May 30, 1664.

GLEMCOE, a glen in Scotland, situated in the north of Argyllshire. Beginning at the northeastern base of Buachaille Etive, it takes a gentle northwesterly trend for 10 mi. to its mouth on Loch Leven, a salt-water arm of Loch Linnhe. On both sides It is shut in by wild and precipitous mountains and its bed is swept by the Coe—Ossian's "dark Cona"—which rises in the hills at its eastern end. About halfway down the glen the stream forms the tiny Loch Triochatan. Toward Invercoe the landscape acquires a softer beauty. Lord Strathcona, in 1894, purchased the heritage of the Macdonalds of Glencoe.

The principal mountains on the south side are the various peaks of Buachaille Etive. Bidean nam Bian (3,766 ft.), Meall Mor and Sgorr Dhearg, and on the northern side the Pap of Glencoe and the ridge of Xonach Eagach. Points of interest are the Devil's Staircase. a steep, boulder-strewn "cut" across the hills to Fort William; the Study; the cave of Ossian. where tradition says that he was born; and the Iona cross erected in 1883 by a Macdonald in memory of his clansmen who perished in the massacre of 1692. About 1 mi. beyond the head of the glen is Kingshouse inn, a relic of the old coaching days. Now the Glencoe excursion is usually made from Oban. One mile to the west of the glen lies the village of BALLACHULISH, with slate quarries. worked since 1760; the new road through the glen was built in 193j. About 13,000 ac. in and around Glencoe belong to the Scottish National trust.

GLEN COVE, a city of Nassau county, on north central Long Island, in southeastern New York. U.S., is bounded on the north by the waters of Long Island sound and on the west by Hempstead harbour. It was founded by colonial farmers in 1668, and was named Glen Cove in the 19th century as the result of a misunderstanding: a member of the group convened to rename the community corrupted the suggested name Glencoe into Glen Cove.

In the early decades of the 20th century, Glen Cove's character and economy were dominated by the great estates characteristic of this section of Long Island. Glen Cove was an unincorporated village governed by the town of Oyster Bay before it became a city on Jan. 1, 1918. After World War II, Glen Cove was absorbed increasingly into the greater New York metropolitan area. The city offers the facilities of a resort community with many beaches near the residential areas. For comparative population figures see table in NEW YORK: Population. (WI. M. D.)

GLENDALE, a city of Los Angeles county. at the southern extremity of the San Fernando valley in southwestern California, U.S.. is 8 mi. N. of the civic centre in the city of Los Angeles.

The land known as Glendale was first taken in a private land grant by José Maria Verdugo in 1784 as the Rancho San Rafael. Portions of the old rancho still remain as Glendale city shrines. The Verdugo title to Rancho San Rafael was confirmed by Mexico and again by the new state of California. In 1869, after the owners' failure to pay a mortgage, the rancho was sold at public auction.

During the early 1880s, portions of the private holdings were pooled and a survey was ordered for a townsite, completed early in 1887. In March of that year, the tomn of Glendale was recognized by Los Angeles county. The name was chosen in 1884 from six others by local residents. Glendale absorbed much of the population influx of the 1880s into the Los Angeles basin. During the boom, several buildings were constructed, including a hotel and a newspaper plant. Although its 1910 population was only 2,700, it had grown to 75.000 by the outbreak of World War II. It is part of the Los Angeles standard metropolitan statistical area. The population of Glendale was 95,702 by 1950 and 119,442 in 1960.

Industries include the manufacture of airplanes and aircraft products, optical instruments, pharmaceuticals and clay and plastic products. Glendale (junior) college was established as a public school in 1927. Forest Lawn Memorial park is a cemetery publicized for its elaborate statuary (which includes reproductions of famous works of art) and other special attractions. Glendale mas incorporated as a city in 1906 and in 1914 adopted the council-manager form of government. (J. M. Wo.)

GLENDALOUGH, VALE OF (also GLENDALOCH), about 20 mi. W. of Wicklom by road, County Wicklow, Ire., is noted for its ecclesiastical ruins. Two lakes lie in this wooded vale which is hemmed in by mountains. There, early in the 6th century, St. Kevin (*q.v.*) lived as a hermit for four years and later founded a monastery which; despite Danish raids, remained for centuries an important ecclesiastical and educational centre. There was a succession of bishops until 1214 when the see was united to that of Dublin. In close proximity are a round tower, about 110 ft. high and 52 ft. in circumference; the small St. Kevin's Kitchen, or church, with a high-pitched roof and round belfry; the cathedral, about 73 it. in total length by 51 ft. in width; a Lady chapel, remarkable for its doorway of wrought granite; a priest's house (restored); and slight remains of St. Kieran's church. There also is St. Kevin's cross, a granite monolith never completed; and the enclosure is entered by a fine though dilapidated gateway. Other remains are Trinity, or the Ivy, church, toward Laragh, and St. Saviour's monastery, while on the upper lough are Reefert church, the burial place of the O'Toole family, and the small Teampall na Sceillige (Teampullna Skellig), the church of the rock. St. Kevin's bed is a cave above the upper lough, and is linked with the legend of St. Kevin's hermitage.

GLENDOWER, OWEN (OWAIN GLYN DWR) (1359?–1415), the last independent prince of Wales, more correctly described as On-ain ab Gruffydd, lord of Glyndyvrdwy in Rlerioneth. Owen was probably born about 1359, studied law at Westminster, was squire to the earl of Arundel and a witness for Grosvenor in the famous Scrope and Grosvenor lawsuit in 1386. Afterward he was in the service of Henry of Bolingbroke, the future king. Welsh sympathies were, however, on the side of Richard II, and combined with a personal quarrel to make Owen the leader of a national revolt.

The lords of Glyndyvrdwy had an ancient feud with their English neighbours. the Greys of Ruthin. Reginald Grey neglected to summon Owen, as was his duty, for the Scottish expedition of 1400. and then charged him with treason for failing to appear. Owen thereupon took up arms: and when Henry IV returned from Scotland in September he found north Wales ablaze. A hurried campaign under the king's personal command was ineffectual. In the spring of 1401 Omen was raiding in south Wales.

A second campaign by the king in the autumn mas defeated, through bad weather and the Fabian tactics of the Welsh. Owen had already been intriguing with Henry Percy (Hotspur), who during 1402 held command in north Wales, and with Percy's brother-in-law, Sir Edmund Mortimer. During the winter of 1401–02 he treated with the rebel Irish, the Scots and the French. In the spring he attacked Ruthin, and took Grey prisoner. In the summer he defeated the men of Hereford under Edmund Mortimer at Pilleth, near Brynglas, in Radnorshire. Mortimer was taken prisoner and treated with such friendliness as to make the English doubt his loyalty: within a few months he married Omen's daughter. In the autumn the English king was for the third time driven "bootless home and weather-beaten back." In May 1403 Henry of Monmouth was allowed to sack Sycharth and Glyndyvrdwy unopposed. Owen had a greater plot in hand. The Percies were to rise in arms, and meeting Owen at Shrewsbury, overwhelm the prince before help could arrive. But Omen was defeated near Carmarthen on July 12, and Percy was crushed at Shremsbury ten days later. But the Welsh revolt was still formidable. Owen styled himself openly prince of Wales, established a regular government and called a parliament at Machynlleth. As a result of a formal alliance the French sent troops to his aid, and in the course oi 1404 the great castles of Harlech and Aberystwith fell into his hands.

In the spring of 1405 the tide turned. Prince Henry defeated the Welsh at Grosmont in March, and twice again in May. Scrope's rebellion in the north prevented the English from following up their success. The earl of Northumberland tool; refuge in Wales, and the tripartite alliance of Owen with Percy and Mortimer (transferred by Shakespeare to an earlier occasion) threatened a renewal of danger. But the English under Prince Henry pained ground steadily. and the recovery of Aberystwith, after a long siege (1408), marked the end of serious warfare. In Feb. 1409 Harlech was recaptured, and Omen's wife, daughter and grandchildren were taken prisoners. According to Adam of Usk Owen died in 1415.

GLENELG, a municipal town and the chief watering place of Adelaide county. South Australia, situated 6½ mi. S.W. of the city of Adelaide. Pop. (1954) 12.966. It is built on a plain and has a magnificent sandy beach. Glenelg is connected with Adelaide by bus and interurban streetcar systems. Gov. Sir John Hindmarsh landed in the vicinity in 1536 and proclaimed the state British territory.

GLEN ELLYN, a city and residential suburb of Du Page county, in northeastern Illinois, U.S., is 23 mi. W. of Chicago. Glen Ellyn assumed its present name in 1891. The first settlement mas made in the area in 1834. Initially the business centre (known as Stacy's Corners) was developed north of the present townsite along a stagecoach route between Chicago and St. Charles. In the 1850s, when Newton (later named Danby and in 1874 Prospect Park) was established as a station on the Galena and Chicago Union (later the Chicago and Northwestern) railroad, the present site became the centre of the village. Commuting to Chicago began in the 1880s and was the prevailing pattern of community life by 1900. In the 1890s an attempt was made to develop a resort business around artificially constructed Lake Glen Ellyn. but the enterprise was abandoned shortly after 1900. After 1940 Glen Ellyn shared moderately in the growth of the suburban communities west of Chicago. For comparative population figures see table in ILLINOIS: *Population.* (S. L. J.)

GLENGARRIFF or GLENGARIFF, a village of County Cork, Ire.. on an inlet of Bantry bay. 62 mi. S.S.W. of Cork by road. Pop. (1956) 398. Because of the beauty of its situation in a deep. wooded valley backed by mountains, and of its warm climate, which enables semitropical plants to grow. it is a well-known tourist and holiday resort.

GLENN, JOHN HERSCHEL, JR. (1921–), first U.S. astronaut to make an orbital space flight. was born July 18, 1921, in Cambridge, O. He attended Muskingum (O.) college but left in his third year to train as a naval aviation cadet. On March 16, 1943, he was commissioned a second lieutenant in the U.S. marine corps. Glenn flew 59 fighter-bomber missions in the Pacific theatre during World War II and another 90 missions during the Korean war. For his outstanding service while on active duty in both conflicts he was 5 times awarded the distinguished flying cross and 19 times the air medal.

Glenn was the oldest of the seven U.S. astronauts selected in April 1959 for space-flight training'in the Project "Mercury" program. In 1961 he served as "back-up" pilot for Comdr. Alan B. Shepard, Jr.. and Capt. Virgil I. Grissom, who made the first U.S. suborbital flights.

Glenn mas selected for the orbital flight on Nov. 29, 1961, and there followed more than two months of preparations and delays caused by mechanical and electronic difficulties and unfavourable weather. On Feb. 20, 1962, after ten postponements, Glenn's space capsule. "Friendship 7," was lifted off from Cape Canaveral, Fla., and put into an orbit that, ranged from approximately 99 to 162 mi. in altitude. He made three orbits about the earth in 4 hr. 56 min. at a speed of approximately 17,545 m.p.h., landing successfully in the Atlantic near the Bahamas.

GLENS FALLS, a city of Warren county, in eastern New York, U.S., on the Hudson river, is 52 mi. above Albany. Long noted for its water power, the city became a manufacturing centre of diverse products ranging from lingerie to heavy machinery and also a residential resort. A pioneer hydroelectric power development was established at nearby Spier falls. The Indians called the area Chepontuc, "a difficult place to climb." The earliest military settlement was at Halfway brook, where Fort Amherst was erected in 1759. In 1762 the Queensbury patent was granted to Abraham Wing and in 1765 Wing built a tavern near the falls. At first it was called Wing's Falls but in 1788 the name was changed to satisfy a debt of honour (so the story goes) owed by Wing to Col. Johannes Glen of Schencctady. Most of the settlers derived from French-Canadian. Scottish, English and Italian origins. Glens Falls was chartered as a city in 1908. For comparative population figures *see* table in NEW YORK: *Population.*

(G. L. F.)

GLIDDEN, CHARLES JASPER (1857–1927), best-known in connection with the tours for antique or classic motorcars conducted by the American Automobile association (A.A.A.) and named in his honour, also was a telephone pioneer and balloonist. Born Aug. 29, 1857, in Lowell, Mass., he became a telegraph messenger there at the age of 15. Later, as a telegraph operator, he held positions with two New England telegraph companies. Introduction of the electric telephone in 1877–79 led him to join a syndicate that opened the first telephone exchange in Lowell and built the first line between Lowell and Boston. This led to a career as promoter of telephone corporations from which he retired in 1900. He helped found the A.A.A., and organized the first Glidden tours (1905–1913) to demonstrate the reliability of early automobiles. He motored some 46,500 miles in 39 countries, and made 49 balloon ascensions in America and abroad. Glidden died Sept. 11, 1927, at Boston, Mass.

See M. M. Musselman, ***Get A Horse!*** (1950); Bellamy Partridge, *Fill 'er* ***Up*** (1952). (RH. E. M.)

GLIDING, a phase of flight by which a bird or aircraft descends on an inclined path toward the ground. Man-made gliders are heavier than air and have no engines. Soaring is the term applied to unpowered flight using the upward motions of the air or pulsations in the wind. Soaring permits man to fly long distances, to reach high altitudes and to remain aloft for days without any form of power except that in the air mass.

HISTORY OF GLIDING EXPERIMENTS

The history of gliding in the U.S. is mainly a record of the scientific achievements of the great pioneers, Samuel P. Langley, Octave Chanute and Wilbur and Orville Wright (*qq.v.*). In the first half of the 19th century the English pioneers, George Cayley, W. S. Henson and John Stringfellow, made valuable theoretical investigations and model flight experiments. It is this group of workers who may be said to have "invented" the airplane. But their invention would never have been reduced to practice without the subsequent efforts of the early exponents of gliding.

Captain Le Bris, a French sailor, carried out the first significant glider work in the 1870s, building gliders with wings shaped like those of an albatross and with a boat-shaped body. Le Bris made many remarkable glides, but he succeeded more by instinct than by scientific skill and did not make any substantial contribution to the science of flight. He merely imitated the bird's form and his gliders lacked any vertical stabilizing surface such as a fin or rudder.

The most famous exponent of gliding was undoubtedly Otto Lilienthal (*q.v.*), who with his brother Gustav began to make experiments in 1867. Lilienthal realized that data were needed for success and accumulated much information from a study of the flight of birds. He was perhaps the first man to understand the superiority of the cambered or curved surface over the flat plate as a lifting surface. In 1891 he built his first man-carrying glider, with a framework of peeled willow rods covered with tough cotton fabric. He attached himself to the glider by thrusting his arm through padded rubber tubes and holding on to a crossbar. His body hung in the air during flight and he attempted to control and stabilize the plane by moving his body. Lilienthal even built a conical hill of earth from which to launch himself and his glider. Lilienthal's great contribution to the aeronautical sciences was to improve the behaviour of wing lift and thereby show the feasibility of flight, which many scientists held impossible at that time.

In 1896, at the age of 64, Octave Chanute began to make gliding flights in the United States. He built a five-deck glider and followed this by a triplane and finally by a biplane. Chanute discarded Lilienthal's method of securing control and substituted a rudder and articulated wings. The wings could be swerved fore and aft to provide both longitudinal and lateral control although the pilot's body still hung beneath the glider. So stable did he make his gliders that they made 2,000 flights without a single accident.

One of America's great scientists, Dr. Samuel P. Langley, secretary of the Smithsonian institution, did fundamental research on the soaring flight of birds. With a large telephoto stereoscopic camera he photographed turkey buzzards in their circling effortless flight. He made studies of the nature of the wind in an effort to explain dynamic soaring. that is soaring by extracting energy from gusts of wind. One of Langley's assistants, Huffaker, wrote a paper entitled "On Soaring Flight" in 1898, in which he explained how birds achieved thermal soaring on rising drafts of warm air 30 years before man duplicated this process.

The next great U.S. exponents of gliding were the Wright brothers. Their first plan was to construct a glider which could be used as a man-carrying kite in a steady breeze. For their flights they selected the Kill Devil sand hills near Kitty Hawk, N.C.. which provided strong steady breezes. Through some errors in calculation. their man-carrying glider, tried out in 1900, proved a failure as a kite and they turned to gliding.

The Wright glider of 1900, though a biplane, differed in many respects from the Chanute glider. The pilot lay prone on the upper wing to reduce resistance; the vertical rudder was discarded; and the horizontal rudder was placed forward. By warping the wings they secured lateral control.

The Wrights' most successful glider was built in 1902. As a result of previous experiments, they now decided to use a vertical rudder, and later they made the rudder adjustable. In Sept. and Oct. 1902, nearly 1,000 flights were made, several of which covered distances of more than 600 ft.

The great glider achievement of the Wright brothers was in securing complete control by combining the horizontal rudder with an adjustable vertical rudder and warping the wings. It was this perfect control that made their gliding so safe and which enabled them to proceed to the building of the first successful powered plane. While the Wrights from 1903 onward devoted the greater part of their energies to power-driven craft, they never lost their interest in gliding.

In 1911 the Wrights returned to gliding and soaring because Wilbur had made some studies of dynamic soaring and wished to test his theories. With more powerful controls, and with the horizontal rudder in the rear, the brothers made many long glides, the longest lasting for 9 minutes 45 seconds in 1911. This remained the record until W. B. Klemperer, a German, on Aug. 30, 1921, soared over the Rhine valley for 13 minutes.

From the time of the Wrights' endurance record in 1911 until Glen Curtiss, whose interest was awakened by the German flights in 1922, began glider construction, no experiments were carried on in the United States. Curtiss built a flying boat hull with the tail surfaces carried on outriggers. The glider weighed 150 lb. and was launched by being towed by a motorboat. It performed admirably. The year 1922 also saw the first experimental congress for gliding held in France.

Gliding reached a high state of popularity in Germany after World War I for two reasons: the Versailles treaty forbade the construction of powered airplanes; and meteorological conditions in the Rhine valley provided upward currents of air that were extremely favourable to soaring flight. In the United States, on the other hand, gliding was neglected because full sway was given to the construction of powered craft, and meteorologically suitable localities such as Kitty Hawk were not readily accessible from large cities.

The remarkable flights of 1922 in Germany were achieved by a radical departure from the past. That year witnessed the advent of the first true sailplane. The sailplane, unlike the heavier, cruder machines hitherto used, is a highly refined glider, light and as near as possible to aerodynamic perfection. It has a sinking speed of 0.8 m. per second which is equivalent to saying that it is a machine that will soar in a wind that rises vertically at a speed of one and three-quarter miles per hour. The first machine of this type was the German "Vampyr."

NEW TECHNIQUES AND FLIGHT RECORDS

Up to 1929 soaring was of a strictly topographical nature using air currents deflected upward by local hills. Such flights were limited by the extent of the range of hills. An increased knowledge of meteorology gave rise to several methods of soaring by which long-distance flights could be made. Of these, thermal soaring and thunderstorm flight are most important. Thermal currents are formed by heat rising from the ground under certain conditions as for example, those existing on a hot summer afternoon. On reaching the cooler upper atmosphere. the moisture in the thermal current sometimes condenses, forming a cumulus cloud. A cumulus cloud indicates a thermal current and soaring flights can be made by circling in this current. Thunderstorm flight is accomplished by keeping near the boundary between two masses of air, one warm and the other cool, a condition that accompanies a thunderstorm. After 1929, constant refinement in glider design and improved methods of flight resulted in continuously better performance.

Until the early 1930s, all gliding records were held by Germany and Austria with little or no competition from other countries. Later, however, Great Britain, the U.S.S.R. and the United States took an active interest in gliding with the result that records moved back and forth between countries with amazing rapidity. In 1932 the Soaring Society of America was established to foster gliding and soaring in the United States.

In 1926 Max Kegel of Germany astonished the aeronautical world by flying 34 mi. in a thunderstorm. The world's distance record, held by a Russian woman pilot, 0. Klepikova, stood at 465.53 mi. in 1939. A flight of 21 hr. 34 min. by Lieut. William Cocke, Jr., although established in 1931, still stood in the mid-1950s as the longest by a U.S. citizen. The international duration record, j6 hr. 1 j min., was made by a Frenchman, Charles Atger, in 1952.

Modern soaring planes, flown by skilled pilots using modern technique, are capable of really amazing performances. They can be put through most of the acrobatic maneuvers practised by pilots of powered planes. In 1933 an American, Jack O'Meara. made 96 consecutive loops; his record mas broken by a Russian, Simonov, who made 300 loops in 1935. Gliders have been flown with as many as 130 men aboard. The world's record flight with two persons aboard nas extended to 513 mi. by the Russian, V. Ilchenko, and a passenger in 1954. During the German attack on Belgium. the Netherlands and Luxembourg in May 1940, the Wehrmacht, in order to take certain bridges and the Albert canal in Belgium, used glider trains, consisting of gliders towed by transport planes. Each glider contained six fully armed German soldiers. Gliders nere also used in taking the Belgian forts, particularly the Eben Emael forts, which resisted for approxirnately a week. The conquest of the island of Crete by the Germans in May 1941, was almost entirely by an air invasion in which gliders played a very prominent part as troop transports. *(See* AIR-BORNE TROOPS.)

Soaring. spurred by the return of technically trained students to its rank after World War II, took on the methods of science to improve performance. Ben Shupack, secretary of the Soaring Society of America. instituted a series of conferences on motorless flight with the idea of exchanging ideas among progressive sailplanists. In 1948 a meeting under the auspices of the Soaring Society of America and the Institute of the Aeronautical Sciences produced the basic concepts for a world-record-breaking sailplane. Richard H. Johnson, a student at Mississippi State university. built such a sailplane and flew it. on Aug. j, 1951, to an international distance record of 53 j mi. from Odessa, Texas. to Salina, Kan.. bettering by 70 mi. the former record held since 1939 by a Russian. The actual ground distance flown was 57 j mi. in 8 hr. 40 min., making an average speed of 65.2 m.p.h.

From 1935 to the mid-1950s the glider gained in reputation as a tool for meteorological and aeronautical research. Gliders equipped with radio and recording instruments were used in thunderstorm research sponsored by the U.S. weather bureau. Paul Tuntland flew one of these gliders into the core of a thunderstorm in order to collect data on the structure of this air mass.

As a result of these meteorological studies a project to study the air flow over the Sierra Nevada mountains by means of sailplanes was sponsored by the U.S. air force in 1950 and 1951. During the latter study. Lawrence Edgar and Harold Klieforth reached an altitude of 44 2 j j ft. above sea level and established two international records. one for absolute altitude and one for altitude gained. The source of lift for this flight was a mountain wave which extends to high altitudes.

The glider was again used, following 1952, in Germany as a means of youth training for aviation. The Germans also rejuvenated a prewar institute for glider research at Munich

Modern soaring planes owe their high performance characteristics in large measure to a high aspect ratio of the wing *(see* ASPECT RATIO). Wing spans are generally from 30 to 50 ft., chord depths from 4 to j ft. They also have an extremely "clean" aerodynamic shaping of the streamlined fuselage and other parts. They are of light, although adequately rigid construction, generally of plynood and fabric but in many instances of duraluminum metal. The controls of gliders and sailplanes are similar in action to those of airplanes. Instruments most commonly carried are the air speed indicator, the bank-and-turn indicator, the altimeter and some type of sensitive instrument to indicate rate of climb or descent. *(See* AIRCRAFT INSTRUMENTS.)

Launching Techniques. — As noted above, extensive gliding and soaring activities were at first limited to regions in which airmen could find reasonably steady ninds blowing up hillside slopes. For best results, slopes were sought rising from plains or from broad valley floors to a hilltop from 200 to 300 ft. high. An ideal slope was one uhich rose slowly from the plain at first and then rose more abruptly as it neared a rounded crest. From such a hilltop, gliders were launched most commonly by the so-called "shock-cord" method. A hook attached to the nose of the glider engaged a ring to which nas fastened two long lengths of rubber-stranded rope similar to that used in the shock-absorbing units of airplane landing gears. One or more persons would hold the glider stationary by grasping a short line fixed to its fuselage. Usually at least two other persons would stretch out each rubber-stranded rope until it reached its maximum stretch. Then, at a shouted signal, those holding the glider released it. Those stretching the ropes ran forward. The glider sprang forward and rose into the air, dropping the ring from its nose hook as it did so. From this point the subsequent flight varied with the nature of the aircraft involved. If it was of crude design its pilot could proceed out over the valley only in ever-descending flight. If of more advanced design, the pilot frequently was able to climb in the winds bloning up the face of the slope and remain for substantial periods in flight "crabbing" back and forth along the crest of the ridge.

Such were the main elements of the launching technique developed in Germany in the first decade after World War I. Young Americans were quick to substitute the auto-tom and the winch-tow techniques. In the first, a rope or cable 500 ft. or more in length is connected between the glider and the rear of an automobile. As the automobile moves across the field the glider rises much as a kite rises until several hundred feet in the air. At this point a hook and ring mechanism attached to the nose of the glider disengages the rope and the pilot is free to practise turns or other evolutions in a glide back to the field (or out over the valley if the launching takes place on a hilltop, but this is obviously no longer necessary). High-speed winches driven by automobile engine power have come into use as substitutes for the moving automobile. A final launching technique. used only by the most experienced pilots. is the airplane tow in which the sailplane is actually towed into the air behind a power-driven aircraft to be cut loose at any desired altitude.

Once launched, the pilot must, if he wishes to soar, immediately search out some current of air which is actually rising in relation to the surface of the earth beneath him. Experienced pilots find such currents along hillside slopes, beneath and within cumulus clouds and along fronts between narm and cold air masses. Long distance flights are frequently achieved through the use of all three types of currents. Altitude records are almost invariably set on flights within thunderhead cumuli. Ridge soaring is of limited use except in attempts merely to remain in the air for long periods.

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(A. KL.; D. SE.; A. W. RT.)

GLINKA, KONSTANTIN DIMITRIEVICH (1867–1927), Russian soil scientist whose work had a tremendous influence throughout the world. He was born in Smolensk in Aug. 1867. While working for a degree in geology at the universities of Moscow and St. Petersburg, he became a student of V. V. Dokuchaiev, the founder of modern soil science (pedology). For the next 18 years he served as lecturer and professor at the Novo-Alexandria institute. In 1911 he returned to St. Petersburg and developed the first course in soil science there. Between 1908 and 1914 Glinka organized more than 100 soil-survey parties. He directed the soil survey of Siberia and of a part of European Russia. He published about 123 scientific books and papers and in 1927 with L. I. Prasolov, a soil map of the Soviet Union.

Although the general theory of soils as independent natural bodies had been proposed by Dokuchaiev and developed further by N. Sibirtsev, it was Glinka who organized the subject. His textbook, Soil Science, was first published in 1908 and went through three subsequent editions. Because of the language barrier, few outside of Russia read it. A German version, Die *Typen* der Bodenbildung, ihre *Klassifikation* und geographische Verbreitung, was published in 1914, and Curtis F. Marbut's translation appeared as The Great Soil Groups of the World and Their Development, 2nd ed. (1937). Glinka's influence reached its climax just before his death when he took an active part in the First International Congress of Soil Science held in the United States in 1927. He died on Nov. 2, 1927. See also RUSSIA: Soils and Their Influence; SOIL: Soil Classification. (C. E. K.)

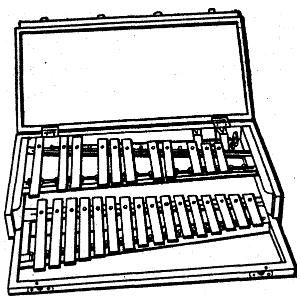
GLINKA, MICHAEL IVANOVICH (1803–1857), Russian composer, was born at Novospassky, Smolensk, on June 2, 1803. The folk music of his native province made a deep impression on the child, and he himself said that perhaps the songs he heard in his early days suggested the idea to him of making use of the national music in his compositions. At 13 he was sent to an aristocratic school at St. Petersburg, the Blagorodrey pension, where he studied music under Carl Maier and John Field, the Irish composer and pianist, who had settled in Russia. In his 17th year he had already begun to compose romances and songs. From 1824 to 1828 he held a post in the civil service in St. Petersburg, and mixed in the literary and scientific society of the capital, where he had the reputation of being a good mathematician and something of a scientist. His thorough musical training began in 1830, when he spent three years in Italy studying the works of old and modern Italian masters. His thorough knowledge of the requirements of the voice may be connected with this course of study, but the study of Italian music did not wean him from his early passion for Russian national melody. His training as a composer was finished under the contrapuntist Dehn, with whom he stayed for several months at Berlin. In 1833 he returned to Russia. and devoted himself to operatic composition. On Sept. 27 (Oct. 9, N.S.), 1836, his opera *A* Life for the Tsar (the libretto by Baron de Rosen) was produced at St. Petersburg. This was the turning point in Glinka's life, and in Russian music, for the production marks the beginning of a Russian school of national music. The story is taken from the invasion of Russia by the Poles early in the 17th century, and the hero, Ivan Susanin, is a peasant. Glinka has wedded this patriotic theme to inspiring music. His melodies, moreover. show distinct affinity to the popular songs of the Russians, so that the term "national" may justly be applied to them. His appointment as imperial chapelmaster and conductor of the opera of St. Petersburg followed. His second opera *Russlan* and Ludmila, founded on Pushkin's poem, did not appear till 1842. Musically it was a great advance on *A* Life for the *Tsar*, but it had less popular success. Just as in his first opera he had contrasted Russian and Polish music, so in the second, oriental themes were set over against Russian melodies. An overture and four entreactes to Kukolnik's drama Prince Kholmsky followed. In 1844 Glinka went to Paris, where he made the acquaintance of Berlioz, and a mutual admiration sprang up between the two composers. Glinka's *Jota* Aragonesa (1847), and the symphonic work on Spanish themes, Une *Nuit à* Madrid, reflect the musical results of two years' sojourn in Spain. On his return to St. Petersburg he wrote and arranged several pieces for the orchestra, amongst which the so-called Kamarinskaya achieved popularity beyond the limits of Russia. He also composed numerous songs and romances. In 1852 he went abroad for the third time; he now wrote his autobiography, orchestrated Weber's Invitation *à* la valse, and began to consider a plan for a symphonic work on Gogol's *Taras-Bulba*. But he now developed a passion for ecclesiastical music, and went to Berlin to study the ancient church modes. There he died suddenly on Feb. 2, 1857.

See H. Berlioz, Michael Glinka (Milan, 1874); M. D. Calvocoressi, "Glinka," Les Musiciens *Célèbres* (Paris).

GLOBEFISH or SEA HEDGEHOG, the name of some sea fishes of the families Diodontidae and Tetrodontidae, which have the faculty of inflating their bodies by swallowing air or water. Their jaws resemble the beak of a parrot, the bones and teeth being coalesced into one sharp-edged mass. With these they are able to break off branches of corals, and to masticate other hard substances on which they feed. Usually they are of a short, thick, cylindrical shape, with weak fins. Their body is covered with tough skin, without scales, but provided with prickles, or variously formed spines. When they are inflated they assume a globular form, and the spines protrude, forming a defensive armour. A fish thus blown out with air turns over and floats belly upward, driving before the wind and waves. Many of these fishes are highly poisonous when eaten. They are most numerous in the tropics; a few species live in large rivers, as, for instance, Tetrodon fahaka, of the Nile. Nearly 100 species are known.

GLOBEFLOWER, any plant of the genus *Trollius* of the family Ranunculaceae (*q.v.*), of which there are about 15 species in northern regions. They take their name from the globelike shape of the flower. There are several North American and more Eurasian species, including the American globeflower (T. *laxus*), native to eastern North America, and the common European globeflower (T. europaeus). The latter is often cultivated, especially in some of its horticultural forms, one of which has orange flowers, while most species are yellow. Also cultivated is the handsome T. *ledebouri* from Siberia, often two to three feet high. (N. TR.)

GLOCKENSPIEL, or ORCHESTRAL BELLS, an instrument of percussion of definite musical pitch. used in the orchestra, and made in two or three different styles. The oldest form of *glockenspiel* consisted of a set of bells of graduated size mounted pyramid-fashion on a frame and played by one performer by means of steel hammers. The lyre-shaped glockenspiel, or steel harmonica (Stahlharmonika), is a newer model, which has instead of bells 12 or more bars of steel, graduating in size according to their pitch. These bars are fastened horizontally across two bars of steel set perpendicularly in a steel frame. Wagner has used the glockenspiel with exquisite effect in the fire scene of the last act of Die *Walküre* and in the peasants' waltz in the last scene of Die Meistersinger. When chords are written for the glockenspiel, as in Mozart's Magic Flute, the keyed harmonica is used. It consists of a keyboard having a little hammer attached to each key, which strikes a bar of glass or steel when the key is depressed.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GLORIA, in general a doxology or ascription of praise, specifically two ancient Latin hymns Gloria in *excelsis* and Gloria Patri, referred to sometimes as the Greater and the Lesser Doxology respectively, and employed in the services of the Catholic Church.

The former, known as the angelic hymn, on the strength of a passage in Luke (ii, 14), is an important part of the Ordinary of the Mass; the latter is appended to the singing of the psalms.

For further particulars and for discussion of the Gloria in music, see MASS; also LITURGY, MISSAL and EUCHARIST.

GLORIOSA, a small genus of bulbous plants of the family Liliaceae (*q.v.*), natives of tropical Asia and Africa. They have slender stems which climb by tendrillike prolongations of the narrow generally lanceolate leaves. The flowers, which are borne in the upper leaf-axils, are very handsome. the six, generally narrow, orange or red petals are bent back and stand erect, the six stamens projecting beyond them. They are grown as greenhouse plants or outdoors in summer and often called climbing-lily or glory-lily.

GLORY, in works of art, is a general term for any radiance of light appearing around the body of a holy person, such as a nimbus, halo, aureole, mandorla or vesica *piscis*. Its purpose is to represent spiritual character through the symbolism of light. The sun disk was used in ancient Egypt to symbolize a divine being's specific relation to the sun. In Hellenistic and Roman art the sun god and emperors appear with a crown of rays. Because of its pagan origin, this form was avoided in early Christian art. By the 5th century, however, a disk-shaped form behind the head, called a nimbus or halo, was fully accepted. Originally reserved for Christ and the Virgin. the nimbus was soon used for the saints, also. A cross within a round nimbus became identified with representations of Christ in the middle ages. The triangular nimbus symbolized the Trinity. For some time, in the 5th century, living persons of eminence were equipped with a square nimbus; the memory of this custom is preserved in the academic mortarboard.

The aureole consists of a large circular or oval (from which the Italian name mandorla "almond") area representing illumination around the figure. Frequently, a nimbus was added. The aureole appeared only toward the end of the Romanesque period, probably inspired by the light symbolism of the Apocalypse. Its greatest artistic realization was reached in the 16th century when the abstract shape of the mandorla had changed into a more naturalistic representation of a radiating light (*e.g.,* Grunewald, "Ascension," Colmar; Raphael, "Liberation of St. Peter." Vatican).

In its development from the middle ages to the baroque the nimbus underwent a fuller artistic evolution than the aureole. Originally it appeared as a disk behind the head of the holy person. In Florentine painting of the Renaissance the disk began to be shown in perspective, following the movements of the figure. Increasingly, the nimbus became a material object and lost its spiritual quality (*e.g.,* angel in F. Cossa's "Annunciation," Dresden).

Another form of the nimbus became popular in Netherlandish painting of the 15th century. It consisted of a representation of light rays emanating from the head of the holy person (*e.g.,* the van Eyck altarpiece at Ghent). In this form, the historic character of the nimbus as a symbolic light m s recovered. A new idea was expressed by the German painters of the early 16th century who gave to the nimbus the character of a real light (*e.g.,* **A.** Diirer's engraving of "St. Jerome").

But it was only with Tintoretto in the middle of the 16th century that all these ideas were combined in one new form. The nimbus was now represented as a supernatural light emanating from the head of the holy person. This new interpretation was the standard form in the baroque period (*e.g.,* Rembrandt, "Christ at Emmaus." Louvre).

The nimbus as well as the aureole is also found in the Buddhist art of India. Their earliest date of appearance is the late 3rd century B.C. and it is likely that these ideas were originally brought to India by the Greek invaders.

See Joseph Wilpert, *Die roemischen Mosaiken* und *Malereien* der *kirchlichen Bauten* vom *4.–13. Jh.* (1917). (P. M. L.)

GLOSS AND GLOSSARY. The Greek word glossa, meaning originally a tongue, then a language or dialect, gradually came to denote any obsolete, foreign, provincial, technical or otherwise peculiar word or use of a word.

In late classical and medieval Latin, glosa was the vulgar and Romanic, glossa the learned form. The diminutive glossula occurs in Diomedes and elsewhere. The same meaning is borne by glos*sarium,* which also occurs in the modern sense of "glossary," as do the words giossa, glossae, *glossulae,* glossemata, expressed in later times by dictionarizrm, *dictionarius, vocabularium, vocabularius* (see DICTIONARY). Glossa and glossema are synonyms, signifying (1) the word which requires explanation; or (2) such a word (called lemma) together with the interpretation (*interpretamentum*); or (3) the interpretation alone.

Early History. — The making of collections and explanations of such glossai was at a comparatively early date a well-recognized form of literary activity. Even in the 5th century B.C., among the many writings of Abdera was included a treatise entitled Peri Homerou e *orthoepeies* kai glosseon. It was not, however, until the Alexandrian period that the glossographoi, glossographers (writers of glosses), or glossators, became numerous.

Of many of these perhaps even the names have perished; but Athenaeus the grammarian (c. A.D. 250) alone alludes to no fewer than 35. Among the earliest was Philetas of Cos (d. c. 290 B.C.), the elegiac poet, who mas the compiler of a lexicographical work entitled Atakta-or Glossai (sometimes Ataktoi glossai). Next came his disciple Zenodotus of Ephesus (early 3rd century B.C.), the compiler of Glossai Homerikai (uncommon words in Homer); he was succeeded by his greater pupil Aristophanes of Byzantium (c. 260–180 B.c.), whose great compilation Peri Lexeon (still partially preserved in that of Pollux), is known to have included Atttkai lexeis, Lakonikai glossai, and the like. From the school of Aristophanes issued more than one glossographer of name, — Diodorus, Artemidorus (Glossai, and a collection of lexeis *opsartytikai*), Nicander of Colophon (Glossai, of which some 26 fragments survive) and Aristarchus (c. 210 B.C.), the famous critic, whose numerous labours included an arrangement of the Homeric vocabulary (lexeis) in the order of the books. Contemporary with the last named was Crates of Mallus, who, besides making some new contributions to Greek lexicography and dialectology, was the first to create at Rome a taste for similar investigations in connection with the Latin idioms. From his school proceeded Zenodotus of Mallus, the compiler of *Ethnikai* lexeis or glossai, a work said to have been designed chiefly to support the views of the school of Pergamum as to the allegorical interpretation of Homer.

Of later date were Didymus Chalcenterus (c. 63 B.C.–A.D. 10), who made collections of lexeis *tragodoumenai komikai,* etc.; Apollonius Sophista (c. 20 B.C.), whose Homeric Lexicon has come down to modern times; and Neoptolemus. known distinctively as o glossoguaphos. In the beginning of the 1st century of the Christian era Apion, a grammarian and rhetorician at Rome during the reigns of Tiberius and Claudius, followed up the labours of Aristarchus and other predecessors with glossai Homerikai, and a treatise Peri tes *Rhomaikes dialektou;* Heliodorus or Herodorus was another almost contemporary glossographer; Erotian also, during the reign of Nero, prepared a special glossary for the writings of Hippocrates. To this period also Pamphilus, the author of the Leinzon, from which Diogenianus and Julius Vestinus afterward drew so largely, most probably belonged. In the following century one of the most prominent workers in this department of literature was Aelius Herodianus, whose treatise Peri *monerous* lexeos has been edited in modern times, and whose *Epimerismoi* survives in an abridgment; also Pollux, Diogenianus (Lexeis *pantodape*), Julius Vestinus (Epitome ton *Pamphilou glosson*) and especially Phrynichus, who flourished toward the close of the 2nd century, and whose *Eclogae nominum* et *verborum* Atticorum has frequently been edited.

To the 4th century belong Ammonius of Alexandria (*c.* 389), who wrote Peri *homoion,* kai *diaphoron* lexeon, a dictionary of words used in senses different from those employed by older and approved writers; Hesychius, nhose Lexikon has come down only in a 15th-century recension. From the jth century date, Cyril, the celebrated patriarch of Alexandria (one form of his work is the basis of Synagoge *lexeon* chresimon); Orus of Miletus (Peri *polysemanton* lexeon), and Orion of Egyptian Thebes who flourished in Alexandria, c. 425.

Compilations of *Justinian.*—To a special category of technical glossaries belong a large and important class of works relating to the law — compilations of Justinian. Although the emperor forbade under severe penalties all commentaries (*hypomnemata*) on his legislation, yet indexes (*indikes*) and references (*paratitla*), as well as translations (*hermeneiai kata* poda) and paraphrases (*hermeneiai* eis *platos*), were expressly permitted, and lavishly produced. Among the numerous compilers of alphabetically arranged *lexeis*

Rhomaikai or Lateinikai, and glossae nomikae, Cyril and Philoxenus are particularly noted; but the authors of paragraphai or semeioseis, whether exothen or esothen keimenai are too numerous to mention. A collection of these paragraphai ton *palaion,* combined with neai paragraphai on the revised code called ta basilika, was made about the middle of the 12th century by a disciple of Michael Hagiotheodorita. The collection of these glossaries is known as the Glossa ordinaria ton basilikon.

In Italy, also, during the period of the Byzantine ascendancy, and later, after the total extinction of Byzantine sway in the west, various glossae (glosae) and scholia on the Justinian code and various legal treatises were produced. The series of legal glossators was closed by Accursius (1182–1260) with the compilation known as the Glossa ordinaria or magistralis, the authority of which soon became very great. For some account of the glossators on the canon law, see CANON LAW.

Latin, like Greek glossography, had its origin chiefly in the practical wants of students and teachers, of whose names we only know a few. No doubt even in classical times collections of glosses (glossaries) were compiled, to which allusion seems to be made by Varro and Verrius-Festus. The scriptores glossematorum were distinguished from the learned glossographers like Aurelius Opilius, Servius Clodius, Aelius Stilo, L. Ateius Philologus, whose *liber* glossematorum Festus mentions.

Verrius Flaccus (who died under Tiberius), and his epitomists, Festus and Paulus, have preserved many treasures of early glossographers no longer extant. He copied Aelius Stilo, author of De *verborum* significatu, Aurelius Opilius, Ateius Philologus, the treatise De obscuris *Catonis.* He often made use of Varro and was also acquainted with later glossographers. Perhaps the glossae *asbestos* may be ascribed to him. Festus was used by Pseudo-Philoxenus (see below):

Bilingual Glossaries.—The bilingual (Gr.-Lat., Lat.-Gr.) glossaries also point to an early period, and were used by the grammarians (1) to explain the peculiarities (idiomata) of the Latin language by comparison with the Greek; and (2) for instruction in the two languages. The most important remains of bilingual glossaries are two well-known lexica; one (Latin-Greek), formerly attributed, but wrongly, to Philoxenus (consul A.D. 525), clearly consists of two closely allied glossaries (containing glosses to Latin authors, as Horace, Cicero, Juvenal, Virgil, the Jurists, and excerpts from Festus), worked into one by some Greek grammarian, or a person who worked under Greek influence (his alphabet runs A, B, G, D, E, etc.); the other (Greek-Latin) is ascribed to Cyril (Stephanus says it was found at the end of some of his writings), and is considered to be a compilation of not later than the 6th century. Furthermore, the bilingual medico-botanic glossaries had their origin in old lists of plants, as Pseudo-Apuleius in the treatise De *herbarum* virtutibus, and Pseudo-Dioscorides; the glossary, entitled Hermeneuma, printed from the Cod. Vatic. reg. Christ. 1260, contains names of diseases. Somewhat similar are names of animals in Polemius Silvius.

Of Latin glossaries of the first five or six centuries of the Roman emperors few traces are left, if Verrius-Festus is excepted. Of this early period we know by name only Fulgentius and Placidus. All that is known of the second of these tends to show that he lived in north Africa in the 6th century, from whence his glosses came to Spain, and were used by Isidore and the compiler of the *Liber* glossarum (see below). These glosses are known from (1) Codices Romani (15th and 16th centuries); (2) the Liber *glossarum;* (3) the Cod. Paris. nov. acquis. 1298 (11th century), a collection of glossaries, in which the Placidus-glosses are kept separate from the others. (Fabius Planciades) Fulgentius (*c.* A.D. 468–533) wrote Expositio *sermonum* antiquorum in 62 paragraphs, each containing a lemma (sometimes two or three) with an explanation giving quotations and names of authors. Next to him come the *glossae* Nonianae, which arose from the contents of the various paragraphs in Nonius Marcellus' work being written in the margin without the words of the text; these epitomized glosses were alphabetized and afterward copied for other collections. In a similar way arose the glossae Eucherii or glossae spiritales secundum *Eucherium episcopum* found in many manuscripts, which are an alphabetical extract from the formulae *spiritalis* intelligentiae of St. Eucherius, bishop of Lyons, c. 434–450. The so-called *Malberg* glosses, found in various texts of the Lex Salica, are not glosses in the ordinary sense of the word, but precious remains of the parent of the present literary Dutch, namely, the Low German dialect spoken by the Salian Franks who conquered Gaul from the Romans at the end of the 5th century. The antiquity and the philological importance of these glosses may be realized from the fact that the Latin translation of the Lex Salica probably dates from the end of the 5th century. See J. Grimm's preface to J. Merkel's edition (1850), and H. Kern's notes to J. H. Hessels's edition (1880) of the Lex Salica.

The Middle Ages.—During the 6th. 7th and 8th centuries glossography developed in various ways; old glossaries were worked up into new forms, or amalgamated with more recent ones. It ceased, moreover, to be exclusively Latin-Latin, and interpretations in Germanic (Old High German, Anglo-Saxon) and Romanic dialects took the place of or were used side by side with earlier Latin ones. Among Celtic glosses the most important are Old Irish, and of these Bishop Cormac's and O'Davoren's have been edited by Whitley Stokes, the former also by Kuno Meyer. The origin and development of the extant late classic and medieval glossaries can be traced with certainty. While reading the manuscript texts of classical authors, the Bible or early Christian and profane writers, students and teachers, on meeting with any obscure or out-of-the-way words which they considered difficult to remember or to require elucidation, wrote above them, or in the margins, interpretations or explanations in more easy or better-known words. The interpretations written above the line are called interlinear, those written in the margins of the manuscripts marginal glosses. Again, manuscripts of the Bible were often provided with interlinear literal translations.

Types of Glossaries.—I. From these glossed manuscripts and interlinear versions glossaries were compiled; that is, the obscure and difficult Latin words, together with the interpretations, were excerpted and collected in separate lists, in the order in which they appeared in the manuscripts, with the names of the authors or the titles of the books whence they were taken or placed at the head of each separate collection. In this arrangement each article by itself is called a gloss; when reference is made only to the word explained it is called the lemma, while the explanation is termed the *interpretamentum.* In most cases the form of the lemma was retained just as it stood in its source, and explained by a single word, so that lemmata appear in the accusative, dative and genitive, explained by words in the same cases; the forms of verbs were treated in the same way. Of this first stage in the making of glossaries, many traces are preserved, in the late 8th century Leyden Glossary, where chapter iii contains words or glosses excerpted from the Life of St. Martin by Sulpicius Severus; ch. iv, v and xxxv glosses from Rufinus, and so forth.

2. By a second operation the glosses came to be arranged in alphabetical order according to the first letter of the lemma, but still retained in separate chapters. Of this second stage the Leyden Glossary contains traces also.

3. The third operation collected all the accessible glosses in alphabetical order, in the first instance according to the first letters of the lemmata. Here the names of the authors or the titles could no longer be preserved, and consequently the sources of the glosses became uncertain.

4. A fourth arrangement collected the glosses according to the first two letters of the lemmata, as in the Corpus Glossary and in the still earlier Cod. Vat. 3321 (Goetz, *Corp.* iv, I sqq.), where even many attempts were made to arrange them according to the first three letters of the alphabet. A peculiar arrangement is seen in the Glossae *affatim* (Goetz, *Corp.* iv, 471 sqq.), where all words are alphabetized, first according to the initial letter of the word and then further according to the first vowel in the word (a, e, i, o. u).

No date or period can be assigned to any of the above stages or arrangements. For instance, the first and second are both found in the Leyden Glossary (end of 8th century) whereas the Corpus Glossary (beginning of 8th century) represents already the fourth stage. For the purpose of identification titles have been given to the various nameless collections of glosses, derived partly from their first lemma, partly from other characteristics, as glossae *abstrusae;* glossae *abavus major* and *minor;* g. *affatim;* g. *ab absens;* g. *abactor;* g. *Abba Pater;* g. *a, a;* g. *Vergilianae;* g. *nominum;* g. *Sangallenses.*

A chief landmark in glossography is represented by the *Origines* (*Etymologiae*) of Isidore (d. 636), an encyclopaedia in which he, like Cassiodorus, mixed human and divine subjects together, and the etymological part of which (book x) became a great mine for later glossographers. His principal source is Servius, the fathers of the church, and Donatus. Next comes the *Liber glossarum,* chiefly compiled from Isidore, but with all articles arranged alphabetically; its author lived in Spain *c.* A.D. 690–750; he has been called Ansileubus, but this name may be merely that of some owner of a copy of the book. Here come, in regard to time, some Latin glossaries already largely mixed with Germanic, more especially Anglo-Saxon interpretations: (1) the *Corpus Glossary* (eds. J. H. Hessels, W. M. Lindsay), of the beginning of the 8th century, in Corpus Christi college, Cambridge; (2) the *Leyden Glossary* (end of 8th century, ed. J. H. Hessels, Plac. Glogger), in Leyden manuscript Voss. Q° Lat. 69; (3) the *Epinal Glossary,* written in the beginning of the 9th century and published in facsimile by the London Philol. Society from the manuscript at Epinal; (4) the *Glossae Amplonianae, i.e.,* three glossaries preserved in the Amplonian library at Erfurt, known as Erfurt^1, Erfurt^2, and Erfurt^3, which are arranged alphabetically according to the first or the first two letters of the lemmata.

The first great glossary or collection of various glosses and glossaries is that of Salomon, bishop of Constance, who died A.D. 919. An edition of it was printed *c.* 1475 at Augsburg as *Salemonis ecclesie Constantiensis episcopi glosse ex illustrissimis collecte auctoribus.* Its sources are the *Liber glossarum,* the glossary preserved in the 9th-century manuscript *Lat Monac.* 14429, and the *Abavus major Gloss.* The *Liber glossarum* has also been the chief source for the important (but not original) glossary of Papias, of A.D. 1053, who also wrote a grammar chiefly compiled from Priscian. It is also the source of (1) the *Abba Pater Glossary,* published by G. M. Thomas (*Sitz. Ber. Akad. Münch.,* 1868, ii, 369 *sqq.*); (2) the Greek glossary *Absida lucida;* and (3) the Lat.-Arab. glossary in the *Cod. Leid. Scal. Orient.* No. 231 (published by Seybold in *Semit. Studien,* Heft xv–xvii, 1900). The *Paulus-Glossary* is compiled from the second *Salomon-Glossary* (*abacti magistratus*), the *Abavus major* and the *Liber glossarum,* with a mixture of Hebraica.

Osbern of Gloucester (*c.* 1123–1200) compiled the glossary entitled *Panormia* (ed. Angelo Mai as *Thesaurus novus Latinitatis,* from *Cod. Vatic.* reg. Christ. 1392), giving derivations, etymologies, testimonia collected from Paulus, Priscian, Plautus, Horace, Virgil, Ovid, Mart. Capella, Macrobius, Ambrose, Sidonius, Prudentius, Josephus, Jerome, etc. Osbern's material was also used by Hugucio, whose compendium was still more extensively used (Goetz enumerates 103 manuscripts of his treatise).

The great work of Johannes de Janua, entitled *Summa quae vocatur catholicon,* dates from the year 1286, and mostly uses Hugucio and Papias; its classical quotations are limited, except from Horace; it quotes the Vulgate by preference; it excerpts Priscianus, Donatus, Isidore, the fathers of the church; it borrows many Hebrew glosses, especially from Jerome; it mentions the *Graecismus* of Eberhardus Bethuniensis, the works of Hrabanus Maurus, the *Doctrinale* of Alexander de Villa Dei, and the *Aurora* of Petrus de Riga.

The gloss manuscripts of the 9th and 10th centuries are numerous, but a diminution becomes visible toward the 11th. A peculiar feature of the late middle ages are the medico-botanical glossaries based on earlier ones. The additions consisted in Arabic words with Latin explanations, while Greek, Latin, Hebrew and Arabic interchange with English, French, Italian and German forms. Glossaries of this kind are (1) the *Glossae alphita;* (2) *Sinonoma Bartholomei,* of the end of the 14th century, ed. J. L. G. Mowat; (3) the compilations of Simon de Janua (*Clavis sanationis,* end of 13th century), and of Matthaeus Silvaticus (*Pandectae medicinae,* 14th century).

There are many biblical glossaries, mostly mixed with glosses on other, even profane, subjects, as Hebrew and other biblical proper names, and explanations of the text of the Vulgate in general, and the prologues of Hieronymus. There is the *Glossae veteris ac novi testamenti* (beginning "Prologus graece latine praelocutio sive praefatio") in numerous manuscripts of the 9th to 14th centuries, mostly retaining the various books under separate headings. Special mention should be made of Guil. Brito, who lived about 1250, and compiled a *Summa* (beginning "difficiles studeo partes quas Biblia gestat pandere") which gave rise to the *Mammotrectus* of J. Marchesinus, about 1300, of which there are editions of 1470, etc. *See* also DICTIONARY.

Modern History.—The modern historical interest in glosses and glossaries began with J. Scaliger (1540–1609), who in his edition of Festus made great use of Ps.-Philoxenus, which enabled O. Müller, the later editor of Festus, to follow in his footsteps. Scaliger also planned the publication of a *Corpus glossarum,* and left behind a collection of glosses known as *glossae Isidori.* The study of glosses was greatly furthered through the publication, in 1573, of the bilingual glossaries by Henri Stephanus (Estienne). In 1600 Bonav. Vulcanius republished the same glossaries, adding (1) the *glossae Isidori,* which now appeared for the first time; (2) the *Onomasticon;* (3) *notae* and *castigationes,* derived from Scaliger. In 1606 Carolus and Petrus Labbaeus published, with the help of Scaliger, another collection of glossaries, republished, in 1679, by Du Cange, after which the 17th and 18th centuries produced no further glossaries, though glosses were constantly used or referred to by scholars at Leyden, where a rich collection of glossaries had been obtained by the acquisition of the Vossius library. In the 19th century came Osann's *Glossarii Latini specimen* (1826); the glossographical publications of Angelo Mai (*Classici auctores,* vol. iii, vi, vii, viii, 1831–36, containing Osbern's *Panormia,* Placidus and various glosses from Vatican manuscripts); Fr. Oehler's treatise (1847) on the *Codex Amplonianus* of Osbern, and his edition of the three Erfurt glossaries, so important for Anglo-Saxon philology; in 1854 G. F. Hildebrand's *Glossarium Latinum* (an extract from *Abavus minor*), preserved in a Cod. Paris. lat. 7690; in 1857, Thomas Wright's vol. of Anglo-Saxon glosses, which were republished with others in 1884 by R. Paul Wülcker under the title *Anglo-Saxon and Old English Vocabularies;* L. Diefenbach's supplement to Du Cange, entitled *Glossarium Latino-Germanicum mediae et infimae aetatis;* Ritschl's treatise (1870) on Placidus, which called forth an edition (1875) of Placidus by Deuerling; G. Loewe's *Prodomus Corporis Glossariorum Latinorum* (1876), and other treatises by him, published after his death by G. Goetz (1884); in 1885, H. Sweet, Latin-Anglo-Saxon glossaries in *Oldest English Texts;* in 1890, J. H. Hessels, apograph of the *Corpus Glossary,* 1906 of the *Leyden Glossary;* and in 1900, Arthur S. Napier, *Old English Glosses,* collected chiefly from Aldhelm manuscripts. Goetz's own great *Corpus glossariorum Latinorum,* appeared in seven volumes between 1888 and 1923, the last two being separately entitled *Thesaurus glossarum emendatarum,* containing many emendations and corrections of earlier glossaries by the author and other scholars. In the 20th century appeared W. M. Lindsay's *Corpus Glossary* and *The Corpus, Epinal, Erfurt, and Leyden Glossaries* both in 1921 and his *Palaeographia Latina,* in 1922. W. M. Lindsay with the collaboration of J. Whatmough, J. F. Mountford, J. H. Thomson *et al.,* edited *Glossaria Latina* (4 volumes) in 1926–1930 for the British Academy.

BIBLIOGRAPHY.—Among encyclopaedic articles the chief are J. Tolkiehn's article "Lexicographie" and G. Goetz's article "Lateinische Glossographie" in Pauly-Wissowa's, *Real-Encyclopädie der classischen Altertumswissenschaft.* Comparable to Goetz's *Corpus* is the great collection of Steinmeyer and Sievers, *Die althochdeutschen Glossen,* 4 vol. (1879–98), containing a vast number of glosses culled from Bible manuscripts and manuscripts of classical Christian authors. See also many important articles in *Anglia, Englische Studien, Archiv f. latein Lexicographie, Romania, Zeitschr. für deutsches Alterthum, Journal of English and Germanic Philology, American Journal of Philology, Classical Review.* On glossai *see* J. Whatmough, *Poetic, Scientific, and Other Forms of Discourse,* ch. 4 (1957); Lindsay and J. H. Thomson, *Ancient Lore in Mediaeval Latin Glossaries* (1921) is an important guide to the problem of gloss derivation. Modern writers on dialects commonly extract relevant items, *e.g.,* F. Bechtel, *Die Griechischen Dialekte,* 3 vol.

(1921–24); J. Whatmough, *Dialects of Ancient Gaul* (1949–51).
(J. H. Hes.; C. T. O.; J. Wh.)

GLOSSOP, an industrial town and municipal borough (1866) in the High Peak parliamentary division of Derbyshire, Eng., 14 mi. E.S.E. of Manchester by road. Pop. (1951) 18,004. Area 5.2 sq.mi. It is a centre of cotton manufacture in Derbyshire and has also woolen and paper mills, dye, print and bleaching works. It is situated near the northwestern boundary of Derbyshire, being built on the foothills which lead to Kinder Scout, the highest point of the Peak district (*q.v.*), and is surrounded on three sides by the Peak District National park. Although an industrial town, mostly stone built, its unique position as the natural gateway to the Peak makes it also a residential brea. Glossop hall, formerly the seat of Lord Howard, lord of the manor, was acquired by the corporation and houses Kingsmoor mixed boarding school. On a hill near the town is Melandra castle, the site of a Roman fort guarding Longdendale and the way into the Peak district. To the north, in Longdendale, there are five reservoirs belonging to the water-supply system of Manchester.

GLOUCESTER, GILBERT DE CLARE, Earl of (1243–1295), 8th earl of Gloucester and 9th earl of Clare, was born at Christchurch, Hampshire, on Sept. 2, 1243. He married Alice of Angoulême, niece of king Henry III, succeeded his father in July 1262, and joined the baronial party led by Simon de Montfort. With Simon Gloucester was at the battle of Lewes in May 1264, when the king himself surrendered to him, and after this victory he was one of the three persons selected to nominate a council. Soon, however, he quarreled with Simon. Leaving London for his lands on the Welsh border he met Prince Edward, afterward king Edward I, at Ludlow, just after his escape from captivity, and contributed largely to the prince's victory at Evesham in August 1265. But this alliance was as transitory as the one with Leicester. Gloucester championed the barons who had surrendered at Kenilworth in November and December 1266, and after putting his demands before the king, secured possession of London (April 1267). The earl quickly made his peace with Henry III and with Prince Edward. Under Edward I he spent several years in fighting in Wales, or on the Welsh border; in 1289 when the barons were asked for a subsidy he replied on their behalf that they would grant nothing until they saw the king in person (nisi *prius personaliter viderent* in *Anglia* faciem *regis*), and in 1291 he was fined and imprisoned on account of levying private war on Humphrey de Bohun, earl of Hereford. Having divorced his wife Alice, he married in 1290 Edward's daughter Joan, or Johanna (d. 1307). The "Red Earl," as he is sometimes called, died at Monmouth on Dec. 7, 1295, leaving in addition to three daughters a son. Gilbert, earl of Gloucester and Clare, killed at Bannockburn.

See references under Montfort, Simon de.

GLOUCESTER, HUMPHREY, Duke of (1391–1447), the fourth son of Henry IV by Mary de Bohun, was born in 1391. He was created duke of Gloucester by Henry V at Leicester on May 16, 1414. He served in the war next year, and was wounded at Agincourt, where he owed his life to his brother's valour. In the second invasion of France Humphrey commanded the force which during 1418 reduced the Cotentin and captured Cherbourg. Afterwards he joined the main army before Rouen, and took part in subsequent campaigns till January 1420. He then went home to replace Bedford as regent in England, and held office till Henry's own return in February 1421. He was again regent for his brother from May to September 1422.

Henry V measured Humphrey's capacity, and by his will named him merely deputy for Bedford in England. Humphrey at once claimed the full position of regent, but the parliament and council allowed him only the title of protector during Bedford's absence, with limited powers. He married (1423) Jacoba of Bavaria, heiress of Holland. to whose lands Philip of Burgundy had claims. In October 1424 Humphrey took up arms in his wife's behalf, but after a short campaign in Hainault went home, and left Jacoba to be overwhelmed by Burgundy. His marriage was annulled in 1428. Returning to England in April 142j he entangled himself in a quarrel with the council and his uncle Henry Beaufort, and stirred up a tumult in London. Open war was averted only by Beaufort's prudence, and Bedford's hurried return. With some difficulty Bedford effected a formal reconciliation at Leicester in March 1426. To check his indiscretion the council, in November 1429, had the king crowned, and so put an end to Humphrey's protectorate, but during Henry VI's absence in France he acted as warden in England. The defection of Burgundy roused English feeling, and Humphrey won popularity as leader of the war party. In 1436 he commanded in a short invasion of Flanders. In 1441 Eleanor Cobham, his former mistress, whom he had married (about 1430), was charged with practising sorcery against the king, and Humphrey had to submit to see her condemned, and her accomplices executed. Nevertheless, he continued to thwart Suffolk, who was now taking Beaufort's place in the council, by opposing the king's marriage to Margaret of Anjou. Under Suffolk's influence Henry VI grew to distrust his uncle altogether. The crisis came in the parliament of Bury St. Edmunds in February 1447. Immediately on his arrival there Humphrey was arrested, and four days later, on Feb. 23, he died.

Humphrey was buried at St. Albans Abbey, in a fine tomb, which still exists. He was long remembered, in spite of his bad political record, as the good Duke Humphrey, on account of his liberal patronage of scholars and of learning.

The most important contemporary sources are Stevenson's *Wars of the English in France*, Whethamstead's *Register*, and Beckington's *Letters* (all in the "Rolls Series"), with the various *London Chronicles*, and the works of Waurin and Monstrelet. For his relations with Jacoba *see* F. von Löher's *Jacobaa von Bayern und ihre Zeit*, 2 vols., (1869). For other modern authorities consult W. Stubbs's *Constitutional History; J. H.* Ramsay's *Lancaster and York; Political History of England*, vol. iv.; R. Pauli, *Pictures of* Old *England*, pp. 373–401 (1861); and K. H. Viekers, *Humphrey, Duke of Gloucester* (1907).

GLOUCESTER, RICHARD DE CLARE, Earl of (1222–1262), 7th earl of Gloucester, 6th earl of Hertford and 8th earl of Clare, was born on Aug. 4, 1222, the son of Gilbert de Clare, 6th earl of Gloucester and 7th earl of Clare. Upon his father's death in Oct. 1230, Richard succeeded to the earldoms. He refused to help Henry III on the French expedition of 1253, but was afterward with the king at Paris. Thereafter he went on a diplomatic errand to Scotland and was sent to Germany to work among the princes for the election of his stepfather, Richard, earl of Cornwall, as king of the Romans. About 1258 Gloucester became a leader of the barons in their resistance to the king, and he was prominent during the proceedings which followed the Mad parliament at Oxford in 1258. In 1259, however, he quarrelled with Simon de Montfort, earl of Leicester; the dispute, begun in England, was renewed in France and he was again in the confidence of the king. This attitude, too, was only temporary, and in 1261 Gloucester and Leicester were again working in concord. The earl died at his residence near Canterbury on July 15, 1262, and his son (see Gloucester, Gilbert de Clare) succeeded to the earldoms.

GLOUCESTER, ROBERT, Earl of (d. 1147), was a natural son of Henry I of England. He mas born, before his father's accession, at Caen in Normandy; but the exact date of his birth, and his mother's name are unknown. His father married him to a daughter of Robert Fitz Hamon, heiress of the lordships of Gloucester and Glamorgan. About 1121 the earldom of Gloucester was created for his benefit. After his father's death, he was sedulously courted by the rival parties of his half-sister the empress Matilda and of Stephen. He tendered his homage to Stephen upon strict conditions, the breach of which should be held to invalidate the contract. But in 1137 Robert left England for Normandy, renewed his relations with the Angevin party, and in 1138 sent a formal defiance to the king. Returning to England in 1139, he revolted, and won the greater part of western England and the south Welsh marches for the empress. By the battle of Lincoln (Feb. 2, 1141), in which Stephen was taken prisoner, the earl made good Matilda's claim to the whole kingdom. He accompanied her to Winchester and London; but was captured by the king's supporters after the siege of Winchester. He was exchanged for Stephen, and after his release continued to fight for Matilda until his death on Oct. 31, 1147.

See the *Historia novella* by William of Malmesbury (Rolls edition); the *Historia Anglorum* by Henry of Huntingdon (Rolls edition);

J. H. Round, *Geoffrey de Mandeville* (1892); and O. Rossler, *Kaiserin Mathilde* (1897).

GLOUCESTER, THOMAS OF WOODSTOCK, DUKE OF (1355–1397), seventh and youngest son of the English king Edward III, was born at Woodstock on Jan. 7, 1355. Having married Eleanor (d. 1399), daughter and co-heiress of Humphrey de Bohun, earl of Hereford, Essex and Northampton (d. 1373), Thomas became constable of England, and was made earl of Buckingham by his nephew, Richard II, at the coronation in July 1377. He helped to defend the English coasts against the attacks of the French and Castilians, led an army through northern and central France, and unsuccessfully besieged Nantes.

Returning to England early in 1381, Buckingham found that his brother, John of Gaunt, duke of Lancaster, had married his wife's sister, Mary Bohun, to his own son, Henry, afterward King Henry IV. The relations between the brothers, already somewhat strained, were not improved by this proceeding. After taking some part in crushing the rising of the peasants in 1381, Buckingham became more friendly with John of Gaunt; and while marching with the king into Scotland in 1385 was created duke of Gloucester. Lancaster having left the country, Gloucester headed the party opposed to the royal advisers, Michael de la Pole, earl of Suffolk and Robert de Vere, earl of Oxford, whose recent elevation to the dignity of duke of Ireland had aroused profound discontent. Gloucester forced on the dismissal and impeachment of Suffolk; was a member of the commission appointed in 1386 to reform the kingdom and the royal household; and took up arms when Richard began proceedings against the commissioners. After defeating Vere at Radcot in December 1387 the duke and his associates entered London to find the king powerless in their hands.

Gloucester was restrained by his colleagues from deposing the king; but, as the leader of the "lords appellant" in the "Merciless Parliament," (February 1388), he took a savage revenge upon his enemies.

In 1396 uncle and nephew were again at variance. Gloucester disliked the peace with France and Richard's second marriage with Isabella of France; it was asserted that the duke was plotting to seize the king. On July 11, 1397 he was arrested by the king himself at his residence, Pleshey castle, Essex. He was taken at once to Calais, and it is probable that he was murdered by order of the king on Sept. 9 following.

Gloucester had one son. Humphrey (*c.* 1381–1399), who died unmarried, and four daughters, the most notable of whom was Anne (*c.* 1380–1438), who was successively the wife of Thomas, 3rd earl of Stafford. Edmund, 5th earl of Stafford and William Bourchier, count of Eu. Gloucester is supposed to have written *L'Ordonnance d'Angleterre pour le camp à l'outrance, ou gaige de bataille.*

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GLOUCESTER (abbreviated as pronounced *Glo'ster*), city, county and parliamentary borough, port. county and cathedral town, Gloucestershire, Eng., 103 mi. W.N.W. of London by road. Pop. (1951) 67,280. Area 8.2 sq.mi. Gloucester lies on the River Severn between the Cotswolds, on the east, and the northern part of the Forest of Dean. The Gloucester and Berkeley or Gloucester and Sharpness ship canal, opened in 1827, runs 16 mi. S.W. to Sharpness docks in the Severn estuary.

The cathedral originated in the foundation of an abbey in 681, the present church being dedicated in 1100 and its first mitred abbot being appointed in 1381. At the Dissolution the abbey was disbanded and became the seat of a bishopric with the abbey church of St. Peter as its cathedral, rededicated to the Holy and Indivisible Trinity. Gloucester lay in the see of Worcester until 1541 when the separate see was constituted, with John Wakeman, last abbot of Tewkesbury, as first bishop. The diocese covers the greater part of Gloucestershire, with small parts of Wiltshire, Oxfordshire, Worcestershire, Herefordshire and Warwickshire. The cathedral consists of a Norman nucleus, with additions in every style of Gothic architecture, being especially rich in early Perpendicular work. It is 420 ft. long and 144 ft. broad and its beautiful 15th-century pinnacled tower, with an internal flying buttress, rises 225 ft. The nave is massive Norman with Early English roof; the aisles, chapter house and crypt, which is one of the four apsidal cathedral crypts in England, are Norman. The choir has Perpendicular tracery over Norman work and the splendid east window is the largest Perpendicular window in England. Between the apsidal chapels is a Perpendicular cross Lady chapel and north of the nave are the cloisters with the first example of fan vaulting (1351–77). There are shrines of Osric, Edward II, Robert Curthose (eldest son of William the Conqueror), Bishop Warburton, Edward Jenner and others. The Festival of the Three Choirs is held annually in this cathedral (the first time being in 1724), and those of Worcester and Hereford in turn.

Gabled and timbered houses preserve the ancient aspect of the city and there are some Regency terraces. None of the old public buildings is left, but the New inn (early 15th century), a beautiful timbered house with a galleried courtyard, was one of the original pilgrim hostels. The Bell inn (1650) was the birthplace of George Whitefield and Cardinal Vaughan. The Fleece hotel has a galleried courtyard (16th century) and a 12th-century vaulted cellar. Bishop Hooper's lodging (16th century) was opened as a folk museum in 1935. Of the churches St. Mary-de-Lode, with a Norman tower and chancel, is on the site of a Roman temple; St. Mary-de-Crypt is from the 11th century; St. Michael's was connected with the ancient abbey of St. Peter; and St. Nicholas' was originally the chapel of St. Batholomew's hospital (12th century). Near St. Mary-de-Crypt are remains of Greyfriars and Blackfriars priories and of the city wall. There are three endowed schools: the King's Cathedral school (1545); the Crypt grammar school, founded by Dame Joan Cooke (1539); and Sir Thomas Rich's school (1666). Robert Raikes held the first Sunday school in Gloucester in 1780.

Gloucester possesses factories for making railway rolling stock, aircraft and components, agricultural implements, "permali" (an insulating material), aluminum bungalows, furniture, matches, cine-cameras, etc., and has heavy and light engineering works, shipyards and many long-established timber mills. Its principal imports are timber, grain and petroleum products; its main exports are its own manufactured goods. It is also a market town.

The Severn fisheries for salmon and lampreys are important and in 1953 the city high sheriff revived the custom (begun in the reign of Henry I) of sending a lamprey pie to the sovereign. The tidal bore in the river attains its extreme height, 9 ft., just below the city, at Stonebench.

History.—Gloucester *(Caer Glow, Gleawecastre)* was the Roman municipality or *colonia* of *Glevum,* founded by Nerva, A.D. 96–98. Its situation and the foundation in 681 of the abbey of St. Peter by King Osric favoured the growth of the town. It became the capital of Mercia and before the Conquest was a borough with a royal residence and a mint. It has been granted numerous fairs and charters, the first by Henry II, and was incorporated by Richard III in 1483, being made a county in itself. The chartered port of Gloucester dates from 1580. James I raised Gloucester to city status in 1605. Its iron trade dates from before the Conquest, tanning was carried on before the reign of Richard III, bell-founding was introduced in the 14th and pin-making in the 17th century, and the long-existing coal trade became important in the 18th century. The cloth trade flourished from the 12th to the 16th century. The sea-borne trade in corn and wine existed before the reign of Richard I.

The town formerly returned two members to parliament, but after 188j returned one member.

GLOUCESTER, a manufacturing, fishing and summer resort city of Essex county on Cape Ann in northeastern Massachusetts, U.S., was originally settled in 1623. During the 17th and 18th centuries, Gloucester flourished as a shipbuilding, maritime and fishing centre, in competition with nearby Salem and Newburyport. The first ship to be called a schooner is said to have been built in Gloucester about 1713. Along with manufacturing, fishing and a declining foreign commerce dominated Gloucester's economic life during the 19th century. After 1900 the economy was primarily industrial, with fish processing the leading industry. Secondary dependence was on fishing and on a large seasonal tourist and resort business. drawn to Cape Ann by historical associations, the scenic rocky coast and salt-water recreational facilities, and to the city by its picturesque water-front, narrow streets and weathered colonial buildings. Of special interest are the reef of Xorman's Woe on the east coast of Cape Ann where occurred the wreck of the "Hesperus," immortalized in Longfellow's famous poem; Hammond's castle; and the well-known bronze statue of a fisherman, a memorial to Gloucestermen lost at sea.

In the later 19th and early 20th centuries, immigrants from Portugal, Italy and a few from the Scandinavian countries settled in Gloucester, adding their traditions to its culture.

Incorporated as a town in 1642 and as a city in 1873, it adopted the council-manager form of government in 1949. For comparative population figures see table in MASSACHUSETTS: *Population.*

Gloucester is described in many books including: Rudyard Kipling, *Captains Courageous;* James B. Connolly. *Gloucestermen* (1930) ; and Percy MacKaye, *Dogtown Common* (1921). Samuel Chamberlain's *Gloucester and* Cape Ann (1938) includes many photographs of the area. (E. L. S.)

GLOUCESTER CITY, originally the seat of Old Gloucester county, became a part of Camden county, in southwestern New Jersey, U.S., when Camden county was detached in 1844.

Gloucester city is on the Delaware river, opposite Philadelphia, Pa., and adjoins the city of Camden on its southern boundary.

The first settlement occurred in 1623, when Fort Nassau, the first Dutch outpost in the Delaware valley, was built near the mouth of Big Timber creek. In 1664 the English gained control and in 1677 a group of Irish Quakers occupied what the Indians called Arwamus. This was renamed Gloucester point after a place on the Severn river in England.

Prior to the American Revolution, Elizabeth Griscom, better known as Betsy Ross (*q.v.*), eloped from Philadelphia to Gloucester City where she married John Ross at Hugg's tavern. For this she was "read out of meeting" by the Quakers in 1774. Hugg's tavern was razed in 1929 to make way for a county park.

Incorporated as a city in 1868, Gloucester City grew with the expansion of the nearby shipbuilding works started in 1899 in Camden. In the second half of the 20th century its industries included the manufacture of building materials and roofing, paperboard boxes. cork products, infants dresses and chemicals. In 1957 it became the site of the New Jersey end of the Walt Whitman bridge over the Delaware. For comparative population figures see table in NEW JERSEY: Population. (H. F. WI.)

GLOUCESTERSHIRE, a county of the west midlands of England, bounded by Worcestershire, Warwickshire. Oxfordshire, Berkshire, Wiltshire, Somersetshire, Monmouthshire and Herefordshire. The area of the geographical county is 1,257.7 sq.mi.

Physical Features. — The outline is very irregular. but three physical divisions are well marked — the Cotswold hills. the vale of Severn and the Forest of Dean. (1) The eastern part of the county lies in the uplands of the Cotswolds (*q.v.*) whose westward face is the steep scarp slope made by the edge of the limestones. The line of heights. of an average elevation of joo ft. but exceeding 1.000 ft. at some points, bisects the county from southwest to northeast. The watershed between the Thames and Severn lies close to it. Thames Head near Cirencester and most of the upper feeders of the Thames being in Gloucestershire. (2) The rich valley of the lower Severn can be separated into the vale of Gloucester and, south of this and east of the Severn estuary, the vale of Berkeley. The great River Severn receives, near Tewkesbury, the Stratford Avon which joins it on the left. The latter is to be distinguished from the Bristol Avon, which rises in the county as an eastward flowing stream of the Cotswolds, sweeps round through Wiltshire. pierces the hills through a narrow valley which becomes a gorge where the Clifton suspension bridge crosses it below Bristol, and enters the Severn estuary at Avonmouth. For 1; mi. from its mouth it forms the boundary between Gloucestershire and Somersetshire, and for 8 mi. it is an important commercial waterway connecting the port of Bristol with the sea. The third great tributary of the Severn is the Wye. From its mouth in the estuary, 8 mi. north of that of the Bristol Avon, it forms the county boundary for 16 mi. northward and above this, over two short reaches of its beautiful winding course. it is again the boundary. (3) Between the Wye and the Severn lies the Forest of Dean, which, unlike the majority of English forests, maintains its ancient character. (*See* DEAN, FOREST OF.) There the collieries are hidden among the dense oak forest.

None of the minor rivers of the county is long. The vale is at no point within the county wider than 20 mi., and so does not permit the formation of any considerable tributary to the Severn from the Dean hills on the one hand or the Cotswolds on the other. The Leadon rises east of Hereford and joins the Severn near Gloucester. In the southern part the Stroud Frome traverses a narrow, picturesque and populous valley, and the Little Avon flows past the town of Berkeley, joining the Severn estuary on the left. The Bristol Frome runs southward to the Bristol Avon at Bristol. The principal northern feeders of the Thames are the Churn rising in the Seven Springs above Cheltenham. the Coln, a noteworthy trout stream, the Windrush and the Evenlode.

Geology. — Gloucestershire is divided. geologically as well as physically, into three distinct sections — the Mesozoic rocks on the east, the Palaeozoic and older rocks on the west and the heavy clay soil of the Severn valley between.

Rising up almost sheer from the Severn on the west is the plateau of the Forest of Dean which is a basin of Carboniferous rocks (limestones, shales, grits and coal measures) resting upon the Old Red Sandstone, the Carboniferous limestones forming scarp faces round most of the outlier. South of the Severn is the Bristol coal field. with Silurian rocks and included volcanic rocks north and northeast of it. The Silurian occurs as inliers (*e.g.,* Tortworth) and Old Red Sandstone rocks crop out beneath the Carboniferous of the coal field. Jurassic and Triassic rocks also occur. resting upon the older rocks. In the vale of the Severn, carved out by the river. the structure is comparatively simple. Between the Malvern hills and the Jurassic escarpment of the Cotswolds is a broad belt of clays, the Triassic on the west separated from the Liassic by a low wooded ridge of blue limestone. It is these soils which yield such excellent crops. The limestones forming the Cotswold hills lie more or less horizontally. Many of them are oölitic and are used for the beautiful Cotswold buildings. Small outliers appear in Robin's Wood hill (651 ft.), south of Gloucester, and Churchdown hill (511 ft.), between Gloucester and Cheltenham.

Early Settlement and History.—The most interesting prehistoric feature of Gloucestershire is its wealth of long barrows, two of the best examples being those at Belas Knap near Winchcomb and Hetty Pegler's Tump at Uley (*see* O. G. S. Crawford, *Ord. Survey, Professional Papers,* New Series no. 6 [1922]). Almost as striking is the absence of Beaker pottery so abundant in Wiltshire to the south and Oxfordshire to the east. The lower Severn valley was apparently largely forest and swamp in early times. The Cotswolds are again remarkably poor in brooches of the first period of La Tene though Wiltshire and Oxfordshire are again rich. In Roman times the Fosse way from Exeter via Seaton and Bath to Lincoln ran east of the Cotswold ridge with *Corinium* (Cirencester) as a station on it and branches west to *Glevum* (Gloucester), southeast and east.

There were numerous Roman villas not far from these roads, one of the largest and most magnificent in Britain being that at Woodchester.

The English conquest of the Severn valley began in 577. The Hwicce (*q.v.*) who occupied the district were an Anglo-Saxon people, but their territory had become a dependency of Mercia in the 7th century. No important settlements were made by the Danes. Gloucestershire probably originated as a shire in the 10th century and is mentioned by name in the *Anglo-Saxon* Chronicle in 1016. Toward the close of the 11th century the boundaries were readjusted to include Winchcomb, and at the same time the forest district between the Wye and the Severn was added to Gloucester. The divisions of the county for a long time remained very unsettled and at the time of the Norman invasion it offered slight resistance to the Conqueror. In the wars of Stephen's reign the cause of the empress Maud was supported by Robert of Gloucester who had rebuilt the castle at Bristol, and the castles at Gloucester and Cirencester mere also garrisoned on her behalf. Bristol and Gloucester actively supported the Yorkist cause during the Wars of the Roses. In 1643 Bristol and Cirencester were captured by the Royalists. but the latter was recovered in the same year and Bristol in 1645. Gloucester was garrisoned for the parliament throughout the struggle.

On the subdivision of the Mercian diocese in 680 the greater part of modern Gloucestershire was included in the diocese of Worcester, and shortly after the Conquest constituted the archdeaconry of Gloucester. The district west of the Severn, with the exception of a few parishes, was within the diocese of Hereford. In 1541 the diocese of Gloucester was created, its boundaries being identical with those of the county. On the erection of Bristol to a see in 1542 the deanery of Bristol mas transferred from Gloucester to that diocese. In 1836 the sees of Gloucester and Bristol were united; but in 1897 the diocese of Bristol was recreated, and included the deaneries of Bristol, Stapleton and Bitton. After the Conquest extensive lands and privileges were acquired by the church, the abbey of Cirencester alone holding seven hundreds. The large estates held by Roger, earl of Hereford, son of William Fitz-Osbern, escheated to the crown in 1075. The Berkeleys have held lands in Gloucestershire from the time of the Domesday survey, and the families of Basset, Tracy. Clifton, Dennis and Poyntz have figured prominently in the annals of the county. Gilbert de Clare, earl of Gloucester, and Richard, earl of Cornwall, king of the Romans, claimed extensive lands and privileges in the shire of the 13th century, and Simon de Montfort owned Minsterworth and Rodley.

In the Cotswold region the churches typically show Romanesque and Perpendicular work, thus illustrating two special periods of economic development in the county related to the manors and the wool trade respectively.

Bristol was made a county in 1373, and in 1483 Richard III created Gloucester an independent county, and both have continued to rank as independent counties, with separate jurisdiction, county rate and assizes. The chief officer of the Forest of Dean was the warden, who was generally also constable of St. Briavel castle. The first justice seat for the forest was held at Gloucester castle in 1282, the last in 1635.

Iron was worked in the county in Roman times and later, and the forest district was one of the chief sources of iron in the country until the 16th century. The Cotswolds became famous for their sheep flocks and wool in the 1 jth century which witnessed the expansion of such beautiful towns as Chipping Campden. Many of the forests had tanneries, and boat building was carried on because timber was available. Silk weaving was introduced in the 17th century and prospered in the Stroud valley. These varied industrial developments promoted the building of houses of local limestone specially characteristic of Cotswold country. The abundance of clay on the edges of the plains promoted industries of bricks, tiles and potteries. Accessory industries, such as the making of pins, buttons, lace, stockings, rope and sailcloth grew up in the 17th and 18th centuries and a good deal of flax was grown. The advent of coal and steam machinery ended the modified and somewhat reduced woollen industry, but the presence of water power and of fuller's earth led the district (especially Stroud) to specialize in the manufacture of broadcloth. Gloucester (*q.v.*) u-as a port of some consequence and Bristol (*q.v.*) very important. The Cotswolds have become a holiday and residential area.

Antiquities. — At Chedworth, near Cirencester, there are well preserved remains of Roman baths. The villa at Woodchester, the existence of which has been known since 1693, is of the courtyard type. The most remarkable feature is the great pavement, an unusually fine piece of mosaic work, 48 ft. 10 in. square. The cathedrals of Gloucester and Bristol, the magnificent abbey church of Tewkesbury, and the church of Cirencester with its great Perpendicular porch, are described under their separate headings. Of the abbey of Hailes near Winchcombe, founded in 1246, little more than the foundations are left. Most of the old market towns have fine parish churches: at Deerhurst, Coln Rogers and Bibury, there are churches of special interest because of their pre-Norman work. Bibury also has a famous row of 17th-century cottages called Arlington Row. Norman doorways are found in the beautiful church at Bishop's Cleeve, near Cheltenham; the Perpendicular church at Lechlade is unusually perfect; and that at Fairford, built c. 1500, contains a remarkable series of stained glass windows. The great Decorated Calcot Barn is an interesting relic of the monastery of Kingswood near Tetbury. The castle at Berkeley is a splendid example of a feudal stronghold; Thornbury castle is a lovely Tudor ruin. Near Cheltenham is a fine 15th-century mansion of timber and stone, which contains a tiled floor from Hailes abbey. Near Winchcombe (*q.v.*) is Sudeley castle (15th century). At Great Badminton is the mansion and vast domain of the Beauforts.

Agriculture and Industries. — Most of the county is under permanent pasture for the cattle in the numerous small dairy farms, and for sheep. The larger farms are in the Cotsmolds. Arable farming is declining though wheat. the chief grain crop. oats and barley are still important. In the vale, the deep rich black (Lias) or red (Trias) loamy soil is well adapted for pasturage. and a moist mild climate favours the growth of grasses and root crops, though less of the latter has been grown since the falling-off in sheep production. The cattle, save on the frontier of Herefordshire, are mostly shorthorns, of which many are fed for distant markets, and many reared and kept for dairy purposes. The rich grazing tracts of the vales of Berkeley and of Gloucester produce butter. A feature of the county is its apple and pear orchards. chiefly for the manufacture of cider and perry, which are attached to every farm. The Cotswold district is comparatively barren except in the valleys (though beech woods cover much of the scarp face), but it has been famous since the 15th century for the breed of sheep named after it. Oats and barley are the chief crops.

In 1953 the National trust owned 2,853 ac. including Roman remains and historic buildings, and protected 211 ac. in the county. The Severn Wildfowl trust has its headquarters on an area of land reclaimed from the river and known as the New Grounds on the left bank of the Severn near Slimbridge.

The most important industrial centre of the county is Bristol. As a port and with an extensive trade with the West Indies, such industries as the manufacture of tobacco, cocoa and chocolate, sugar refining and soap have become important. The leading industry, however, is engineering with aircraft manufacture predominating. There are also iron foundries, chemical works, shipbuilding yards, breweries, glass, earthenware and furniture factories and a long-established plastics factory. The district around Stroud is famous for the manufacture of the woollen cloth known as broadcloth, and hardware is also made in this neighbourhood. Gloucester manufactures railway cars. freight cars, agricultural implements, prefabricated houses, matches, aircraft and aircraft components. There are a number of smaller industries in the Cheltenham area. In other scattered parts of the county, gloves and silk manufactures and engineering are carried on. At Lydney tinplate and plywood are produced and at Coleford is a large factory for extracting fruit juice. Coal is mined in the Forest of Dean and the Bristol coal fields, limestone and freestone are quarried in the Cotswolds, bricks and tiles manufactured from the Lias clays. In the southern part of the county strontium is found.

There are a number of important public schools and colleges, and Bristol is the seat of a university.

The Thames and Severn canal starts from the Thames at Lechlade, but the section between Stroud and the Thames has been abandoned and the remainder is seldom used. It rises to a summit level in the tunnel (23 mi. long) through the Cotswolds at Sapperton and is continued from Wallbridge (Stroud) by the Stroudwater canal. The Gloucester and Berkeley ship canal (16 mi.) connects the port of Gloucester with its outport of Sharpness on Severn. It is also connected, via Worcester and Stourport, with the Midland canal system. The railway runs 4.33 mi. through the Severn tunnel to Wales from Redwick, 5 mi. northeast of Avonmouth. At Staverton, midway between Gloucester and Cheltenham, is the Gloucester and Cheltenham municipal airport for civil aviation.

Population and Administration.— The area of the administrative county with boroughs is 1,258 sq.mi. and the population (1951) was 939,433. Population movements caused by World War II raised the population of the county by 7% between Sept. 1939 and Feb. 1941. Gloucestershire contains 29 hundreds; is divided into four parliamentary divisions; contains two cities and county boroughs, Bristol and Gloucester; two municipal boroughs, Cheltenham and Tewkesbury; six urban districts, Cirencester, Charlton Kings, Nailsworth, Stroud, Kingwood and Mangotsfield; 15 rural districts and 296 rural parishes. There are several ancient market towns. Gloucestershire is principally in the diocese of Gloucester, but part is in that of Bristol and small parts in those of Worcester and Oxford. It has three courts of quarter sessions, city, county (both held at the Shire hall, Gloucester) and Tewkesbury borough, and there are 25 petty sessional divisions. For assize purposes Gloucester is in the Oxford circuit.

Gloucestershire was represented in parliament in 1290 and returned two members. Bristol and Gloucester acquired representation in 1295, Cirencester in 1572 and Tewkesbury in 1620. In 1832 the county returned four members in two divisions; Bristol, Gloucester, Cirencester, Stroud and Tewkesbury returned two members each, and Cheltenham returned one member. The act of 1868 reduced the representation of Cirencester and Tewkesbury to one member each. By the act of 1918 the county was divided into four divisions; viz., those of Cirencester and Tewkesbury, the Forest of Dean, Stroud, and Thornbury divisions, each returning one member. By the 1949 act the county was redivided into Cirencester and Tewkesbury, Gloucestershire West, Stroud and Thornbury, and Gloucestershire South, each returning one member. Bristol returns six members, Cheltenham and Gloucester one each.

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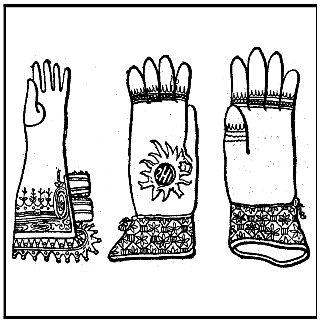
GLOVE, a covering for the hand, commonly with a separate sheath for each finger.

The use of gloves is of high antiquity, and apparently was known even to the pre-historic cave dwellers. In Homer Laërtes is described as wearing gloves in his garden. Herodotus tells how Leotychides filled a glove with money received as a bribe, and Xenophon records that the Persians wore fur gloves having separate sheaths for the fingers. Among the Romans also there are occasional references to the use of gloves. Varro remarks that olives gathered with the bare fingers are better than those gathered with gloves. In the northern countries the general use of gloves would be more natural than in the south, and it is not without significance that the most common mediaeval Latin word for glove (*guantus* or *wantus*, Mod. Fr. *gant*) is of Teutonic origin (O.H.G. *want*). Among the Germans and Scandinavians, in the 8th and 9th centuries, the use of gloves, fingerless at first, would seem to have been but universal; and in the case of kings, prelates and nobles they were often elaborately embroidered and bejewelled. This was more particularly the case with the gloves which formed part of the pontifical vestments. In war and in the chase gloves of leather, or with the backs armoured with articulated iron plates, were early worn; yet in the Bayeux tapestry the warriors on either side fight ungloved. So far as the records go, there is no evidence to prove that gloves were in general use in England until the 13th century. It was in this century that ladies began to wear gloves as ornaments; they were of linen and sometimes reached to the elbow. It was, however, not till the 16th century that Queen Elizabeth set the fashion for wearing them richly embroidered and jewelled.

Symbolical Uses.—Of the symbolical uses of the glove one of the most widespread during the middle ages was the practice of tendering a folded glove as a gage for waging one's law. The origin of this custom is probably not far to seek. The promise to fulfil a judgment of a court of law, a promise secured by the delivery of a *wed* or gage, is one of the oldest of all enforceable contracts. This gage was originally a chattel of value, which had to be deposited at once by the defendant as security into his adversary's hand; and that the glove became the formal symbol of such deposit is doubtless due to its being the most convenient loose object for the purpose.



FROM PLANCHÉ, "CYCLOPAEDIA OF COSTUME" LEFT, A GLOVE OF MARY QUEEN OF SCOTS, 1542–1587. RIGHT. GLOVES OF WILLIAM OF WYKEHAM, BISHOP OF WINCHESTER. 1367-1404

Associated with this custom was the use of the glove in the wager of battle. The glove here was thrown down by the defendant in open court as security that he would defend his cause in arms; the accuser by picking it up accepted the challenge. This form is still prescribed for the challenge of the king's champion at the coronation of English sovereigns, and was actually followed at that of George IV. (*see* CHAMPION).

The use of the glove as a pledge of fulfilment is exemplified also by the not infrequent practice of enfeoffing vassals by investing them with the glove; similarly the emperors symbolized by the bestowal of a glove the concession of the right to found a town or to establish markets, mints and the like. Conversely, fiefs were held by the render of presenting gloves to the sovereign. The most notable instance in England, however, is the grand serjeanty of finding for the king a glove for his right hand on coronation day, and supporting his right arm as long as he holds the sceptre.

Pontifical Gloves are liturgical ornaments peculiar to the Western Church and proper only to the pope, the cardinals and bishops, though the right to wear them is often granted by the Holy See to abbots, cathedral dignitaries and other prelates. According to the present use the gloves are of silk and of the liturgical colour of the day, the edge of the opening ornamented with a narrow band of embroidery or the like, and the middle of the back with a cross. They may be worn only at the celebration of mass (except masses for the dead) and only until the ablution before the canon of the mass.

During the middle ages the occasions on which pontifical gloves were worn were not so carefully defined as now, the use varying in different churches. Nor were the liturgical colours prescribed. Liturgical gloves have not been worn by Anglican bishops since the Reformation, though they are occasionally represented as wearing them on their effigies.

Gloves made of thin indiarubber or of white cotton, which may be thoroughly and easily sterilized, are worn by many surgeons while performing operations.

GLOVE MANUFACTURE. Modern gloves fall naturally into two main groups: (1) leather gloves; (2) fabric and knitted gloves. The character of a leather glove depends partly upon the type of skin used, but more particularly upon the processes by which the leather is produced.

Glove Skins.—A large variety of skins are used by the trade; but the humble sheep supplies the bulk of the raw material. Apart from sheepskin, the principal skins used for grain (or *glacé*) glove leathers (*i.e.,* those finished on the hair side of the skin) are kid, goat (chevrette) and lamb. French "national" skins from milk-fed kids are used extensively for ladies' high grade gloves; Tuscany, French "regord" and Kasan (Russia) lambskins are of high repute. In the grain group, also, the genuine Cape or South African hairy sheep furnish a strong, pliant leather for men's gloves. Many so-called "Capes," however, are made from Spanish, oriental or domestic sheepskins. Pigskin and coltskin are used for gloves to some extent in America, and dogskins are occasionally made into glove leather.

For velvet finished gloves. reindeer and buckskins yield the finest leathers. but they are expensive. The diminutive North African gazelle (a tiny creature, so small that three skins barely suffice for a single pair of gloves), the Arabian (or Mocha) sheep, and Sudanese sheep also furnish capital leather for velvet finishes. Suede leathers (*i.e.*, those finished on the flesh side of the skin) are produced from kid, lamb and sheepskins. Sheepskins, again, furnish most of the raw material for so-called "chamois," or washleather gloves, and also for what in the trade are called "doeskins."

Many glove manufacturers dress and dye skins for their own use; others purchase glove leather ready dressed. The skins are first partly cleansed in tanks or pits filled with water. They are then de-haired, the flesh side of the skins being painted with a solution of slaked lime and sodium sulphide or lime and red arsenic, which loosens the hair or wool and facilitates its removal by hand or machine. Any flesh adhering to the skin is next removed by "beaming" or "fleshing." Beaming is a hand operation, the skin being laid across a sloping beam let into the floor and the operative shaving away the flesh with a beaming knife. In the fleshing machine, which performs the same operation, the knives are mounted spirally upon a revolving cylinder, under which the skins are passed as through a mangle. The cleansed skins are steeped for some weeks in pits or vats containing a solution of slaked lime to loosen the sweatglands and hair cells and to remove grease, dirt, etc. Liming also makes the skins plumper. More washing follows, and the hides are then placed in a "puer" (or "bate") consisting either of a solution of dog manure, or a chemical solution of pancreatic extracts in combination with ammonium salts. "Drenching" is the next stage, wherein the raw material of the glove is immersed in vats containing a fermenting infusion of flour, pea-meal or bran, in which the skins swell or "rise" still more. Alternatively skins are pickled in a weak solution of sulphuric acid and salt. "Puering" and "drenching" or "pickling" complete the reduction of the hides to a soft, porous, pulpy, gelatinous condition which facilitates the entry of the dressing ingredients into the fibres of the skins. Further rinsings and cleansings follow, and the skins are then gently scraped with a scudding knife to remove the last vestige of hair or scum.

Dressing. — Dressing proper follows. There are several processes which may be adopted, according to the type of leather required and the practice of the factory. Different factories use different methods to produce the same kind of leather.

The "tawing" method, or white dressing, is very commonly used. A typical tawing mixture consists of 4 parts alum, 2 parts salt, 1 part egg-yolk and 5 parts flour. Sometimes a little vegetable oil is added. The mixture is dissolved in water (about 12 lb. to 2 gal.) and is applied by means of a drum-tumbler — a vessel shaped like a drum, the inner sides of which are fitted with pegs. The drum rotates on its own axis, and the pegs knead the mixture into the skins. Subsequently the skins are "stoved," or dried in heated chambers and emerge in the "crust" stage, resembling a piece of damp washleather which has dried hard in the sun. They are softened by "staking," a process in which the hides are drawn (flesh side downwards) over a blunt metal tool, fixed to a short stake or post set in the floor. Machine staking is now much used, especially for strong skins. The skins are later pared to an even thickness and usually stored for long periods before dyeing. Colour is applied either by brushing the dye on the outer surface of the leather, or by immersion in a drum tumbler. Vegetable or bark dyes are much used; but aniline and coal tar colours are suitable.

The foregoing process is much used for dressing *glacé* leathers, such as kid, lamb, nappa (a German term used to distinguish a drum-dyed article from a brush-dyed), and many so-called "Capes." *Clack* or grain leathers are finished by polishing the grain side with a lamb's wool pad, a glass slicker or a revolving felt wheel. Suede (named after Sweden, the country of its origin) is tanned by an alum and salt process, but it is finished by buffing the flesh surface on an emery wheel. Real "mochas" are dressed with lactic acid, alum and egg yolk; but the grain is first frized (raised with a frizing knife) and the grain side finished by buffing with emery and pumice.

Bark tanning (in which oak, chestnut, gambier, sumach and other barks are used) is adopted for leathers like genuine "Cape," goat, colt, pig and similar heavyweight skins.

An oil tannage is used to produce so-called "chamois" leather and washleather. For these, "fleshers" (the flesh section of the split sheepskins) are dressed with cod oil in a "stocking" machine, which pummels the oil into the leather. The process is sometimes termed "samming," and it involves repeated applications of oil, each dressing being followed by stove drying. Reindeer and buckskins are often oil-dressed, as are some "degrains"—leather with the grain "frized" or shaved off. These are then dyed as required. White washable leather is tanned by drumming skins in a solution of sodium carbonate and formaldehyde. later treating them with an emolient of egg yolk and neat's-foot or olive oil. Much progress has been made since 1920 with chrome dressing, and an entirely new range of coloured washable gloves is available in consequence. This process is much used for washable grain leathers, particularly in America; but velvet finished, especially "degrains" made from frized gazelle or Cape. Spanish and Sudanese sheep are successfully treated in this nay. The tannage is effected by drumming in a solution of chrome salts, after which the skins are treated with an oil emulsion. "Doeskins" are usually oil-dressed sheepskins or lambskins dyed with a liquid clay dye. In America, they are dressed by the formaldehyde process. Gazelle, antelope and the various deerskins are often "degrained" (or frized) and dressed with a velvet finish. Sometimes the white tannage is used and sometimes the formaldehyde or chrome process.

Glove-cutting. — Glove-cutting is a twofold operation. The cutters first stretch and manipulate the skins, and then cut them into oblong "tranks" of leather. Several tranks are placed together in a punching press fitted with a "calibre" (knives shaped like a double thumbless hand) and the shaped glove is punched out at one operation. "Fourchettes" (pieces for the sides of the fingers) and thumb pieces are punched out separately

The work of sewing is principally a cottage industry. Hand sewing is preferred for the highest class of work; but machine sewing is general Three special types of stitch are used: — (I) "round seam" (for light-weight gloves), in which the edges of the leather are brought together, back to back, and each stitch goes through the leather, and over the edge; (2) "prix-seam" (for heavyneight gloves), in which the edges are brought together and the stitching goes through and through, parallel to the edge; and (3) "pique," in which one edge is lapped over the other, and the stitches sewn through. When sewn, the gloves are dressed on heated metal "hands" and ironed and polished ready for boxing.

Fur gloves are made in much the same way, except that the fur is cut by hand.

The annual production of leather gloves fluctuates considerably; fashion and the severity of minter weather have an important bearing on demand.

The principal centres of manufacture are France, the United States. Italy. Germany, Czechoslovakia, England, Belgium, Luxemburg and Canada.

The French industry dates from the 11th century. It is carried on at Grenoble. Millau. St. Junien and Niort, and there are large dressing yards at Annonay in the Ardeche. Though France is the largest glove manufacturing country in the world, no figures of the annual production are available.

The output is chiefly in kids. lambs and lightweight suedes and washables.

The glove industry of the United States dates from 1760, when Sir William Johnson introduced a colony of Scottish glovers from Perth. These founded the town of Gloversville, Fulton county, N.Y., the chief seat of the industry.

Czechoslovakia manufactured mainly kid, nappa and chamois gloves. Prague became the chief centre. and Kaadan (or Caadan) famous for cheap washables.

The German industry developed chiefly in Bavaria. Munich being the principal centre; and factories were established in Berlin.

The chief Italian glove town is Naples (where cheap kid and lamb gloves are made); Milan, Turin and Genoa are smaller centres producing better quality gloves.

The British leather glove industry is centred mainly at Worcester and Yeovil; but it is carried on in many scattered hamlets in the west country and in Oxfordshire. Large quantities of lined and heavpaeight gloves are made.

Fabric Gloves.—Fabric gloves are of two kinds: (1) gloves cut from knitted cotton or silk fabric; and (2) knitted woolen gloves or "Ringwoods." The fabric for the former is knitted on warp-knitting machines of the Atlas or Milanese type, bleached or dyed and sometimes finished to simulate suede or washable or any other velvet-finished leather by treatment on an emery or other buffing wheel, or by teazles.

The fabric glove is cut out and sewn much in the same way as a leather glove. These gloves are made in Germany, in France at Paris and Lyons and in the English glove centres. Superfine silk gloves are made in New Jersey, U.S.

Woolen gloves are made in hosiery mills. The seamless type is produced, partly on circular knitting machines (wrist and hand) and partly on flat hand-operated machines (thumbs and fingers). Wrought gloves are usually knitted on straight bar machines, which enable various designs to be worked. The gloves are seamed on a cup-seaming machine. Leicester, Nottingham and the Scottish border towns are the main centres of manufacture.

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(B. E. E.; X.)

GLOVER, RICHARD (1712–1785), English poet, son of Richard Glover, a Hamburg merchant, was born in London and educated at Cheam in Surrey. In 1737 he published an epic poem in praise of liberty. *Leonidas,* which was thought to have a special reference to the politics of the time; and being warmly commended by the prince of Wales and his court, it soon passed through several editions. In 1761 he entered parliament as member for Weymouth. He died on Nov. 25, 1785.

Glover was one of the reputed authors of *Junius;* but his claims —which were advocated in an *Inquiry concerning the author of the Letters of Junius* (1815), by R. Duppa—rest on very slight grounds. His other works include *London* (1739), a poem; *Hosier's Ghost* (1739). a ballad directed against the Spaniards; *Athenaid* (1787), an epic; and his diary, *Memoirs . . . from 1742 to 1757* (1813).

GLOVERSVILLE, a city of Fulton county about 45 mi. N.W. of Albany, in eastern New York, U.S., forms with adjoining Johnstown a small metropolitan centre in the industrialized Mohawk valley. The cities are adjacent to the Adirondack State park; forest land covers over 60% of the county and there are many lakes and streams in the immediate vicinity. Small dairy farms are the principal form of agriculture.

Glovemaking and the tanning of leather, which were still the most important industries of the region in the second half of the 20th century, began in the colonial period. After 1800, wide-ranging peddlers from Gloversville exchanged tinware for deerskins with the settlers in the Mohawk valley. The greater supply of skins, the large amount of tannin available and the abundant water supply accelerated the expansion oi the industries. By 1900 the region made 80% of the gloves manufactured in the United States. The factories were usually small, and the workers were often of English or German origin.

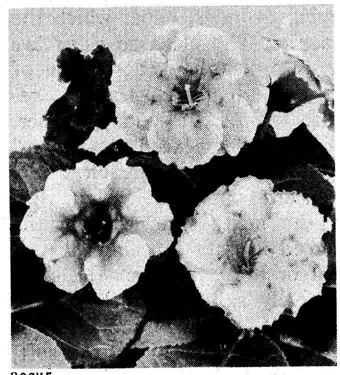
Located within 10 mi. of the New York State Barge canal, the New York State thruway and the New York Central railroad, Gloversville became a wholesale and retail distribution centre. It was called Stump City until 1828. Incorporated as a village in 1851, it became a city in 1890. For comparative population figures of both cities *see* table in NEW YORK: *Population.* (H. S. PR.)

GLOWWORM, a name chiefly applied to larviform, light-giving females of certain species of beetles of the families Lampyridae. Phengodidae and Drilidae. The best-known glowworm is the female of *Lampyris noctiluca* (fam. Lampyridae), a widespread European and Siberian insect, whose ability to emit a greenish-white light has been familiar for centuries. The light given out by the wingless female is believed to attract the flying male, ahose light organs are rudimentary. *Microphotus angustus* is a similar North American species. Many species of Lampyridae are knonn in which both sexes are luminous and winged; these are generally known as "fireflies" (*q.v.*).

The most remarkable glowworm is the female of a South American species of *Phrixothrix* (fam. Drilidae), which emits both red and greenish-yellow light, either simultaneously or independently; the red light emanates from the head, the green from a series of luminescent organs along the sides of the abdomen. The luminous larva of a New Zealand crane fly, *Bolitophila luminosa* (fam. Tipulidae, order Diptera) is knonn as glowworm. Certain luminous centipedes (fam. Geophilidae) are sometimes mistaken for glowworms.

See BEETLE. (R. L. WL.)

GLOXINIA. the common name for a plant botanically classified as *Sinningia speciosa,* belongs to the Gesneriaceae (*q.v.*) family and is a native of Brazil. The plants grow eight to ten inches in height and produce large tubular flowers surrounded by attractive foliage of a soft, velvety texture. The blooms of this well-known plant are characterized by the richness and variety of colouring, which ranges through all shades of blue and purple, pink and crimson and white. After blooming they need a rest period. The preferred method of propagation is by seed but choice varieties can be increased by cuttings of medium-sized leaves with a small portion of the stem attached.



ROCHE

HYBRID GLOXINIAS

(R. T. V. T.)

GLOZEL, a hamlet in France, about 12½ mi. southeast of Vichy, *département* of Allier. On March 1, 1924, the son of a local farmer named Fradin discovered the remains of a glass furnace of some antiquity of a type not uncommon in that region. In April 1925 Dr. Morlet, in consulting practice at Vichy, got into touch with Fradin, whose excavations continued. These included three bricks engraved before baking with alphabetic form signs, and the complete apparatus of a glass manufactory. Details were published by Dr. Morlet and Fradin. By 1926 twenty-one inscribed tablets had been found. Nine further tablets with new characters were found. In August 1926 M. Salomon Reinach, the distinguished scholar, visited Glozel and gave the weight of his authority in support of the authenticity of the objects thus discovered.

The attention of the learned world was drawn to Glozel by a letter from M. Reinach published in the London *Times.* He pointed out that the discoveries included objects akin to the Neolithic cultures of the Aegean, one of them being an idol in the shape of a violin, inscriptions closely related to those found in 1894 in an early Portuguese dolman and numerous engravings of animals on pebbles, in a degenerate Magdalenian style. Obviously, the most surprising objects were the inscribed clay tablets. If genuine and if datable to a remote period, many theories of the origin of the alphabet would need revision and the whole question of the content and scope of Neolithic civilization would have to be considered. It is the peculiar virtue of archaeology that it offers us from time to time discoveries which produce a revolution of hypotheses based on earlier, less accurate, less ample, data. Every science, too, demands periodic revision of its fundamental hypotheses. It is necessary, therefore, that discoveries of this nature should be completely free from doubt in order that their value as keys to accurate knowledge may be utilised.

The authenticity of these discoveries was criticised by the Abbe Breuil in *Anthropologie* xxxvi. 1926, pp. 543–558. Reinach contributed an article to *The Antiquary's Journal* supporting his views. In June, 1927, Mr. O. G. S. Crawford, the editor of *Antiquity* published an article in which, profiting by a visit to Glozel, he concluded that the majority of the objects were certainly forgeries. Some there were which, in his opinion, were genuine antiquities though not prehistoric and his emphatic opinion is that the inscriptions, engravings and the majority of the other finds are forgeries and that those who believe in their authenticity have been the victims of a hoax (*Antiquity* March and June, 1927). In September 1927 the International Institute of Anthropology at its meeting in Amsterdam appointed a Commission to visit Glozel to examine the site and the objects found therein and to pronounce their opinion upon the authenticity of the discoveries.

By this time the French government had taken official action to recognize the site as one of scientific importance meriting the protection of the law. The Commission consisted of eight members from Spain, France, Alsace, Great Britain, Belgium, Switzerland and Czecho Slovakia, one of whom was unable to take part in its investigations and deliberations. In November 1927 the Commission visited Glozel, examined and tested the site and the objects already found and reported unanimously the antiquity of the material discovered at Glozel had not been proved. It was admitted that authentic material of an early date may have been introduced by natural methods. In a series of articles in the *Mercure de France* Dr. Morlet maintained the authenticity of the discoveries, hotly repudiated the suggestion that the scientific world had been hoaxed, and vigorously criticized the methods and findings of the Commission. A remarkable degree of acrimony characterizes the controversy which has arisen and reference to the Law Courts has been made.

See Revue Anthropologique, Supplement No. 10–12, 1927.

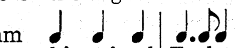
GLUCINUM, an alternative name for the metal beryllium (*q.v.*). When L. N. Vauquelin in 1798 published in the *Annales de chimie* an account of a new earth obtained by him from beryl he refrained from giving the substance a name, but in a note to his paper the editors suggested glucine, from γλυκύς, sweet, in reference to the alleged taste of its salts, whence the name glucinum or glucinium (symbol Gl. or sometimes G).

GLUCK, CHRISTOPH WILLIBALD (1714–1787), operatic composer, German by birth, French by his place in art, was born at Weidenwang, near Neumarkt, in the upper Palatinate, on July 2, 1714. His father was gamekeeper to Prince Lobkowitz; and from his 12th to his 18th year he received a good general education, including music lessons, at the Jesuit school of Kommatan, near Prince Lobkowitz's estate in Bohemia. At the age of 18 he went to Prague, where he studied under Czernohorsky, and maintained himself by hand-to-mouth musical jobs, sometimes at village fairs and dances. Prince Lobkowitz introduced him to the best families of the Austrian nobility; and when in 1736 he proceeded to Vienna he was hospitably received at his protector's palace. Here he met Prince Melzi, an ardent lover of music, whom he accompanied to Milan, continuing his education under Giovanni Battista San Martini (or Sammartini), a great musical historian and contrapuntist, whose al fresco style of chamber-music was an important if unconscious step towards the dramatic orchestration of the future. Gluck soon becomes a fluent writer, producing nine operas at various Italian theatres between 1741 and 1745. Unimportant as they are in the light of his mature art, they were so well received that in 1745 he was invited to London to compose for the Haymarket, where he produced *La Caduta dei giganti* and followed it by a revised version of an earlier opera. He also appeared in London as a performer on the musical glasses (*see* HARMONICA).

The poor success of his two operas, as well as that of a *pasticcio* entitled *Piramo e Tisbe,* shortened his London visit. But his stay in England was not without important consequences for his future. Gluck at this time was rather less than an ordinary producer of Italian opera. Handel said that Gluck "knows no more counterpoint than my cook," which was probably true, seeing that that cook was an excellent bass singer who performed in many of Handel's own operas. Musical cookery demands more counterpoint than Gluck ever mastered; and, if Gluck did not as yet see any connection between counterpoint and drama, he learnt much from the surprising discovery that arias which in their original setting had been much applauded lost all effect when adapted to new words in the *pasticcio.* Handel's criticism was by no means irrelevant. The use of counterpoint is independent of contrapuntal display; its real and final cause is a certain depth of harmonic expression which Gluck attained only in his most inspired moments, and for want of which many of his subtle details are dangerously like oversights. And in later years his own mature view of the importance of harmony, which he upheld in long arguments with Grétry, who believed only in melody, shows that he knew that the dramatic expression of music must strike below the surface. At this early period he was simply producing operas on Handel's, or rather Hasse's lines without a sign of mastery. Yet the failure of his *pasticcio* is profoundly significant, since it shows that already the effect of his music depended upon its characteristic treatment of dramatic situations. This characterizing power was as yet only thus indirectly evident, and the art of music needed all the new resources of the rising sonata-forms (*q.v.*) before it could break through its architectural and decorative restraints and enter into dramatic regions at all.

The chamber music of Sammartini had already indicated to Gluck a style incompatible with the older art, and a short trip to Paris brought him into contact with the classic traditions and the declamatory style of the French opera — things which an intelligent prophet might have foreseen to be of immense importance to a pupil of Sammartini. Little change, however, is to be found in the works produced by Gluck with varying success during the 15 years after his return from England. His first opera written for Vienna, La *Semiramide riconosciuta,* is again a fashionable opera seria, and little more can be said of *Telemacco,* although 30 years later Gluck was able to use most of its overture and an energetic duet in one of his greatest works, *Armide,* and to adapt another number to the sublime purposes of a still greater work, *Iphigknie en Tauride.*

Gluck settled permanently at Vienna in 1756, having two years previously been appointed court chapel-master, with a salary of 2,000 florins, by the empress Maria Theresa. He had already received the order of knighthood from the pope after the success of two of his works in Rome. During the long interval from 1756 to 1762 Gluck seems to have been meditating his plans for the reform of the opera, producing little more than the ballet *Don Giovanni* and some French *airs nouveaux* with pianoforte. Several later *pieces d'occasion,* such as *Il Trinofo di Clelia* (1763), are still written in the old manner. But already in 1762 *Orfeo ed Euridice* had revolutionized the whole art of music. Gluck had for the first time deserted Metastasio for Raniero Calzabigi, who, as Vernon Lee suggests, was in all probability the immediate cause of the formation of Gluck's new ideas. He was a hot-headed dramatic theorist with a violent dislike for Metastasio, who had hitherto dominated the whole sphere of operatic libretto. Calzabigi reduced the operatic scheme from a complicated plot designed for working in three arias in each act for each of seven expensive singers, to the simplest possible means of expressing and concentrating the obvious emotions aroused by a classical myth.

In *Orfeo* there are only three characters besides the chorus. The chorus itself has to play a different part in each scene; human mourners in the first act; Furies in the first part of the second act, Elysian shades in the second part, and a rejoicing human crowd when, as in Monteverde's pioneer work of 150 years earlier, the pathos of the story becomes intolerable to the poet, the composer, and the audience, so that Eurydice has to be galvanized back into life and received with Orpheus and the thaumaturgic Amor by a triumphant chorus and a long series of ballets. For the rest, the pathos of the music is among the greater experiences of the art. Even in the first act, which is occupied, until the sudden entry of Eros (Amor), entirely with the chorus of mourners and the lament of Orpheus at Eurydice's tomb, there is no feeling of monotony, no lack of dramatic power, and no lapse from the highest activity of the composer's imagination. Nothing like it had been dreamt of before, and one of its most interesting features is that it is neither histrionic nor realistic. The echoes of Orpheus's cadences by a cor anglais behind the scene are sheer gratuitous poetry as far transcending real echoes as Shelley's skylark transcends a real bird. The central feature of *Orfeo* is, of course, his conquest of the Furies who would bar his way to Eurydice. Gluck lived to master more complex situations, but neither he nor anyone else ever achieved, even with Wagner's resources, a more perfect and touching piece of music-drama. From the cavernous reverberations of the first chords of the orchestra, interrupted by the approaching sounds of Orpheus's harp, to the last subdued assent of the vanquished Furies, the dramatic and musical power are of the highest order. The Furies sing throughout in the rhythm 

until they are reduced to interrupting Orpheus's gathering flow of melody by "No:—No," at first thunderous, then softer. For the later productions in Paris, Gluck had to rewrite the castrato-alto part of Orpheus for a tenor, with transpositions ruinous to the key-system of the whole; but this did not impair the wonderful power of Orpheus's declamation. The inspiration is fully maintained in the following Elysian scene, an even greater test of the composer's depth of feeling.

No surprise should be felt that Orpheus was followed by work of no importance. Even reformers of opera must live; and Gluck's five great reform-operas were enough to occupy him but not enough to support him for the remaining 25 years of his life. Besides, he constantly drew upon his inferior works for whole movements in his greatest. In 1767 Gluck and Calzabigi followed up *Orfeo* by a similar work on a larger scale. Gluck's dedication of the score to the grand-duke of Tuscany is the Magna Charta of opera. "I have tried," he wrote, "to reduce music to its real function, that of seconding poetry by intensifying the expression of sentiments and the interest of situations without interrupting the action by needless ornament. I have accordingly taken care not to interrupt the singer in the heat of the dialogue, to wait for a tedious ritornel, nor do I allow him to stop on a sonorous vowel, in the middle of a phrase, in order to show the nimbleness of a beautiful voice in a long cadenza." Less obvious and far more important is his principle that the orchestral instruments shall be "combined in accordance with the passions represented," an epitome of the whole difference between symphonic (or dramatic) orchestration and the decorative schemes of the continuo period. (*See* CHAMBER MUSIC and INSTRUMENTATION.)

Vienna was no easy town to conquer by principles apparently so hostile to music for music's sake; and neither *Alceste* nor *Paris and Helena* (1769) was received as cordially as Gluck had hoped. He therefore eagerly accepted the chance of bringing his art into contact with the encyclopaedists and dramaturgists of Paris, where his enthusiastic admirer, the *bailli* Le Blanc du Roullet, attaché of the French embassy at Vienna, set in motion the project of an opera for the Paris stage. Racine's *Iphigénie en Aulide* was the subject chosen. Obstacles, usual and unusual, were removed chiefly by the intervention of Gluck's former pupil, the dauphiness Marie Antoinette, and the opera was eventually performed at the Académie de Musique, on April 19, 1774.

Heated controversy immediately emphasized the importance of the new work, both in its musical and in its literary aspects. At first the upholders of French music were no more favourable to Gluck than the connoisseurs of Italian singing; they forgot that Lulli was no more a Frenchman than Gluck, and they could see only that Gluck was no Rameau. Marmontel, La Harpe and D'Alembert were his opponents, the Abbé Arnaud and others his enthusiastic friends. Rousseau had the sense to change his mind. Beginning as a violent partisan of Italian music, when Gluck himself asserted the merits and possibilities of French music, he acknowledged his genius, although he did not always understand it, as for example when he suggested that in *Alceste,* "Divinités du Styx," perhaps the most majestic of all Gluck's arias, ought to have been set as a rondo. But in a letter, written shortly before his death, to Dr. Burney, Rousseau gives a close and appreciative analysis of *Alceste,* the first Italian version of which Gluck had submitted to him for suggestions; and when after the first performance of the French version the composer exclaimed, *"Alceste est tombée,"* Rousseau replied, *"Oui, mais elle est tombée du ciel."*

The contest turned to fresh issues when Piccinni, a celebrated and by no means incapable composer, came to Paris as the champion of the Italian party at the invitation of Madame du Barry, who held a rival court to that of the young princess (*see* OPERA). It is a mistake to see in the war of Gluckists and Piccinnists a foreshadowing of the Wagnerian controversy; the issues were merely those of cliques, and anybody who has the patience to read Piccinni's music will be amused at his pathetic attempts to copy Gluck in every point where public applause had justified the shocking risks Gluck was always taking. Gluck was by far the better musician, but contemporaries could see the weaknesses of his technique as easily as they could see the vaguely different weaknesses of Piccinni's. Gluck's gift of melody was sublime, and Piccinni's was by no means contemptible; and both composers had the gift of making incorrect music sound agreeable. Gluck's indisputable dramatic power did not concern upholders of music for music's sake, and was no ground of opposition to the Piccinnists as far as they could understand it. The rivalry between the two composers was soon skilfully engineered into a quarrel. In 1777 Piccinni was given a libretto by Marmontel on the subject of *Roland,* to Gluck's intense disgust, as he had already begun an opera on that subject himself. This, and the failure of attempts in a lighter style furbished up from earlier works at the instigation of Marie Antoinette, inspired Gluck to produce his *Armide,* which appeared four months before Piccinni's *Roland* was ready, and raised a storm of controversy, admiration and abuse. Gluck did not anticipate Wagner more clearly in his dramatic reforms than in his caustic temper; and, as in Gluck's own estimation, the difference between *Armide* and *Alceste* is that "l'un (Alceste) doit faire pleurer et l'autre faire éprouver une voluptueuse sensation," it was extremely annoying for him to be told by Laharpe that he had made Armide a sorceress instead of an enchantress, and that her part was "une criaillerie monotone et fatiguante." He replied to Laharpe in a long public letter worthy of Wagner in its venom and its effect in immortalizing its recipient.

Gluck's next work was *Iphigénie en Tauride,* the success of which finally disposed of Piccinni, who produced a work on the same subject at the same time and who is said to have acknowledged Gluck's victory. It was followed by *Echo et Narcisse,* the comparative failure of which greatly disappointed Gluck; and during the composition of another opera, *Les Danaïdes,* an attack of apoplexy compelled him to give up work. He left Paris for Vienna, where he lived for several years in dignified leisure, disturbed only by failing health which ended in his death on Nov. 15, 1787. Burney gives a charming account of a day with Gluck, whom he visited in the same week as he visited Metastasio.

The dramatic importance of Gluck's reforms is apt both to overshadow and to idealize his merit as a musician. Where Gluck differs from the greatest musicians is in his absolute dependence on literature for his inspiration. Where his librettist failed him (as often in his last complete work, *Écho et Narcisse*), he had no first-rate routine to lean upon; and, even in the finest works of his French period, the less emotional situations are sometimes set to music which has little but historic interest. A mere inability to set a bad text to good music might be a sign rather of good literary sense than of poor musicianship. But it points to a certain weakness as a musician that Gluck could not be inspired except by the more emotional features of his libretti. When he was inspired he was unquestionably the first and only essentially dramatic composer before Mozart, except the miraculous and untimely born Purcell.

To begin with, he could invent sublime melodies; and his power of producing great musical effects by the simplest means was nothing short of Handelian. Moreover, if Haydn is the father of modern orchestration, the writer of the preface to *Alceste* is its godfather. He was by no means the first to use the timbre of instruments with a sense of emotional effect, for Bach and Handel well knew how to give a whole aria or whole chorus an appropriate tone by means of a definite scheme of instrumentation. But it is just such definite schemes that impeded the progress of music-drama. Gluck did not treat instruments as part of a decorative design, any more than he so treated musical forms. His instrumentation changes with every shade of feeling in the dramatic situation. Strings, oboes and flutes were an ordinary accompaniment for an aria; nor was there anything unusual in making the wind instruments play in unison with the strings for the first part of the aria, and writing a passage for one or more of them in the middle section. But it was an unheard-of thing to make this passage consist of isolated long appoggiaturas once every two bars in rising sequence on the first oboe, answered by deep pizzicato bass notes, while Agamemnon in despair cries: "J'entends retentir dans mon sein le cri plaintif de la nature." Gluck is a master of tragic irony and subconscious confession. When, for instance, in *Iphigénie en Tauride*, Orestes gasps "Le calme rentre dans mon coeur," the agitated rhythms of the strings belie him. Again, the power of orchestral climax shown in the oracle scene in *Alceste* was a thing inconceivable in older music and on that plane of absolute masterpieces that no later music can supersede. Its influence in Mozart's *Idomeneo* is obvious at a first glance.

The capacity for broad melody always implies a true sense of form, whether that be developed by skill or not; and Gluck's form is inspired not merely by melody but by a magnificent sense of free phrase-rhythm, worthy of the mature sonata-style of Mozart. And his power in persistent quantitative rhythms is Wagnerian. Hence he had plenty of resource for replacing by better things the civilization he destroyed. Moreover he, in consultation with his librettist, achieved great skill in holding together entire scenes, or even entire acts, by dramatically apposite repetitions of short arias and choruses. And thus in large portions of his finest works the music, in spite of frequent full closes, seems to move *pari passu* with the drama in a manner which for naturalness and continuity is surpassed only by the finales of Mozart and the entire operas of Wagner. This continuity is most impressive in both scenes of the second act of *Orfeo*. The damage done to the key-system of these perfectly unified scenes by the Parisian transposition of Orpheus's part is, as previously noted, dreadful, but easily remedied by transposing Orpheus's part back again; and in a suitable compromise between the two versions *Orfeo* remains Gluck's most perfect and inspired work. The emotional power of the music is such that the ruin of the story by a happy ending is a real relief from tension: it is like the gesture of Shakespeare's last works. where we know all about the tragic issues and may as well dismiss them with fairy-tales. Moreover, Gluck's genius was of that high order which is as great in happiness as in grief. He failed only in the business capacities of artistic technique; and there is less business in *Orfeo* than in any other music-drama. It was Gluck's first great inspiration, and his theories had not had time to become doctrinaire, though Calzabigi was disposed to magnify his office.

Alceste contains Gluck's grandest music and is also very free from weak pages; but in its original Italian version the third act had no adequate climax. a defect wholly inadmissible in Paris, where, after continual retouchings a part for Hercules was. in Gluck's absence, added by Gossec; and three pages of Gluck's music. dealing with the supreme crisis where Alceste is rescued from Hades (either by Apollo or by Hercules) were no longer required in performance and have been lost. The Italian version cannot help us to restore this passage. in which Gluck's music now stops short just where we realize the full height of his power. The stiffness of Gossec's rhythm reveals the immense distance Gluck had traveiled from all contemporaries as well as from the old ways; and the comparison between the Italian and French *Alceste* measures the pace of Gluck's development between 1767 and 1775. It would have been far easier for Gluck to write a new opera if he had not been so justly attached to his second Italian masterpiece. So radical are the differences that in retranslating the French libretto into Italian for performance with the French music not one line of Calzabigi's original text can be retained.

In *Iphigénie en Aulide* and *Iphige'nie en Tauride,* Gluck shows signs that the doctrinaire is beginning to gain on the spontaneous artist. This. at least, is the general impression left in a reflective memory, though one indignantly denies it on renewing acquaintance with the works in performance. Gluck had not. in *Orfeo,* gone out of his way to avoid rondos, or we should have had no "Che farò senza Euridice." We read with a respectful smile his assurance to the *bailli* Le Blanc du Roullet that "you would not believe *Armide* to be by the same composer" as *Alceste*. But there is no question that *Armide* is a very great work, full of melody, colour and dramatic point; and that Gluck has availed himself of every suggestion that his libretto afforded for orchestral and emotional effects of type almost entirely new to him. He has been absurdly blamed for his inability to write erotic music. The intention of the work is no more erotic than that of Tasso's *Gierusalemme liberata.* Love is *a* baleful enchantment, viewed through the eyes of crusading knights. Even so, the conflict of passions, where Armide summons the demons of Hate to exorcise love from her heart, and her courage fails her as soon as they begin, has never, even in *Alceste,* been treated with more dramatic musical power. The work as a whole is unequal, partly because Quinault's go-year-old poem had far too much action in it to suit Gluck's methods, but it shows, as does no other opera until Mozart's *Don Giovanni,* a sense of the *development* of characters, as distinguished from the mere presentation of them as fixed types.

In *Iphigénie en Aulide* and *Iphigénie en Tauride,* the very subtlety of the finest features reveals a self-consciousness which, when inspiration is lacking, becomes mannerism. Moreover, in both cases the libretti, though skilfully derived from Racine and Corneille, are more complicated than those of Gluck's first masterpieces; and where inspiration fails, the awkward technique has lost its earlier naïveté. Still, these works are immortal, and their greatest passages are equal to anything in *Alceste* and *Orfeo.* *Iphigénie en Tauride* is indeed, as realized by Gluck, an amazingly spiritual work to find its way to the operatic stage and prove itself so effective there. We must agree with Gluck's contemporaries to call *Echo et Narcisse* a failure. As in *Orjeo,* the pathetic story is ruined by a violent happy ending, but here this artistic disaster takes place before the pathos has begun to move us. Prettiness was the highest possibility of the subject; and with Gluck beauty, without emotional impulses, was less than skin-deep The great Pelletan-Damcke *édition de luxe* of Gluck's French operas includes this work, gives only the French version of *Orphée,* and excludes *Paride e Elena* which was never given in Paris. A modern full score of *Paride e Elena* is a desideratum to complete the study of Gluck's work with Calzabigi, to whom he owed more than he owed to France. Perhaps this may be given in the miniature scores inaugurated in 1927 by that of *Iphigénie en Tauride* with an excellent preface and critical revision by H. Abert (Eulenburg). (D. F. T.)

GLÜCKSBURG, a town of Germany, in the Prussian province of Schleswig-Holstein, on the Flensburg Fjord, 6 m. N.E. from Flensburg by rail. Pop. (1933) 1,792. It is a sea-bathing resort. The castle occupies the site of a former Cistercian monastery.

GLÜCKSTADT, a town of Germany, in the Prussian province of Schleswig-Holstein, on the right bank of the Elbe, 28 m. N.W. of Altona, by rail. Pop (1933) 6,839. It was founded by Christian IV. of Denmark in 1617, fortified in 1620, and soon became an important trading centre. In 1627–28 it was besieged unsuccessfully by the Imperialists under Tilly. In 1814 it was blockaded and its fortifications were demolished. In 1830 it was made a free port. It came into the possession of Prussia with the rest of Schleswig-Holstein in 1866.

The inhabitants are chiefly engaged in herring fishery, but have suffered frequent losses from inundations.

GLUCOSE: see CARBOHYDRATES.

GLUCOSIDES: see GLYCOSIDES, NATURAL.

GLUE, a valuable agglutinant, consisting of impure gelatin and widely used as an adhesive medium for wood, leather, paper and similar substances. Glues and gelatins merge into one another by imperceptible degrees. The difference is conditioned by the degree of purity; the more impure form is termed glue and is only used as an adhesive, the purer forms, termed gelatin, have other applications, especially in culinary operations and confectionery. (*See* GELATIN.) It is only necessary to state here that gelatigenous or glue-forming tissues occur in the bones, skins and intestines of all animals, and that by extraction with hot water these agglutinating materials are removed, and the solution on evaporating and cooling yields a jellylike substance—gelatin or glue. Glues may be most conveniently classified according to their sources: bone glue, skin glue and fish glue; these may be regarded as impure forms of bone gelatin, skin gelatin and isinglass.

Bone Glue.—For the manufacture of glue the bones are supplied fresh or after having been used for making soups; Indian and South American bones are unsuitable, since, by reason of their previous treatment with steam, both their fatty and glue-forming constituents have been already removed (to a great extent). On the average, fresh bones contain about 50% of mineral matter, mainly calcium and niagnesium phosphates, about 12% each of moisture and fat, the remainder being other organic matter. The mineral matter reappears in commerce chiefly as artificial manure; the fat is employed in the candle, soap and glycerin industries, while the other organic matter supplies glue.

The separation of the fat, or "degreasing of the bones," is effected (1) by boiling the bones with water in open vessels; (2) by treatment with steam under pressure; or (3) by means of solvents. The last process is superseding the first two, which give a poor return of fat—a valuable consideration—and also involve the loss of a certain amount of glue. Many solvents have been proposed; the greatest commercial success appears to attend Scottish shale oil and natural petroleum (Russian or American) boiling at about 100° C. The vessels in which the extraction is carried out consist of upright cylindrical boilers, provided with manholes for charging, a false bottom on which the bones rest; and with two steam coils—one for heating only, the other for leading in live steam. There is a pipe from the top of the vessel leading to a condensing plant. The vessels are arranged in batteries. In the actual operation the boiler is charged with bones, solvent is run in, and the mixture gradually heated by means of the dry coil; the spirit distils over, carrying with it the water present in the bones; and aiter a time the extracted fat is run off from discharge cocks in the bottom of the extractor. A fresh charge of solvent is introduced, and the cycle repeated; this is repeated a third and fourth time, after which the bones contain only about 0 2% of fat, and a little of the solvent, which is removed by blowing in live steam under 70 to 80 lb. pressure. The degreased bones are now cleansed from all dirt and flesh by rotation in a horizontal cylindrical drum covered with stout wire gauze. The attrition accompanying this motion suffices to remove the loosely adherent matter, which falls through the meshes of the gauze; this meal contains a certain amount of glue-forming matter, and is generally passed through a finer mesh, the residuum being worked up in the glue house, and the flour which passes through being sold as a bone meal, or used as a manure.

The bones, which now contain 5% to 6% of glue-forming nitrogen and about 60% of calcium phosphate, are next treated for glue. The most economical process consists in steaming the bones under pressure (1j lb. to start with, afterward 5 Ib.) in upright cylindrical boilers fitted with false bottoms. The glue liquors collect beneath the ialse bottoms, and when of a strength equal to about 20% dry glue they are run off to the clarifiers. The first runnings contain about 65% to 70% of the total glue; a second steaming extracts another 25% to 30%. For clarifying the solutions ordinary alum is used, one part being used for 200 parts of dry glue.

The clear liquors are now concentrated to a strength of about 32% dry glue in winter and 35% in summer. This is invariably effected in vacuum pans—open boiling yields a dark-coloured and inferior product. Many types of vacuum plant are in use; the Yaryan form, invented by H. T. Yaryan, is perhaps the best, and the double effect system is the most efficient. After concentration the liquors are bleached by blowing in sulphur dioxide, manufactured by burning sulphur; by this means the colour can be lightened to any desired degree. The liquors are now run into galvanized sheet-iron troughs, 2 ft. long, 6 in. wide and 5 in. deep, where they congeal to a firm jelly, which is subsequently removed by cutting round the edges. or by warming with hot water, and turning the cake out. The cake is sliced to sheets of convenient thickness, generally by means of a wire knife; *i.e.*, a piece of wire placed in a frame. Mechanical slicers acting on this principle are in use. Instead of allowing the solution to congeal in troughs, it may be "cast" on sheets of glass, the bottoms of which are cooled by running water. After congealing, the tremulous jelly is dried; this is an operation of great nicety: the desiccation must be slow and is generally effected by circulating a rapid current of air about the cakes supported on nets set in frames.

Skin Glue.—In the preparation of skin glue the materials used are the parings and cuttings of hides from tan yards, the ears of oxen and sheep, the skins of rabbits, hares, cats, dogs and other animals, the parings of tawed leather, parchment and old gloves and many other miscellaneous scraps of animal matter. Much experience is needed 'in order to prepare a good glue from such heterogeneous materials; one blending may be a success and another failure. The raw material or stock is first steeped for from two to ten weeks, according to its nature, in wooden vats or pits with limewater, and afterward carefully dried and stored. The object of the lime steeping is to remove any blood and flesh which may be attached to the skin, and to form a lime soap with the fatty matter present. The "scrows" or glue pieces, which may be kept a long time without undergoing change, are washed with a dilute hydrochloric acid to remove all lime, and then very thoroughly with water; they are now allowed to drain and dry. The skins are then placed in hemp nets and introduced into an open boiler which has a false bottom, and a tap by which liquid may be run off. As the boiling proceeds test quantities of liquid are from time to time examined, and when a sample is found on cooling to form a stiff jelly, which happens when it contains about 32% dry glue, it is ready to draw off. The solution is then run to a clarifier, in which a temperature sufficient to keep it fluid is maintained, and in this way any impurity is permitted to subside. The glue solution is then run into wooden troughs or coolers in which it sets to a firm jelly. The cakes are removed as in the case of bone glue (see above), and, having been placed on nets, are, in the Scottish practice, dried by exposure to open air. This primitive method has many disadvantages: on a hot day the cake may become unshapely, or melt and slip through the net, or dry so rapidly as to crack; a frost may produce fissures, while a fog or mist may precipitate moisture on the surface and occasion a mouldy appearance. The surface of the cake, which is generally dull after drying. is polished by washing with water. The practice of boiling, clarification, cooling and drying, which has been already described in the case of bone glue, has been also applied to the separation of skin glue.

Fish **Glue.**—Whereas isinglass, a very pure gelatin. is yielded by the sounds of a limited number of fish, it is found that all fish offals yield a glue possessing considerable adhesive properties. The manufacture consists in thoroughly washing the offal with water and then discharging it into extractors with live steam. After digestion, the liquid is run off, allowed to stand, the upper oily layer removed and the lower gluey solution clarified with alum. The liquid is then filtered, concentrated in open vats and bleached with sulphur dioxide. Fish glue is a light-brown viscous liquid which has a distinctly disagreeable odour and an acrid taste; these disadvantages to its use are avoided if it is boiled with a little water and 1% of sodium phosphate, and 0.025% of saccharine added.

Properties of **Glue.**—A good quality of glue should be free from all specks and grit, have a uniform, light brownish-yellow, transparent appearance, and should break with a glassy fracture. Steeped for some time in cold water it softens and swells up without dissolving, and when again dried it ought to resume its original properties. Under the influence of heat it entirely dissolves in water, forming a thin syrupy fluid with a not disagreeable smell. The adhesiveness of different qualities of glue varies considerably; the best adhesive is formed by steeping the glue, broken in small pieces, in water until they are quite soft, and then placing them with just sufficient water to effect solution in the gluepot. The hotter the glue, the better the joint; remelted glue is not so strong as the freshly prepared; and newly manufactured glue is inferior to that which has been long in stock. A well-prepared joint may withstand a pull of about 700 lb. per square inch. The following table, after Kilmarsch, shows the holding power of glued joints with various kinds of woods.

Wood	Pounds per square inch With grain	Pounds per square inch Across grain
Beech	852	434.5
Maple	484	346
Oak	704	302
Fir	605	132

Special Glues, Cements, **etc.**—By virtue of the fact that the word glue is frequently used to denote many adhesives, which may or may not contain gelatin, there will now be given an account of some special preparations. These may be conveniently divided into: (1) liquid glues, mixtures containing gelatin which do not jelly at ordinary temperatures but still possess adhesive properties; (2) waterproof glues, including mixtures containing gelatin, and also the "marine glues," which contain no glue; (3) glues or cements for special purposes, *e.g.*, for cementing glass, pottery, leather, etc., for cementing dissimilar materials, such as paper or leather to iron.

Liquid Glues.—The demand for liquid glues is mainly due to the disadvantages—the necessity of dissolving and using while hot--of ordinary glue. They are generally prepared by adding to a warm glue solution a reagent which destroys the property of gelatinizing. The reagents in common use are acetic acid; magnesium chloride, used for a glue employed by printers; hydrochloric acid and zinc sulphate; nitric acid and lead sulphate; and phosphoric acid and ammonium carbonate.

Waterproof Glues.—Numerous recipes for waterproof glues have been published; glue, having been swollen by soaking in water, dissolved in four-fifths its weight of linseed oil, furnishes a good waterproof adhesive; linseed oil varnish and litharge, added to a glue solution, is also used; resin added to a hot glue solution in water and afterward diluted with turpentine is another recipe. The best glue is said to be obtained by dissolving one part of glue in one and a half parts of water, and then adding one-fiftieth part of potassium bichromate. Alcoholic solutions of various gums, and also tannic acid, confer the same property on glue solutions. The "marine glues" are solutions of India rubber, shellac or asphaltum, or mixtures of these substances, in benzene or naphtha. Jeffrey's marine glue is formed by dissolving India rubber in four parts of benzene and adding two parts of shellac; it is extensively used, being easily applied and drying rapidly and hard. Another waterproof glue which contains no gelatin is obtained by heating linseed oil with five parts of quicklime; when cold it forms a hard mass, which melts on heating.

There are innumerable recipes for adhesives specially applicable to certain substances and under certain conditions. For repairing glass, ivory, etc., isinglass (*q.v.*), which may be replaced by fine glue, yields valuable cements. Bookbinders employ an elastic glue obtained from an ordinary glue solution and glycerin, the water being expelled by heating; an efficient cement for mounting photographs is obtained by dissolving glue in ten parts of alcohol and adding one part of glycerin; portable or mouth glue—so named because it melts in the mouth—is prepared by dissolving one part of sugar in a solution of four parts of glue. An India rubber substitute is obtained by adding sodium tungstate and hydrochloric acid to a strong glue solution.

See Thomas Lambert. *Glue, Gelatine and Their Allied Products* (1905); *R. L.* Fernbach, *Glues and Gelatine* (1907); *H. C.* Standage, *Agglutinants of all Kinds for all Purposes* (1907).

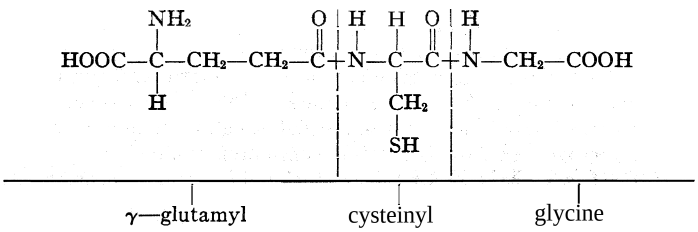
GLUTATHIONE is a sulfur-containing substance found within almost all kinds of living cells. It can protect an animal against radiation damage to some extent, if large dosages are administered almost simultaneously with exposure to radiation. This protective action may be associated with the ready reaction of glutathione with the peroxides that are formed on irradiation of the tissues.

Liver and yeast are particularly rich in glutathione. which may reach a concentration in tissues as high as 0.1 or 0.2%. Because of the expense of its chemical synthesis. glutathione is generally obtained by isolation from natural sources. When purified, it is usually obtained as a white, amorphous solid, which is exceedingly soluble in water.

The physiological function of glutathione has been investigated extensively since the discovery of the compound in 1921 by Sir Frederick Gowland Hopkins of Cambridge university. Great interest has centred on the fact that glutathione can affect the activity of a variety of enzymes, which are essential for the normal operation of any living cell. The activating effect of glutathione on enzymes is associated with the chemical action of the sulfur group. In glutathione, the sulfur normally is present in a reduced or sulfhydryl (-SH) form.

Enzymes also contain sulfhydryl groups, and often are inactivated by oxidation of these -SH groups to the disulfide (-SS-) form. Glutathione reacts with these -SS- groups to regenerate the -SH groups of the enzyme. The reaction involves a simultaneous conversion of the -SH groups of glutathione to -SS- groups, which are in turn reconverted to the -SH form by the action of an enzyme known as glutathione reductase. Thus, by a cyclic chemical process, the glutathione operates as an agent controlling the activity of enzymes within the cell.

The chemical name of glutathione, y-glutamyl-cysteinyl-glycine, indicates that it is made up of three amino acids, linked together as shown in the structural formula:



The bonds between the amino acids are known as peptide bonds. Glutathione is structurally related to proteins, which, however, have a greater molecular size because they contain many more amino acids. Because of the chemical similarity of glutathione to proteins, the biological synthesis of glutathione has been studied as a simple model for protein synthesis The latter process underlies the processes of growth and differentiation of all living cells, and thus constitutes one of the most fundamental biological problems.

See also ENZYMES; PROTEINS. (B. V.)

GLUTEN, a tough, tenacious, ductile, somewhat elastic, nearly tasteless, grayish-yellow albuminous substance, obtained from the flour of wheat by washing in water, in which it is insoluble. Gluten, when dried, loses about two-thirds of its weight, becoming brittle and semitransparent; when strongly heated it crackles and swells, and burns like feather or horn. It is soluble in strong acetic acid, and in caustic alkalis, which latter may be used for the purification of starch in which it is present. When treated with .1% to .2% solution of hydrochloric acid it swells up, and at length forms a liquid resembling a solution of albumin, and levorotatory as regards polarized light. Moistened with water and exposed to the air, gluten putrefies and evoives carbon dioxide, hydrogen and sulfuretted hydrogen. and in the end is almost entirely resolved into a liquid, which contains ieucin and ammonium phosphate and acetate. On analysis, gluten shows a composition of about 53% of carbon, 7% of hydrogen, and nitrogen 15% to 18%, besides oxygen, about 1% of sulfur and a small quantity of inorganic matter. According to H. Ritthausen, it is a mixture of glutencasein (Liebig's vegetable fibrin), glutenfibrin, gliadin (Pflanzenleim), glutin or vegetable gelatin and mucedin, which are all closely allied to one another in chemical composition. It is the gliadin which confers upon gluten its capacity of cohering to form elastic masses, and of separating readily from associated starch. In the so-called gluten of the flour of barley, rye and maize, this body is absent (H. Ritthausen and U. Kreusler). The gluten yielded by wheat which has undergone fermentation or has begun to sprout is devoid of toughness and elasticity. These qualities can be restored to it by kneading with salt, limewater or alum. Gluten is employed in the manufacture of gluten bread and biscuits for the diabetic, and of chocolate. and also in the adulteration of tea and coffee. For making bread it must be used fresh, as otherwise it decomposes and does not knead well. Granulated gluten is a kind of vermicelli, made in some starch manufactories by mixing fresh gluten with twice its weight of flour.

GLUTTON or WOLVERINE (*Gulo gulo*), a carnivorous mammal of the weasel family, Mustelidae (see CARNIVORA). The legs are short, the feet large, the claws sharp and curved and the tail thick and bushy. The fur, blackish-brown, with a broad band of chestnut on the sides of the body, consists of an undergrowth of short woollv hair, mixed with long, straight hairs, the latter giving it a shaggy appearance. Like all Mustelidae, the glutton possesses anal glands secreting a fetid-smelling, yellowish fluid. It inhabits the northern regions of the world, but is most abundant in arctic North America. A voracious animal, it feeds on small mammals, birds and carrion, and causes great annoyance to the trapper by robbing his traps of both bait and captives. Although inquisitive, the wolverine is both cunning and cautious. It has the habit of stealing and hiding all sorts of articles. The rutting season is in March, and the female brings forth four or five young in June or July, in defense of which she is exceedingly bold. It is nocturnal in habits, spending the day in its burrow. The fur is of some commercial value.

WOLVERINE (GULO GULO); IT BELONGS TO THE WEASEL FAMILY AND IS A COMMERCIAL FUR BEARER. BUT DESTROYS OTHER ANIMALS CAUGHT BY TRAPPERS

GLYCAS, MICHAEL, Byzantine historian (according to some a Sicilian, according to others a Corfiote), flourished during the 12th century A.D. His chief work is his *Chronicle* of events from the creation of the world to the death of Alexius I Comnenus (1118). Glycas was also the author of a treatise and a number of letters on theological questions. A poem of about 600 "political" verses, written during his imprisonment on a charge of slandering a neighbour and containing an appeal to the emperor Manuel, is still extant. The exact nature of his offense is not known, but the answer to his appeal was that he was deprived of his eyesight by the emperor's orders.

Editions: "Chronicle and Letters" in J. P. Migne, Patrologia Graeca, clviii; poem in E. Legrand, *Bibliothèque* grecque *vulgaire,* i; see also F. Hirsch, Byzantinische Studien (1876); C. Krumbacher in Sitzungsberichte *bayer.* Acad. (1894); C. F. Bahr in Ersch and Gruber, *Allgemeine* Encyklopadie.

GLYCERIDES: see OILS, FATS AND WAXES.

GLYCERIN, GLYCEROL (in pharmacy *Glycerinum*), is a trihydric alcohol, $C_3H_5(OH)_3$, which is a component part of all animal and vegetable fats and oils. A sweet, colourless, odourless, sirupy liquid in its pure state, it was discovered by Karl Wilhelm Scheele in 1779 and named *ölsüss*. Michel Chevreul, in working on fats in 1813, studied the substance further and gave it its present name (Gr. *glycus,* sweet). Theophile Pelouze (1836), Pierre Berthelot and others identified it chemically. Obtainable from fats and oils by saponification (see OILS, FATS AND WAXES), it also occurs widely in nature in combination with various acids in such substances as lecithin (eggs and various organs) and cephalin (brain, liver and other organs). It is customary to refer to the pure chemical product as glycerol, whereas the term glycerin denotes commercial grades with varying glycerol content.

Applications of Glycerin. — Applications fall into two distinct groups: (1) those arising from glycerin's physical properties: humectancy, viscosity, solvent power, nontoxicity, antifreeze properties and the like; (2) those arising from its three chemically reactive hydroxyl groups — used by nature in the structure of fats and oils (glycerides) and by industry for many derivatives. These range from explosive nitroglycerin (*q.v.*) to highly resistant resins.

Alkyd resins based on glycerin enter a wide range of protective coatings. The "short-oil" type is used in baking enamels for automotive and other machine finishes. "Long-oil" glycerin alkyds are used in brushing enamels and exterior house paints.

U.S. consumption of glycerin in the manufacture of alkyd resins was estimated in the late 1950s to exceed 70,000,000 lb. annually. Other major markets include explosives, tobacco (as a humectant), cellophane (as a plasticizer) and dentifrices. A highly diverse range of uses in the pharmaceutical and toilet goods field includes skin lotions, mouth washes, cough preparations, drug solvents, serums, vaccines and suppositories.

Growing application of mono- and di-glyceride emulsifiers — particularly in the food field — has led to increased use of glycerin in their manufacture. These derivatives act as softening agents in baked goods, plasticizers in shortening and stabilizers in ice cream. Another group of glycerol esters, the acetoglycerides, appear to have possibilities as protective food coatings.

Glycerin is no longer used in commercial quantities as an automotive antifreeze. However, many specialized applications for the antifreeze properties of glycerol solutions have been developed.

One of the most significant is its use as a protective medium for freezing red blood cells, sperm cells, eye corneas and other living tissue. For additional information on applications, see below, Commercial Grades.

.Physical Properties. — Pure glycerol has a molecular weight of 92.06. It has a specific gravity of 1.26j57 at 15° C., an average specific heat of 0.6469 in the range from 16° C. to 179° C.. a refractive index of 1.47399 at 20° C., a flash point of 174° C. and a melting point of 17.8° C. (although glycerin is seldom found in crystalline form). It boils at 290° C. with some decomposition at atmospheric pressure but is unchanged at diminished pressure (*e.g.,* 182°/20 mm. and 153.8°/5 mm.). It is miscible with water and alcohol in all proportions but less so with ether and with fixed and volatile oils.

Some of its more important physical characteristics are: (1) low vapour pressure and high boiling point, which make it nonvolatile at ordinary temperatures; (2) solubility and solvent properties that are comparable with those of water and the lower aliphatic alcohols; (3) high viscosity as an aid to lubrication; (4) low freezing point which is valuable in antifreeze mixtures; and (5) hygroscopicity which aids the retention of moisture and freshness in a wide variety of consumer products. Biologically, it has a food value comparable to that of carbohydrates and a sweetening value approaching that of sucrose.

Glycerin has been exempted from clearance under federal food additive legislation, being one of the products classified as "recognized by appropriately qualified experts as being safe for food use."

Chemical Properties. — Glycerol, because of its three hydroxyl groups, reacts readily with many organic and inorganic compounds to form esters (alkyd resins, ester gums, nitroglycerin and the fatty-acid esters), aliphatic and aromatic ethers, acetals, amines, halohydrins, tartrates, acetates and metallic glycerides. The more important derivatives are: (1) alkyd resins and ester gums, which are basic ingredients of many modern protective coatings; (2) nitroglycerin, which is used in the production of explosives; and (3) numerous further products which are used as solvents, emollients or emulsifiers in edibles, drugs and cosmetics. The reaction of glycerol with tartaric acid and the formation of polyesters were studied by Jons J. Berzelius in 1847, and later research on the glycerol-phthalic acid reactions laid the foundation of the present protective-coating industry. Ascanio Sobrero (1846) noted the reaction of nitric acid with glycerol to form nitroglycerin, and

Alfred B. Nobel (1868–75) converted this highly explosive material into safer and more convenient forms of use. Nitroglycerin is an important component of double-base powders and was used extensively in rocket powder in World War II. (See EXPLOSIVES: *Dynamite;* CORDITE.)

As originally shown by Louis Pasteur (1858), glycerol is a natural product (about 3%) of the alcoholic fermentation of sugar by yeast, and is therefore present in varying percentages in all wines and beers. Carl Neuberg (1912) and others showed that if the fermentation occurs in the presence of a salt such as sodium sulfite, sugar can yield in excess of 30% of its weight in glycerol.

Manufacture. — Most of the world's supply of glycerin is produced as a coproduct in the saponification or hydrolysis of fats. About 10% of the weight of fat is released as glycerol.

In the manufacture of soap by the kettle process, fats are treated nith alkali and yield (along with soap) a "spent lye" consisting of glycerol solution and salt. This spent lye is filtered and concentrated to "soap-lye crude," a grade of glycerin containing 80% glycerol.

More modern soapmaking starts with the production of fatty acids by hydrolysis. This reaction is carried out in a high-pressure splitting tower in which steam is caused to react continuously with the hot fat. Other fat-splitting methods, using autoclaves or using the Tnitchell (catalyst) process, are also employed in fatty acid production. All produce a salt-free "sweet nater" nhich upon evaporation yields a crude glycerin of 88% glycerol content, known as "saponification crude."

Fatty alcohols, in particular lauric alcohol and related types from coconut oil, have become increasingly important as intermediates for detergents. Production of fatty acids or esters for hydrogenation to alcohols. and sodium-reduction methods of fatty alcohol production. are secondary sources for crude glycerin.

Following World War II, glycerin faced increased competition from other polyols originally developed as wartime substitutes. However. U.S. production of refined glycerin rose about 2% per year to a level of about 240,000,000 lb. per year in the late 1950s.

Taken together, the production of glycerin from fats in the late 1950s constituted about 55% of the total U.S. production. The remaining 45% was produced by synthesis from propylene. Production of glycerin from propylene was stimulated by the decline in ioap production resulting from the expansion of synthetic detergents.

The key to glycerin synthesis is the direct, high-temperature vapour phase chlorination of propylene to give high yields of allyl chloride. a process first operated commercially in 1948. Alternative processes, involving the production of allyl alcohol. glycerol mono- and di-chlorohydrins or trichloropropane. lead to products which, upon hydrolysis, yield dilute glycerol solution. The particular route will depend on the specific coproducts, such as epichlorohydrin, for which there is industrial demand.

Concentration and purification yield a finished glycerin of 99% or more. The product is interchangeable with natural glycerin, and is produced to meet the specifications of the U.S. *Pharmacopoeia.*

Fermentation glycerin has never been produced commercially in the U.S , although experimental and pilot plants have been developed there and abroad. Various other reactions, such as the hydrogenolysis of carbohydrates. have also been proposed for glycerin production, but the separation of end products (mixed glycols and other polyhydric alcohols) has precluded their commercialization

Distillation in the presence of steam in vacuum stills is the primary means of purifying glycerin. Redistillation and bleaching are employed for the highest grade. Since 1950, the introduction of ion-exchange processes has provided an alternative means of purification without distillation.

Commercial **Grades.**—*Crude* Glycerin —This grade, in purities of 80% and 88%, although an important article of commerce, has little direct utility. A substantial tonnage moves from smaller plants and from foreign soapmakers to U S glycerin refiners to supplement their own production of crude glycerin.

Refined glycerin is sold by U.S. producers on individual product specifications which differ in minor respects from company to company. Glycerin for a particular field of use—say for cellophane or alkyd resins—may be designated as such by the producer in meeting special tests of the consuming industry.

Glycerin, *U.S.P.*—This clear, colourless product conforms to the specifications of the U.S. *Pharmacopoeia* (minimum specific gravity 1.249 at 25° C.), and is chemically pure except for some 4% of water. It is employed in drugs, foods, toilet goods, tobacco, food wraps, cork bottle-crown liners and wherever glycerin may be used for human consumption. Glycerin of the same quality, but sold at a higher concentration (minimum specific gravity 1.2595 at 25° C.), is also supplied. British standards for chemically pure glycerin (B.P.) are similar, except for specific gravity limits of 1.255 to 1.260 at 20° C.

High Gravity Glycerin.—This is a commercial grade of glycerin conforming to Federal Specification O-G-491a, grade B, and commonly supplied at not less. than 99.0% concentration (specific gravity 1.2595 at 25° C.). It is directed to glycerin's largest U.S. field of use. the manufacture of alkyd resins. Glycerin from propylene. referred to as synthetic glycerin, conforms to these specifications, but is commonly supplied at 99.5% glycerol content.

Dynamite glycerin is comparable in concentration with high-gravity grades, but less emphasis is placed on minimum colour requirements. Yellow distilled is a refined grade meeting less critical standards of colour, with concentration not less than 96% glycerol.

See C. S. Miner and N. N. Dalton, *Glycerol* (1953); Glycerine Producers Association, *Glycerine Properties and Applications* (1957).

(N. N. D.; E. S. PN.)

GLYCOLS, the generic name applied to a class of alcohols having two hydroxyl groups. The glycols of lower molecular weight are colourless, oily liquids boiling at about 180° C. Several of the lower glycols are important commercially, but the glycols of high molecular weight have little or no commercial importance. Hundreds of them have been prepared for scientific studies. This is particularly true of the pinacols which are obtained by the reduction of ketones and undergo the pinacolone rearrangement.

Ethylene Glycol. — Glycol, ethane-1,2-diol, $CH_2(OH)CH_2OH$, is a colourless, oily liquid possessing a sweet taste and mild odour.

The commercial importance of ethylene glycol and its derivatives (generally derived directly from ethylene oxide) increased rapidly. Large quantities of ethylene glycol are used annually as antifreeze in automotive cooling systems. Its availability at low cost, high antifreeze efficiency (low molecular weight) coupled with the relatively high heat capacities and low viscosities of its aqueous solution admirably suit ethylene glycol for this service. The second largest commercial use by the 1950s was the manufacture of glycol dinitrate. Because of its low freezing point, glycol dinitrate is used in the manufacture of low-freezing dynamites.

Ethylene glycol resembles glycerin in many of its chemical and physical properties. Ethylene glycol boils at 197.2° C., freezes at −13° C. and is heavier than water; its specific gravity at 20/20° C. is 1.115 It is completely soluble in water and in many industrial solvents. Unlike glycerin, ethylene glycol and all of its derivatives are toxic to warm-blooded animals and must not be used in food and pharmaceutical preparations. Ethylene glycol is produced commercially from ethylene gas. The oldest process consists in treating ethylene with hypochlorous acid to produce ethylene chlorohydrin $HOCH_2CH_2Cl$. The chlorohydrin is then converted into glycol by action of an alkali such as calcium hydroxide or sodium bicarbonate. Ethylene glycol is produced commercially from formaldehyde, hydrogen and carbon monoxide under heat and pressure or by the hydration of ethylene oxide. The ethylene oxide is obtained either by the oxidation of ethylene or by the dehydrochlorination of ethylene chlorohydrin.

In both processes, the glycols are obtained as dilute aqueous solutions and are recovered and purified by evaporation and distillation procedures.

Ethylene glycol exhibits many of the reactions common to primary alcohols. Careful oxidation yields glycolic acid. Heating the reaction mixture produces oxalic acid. With dehydrating agents. ethylene glycol yields acetaldehyde. Heat alone at 500° C. produces the same change. The ethers which would be expected, ethylene oxide and diethylene oxide, are both known, but only the latter is obtained by dehydration of glycol. Both are commercially prepared from ethylene chlorohydrin. Halide acids react readily with one hydroxyl group to produce halohydrins. Alkali metals replace the alcoholic hydrogen atoms. Glycols react with monocarboxylic acids to form mono- and di-esters. With dicarboxylic acids, linear polyesters are obtained; the fibre Dacron, for example, is such an ester with terephthalic acid (see PHTHALIC ANHYDRIDE).

As stated above, many glycol derivatives are manufactured from ethylene oxide or from combinations of ethylene oxide with glycol. Commercial products produced in this manner are diethylene glycol (from glycol plus ethylene oxide), triethylene glycol (from ethylene oxide plus diglycol). The ethers of ethylene glycol with the lower aliphatic alcohols are of considerable importance. These are made by the direct addition of ethylene oxide to the corresponding alcohol. Ethylene glycol monoethyl ether is produced by the reaction of ethylene oxide with ethyl alcohol. The corresponding ethers of diethylene glycol are prepared by the action of ethylene oxide on the glycol ethers.

Acetone Glycol, 2-methylpentane-2,4-diol, $(CH_3)_2C(OH)CH_2CH(OH)CH_3$, boiling point 192° C., is obtained by the reduction of diacetone alcohol which, in turn, is produced by the dimerization of acetone under the influence of alkalies. Its reactions are those that would be expected from a secondary and tertiary alcohol.

Pinacol, tetramethylethylene glycol, 2,3-dimethylbutone-2,3-diol, $(CH_3)_2C(OH)C(OH)(CH_3)_2$ (boiling point 172° C., melting point 42° C.), is obtained from the bimolecular reduction of acetone by amalgamated magnesium. Its most important reaction is its rearrangement to pinacolone, $(CH_3)_3C.COCH_3$, by dehydration with acid reagents.

Some commercial interest was shown in this compound in Germany during World War I, for by catalytic dehydration it is possible to obtain 2,3-dimethylbutadiene-1,3 (also called methylisoprene) from which methyl rubber can be made.

(D. G. Z.; N. C. S.)

GLYCONIC, a form of Aeolic verse, uhich may be described as a combination of one or more dactyls (or perhaps choriambi) with shorter feet. It has many forms,

as ⏒⏒ – ⏑⏑ – ⏑⏑ – ⏑⏑

or ⏒ – ⏑ ⏑ – ⏑ ⏓ (acephalous glyconic)

or grato Pyrrha sub antro (Pherecratic).

But the commonest is ⏒ ⏒ – ⏑ ⏑ – ⏑ ⏒, often called simply a glyconic; this is a great favourite of Catullus and Horace, as sic te *diva potens* Cypri; it may be imitated in English by immemorial harmonies.

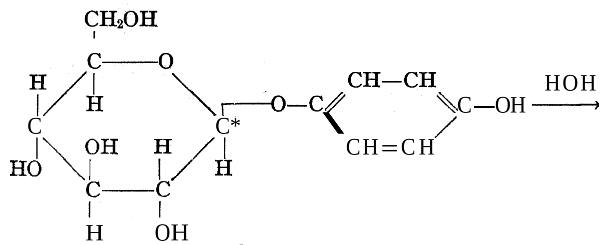
The name is from Glycon, a lyric poet.

GLYCOSE: see SUGAR.

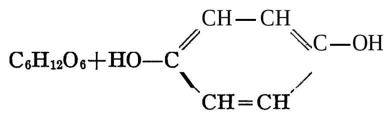
GLYCOSIDES, NATURAL. The term glycoside is applied to a large number of substances found mainly in plants. Formerly the names glucoside and aglucone were used, but these terms came to be restricted to those glycosides that contain only glucose as their sugar component. While the exact biological function of the plant glycosides is not established, it is probable that their formation provides the plant with a means of storing, in a harmless form, toxic and physiologically active materials which may be liberated by enzymes, in small quantities, when required. Glycosides are solids, generally crystalline, and most have a bitter taste. Their solutions show the property of rotating the plane of polarized light, usually to the left. Under the influence of aqueous solutions of acids they can be split (hydrolyzed) by the elements of water (H-OH) into one or more sugars and a nonsugar portion termed the aglycon. This change can also be effected by naturally occurring substances present in trace amounts in neighbouring cells. These substances are known as enzymes and are effective only for one glycoside or for a group of closely related glycosides. The aglycons are widely diversified in chemical structure but all contain a hydroxyl (OH) group through which they combine with the sugar. From the standpoint of chemical structure, a glycoside is a mixed acetal and shows all the properties of such a combination.

Most of the natural glycosides have been assigned names derived from the botanical names of their plant sources. Thus arbutin is a colourless, crystalline, bitter substance that was first extracted from the leaves of the small evergreen shrub Arbutus *uva-ursi;* later it was found in other plant sources, such as the leaves, bark and roots of many varieties of the common pear. Arbutin is hydrolyzed by acids or by the enzyme β-D-glucosidase present in the mixture of enzymes known as almond emulsin, extractable from the bitter almond. Arbutin thus can be split into the sugar D-glucose and the aglycon hydroquinone; its rational chemical name is therefore para-hydroxyphenyl β-D-glucopyranoside.

The term "pyranoside" refers to the size of the internal cyclic acetal in the sugar moiety and "β-D" designates the spatial orientation of the "glycosidic carbon," marked with an asterisk in the following formula:

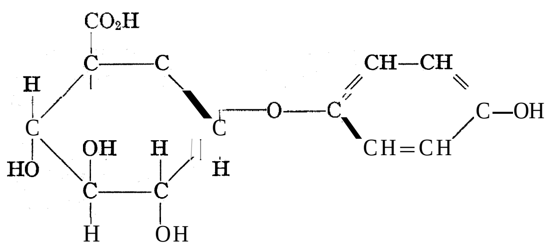


Arbutin



D-Glucose Hydroquinone
(1,4-dihydroxybenzene)

Glycosides are usually at least sparingly soluble in water and since only soluble substances are transportable in a plant by movements of sap, it is at least useful as a working hypothesis to assume that the plant converts into glycosides: (1) harmful or useless substances which must be transported to the barks, fruit rinds or seed coats, where they can do no harm and will eventually be shed; (2) necessary but harmful substances, which may be useful later; (3) decorative or attractive substances, such as floral pigments, formed in the leaves and transported at the proper season to the flowers or fruits. Experimental support for the theory that glycoside formation in the plant is a detoxication mechanism is provided by the finding that 2-chloroethanol $(ClCH_2CH_2OH)$, a substance which breaks the dormancy of tubers, is converted by plant tissue to 2-chloroethyl β-D-glucopyranoside. Such a detoxication mechanism also operates in animals, where harmful or unwanted substances are eliminated in the urine as glycosides of D-glucuronic acid. Thus, when hydroquinone is fed to a dog, the following substance appears in the urine:



Para-hydroxyphenyl β-D-glucopyranosiduronic acid

Many glycosides of D-glucuronic acid with steroidal fragments are normally present in urine and the nature of these materials is modified by such biological conditions as pregnancy.

Uses.—The plant glycosides exist in a bewildering variety both in regard to their sugar components and, especially, in the nature of their aglycons. To their presence in plants are ascribable the many uses of plant materials established by primitive peoples and exploited by modern civilization. The medicines, condiments and dyes from plant sources occur largely as glycosides. As their chemical nature has become established, most, but not all, of these substances have been replaced by synthetic products. This has been especially true of plant or vegetable dyes, but many condiments and some medicines are still derived from plant extracts.

Arbutin, described above, is an example of a simple, colourless, phenolic glycoside, many varieties of which are found in plants. Arbutin is accompanied by methylarbutin, which contains hydroquinone monomethyl ether as its aglycon.

Salicin is the active constituent of willow (Salix) bark and has long been used as a remedy against fever and in acute rheumatism. Its hydrolytic products are D-glucose and saligenin [salicyl alcohol, *ortho*-hydroxybenzyl alcohol, $C_6H_4(OH)(CH_2OH)$]. Phloridzin (phlorizin, phlorhizin), from the bark of the Rosaceae (apple, pear, cherry and plum tree), is the D-glucoside of a rather complicated phenolic aglycon. Its administration produces a type of diabetes in the dog and this circumstance has been utilized in studies of the disease.

Glycosides of aliphatic alcohols are represented by the purgatives convolvulin and jalapin, whose sugars are in glycosidic combination with the hydroxyl groups of hydroxylated fatty acids and are thus related to the constituents of castor oil. The β-D-glucopyranoside of the terpene alcohol geraniol occurs in Pelargonium odoratum. Although most glycosides,are characterized by their bitter taste, stevioside is one of remarkable sweetness. It is extractable from the leaves of *Stevia rebaudiana* Bertoni, a wild shrub of the Compositae family. native to Paraguay. Stevioside contains three units of D-glucose, two of which are in combination with each other; its aglycon, steviol, is a diterpenoid.

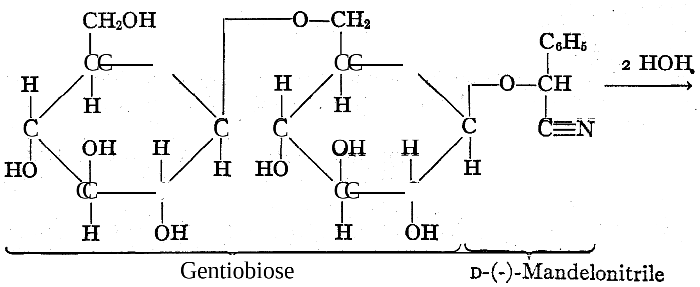
The saponins are glycosides of aliphatic alcohols and are widely distributed in plants. They are characterized by their property of producing foams when shaken in aqueous solution. They are toxic to fish and were used as a fish poison by primitive peoples, since the fish so killed were not toxic to humans when eaten. The saponins yield a variety of sugars on hydrolysis; some yield D-glucuronic acid. Their aglycons are termed sapogenins and may be classified as either triterpenoid or steroid. Glycyrrhizin, the saponin of licorice (*Glycyrrhiza* glabra) root, contains a triterpenoid sapogenin, while sarsasaponin, from Mexican sarsaparilla root, contains the steroid sarsasapogenin. (See SAPONINS AND SAPOGENINS.)

Another large group of steroid glycosides that are not saponins are collectively known as the cardiac glycosides. These are powerful heart poisons but are useful heart stimulants in minute dosages. The primitive tribes of Africa employ extracts of the seeds of Strophanthus and of the wood and bark of the ouabaio as arrow poisons. Extracts of the bulbs of the squill have been utilized in medicine since ancient times, but better known in modern medicine are the extracts of the leaves of Digitalis or common garden foxglove. The flower of the lily of the valley also yields such extracts. The cardiac glycosides from all of these divergent plant sources are related chemically. On hydrolysis they yield a large variety of unusual sugars but their physiological action lies in the aglycons which possess chemical structures related to those of the steroids.

A group known as the cyanogenetic glycosides is found in the kernels of peaches, cherries and plums and in other parts of a variety of plants. These are mainly glycosides of the cyanohydrin mandelonitrile. When hydrolyzed by enzymes or by acids they liberate poisonous hydrocyanic acid together with benzaldehyde and one or more sugars, chiefly D-glucose (see formula below). To this group belongs amygdalin, one of the earliest investigated glycosides. The sugars of amygdalin are two moles of D-glucose combined as the disaccharide gentiobiose.

The condiment mustard is prepared by grinding mustard seed with salt, spices and vinegar. A variety of mustard seeds are used, but all contain a glycoside in which a D-glucose entity is directly attached to a sulfur atom rather than to an oxygen atom.

Many of the vegetable dyes formerly so widely used were glycosides. One of the chief of these was madder (Rubia *tinctorum*), formerly grown commercially in the near east. The main glycoside of the madder root yields on hydrolysis the sugars D-glucose and D-xylose, present in disaccharide combination in the glycoside, and 1,2-dihydroxyanthraquinone or alizarin (*q.v.*). Alizarin is employed with mordants (certain metallic salts) to form lakes in a wide variety of colours. It was the first vegetable dye whose chemical structure was determined and as a result of this the natural product was replaced by a synthetic preparation of better quality. An interesting yellow dye, known as Indian yellow, is prepared in Bengal by feeding mango leaves to cattle and isolating the dye from the urine. It is a glycoside of D-glucuronic acid attached to a structure quite closely related to alizarin and known as 4,7-dihydroxyxanthone.



$$2\ C_6H_{12}O_6 + HCN + C_6H_5CHO$$

D-Glucose   Hydrocyanic acid   Benzaldehyde

The wide variety of pigments present in flowers and fruits are largely mixtures of glycosides with carotenoids. Most of the blue colours and some of the red are glycosides (anthocyanins) of aglycons known as anthocyanidins, which are reduction products of hydroxylated phenyl-benzo-y-pyrones. Glycosides of the latter constitute a large group of yellow pigments widely distributed in fruits, flowers, bark and other pigmented plant structures. A typical yellow glycoside is quercitrin, present in oak bark (see QUERCITRON BARK).

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GLYPTODON, a gigantic extinct South American genus of edentate mammals, the type of a group, the Glyptodontia or tortoise-armadillos, in which the carapace is all in one piece, composed wholly of polygonal bony plates united together without any of the movable rings of the armadillos. The skull is short, with deep jaw and fluted teeth (whence the name), the backbone is welded into a rigid tube, and a complex joint in the neck permits the head to be retracted within the shell as in tortoises. The limb bones are stout and the feet short, rounded, with hoofs instead of claws on the toes. In Glyptodon and the related *Glyptotherium* of North America there are four toes on each front foot and five behind, and the tail is encased in a series of movable rings. *Doedicurus,* of the South American Pleistocene, the largest known glyptodont, has three toes on each front foot and four behind, and a tail tube covered by horny spikes. The pattern of the plates composing the carapace differs in each genus. The glyptodonts originated in South America where they are represented during the middle and later Tertiary by smaller and more primitive genera. In the Upper Pliocene and Pleistocene they invaded North America as far as southern United States. (W. D. M.)

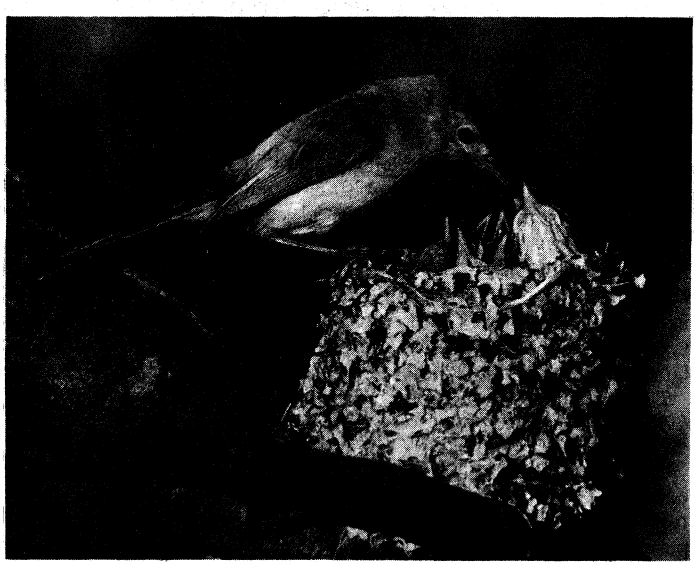
G-MEN, or government men, a journalistic term for special agents of the United States department of justice, bureau of investigation. The phrase is supposed to have obtained currency after the capture of a notorious criminal, George ("Machine Gun") Kelly, in Sept. 1933. *(See* FEDERAL BUREAU *OF* INVESTIGATION.) By analogy, investigative agents of the U.S. department of the treasury became known as T-men.

GMÜND (SCHWÄBISCH GMÜND), a town of Germany, in the *Land* of Baden-Württemberg, on the Rems, 31 mi. E.N E. of Stuttgart by rail. Pop. (1959 est.) 40,629. It was surrounded by walls early in the 12th century. It received town rights from Frederick Barbarossa, and after the extinction of the Hohenstaufen became a free imperial town. In 1803 it passed to Wurttemberg. The church of the Holy Cross, St. John's church, dating from the time of the Hohenstaufen, and the pilgrimage church of the Saviour are notable. Clocks and watches, optical instruments and gold and silver work are the chief manufactures. Trade is in precious stones.

GMUNDEN, an old town in Upper Austria at the issue of the Traun river from the lake of that name. It is a favourite summer health resort, for it lies about 1,400 ft. above sea level amid delightful scenery and has a variety of lake, brine, pine cone and other baths, and is an excellent centre for excursions to the Traun fall and other features of scenic interest in Salzkammergut. It shares in the salt industry of this region. Pop. (1961) 12,922.

GNAT, the common English name for various kinds of small flies *(see* DIPTERA), including more especially mosquitoes (*q.v.*) and other forms with piercing mouth parts; *e.g.,* buffalo gnats (family Simuliidae).

GNATCATCHER, the name given to birds of the American subfamily Polioptilinae (family Regulidae, kinglets). About 12 species are recognized. Gnatcatchers are small, slender, grayish and white birds with relatively long, slender tails. They build beautifully symmetrical compact nests of plant down and other



BY COURTESY OF L. H. WALKINSHAW

BLUE-GRAY GNATCATCHER (POLIOPTILA CAERULEA CAERULEA)

soft materials bound together with spider webs and covered with lichens. The nests occur at elevations of a few feet to as much as 70 ft. above the ground. Although the name gnatcatcher has come to be applied generally to these birds, they by no means are restricted in diet to. or even show any noticeable partiality for, these insects. They feed on all small insects, and occasionally have been known to seize others large enough to require tearing apart before they can swallow them. Stomach contents of these birds have revealed longicorn beetles, jointworm flies, caddis flies and other insects.

The best-known species is the blue-gray gnatcatcher *(Polioptila caerulea caerulea)* of the eastern United States, in which the male has a black forehead. The western gnatcatcher *(P. c. amoenissima)* breeds from California and Colorado south into Mexico. The plumbeous gnatcatcher *(P. melanura melanura)* breeds from southeastern California, southern Nevada and the Rio Grande valley southward; the black-tailed gnatcatcher (P. *m. california)* occurs in the San Diego district of California. Other races and species occur in Central and South America, extending as far south as Argentina and Chile. (G. F. Ss.; HT. FN.)

GNATIA (also GNATHIA, EGNATIA or IGNATIA), near Fasano, Italy, an ancient city of the Pevcetii, and their frontier town toward the Sallentini (*i.e.,* of Apulia toward Calabria), a port on the Via Traiana when a short cut from Butunti (mod. Bitonto) joined it, 38 mi. S.E. of Barium. Roman remains include part of the city walls and objects in museums at Fasano and at Bari.

GNEISENAU, AUGUST WILHELM ANTON, COUNT NEITHARDT VON (1760–1831), Prussian field marshal, son of a Saxon officer named Neithardt, was born on Oct. 27, 1760, at Schildau, near Torgau. He assumed the name of Gneisenau from the lost estates of the family in Austria. After two years' study at Erfurt he entered the Austrian army in 1779 and transferred in 1782 to the service of the margrave of Baireuth-Anspach. With one of that prince's mercenary regiments in English pay he fought in the American Revolution, and returning in 1786, applied for Prussian service. Gneisenau served in Poland in 1793–94 and in the next ten years devoted himself to military study. In 1796 he married Caroline von Kottwitz. In 1806 he was one of Hohenlohe's staff officers, fought at Jena, and commanded a provisional infantry brigade which fought under Anton von Lestocq in the Lithuanian campaign. Early in 1807 Gneisenau was commandant at Colberg, which succeeded in holding out until the peace of Tilsit. For this service he received the much-prized order *"pour le mérite,"* and was promoted to lieutenant colonel.

A wider sphere of work was now open to him. As chief of engineers, and a member of the reorganizing committee, he played a great part, with Scharnhorst, in the reorganization of the Prussian army. His energy aroused the suspicion of the dominant French, and Stein's fall was followed by Gneisenau's retirement. But, after visiting Russia, Sweden and England, he returned to Berlin and resumed his place as a leader of the patriotic party. In open military work and secret machinations his energy and patriotism were equally tested, and with the outbreak of the War of Liberation, Gneisenau, now a major general, became Bliicher's quartermaster general. With Bliicher, Gneisenau served to the capture of Paris; his military character was the exact complement of Bliicher's and under this happy guidance the young troops of Prussia, often defeated but never discouraged, fought their way into the heart of France. The plan of the march on Paris was specifically the work of the chief of staff. In reward for his distinguished service he was made a count.

In 1815, once more chief of Bliicher's staff, Gneisenau played a conspicuous part in the Waterloo campaign (*q.v.*). When the old field marshal was disabled at Ligny, Gneisenau assumed control of the Prussian army.

The precise part taken by Gneisenau in the events which followed is much debated. Gneisenau distrusted Wellington, who, he considered, had left the Prussians in the lurch at Ligny, and even considered falling back on the Rhine. Blucher, however, soon recovered from his injuries, and, with Grolmann, the quartermaster general, he managed to convince Gneisenau. The relations of the two may be illustrated by Brigadier General Hardinge's report. Blücher burst into Hardinge's room at Wavre, saying *"Gneisenau has given way,* and we are to march at once to your chief." On the field of Waterloo, however, Gneisenau was quick to realize the magnitude of the victory, and he carried out the pursuit with relentless vigour. In 1816 he was appointed to command the Prussian 8th corps, but soon retired. In 1818 he was made governor of Berlin and member of the *Staatsrat.* In 1825 he became general field marshal. In 1831 he was appointed to the command of the army of observation on the Polish frontier, with Clausewitz as his chief of staff. At Posen he was struck down by cholera and died on Aug. 24, 1831.

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GNEISS, in geology a generic term signifying a large and varied series of rocks with a banded and usually foliated structure in which layers of minerals with a granular texture alternate with thin layers composed of lamellar or fibrous minerals, usually in parallel arrangement. The term originally was used by the miners of the Erzgebirge in Germany to designate the country rock in which the mineral veins occur. The word is of Slavonic origin meaning rotted, or decomposed, in allusion to the altered character of the country rock in the immediate vicinity of the ore veins.

The foliation of gneiss may be frequently interrupted and the ease of splitting of the rock is usually much less in evidence than in the case of schists (*q.v.*). Gneisses, however, may also be built up wholly of granular minerals, the gneissose structure being given by the alternation of bands of different mineral composition; *e.g.*, pyroxene gneiss.

As used in its widest sense, gneiss is a structural term rather than a name applied to rocks of a particular mineral composition or genesis. Thus gneisses may be of igneous or metamorphic origin, and have a great range of chemical composition. The minerals of the granular bands usually consist of quartz, feldspar (orthoclase, microcline, plagioclase) or both, and the lamellar or fibrous bands are usually composed of chlorite, mica (muscovite, biotite), graphite, amphibole, sillimanite, etc.

According to their origin, gneisses are subdivided broadly into four groups: (1) primary gneisses, (2) injection gneisses, (3) orthogneisses and (4) paragneisses.

Primary gneisses are plutonic igneous rocks possessing a banded structure, in which a parallel arrangement of the lamellar or fibrous minerals (if present) is evident. These rocks owe their structures to a flow movement in a magma in which crystallization has already progressed. Primary gneisses are often of granitic composition and build up great areas of Pre-Cambrian Archean formations. Much of the Lewisian gneiss of Scotland, the Laurentian gneiss of Canada and the igneous gneisses of other continental shields may be rocks of this character. The setting up of gneissic banding in a fluid magma by flow movement presupposes a magmatic heterogeneity which in nature arises either by imperfect differentiation or by the incorporation of foreign material within the magma. In many Archean shields the granite gneisses are characterized by containing numerous bands of rock, usually of the nature of amphibolites or hornblende schists, representing basic igneous rocks of earlier date incorporated in the magma during intrusion. These basic bands become injected along planes of bedding or foliation by the granitic material and ultimately in places become so intimately intermingled with the magma as to produce a gneiss of hybrid origin. Less advanced stages of this process where injection takes place along the foliation planes of inclusions or of the country rock adjacent give rise to injection gneisses. Migmatite gneisses (from the Greek *migma,* "a mixture") are mixed, composite or injection gneisses sometimes extensively developed in crystalline schist formations u-hich have been invaded by granitic intrusions.

They develop both by mechanical injection of fluid between the folia of schists and by intimate soaking and metasomatism whereby new feldspar (orthoclase and plagioclase) arises in the body of the schist. conspicuously in the form of porphyroblasts, or large pseudoporphyritic crystals, but also in finer elements in the ground mass. In advanced stages. particularly where the schist is of argillaceous or clayey type, the resultant rocks may simulate primary granite gneisses with but vague remnants or "ghosts" of the original schist to tell the story of their origin.

The term orthogneiss refers strictly to igneous rocks in which a gneissic structure has been superimposed by metamorphism, but the name is used by some writers to include also primary gneisses. Criteria for the distinction of orthogneisses from primary gneisses are sometimes difficult to establish, and are chiefly provided in the textural and structural relations of the rocks. They may be evidenced by signs of crushing (cataclastic structure), relict textures, or where the uhole rock has been totally recrystallized by the textural relations of the minerals. In primary gneisses the form development of the crystals is largely dependent on the order in which the minerals have crystallized from the magma, while in totally recrystallized orthogneisses the growth of the minerals has taken place in an essentially solid environment, and the form development is dependent on the crystallizing power of the several minerals, giving rise to crystalloblastic texture (*see* METAMORPHISM). Some of the best-known orthogneisses are those of the granulite districts of Saxony and the Austrian Waldviertel near Krems.

Many gneisses are undoubtedly sedimentary rocks brought to their present state by such agents of metamorphism as heat, movement, crushing and recrystallization. This may be demonstrated partly by their mode of occurrence; they accompany limestones, graphite schists, quartzites and other rocks whose sedimentary origin is never in doubt. In many cases bulk chemical composition is a certain clue to their origin, since they correspond in this particular to normal sediments and not to any known igneous rocks. Structural or textural criteria, such as bedding, evidence of original pebbly or clastic character, are not infrequently to be found. The chemical composition of paragneisses is reflected in their mineralogical constitution.

Gneisses derived from argillites may be rich in biotite, muscovite, cordierite, almandine garnet, staurolite, chloritoid, kyanite and sillimanite, some of which minerals are practically unknown in metamorphosed igneous rocks, while gneisses derived from limestones or dolomites carry such characteristic minerals as grossularite, idocrase, wollastonite, scapolite or forsterite. Some paragneisses are rich in feldspar and quartz and may show so close a resemblance to gneisses of igneous origin that by no single character, chemical or mineralogical, can their original nature be definitely established. (C. E. T.)

GNEIST, RUDOLF VON (1816–1895), German jurist and political thinker who exercised a profound influence on the growth of German administrative law, was born in Berlin on Aug. 13, 1816, the son of a judge of the supreme tribunal. From 1833 to 1836 he studied law, especially Roman law under Karl Friedrich von Savigny, at Berlin university. In 1841 he became a judge, and from 1847 he sat in the high court in Berlin. Though he was no revolutionary, he soon had to resign because of his opposition to the reactionary policy of the Prussian government after 1848.

After resigning his judgeship, Gneist devoted himself to academic studies. Already in 1842 he had become a reader in Roman law at Berlin university. Gradually, however, he turned his attention from this subject and won a growing reputation with lectures on assizes, on public and oral proceedings, on English and French judicial organization and on Prussian, German and English constitutional and administrative law. Between 1850 and 1860, completely withdrawn from political affairs, he wrote his great work on English constitutional law.

Though he had remarkable success as a teacher, it was only in 1858 that he became a full professor in Berlin—a position that he was to hold until his death. In all his works, most of which even carried the words "English" or "self-government" in their titles. he drew upon English conditions past and present. His writings earned him a widespread reputation. For more than 20 years (from 1868) he was president of the German jurists' association; and he received honorary degrees from Edinburgh, Berlin (doctor of philosophy), Bologna and Rostock.

Gneist's political career began in 1845 with his election as a town councilor in Berlin. This gave him considerable experience in local politics, which was of great value to him for his later academic treatises on "self-government." He lost his seat because of his views on the reaction after 1848, but regained it in 1858 He was also a member of the Prussian house of representatives from 1859 to 1893, of the *Reichstag* from 1867 to 1884 and of the Prussian state council from 1884. A liberal by conviction, he joined the moderate National Liberal party in 1866, though originally he had been inclined more to the Progressive party. Later he turned to a more conservative liberalism, under the influence of Lorenz von Stein (Stein's theory—developed about 1850—is based on the dualism of state and society). Bismarck frequently asked his advice. In the *Kulturkampf* period (1871–78) Gneist opposed the Jesuits and the demand for denominational schools. He took a strong interest in political matters without holding any extreme views. This position is particularly apparent in his writings. Though these do not always stand up to scholarly criticism. they reveal a powerful and practical political mind that could at the same time present clearly defined legal conceptions. These assets also explain Gneist's great popular success.

At the height of his success Gneist resumed his career as a judge. His untiring advocacy of an independent administrative jurisdiction was rewarded when, at the founding of the Prussian supreme administrative court in 1875, Gneist was invited to become a member of it. This court was then the highest of its kind in Germany, and Gneist exercised a decisive influence in the development of its jurisdiction. Gneist died in Berlin on July 22, 1895.

Gneist's main field of work was public law. Here he emphasized the idea of "self-government"; by this he understood the administration of public affairs by self-responsible, honorary officials appointed by the king from among the aristocracy and the middle classes, in contrast to an administration from above by professional civil servants or elected bodies. His model was the administration of the English counties by the justices of the peace whereas most other contemporary advocates of "self-government" inclined rather to the Franco-Belgian systems. Though Gneist's presentation of English conditions was not always accurate. since he sometimes saw them in the light of preconceived political notions, his writings nevertheless provided a basis on which the German middle classes came to participate widely in public administration. The greater part of the German administration remained, however, in the hands of the professional civil service, mainly because the needs of the modern state favoured the growth of specialization in this field, so that the term "self-government" is hardly any longer applied in the specific meaning used by Gneist.

The most pregnant of Gneist's ideas proved to be his demand for the establishment of independent administrative courts run by legal and administrative experts charged with the control of the administration. The German states one after another set up an independent administrative jurisdiction which was repeatedly extended. The opening of the federal administrative court in Berlin on June 8. 1953, and the promulgation of the federal code for administrative procedure on Jan. 21, 1960, completed the development which Gneist had initiated.

Gneist's writings include *Das heutige englische Verfassungs- und Verwaltungsrecht*, 2 vol. (1857–60; later editions under different titles); *Englische Verfassungsgeschichte* (1882; Eng. trans.. *History of the English Constitution*, 1886'); *Verwaltung, Justiz, Rechtsweg: Staatsverwaltung und Selbstverwaltung nach englischen und deutschen Verkaltnissen* (1869); *Das englische Parlament* (1886; Eng. trans., *English Parliament*, 1889).

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GNIEZNO, a town of Poland, in the Poznan *wojewodztwo* (voivodeship), is a district capital and one of the two capitals of the R'arsaw-Gniezno Roman Catholic archdiocese. Pop. (1960) 44,000. Gniezno lies on the Poznan-Torun railway in a region of many lakes. It is a trade centre and has industries processing the agricultural produce of the area. Gniezno is rich in fine old buildings, among which the cathedral is outstanding. Its Komanesque door, dating from the 12th century and cast in bronze, showing episodes from the life of St. Adalbert, is one of the finest examples of early medieval Polish art.

Gniezno was one of the oldest fortresses of the Polan tribe (8th century A.D.) and the first capital of the Piast state. The importance of the town increased greatly after the burial in the cathedral of the remains of St. Adalbert. In A.D. 1000 the town became the capital of the archdiocese (rendering the Polish church independent of the German) and the place of coronation of Polish kings. It obtained town rights in 1243. In 1793 Gniezno came under Prussian rule; it passed to Poland in 1919. During their occupation in World War II the Germans set up at Gniezno one of the first forced-labour camps in Poland. (K. M. WI.)

GNOME, AND GNOMIC POETRY. Sententious maxims, put into verse for the better aid of the memory, were known by the Greeks as gnomes. γνῶμαι, from γνώμη, an opinion. A gnome is defined by the Elizabethan critic Henry Peacham (1576?–1643?) as "a saying pertaining to the manners and common practices of men, which declareth, with an apt brevity, what in this our life ought to be done, or not done" The Gnomic Poets of Greece, who flourished in the 6th century B.C., were those who arranged series of sententious maxims in verse. These were collected in the 4th century, by Lobon of Argos, an orator, but his collection has disappeared. The chief gnomic poets were Theognis, Solon, Phocylides, Simonides of Amorgos, Demodocus, Xenophanes, and Euenus. With the exception of Theognis, whose gnomes were fortunately preserved by some schoolmaster about 300 B C., only fragments of the Gnomic Poets have come down to us Of the gnomic movement typified by the moral works of the poets named above, Prof. Gilbert Murray has remarked that it receives its special expression in the conception of the Seven Wise Men, to whom such proverbs as "Know thyself" and "Nothing too much" were popularly attributed. These gnomes or maxims were extended and put into literary shape by the poets. Theognis enshrines his moral precepts in his elegies, and this was probably the custom of the rest; it is improbable that there ever existed a species of poetry made up entirely of successive gnomes. But the title "gnomic" came to be given to all poetry which dealt in a sententious way with questions of ethics. It was, unquestionably, the source from which moral philosophy was directly developed, and theorists upon life and infinity, such as Pythagoras and Xenophanes. seem to have begun their career as gnomic poets. By the very nature of things. gnomes, in their literary sense. belong exclusively to the daun of literature; their naïveté and their simplicity in moralizing betray it. But it has been observed that many of the ethical reflections of the great dramatists, and in particular of Sophocles and Euripides, are gnomic distiches expanded It would be an error to suppose that the ancient Greek gnomes are all of a solemn character, some are voluptuous and some chivalrous; those of Demodocus of Leros had the reputation of being droll. In modern times, the gnomic spirit has occasionally been displayed by poets of a homely philosophy, such as Francis Quarles (1592–1644) in England and Gui de Pibrac (1529–1584) in France. The once-celebrated *Quatrains* of the latter, published in 1574, enjoyed an immense success throughout Europe; they were composed in deliberate imitation of the Greek gnomic writers of the 6th century B C These modern effusions are rarely literature and perhaps never poetry. With the gnomic writings of Pibrac it was long customary to bind up those of Antoine Favre (or Faber) (1557–1624) and of Pierre Mathieu (1563–1621). Gnomes are frequently to be found in the ancient literatures of Arabia, Persia and India, and in the Icelandic staves. (E. G.)

GNOMON, a term originally used to mean an instrument for allowing one to know the time (*γνώμων*, *gnōmōn,* from *γιγνώσκειν*, *gignōskein,* to know). In its simple and primitive form it seems to have been a stick placed vertically on a plane surface, and later upon the concave surface of a hemisphere. This second form is seen in pocket sundials still used in certain parts of the world. That the term was at one time substantially synonymous with "vertical line" is seen in an expression of Oenopides of Chios (*c.* 465 B.C.), for Proclus (*c.* 460) says that he called "the perpendicular in the archaic manner 'gnomon-wise' (κατὰ γνώμονα), because the gnomon is also at right angles to the horizon." From this early use it came to represent a figure like a carpenter's square, but usually with equal arms. Seeking, as the Pythagoreans especially did, to relate number to geometric forms, the early Greek mathematicians imagined squares as built up of gnomons added to unity. For example, they saw that $1+3$, $1+3+5$, $1+3+5+7$, and so on, are squares, and that the odd numbers in a figure like this were related to the geometric gnomon. Such numbers were, therefore, themselves called *gnomons.* The early idea of a geometric gnomon was extended by Euclid (*q.v.; c.* 300 B.C.) to include a figure consisting of two parallelograms forming an **L.** Four or five centuries later Heron extended the term still farther, using it to mean that which, added to any number or figure, makes the whole similar to that to which it is added. This usage is also found in the writings of Theon of Smyrna (c. 125) in connection with figurate numbers (*q.v.*). For example, the pentagonal numbers are $1+4$, $1+4+7$, $1+4+7+10$, . . ., and the gnomons in this case are 4, 7, 10, . . .; *i.e.,* they constitute an arithmetical series with a common difference of 3. In the same way gnomons are developed with respect to hexagonal and higher polygons. The gnomon with respect to the square was used by early writers in the finding of square roots, and may still be seen in various elementary arithmetics and algebras.

As to the sundial, with a gnomon as a vertical needle, this is said to have been introduced into Greece by Anaximander (*q.v.;* c. 575 B.C.), and Herodotus states that it came from the Babylonians.

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GNOSTICISM, derived from the Greek word *gnostikos* (one who has *gnosis,* "knowledge"), is a term used by modern scholars to designate a religious movement of late antiquity, with which the Christian church came into contact. Gnosticism is not primarily or exclusively a Christian heresy but rather a religion in its own right, which is also known from pagan sources such as the *Corpus Hermeticum* and the *Oracula Chaldaica,* and from the oldest sources of Jewish mysticism, which can be traced back to the 1st and 2nd centuries A.D. Though it is not always easy to distinguish Gnosticism from Greek philosophy and the Christian religion, it has certain characteristics of its own which are alien to Greek or Christian tradition, such as the depreciation of the cosmos and the rejection of atonement. Historically most important is Christian Gnosticism, the systems of which can be proved to have existed in the 2nd century and which extended into Manichaeism (*q.v.*), a Gnostic world religion.

Origins.—In the Dead sea scrolls (*q.v.*) the knowledge of God and the opposition of light and darkness are strongly stressed. Their authors, probably the Essenes, may be considered as forerunners of Gnosticism, though no coherent Gnostic system can be proved to lie behind their conceptions. More important for Gnosticism are the early Merkaba mystics of Palestinian Judaism, who conceived their doctrine concerning the ascent through the heavens and the "measuring of the body of God" as an esoteric lore for the elect, a higher knowledge of things heavenly and divine. This current may have been stimulated by the magic and syncretism of the contemporary Hellenistic world, but it developed in the very midst of Judaism itself. It has been shown that both the terminology and the concepts of this Jewish mysticism survive in later Gnosticism. At its Jewish stage, however, Gnosticism remained monotheistic and preserved the distinction between man, even at the highest point he can reach, and the transcendent God.

The first Gnostic about whom something can be said with confidence is Simon Magus (*q.v.*), a Jewish heterodox teacher from Gitta in Samaria, who may have considered himself as the magical incorporation of the great power of God (Acts viii, 9–10). In his school a certain Helen was venerated as the image of Sophia, the "first idea of God." who generated the world and fell. This seems to be mainly a combination of a local cult of Helen with elements of Jewish wisdom and Greek philosophy. The fundamental conception that evil is due to a break within the Godhead is new and remained characteristic for all Gnostic schools. There is, however. no trustworthy evidence that Simon Magus distinguished between the creator and the highest God. His *gnosis* was still Jewish and monotheistic. This is Gnosticism in its earliest form. The same must be said about the gnosticizing circles which are alluded to in the later part of the New Testament, especially in the Epistle to the Colossians. Stress on "knowledge," cult of angels, ascetic or libertinistic tendencies, though perhaps already gnostic, did not yet imply dyotheism.

This dualistic phase was reached after the expansion of Gnosticism into the Hellenistic world and under the influence of Platonic philosophy (especially that of the *Timaeus*) from which the doctrine was borrowed that a lower demiurge was responsible for the creation of this world. This teaching is to be found in the *Apocryphon* of John (early 2nd century) and other documents of popular *gnosis* found near Naj' Hammadi in upper Egypt in the 1940s and in the *Pistis Sophia,* a 3rd-century Gnostic work in Coptic belonging to the same school. The learned *gnosis* of Valentinus, Basilides (*qq.v.*) and their schools presupposes this popular *gnosis* which, however, has been thoroughly Hellenized and Christianized and sometimes comes very near to the views of middle-Platonism (especially the teaching of Numenius). Eastern Gnosticism took a somewhat different course. Under the influence of the Iranian religion Manichaeism developed an absolute cosmic dualism between soul and matter. Moreover. it shows the enormous influence of Syrian asceticism, but it is equally rooted in popular Gnosticism and has preserved its essential doctrines.

Nature.—Gnosticism has its own conception of man, the world and God. expressed in various ways and based on a typical religious experience. The unconscious self of man (or some man) is consubstantial with the Godhead. but because of a tragic fall it is thrown into a foreign world which is completely alien to its real being. Through revelation from above man becomes conscious of his origin, essence and transcendent destiny. This revelation is often identified with the call of Jesus (not to be found in the Gospels, which the Gnostics regard as merely an exoteric allegory, but rather in a visionary experience or the initiation into a secret doctrine). So Gnostic revelation is to be distinguished both from philosophical enlightenment, because it cannot be acquired by the forces of reason, and from Christian revelation, because it is not rooted in history and transmitted by Scripture. It is rather the intuition of the mystery of the self. The world, produced from evil matter and possessed by evil demons, cannot be a creation of a good God; it is mostly conceived of as an illusion, or an abortion, dominated as it is by Yahweh, the Jewish demiurge, whose creation and history are depreciated. This world is therefore alien to God, who is for the Gnostics depth and silence, beyond any name or predicate, the absolute. the source of good spirits who form together the pleroma or realm of light. These conceptions are expressed in various myths, which have used material from many oriental and Greek religions, but serve to express a basic experience which is new, the discovery of the unconscious self or spirit in man which sleeps in him until awakened by the Saviour.

Gnosticism in the technical sense of the word should be distinguished from Encratism, which taught the rejection of marriage as well as the heavenly origin of the soul and "knowledge" but did not express this view in myth and knew of no split within the Godhead. It is misleading to quote (as is often done) the Odes of Solomon, the teaching of Tatian, the Gospel of Thomas or the Acts of Thomas, which are encratic, as witnesses of Gnostic doctrine. Encratism, which is deeply rooted in primitive Christianity and for a long time and in various countries remained a current within Christianity, was rather older than classical Gnosticism. It served as a starting point for Gnostic speculations and made it possible for the Gnostics to link up their views with Christianity.

Influence.—Scholars differ in their assessment of Gnostic influence. Following R. Reitzenstein, R. Bultmann supposes that a pre-Christian Gnostic myth of the saved Saviour, of Iranian origin. had a considerable influence on St. Paul, on the author of the Gospel of John and on the Christology of the Synoptic Gospels. Neither the Valentinian "Gospel of Truth" nor the Dead sea scrolls contains such a myth and it remains uncertain that it existed at all before Manichaeism. The Mandaeans (*q.v.*), a Gnostic sect still existing in Iraq, may have developed out of a Jewish sect under the influence of Syrian Gnosticism in the 3rd century. It seems doubtful whether the nucleus of their teachings influenced primitive Christianity, though their writings contain many striking parallels to the Gospel of John. If Gnosticism is mainly a product of the 2nd century, it may preserve Christian elements which have been gnosticized and for the inexperienced eye appear to be Gnostic. So the influence of the learned *gnosis* of Valentinus, Rasilides and others upon Christianity seems to have been mainly negative:

1. They considered Christ primarily as the exclusive revealer, but they denied the reality and necessity of atonement. Therefore they very often negated the humanity of Christ, which led to so-called docetism (*q.v.*). Against this view the Fathers of the Church, especially Irenaeus, underlined the reality of the incarnation and stressed the importance of the work of Christ.

2. They denied the reality of the creation as the theatre of God's glory, and the place of fulfillment of his designs and of obedience to his commandments, thus rejecting the Old Testament. Against this the Fathers maintained the identity of Creator and Saviour and developed a theology of history.

3. They annulled the unity of the human race by dividing it into spiritual, psychic and material classes. This led the Fathers to extol free will and personal responsibility of each individual.

Thus the development of Christian doctrine was to a large extent a reaction against Gnosticism. Some Christians, however, especially Clement of Alexandria and Origen (*qq.v.*), tried to integrate Gnostic values into their own religion: Christ is the revealer of "true *gnosis*," pre-existent fall of the spirits, image of God in man, return of all to their spiritual origin. It was, however, more an atmosphere and a certain attitude than specific teachings that were adopted.

It is difficult to discern when and where the Gnostic movement was halted by the church. In Rome the Gnostics Valentinus and Cerdo as well as the semi-Gnostic Marcion (*q.v.*) were excommunicated as early as A.D. 150, but at the same time the Gnostics seem to have remained members of the church in Egypt. In the west the last remnants of Gnostic groups were dissolved in the 4th century only with the help of the state. In the Syrian east all sorts of Gnostic conventicles seem to have continued their existence and may even have influenced the Paulicians and so the Bogomils and Cathari (*qq.v.*) of the middle ages. Moreover, Gnostic Manichaeism spread in Asia as far as Turkistan and China. On the whole the history of extension and extinction of the Gnostic groups after the 4th century (with the exception of Manichaeism) remains largely unknown; therefore the relation of medieval Gnosticism (Catharism, Bogomilism, etc.) to ancient forms of *gnosis,* probable though it is, cannot be demonstrated with certainty.

After the opinions of the Gnostics had become known in the 16th century through the edition of the works of their opponents, the antiheretical Fathers, which contained large extracts from their teachings, and after the new appraisal of the heresies through the work of the German Protestant theologian Gottfried Arnold (in the late 17th century) and others, Gnostic ideas had a considerable influence upon such idealists as Goethe, Novalis and Hegel. The theosophical movement of the 20th century, with which Gnosticism has much in common, rightly claims the Gnostics as its spiritual ancestor (*see* THEOSOPHY). Jungian psychology, which owes not a little to this movement, can be of some help in interpreting Gnostic mythology and may help to show that behind it there is a religious experience of a certain type. Modern Gnosticism, however, is monistic, whereas ancient Gnosticism is basically dualistic.

See also references under "Gnosticism" in the Index volume.

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GNU, the large white-tailed south African antelope (*q.v.*), known to the Boers as the black wildebeest and to naturalists as *Connochaetes gnou.* A second and larger species is the brindled gnu or blue wildebeest (*Gorgon taurinus*) of central and east Africa; its horns are directed laterally instead of forward.

GO (I-GO), a skilled maneuver game for two players, probably Japan's most popular board game, originated in China as *wei-ch'i.* An ancient Chinese encyclopaedia attributes its invention to Wu Ts'an; other sources credit it to the emperor Gio in 2356 B.C. It is also attributed to the emperors Yan and Shun. It was reportedly brought to Japan in A.D. 735 by Kibi Dajin, where it became popular with both feudal lords and the common people. The Go institute was founded by the first national champion, Hon-inbō-Sansa; the earliest recorded game is dated A.D. 1253. Go is played on a square wooden board (*goban*) checkered by 19 vertical lines and 19 horizontal lines. It is played with about 180 black and 180 white *go-ishi* or flat, round "stones." Each player in his turn places a stone on the intersection of two lines (a *me*) which constitutes one unit of territory. The winner is the player who has conquered the largest territory by the establishment of a boundary made of his own "stones." Go demands great skill, strategy and patience, and is capable of infinite variety; yet the rules and pieces are so simple that children can play. Special handicap rules allow players of unequal skill to play together enjoyably. A modern Japanese Go association, founded in 1924, supervises tournaments, rules and players. Gobang was an English version of the 19th century. (P. FR.)

GOA, the name of the capital of former Portuguese India (Estado da Índia) and of the surrounding territory, which was more exactly described as Goa settlement, prior to its annexation by India in Dec. 1961. It is situated on the western coast of India about 250 mi. S. of Bombay. The population of the settlement in 1950 was 547,448, and the area, 1,394 sq.mi. Goa is bounded on the north by the Terakhul or Araundem river (beyond which is the Ratnagiri district of Maharashtra state), east by the Western Ghats, south by North Kanara district of Mysore state and west by the Arabian sea.

With Damão and Diu (*qq.v.*), Goa settlement formed a single administrative province ruled by a governor general, and a single ecclesiastical province subject to the archbishop of Goa, who is primate of the east and patriarch of the East Indies. There were legislative and executive councils which worked in collaboration with the governor. Goa settlement comprised the four districts conquered early in the 16th century (1510) and known as the Velhas Conquistas (Old Conquests); seven districts acquired later (Novas [New] Conquistas); and the island of Angediva or Anjidiv. The settlement, with a coast line of 62 mi., is hilly, especially in the Novas Conquistas, including a portion of the Western Ghats rising to nearly 4,000 ft. The two largest rivers are the Mandavi and the Juari, which together encircle the island of Goa (Ilhas), being connected on the landward side by a creek. The island is triangular, the apex (called the *cabo* or cape) being a rocky headland separating the harbour of Goa into two anchorages: Aguada at the mouth of the Mandavi on the north and Mormugão (Marmagão) at the mouth of Juari on the south. There are three cities in Goa: Old Goa, New Goa (Pangim) and Mormugão.

Old Goa is, for the most part, a city of ruins. The chief surviving buildings include the cathedral, founded by Affonso d'Albuquerque in 1511, rebuilt in 1623 and still used for public worship; the convent of St. Francis (1517), a converted mosque rebuilt in 1661 (with a portal of carved black stone), the only relic of Portuguese architecture in India dating from the first quarter of the 16th century; the chapel of St. Catherine (1551); the fine church of Bom Jesus (1594–1603) containing the shrine of St. Francis Xavier (*see* XAVIER, ST. FRANCIS); and the 17th-century convents of St. Monica and St. Cajetan. The college of St. Paul is in ruins.

Pangim (Panjim or New Goa), originally a suburb of Old Goa, is built (like the parent city) on the left bank of the Mandavi estuary. Pop. (1950) 31,950. It is a modern port and contains the archbishop's palace, government house and barracks; it has a medical school, teachers' training college and several secondary and primary schools. Pangim became the residence of the viceroy in 1759 and the capital of Portuguese India in 1843.

Mormugão, with its modern breakwater and quay and sheltered by the promontory of Salsette, is the best port between Bombay and Kozhikode (Calicut). A railway connects it (south of the Juari estuary) with Castle Rock on the Western Ghats and so with the Southern railway (narrow or metre gauge). Goa exports coconuts, fruit, spices, manganese and iron ores, fish and salt, but its trade is small and its manufactures few. Rice is the staple product, with fruit, salt, coconuts and betel nut.

The population of the Velhas Conquistas is largely Christian and that of the Novas Conquistas Hindu. The Christians generally speak Portuguese. The Hindus speak Konkani. Economic conditions in Goa caused emigration on a large scale, mainly to the eastern coast of Africa and to India. More than 1,000 persons left Goa every year and large Goanese colonies have consequently been formed in Bombay, Mozambique, Natal, etc. Many Goanese are partly of Portuguese descent and bear Portuguese names as a result of intermarriage between early Portuguese settlers and the local inhabitants. They inherit the seafaring habits of their ancestors and many find employment as stewards, etc., in liners.

History. — The ancient Hindu city of Goa, of which hardly a fragment survives, was built at the southernmost point of the island and it was famous in early Hindu legend and history. In the *Puranas* and certain inscriptions its name appears as Gove, Govapuri. Gomant, etc. The medieval Arabian geographers knew it as Sindabur or Sandabur and the Portuguese as Goa Velha. It was ruled by the Kadamba dynasty from the 2nd century A.D. to 1312 and by Muslim invaders of the Deccan from 1312 to 1367. It was then annexed by the Hindu kingdom of Vijayanagar and later conquered by the Bahmani dynasty, who founded Old Goa in 1440.

With the subdivision of the Bahmani kingdom after 1482, Goa passed into the power of Yusuf Adil Shah, the Muslim king of Bijapur, who was its ruler when the Portuguese first reached India. At this time Goa was important as the starting point of pilgrims from India to Mecca, as a market with no rival except Kozhikode on the west coast and especially as the centre of the import trade in horses (Gulf Arabs) from Hormuz. It was easily defensible by any power with command of the sea, and was attacked in March 1510 by the Portuguese under Albuquerque. The city surrendered without a struggle, and Albuquerque entered it in triumph.

Three months later Yusuf Adil Shah returned with 60,000 troops, forced the passage of the ford and blockaded the Portuguese in their ships from May to August, when the cessation of the monsoon enabled them to put to sea. In November Albuquerque returned with a larger force and, after overcoming a desperate resistance, recaptured the city, massacred all the Muslims and appointed a Hindu, Timoja, governor of Goa.

Goa was the first territorial possession of the Portuguese in Asia. Albuquerque and his successors left almost untouched the customs and constitutions of the 30 village communities on the island, only abolishing the rite of suttee (*q.v.*). A register of these customs *(Foral de usos e costumes)* mas published in 1526.

Goa became the capital of the whole Portuguese empire in the east. It was granted the same civic privileges as Lisbon. In 1542 St. Francis Xavier mentions the architectural splendour of the city; but it reached the climax of its prosperity between 1575 and 1600 The appearance of the Dutch in Indian waters was followed by the gradual decline of Goa In 1603 and 1639 the city was blockaded by Dutch fleets, though never captured, and in 1635 it was ravaged by an epidemic. In 1683 only the timely appearance of a Mogul army saved it from capture by Maratha raiders, and in 1739 the whole territory was attacked by the same enemies and only saved by the unexpected arrival of a new viceroy with a fleet. The seat of the government was moved to Mormugão and in 1759 to Pangim. Cholera epidemics were one of the chief reasons for the migration of the inhabitants from Old Goa to New Goa. Between 1695 and 1775 the population of Old Goa dwindled from 20,000 to 1,600 and in 1835 it was inhabited by only a few priests, monks and nuns.

During the 19th century events of importance affecting the settlement were its temporary occupation by the British in 1809 as a result of Napoleon's invasion of Portugal ; the governorship (1855–64) of Conde de Torres Novas, who inaugurated a great number of improvements, and the military revolts of the second half of the century. The most notable of these was the revolt of Sept. 3, 1895, which necessitated the dispatch of an expeditionary force from Portugal. The infante Affonso Henriques, duke of Oporto, accompanied this expedition and exercised governor's powers with the title of viceroy from March to May 1896.

After Indian claims on Goa in 1948 and 1949, Portugal came under increasing pressure to cede Goa, with its other possessions in the subcontinent, to India. A crisis was reached in 1955 when satyagrahis (nonviolent resisters) from India attcmptcd to penetrate the territory of Goa. At first the satyagrahis were deported, but later when large numbers attempted to cross the borders the Portuguese authorities resorted to force and casualties were inflicted. This led to the severance of diplomatic relations between Portugal and India on Aug. 18, 1955. Tension between India and Portugal came to a head when on Dec. 18, 1961, Indian troops supported by naval and air forces invaded and occupied Goa, Damão and Diu. The annexation of Portuguese India thus became a military fact.

Christianity. — Some Dominican friars came out to Goa in 1510, but no large missionary enterprise was undertaken before the arrival of the Franciscans in 1517. A Franciscan friar, João de Albuquerque, came to Goa as its first bishop in 1538. In 1542 Francis Xavier took over the Franciscan college of Santa FC for the training of native missionaries; this was renamed the College of St. Paul, and became the headquarters of all Jesuit missions in the east, where the Jesuits were commonly styled *Paulistas*. By a bull dated Feb. 4, 1557, Goa was made an archbishopric with jurisdiction over the sees of Malacca and Cochin, to which were added Macao (1575), Japan (1588), Angamale or Cranganore (1600), Meliapur (Mylapur; 1606), Peking and Nanking (1610), together with the bishopric of Mozambique, which included the entire coast of east Africa. In 1606 the archbishop received the title of primate of the east, and the king of Portugal was named patron of the Catholic missions in the east; his right of patronage mas limited by the concordat of 1857 to Goa, Malacca, Macao and certain parts of British India. The Inquisition was introduced into Goa in 1560; five ecclesiastical councils, which dealt wth matters of discipline, were held at Goa—in 1567, 1575, 1585, 1592 and 1606. By the concordat and missionary agreement with the Vatican (May 7, 1940), Goa recognized the lawful existence of the Catholic church and the exercise of its spiritual mission according to the canon law. The additional protocol signed on Sept. 25, 1953, made the archdiocese of Goa coincident with Portuguese India.

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GOALPARA, a town and district in the Brahmaputra valley of Assam, India. The town (pop., 1951, 10,192) stands on the left bank of the Brahmaputra, 75 mi. W. of Gauhati, with which it is connected by road. It was the frontier outpost of the Muslim power, and has long been a great centre of river trade. It has a college affiliated to Gauhati university. The town declined in importance after the district headquarters were removed to Dhubri in 1879.

GOALPARA **DISTRICT** covers an area of 3,983 sq.mi. Pop. (1961) 1,533,841. It is situated astride the Brahmaputra where the river bends southward from Assam into East Pakistan. Along the banks of the river grow clumps of cane and reed; farther back stretch fields of rice cultivation, broken only by the fruit trees surrounding the villages; and in the background rise the forest-clad hills overtopped by the white peaks of the Himalayas. The Brahmaputra annually inundates vast tracts of country. Extensive forests yield valuable timber and there are about 900 sq.mi. of reserved forest. Wild elephants, buffalo, boars. sambar and deer abound in the forest. Rice forms the staple crop of the district but jute is important in the flood plain, and pulses, mustard, tobacco, sugar and a little tea are also grown.

Dhubri (pop., 1951, 22,787), the administrative headquarters of the district, stands on the right bank of the Brahmaputra where that river takes its southward bend.

GOAT. Goats belong to the family of hollow-horned ruminants, or Bovidae (*q.v.*), and are members of the genus *Capra,* closely allied to the sheep. Domesticated goats are descended from the pasang (*Capra aegagrus*). Probably the east was its original home, the earliest records being Persian. *C. aegagrus* is probably represented in Europe by the Cretan and Cyclades races, now crossed with the common goat *(C. hircus)*. For other wild goats *see* IBEX; MARK-HOR; ROCKY MOUNTAIN GOAT; TAHR.

Products. — In China, Great Britain, Europe and North America the domestic goat is primarily a milk producer. By good management its limited breeding season and the consequent difficulty of maintaining a level supply of milk throughout the year can be largely overcome. For large-scale milk production, goats are inferior to cattle in the temperate zone but superior in the torrid or frigid zone.

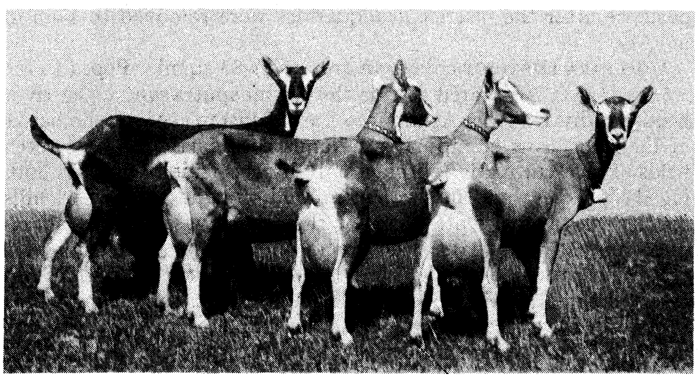
The goat is especially adapted to small-scale production of milk for the family table. One or two goats will supply sufficient milk for a family throughout the year and can be maintained economically in small quarters where it would not be practical to keep a cow.

Goat's milk is pure white in colour, and compares favourably with cow's milk in flavour and keeping qualities under sanitary conditions. It has certain characteristics differing from cow's milk which make it more easily digested by infants, invalids and persons allergic to cow's milk. The curds of goat's milk are much smaller, more flocculent and very soluble. The fat globules are smaller, finer, more easily assimilated and remain by nature in emulsion, so homogenization is unnecessary. These qualities explain why the goat has long been known in Europe as the "wet nurse" of infants. It has been estimated that the annual retail value of goat's milk sold in the United States is over $10,000,000. The retail price per quart varies from 40 to 55 cents. Large commercial dairies milk as many as 400 goats. Goat's milk is also used to make cheese. (For world production statistics *see* DAIRY INDUSTRY; MILK.)

The Angora and Cashmere goats produce wool or mohair (*q.v.*). *See* also CASHMERE. The flesh is edible, that from young kids being quite tender and more delicate in flavour than lamb, which it resembles. The goat has long been used as a source of milk, cheese, mohair and meat and its skin has been valued as a source of leather. (For world production and uses *see* LEATHER: *Sources* of *Hide and Skin Supply; Major Types of Leather.)* Goats are also used to keep sheep spread out and on the move.

Distribution and Kinds.—There are many breeds of goat, which may be roughly grouped: the prick-eared, *e.g.,* Swiss goats; the eastern or Nubian, with long drooping ears; and the wool goat, *e.g.,* Angora. While it is usually easy to distinguish goats from sheep, certain hair breeds of the latter are, to the layman. only distinguishable from goats by the direction of the tail, upward in goats, downward in sheep.

Of the Swiss goats, from which many of the best modern breeds are derived. the Toggenburg and Saanen are most important. The French breeds have much Swiss blood. In Germany the many



BY COURTESY OF MRS. CARL SANDBURG

FOUR TOGGENBURG DOES

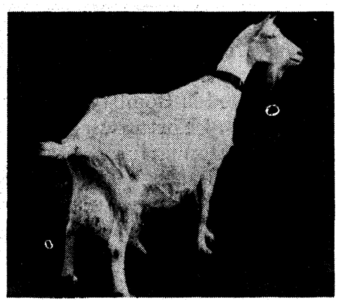
varieties trace to Swiss breeds. There are many goats of Swiss type throughout Scandinavia and the Netherlands, where they are held in high esteem.

The Maltese goat probably contains eastern blood and is an important source of milk on the island of Malta. Many goats are found in Spain, northern Africa and Italy, among them the Murcian. Grenada and La Mancha.

Nubians are African goats, chiefly Egyptian. They are usually large. short-haired goats with large lop ears and Roman noses. They may be of any solid colour, parti-coloured or spotted. The goats in Israel and Syria have long hair and large lop ears. Black, with or without white, is the commonest colour. Most Indian varieties have lop ears, the best coming from the Jumna river area.

In Britain the native goat was small, with short legs, long hair, usually gray but of no fixed colour and with no definite markings. The widespread use of pedigree males, mostly of Swiss extraction, to improve the milk yield, resulted in the almost total disappearance of the native types.

In 1896, a Jumna Pari (Indian) male goat (Sedgemere Chancellor) was imported by a British breeder. Since 1850 goats of Nubian and other lop-eared breeds had come to England in various ways. These eastern-type goats, variously described as Persian, Indian, Syrian, etc.. and characterized by long pendulous ears and convex facial outline, won prizes at shows and found public favour. With the importation of Chancellor, serious breeders took up the project of developing an improved Nubian-type goat. Eventually the Anglo-Nubian name was adopted for this made breed and a section of the herdbook established for registering approved progeny.



BY COURTESY OF MRS. CARL SANDBURG

SAANEN DOE

Interest in this new breed spread to the United States and in 1910 three Anglo-Nubians were imported, the first, of a long line of importations. In time this breed, its name shortened to Nubian, became one of the most popular goat breeds in the United States. In the second half of the 20th century about one-third of the goats registered annually by the American Milk Goat Record association were Nubians. The four breed clubs were the Alpine, Nubian. Saanen and Toggenburg. The record association handles registry. official testing and goat shows for all four breeds.

The goats of India, north Africa and Syria have been maintained since early times chiefly for their milk, and it is not surprising that Nubians have made fine milk records. In England a Nubian set a breed record with more than 4,250 lb. of milk in 365 days of lactation. This record compared favourably with a 305-day lactation record made in California by a Nubian which produced just under 4,250 lb. of milk and 185 lb. of butterfat.

In both England and the United States the Swiss breeds are considered, on the average, superior in quantity of milk produced, while the Nubians are known as leading in butterfat production. A Saanen goat in Great Britain produced more than 6,400 lb. of milk in 365 days of lactation. bearing out the reputation of the Saanen breed in its Swiss homeland and in the countries to which this breed has spread. In the U.S. a Saanen produced more than 4,900 lb. of milk and 180 lb. of butterfat; a Toggenburg produced more than 4,400 lb. of milk and 150 lb. of butterfat; and a French Alpine produced more than 4,600 lb. of milk and 130 lb. of butterfat. The last three records are for 305 days of lactation.

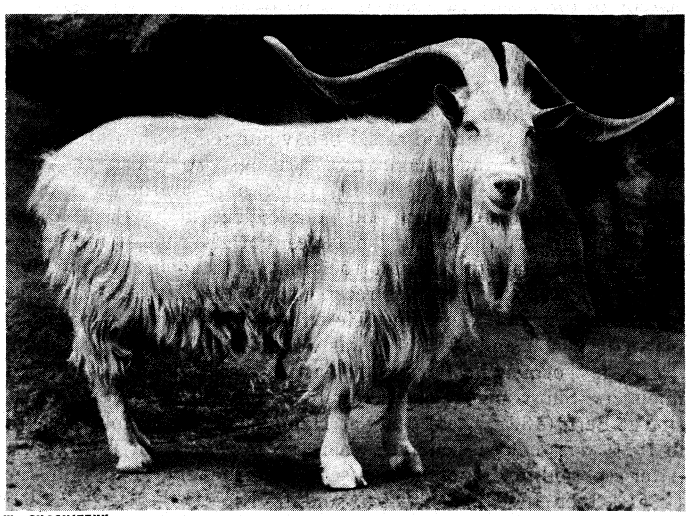
Of the wool goats there are two main types: the Angora, or Mohair, and the Cashmere, or Shawl, goat. Angoras have been established in South Africa, Australia, the United States and Canada. About three-quarters of the mohair produced in the United States comes from Texas. The Angora is a poor milker. The soft, silky hair covers the whole body and most of the legs with close-matted ringlets. If not shorn in spring the fleece drops off naturally as summer approaches. There is an undergrowth of short hair. The average weight of fleece is about $2\frac{1}{2}$ lb., though good specimens yield up to 12 lb. The Angora must have a dry climate and then stands cold well.

In the Cashmere, which is more like the common goat than the Angora, it is the undergrowth which is valuable. The longer the hair, the more abundant the fine undergrowth. These goats are rather small, with lop ears and twisted horns.

Husbandry.—Five dairy goats can be housed in a 10 ft. by 12 ft. shelter and will require less feed than one cow. They produce best on alfalfa or other leguminous hay as roughage, with a grain mixture coarsely ground of about 15% protein content. The subsistence ration for the dry doe is 1 lb. of grain daily. Milking goats are fed 1 lb. of grain daily, above the subsistence ration, for

3 lb. of milk produced. They should have free access to salt and water.

If they are kept dry, sufficiently exercised in fresh air and sunshine and intelligently fed, they are very hardy animals. If they are on pasture, or tethered, they should be moved frequently to fresh ground as a precaution against infestation by worms. They prefer browse to pasture, and goats that are stall-fed should have branches and leaves brought to them. They are relatively free from tuberculosis and goat's fever, or brucellosis (*q.v.*), in the



W. SUSCHITZKY

COMMON GOAT (CAPRA HIRCUS)

United States and Great Britain. The diseases and parasites that affect goats and sheep are discussed in the article SHEEP.

The normal lifespan of a goat is 8 to 12 years. They average two kids in a litter. Triplets are very common and quadruplets and quintuplets are occasionally dropped.

The female goat, variously called "Nanny" or "Doe," is ready for the male ("Billy" or "Buck") between September and February, during which time they come in heat every three weeks. The gestation period is 21-22 weeks. Goats are sexually mature at 6 months, but it is unwise to mate females before they are 15 months old, and a male should be used sparingly until 12 months old.

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(H. E. J.; M.L.F.; L. P. SG.)

GOATSUCKER: *see* NIGHTJAR.

GOBAT, CHARLES ALBERT (1843–1914), Swiss philanthropist and worker for international peace, awarded the Nobel peace prize in 1902 jointly with his compatriot Elie Ducommun, was born at Tramelan in the Bernese Jura, on May 21, 1843. After studying at Basel, Heidelberg and Paris, he took his degree in law and set up practice in Berne. Concurrently he lectured on French civil law at the Paris Sorbonne. On transferring his office to Delémont, he took an increasingly active part in local government and public administration. He was elected to the cantonal council in 1882, presided over the government board of Berne in 1886 and 1887, and in 1884 was elected to the national council. In 1890 he became a member of the Swiss federal council.

Gobat was president of the fourth conference of the Inter-Parliamentary union held at Berne in 1892. In this capacity he helped to found its permanent bureau. Henceforth, for more than 20 years, the work of the bureau absorbed his time and his energy, and in 1906 Gobat succeeded Ducommun as director. He wrote several books on international affairs and on history, including *Le Cauchemar de l'Europe* (1911). He died at Berne on March 16, 1914. (L. R. A.)

GOBAT, SAMUEL (1799–1879), second Anglican bishop in Jerusalem, was born at Crémines, Bern, Switz., on Jan. 26, 1799. Trained as a missionary in Basel, Paris and London, he was sent by the Church Missionary society overseas, chiefly to Ethiopia. He became widely known as a missionary and linguist.

The Jerusalem bishopric had been founded as a joint Anglo-Prussian venture in 1841, on the suggestion of Frederick William IV of Prussia, to protect Protestant Christians in the middle east and to combine a united Protestantism with the Orthodox Eastern Church to counteract Roman Catholic influence in Jerusalem. Efforts were to be made to convert Jews but not members of other Christian churches. Co-operation between Anglicans and Lutherans was uneasy, since Tractarians in England disliked working with a nonepiscopal body and German Protestants opposed any form of episcopate.

On the death in 1845 of Michael Alexander, first Anglican bishop. it became the turn of the Prussian crown to nominate a successor. and Frederick William chose Gobat, who was consecrated in 1846. He was allowed some latitude in applying the canons of the Church of England but disregarded the terms of his appointment in proselytizing, particularly from the Orthodox Church, which caused bitter controversy at a time of deteriorating political relations. From 1851 Gobat was aided by the Church Missionary society in establishing schools and in starting medical work among the Muslims. He died in Jerusalem, May 11, 1879. In 1886 the connection with the Lutheran Church ended and the reconstructed bishopric became fully Anglican.

See *Samuel Gobat, His Life and Work*, Eng. trans. *by* S. M. S. Clarke (1884). (J. D. TA.)

GOBEL, JEAN BAPTISTE JOSEPH (1727–1794), archbishop of Paris and Hébertist, was born at Thann, Alsace, on Sept. 1, 1727. He became suffragan bishop of the French port of the diocese of Basel. As deputy to the states-general of 1789 he took the oath of the civil constitution of the clergy, and in 1791 was consecrated archbishop of Paris. On Nov. 7, 1793, he came before the bar of the Convention and resigned his episcopal functions, proclaiming that he did so for love of the people, and through respect for their wishes. The followers of J. R. Hébert (*q.v.*), who were then pursuing their "worship of reason," claimed Gobel as one of themselves, and he was thus involved in the fate of the Hébertists, being condemned to death with P. G. Chaumette, Hébert and Anacharsis Cloots. He was guillotined on April 12, 1794.

See G. Gautherot, *Gobel, évêque métropolitain constitutionnel de Paris* (1911).

GOBELIN, the name of a family of dyers and clothmakers who probably came from Reims and in the middle of the 15th century established themselves in the Faubourg St. Marcel, Paris. The first head of the firm, named Jehan (d. 1476), discovered a scarlet dyestuff and spent so much on his establishment that it was named *la folie Gobelin*. In the third or fourth generation some of the family purchased titles of nobility. Balthasar Gobelin (d. *c.* 1617), who became successively treasurer general of artillery, treasurer extraordinary of war, councilor secretary of the king, chancellor of the exchequer, councilor of state and president of the chamber of accounts, in 1601 received from Henry IV the lands and lordship of Brie-Comte-Robert. The name of the Gobelins as dyers cannot be found later than the end of the 16th century. In 1601 the Gobelins lent their works to Henry IV, who set up there 200 workmen from Flanders, to make tapestries; in fact the Gobelin family had never produced any tapestry.

In 1662 the works in the Faubourg St. Marcel were purchased by Colbert on behalf of Louis XIV and transformed into a general upholstery manufactory, in which designs were executed under the superintendence of the royal painter, Charles le Brun. The establishment, closed in 1694, was reopened in 1697 for the manufacture of tapestry, chiefly for royal use and presentation.

The industry, suspended during the Revolution, was revived by Napoleon; in 1826 the manufacture of carpets was added.

See also LE BRUN, CHARLES; TAPESTRY.

GOBI, one of the world's largest deserts, mostly in the Mongolian People's Republic and the Inner Mongolian Autonomous Region of China and covering parts of the province of Kansu and the Ningsia Hui Autonomous Region. It occupies a vast arc of land in the Mongolian plateau, 300–600 mi. wide and over 1,000 mi. long, running southeast from the eastern borders of Chinese Turkistan and the Mongolian Altai, and then east and northeast to the Hsing-an (Khinghan) mountains of Manchuria. The south slopes of the Khangai mountains in central Outer Mongolia (Mongolian People's Republic) bound it in the north and the plateau of Tibet and the Ho-lan Shan (Ala Shan) and Yin Shan ranges in the south.

The term Gobi desert often has not been well defined. At times it has been applied to all the desert and semidesert lands east of the Pamirs and north of the plateau of Tibet and the Great Wall. Properly, the Tarim (including Takla Makan; *q.v.*) and Dzungarian basins of Chinese Turkistan are separate from the Mongolian Gobi, as is the Ordos desert south of the Yin Shan. Gobi to the Mongol refers to the level, alkaline, often marshy and sometimes grassy bottoms of the broad, shallow basins which the Mongols call *tals*. Gobi is thus associated with basin structures believed to have been scoured out by the wind and is descriptive of terrain. By transference, the term Great Gobi or Gobi desert has come to be applied to the area here defined. Although the Gobi surface is a plateau with an altitude of about 3,000 ft. in the east and about 5,000 ft. in the west and south, the bounding mountains on all sides give it a basin character. In addition to the low swells separating the basins in the Gobi desert, its surface is interrupted occasionally by worn, flat-topped folded ranges and in the west by the complex uplifted fault blocks of the Altai which extends at diminishing altitude into the Gobi.

Sometimes in the plains. the edges of the sedimentary strata are exposed to view. and these form the great fossil fields of Mongolia, indicating that a change has occurred from a past humid climate to the present desert state. Lakes such as the Ulan Nuur, Orog Nuur and Boon Tsagaan Nuur northwest of Dalan Dzadagad in Outer Mongolia are only a small fraction of the size that elevated strand lines show they once were. Several culture horizons have been distinguished in the Gobi area. Finds have been made of relics representing Eolithic, Upper Paleolithic, Azilian, Neolithic and Metallic cultures.

The Chinese term sha-mo (sand desert) often applied to the Gobi gives a misleading impression of its character, for only small sections of the Gobi comprise sandy or dune deserts. Much of it is of bare rock over which one can drive by car easily for long distances in any direction. Toward the north and southeast of the desolate centre, the precipitation gradually increases from 1 or 2 in. to 6 or 8 in. Scattered bunch grass appears, then the short grass steppe grazed by livestock watered from wells or at rare streams. Such streams entering the Gobi are seasonal in their flow. The largest in the eastern Gobi is the Kerulen (Hereleng) which flows out of the Henteyn Kuruu (Khentei mountains) and diminishes in volume to terminate in Hu-lun Chih (Hulun Nuur), but during floods may continue on to become a tributary of the upper Amur. Flowing into the Gobi from the Tibetan rim lands in the south and irrigating oases are the branching O-Chi-na Ho (Etsin Gol) and, farther west, the Su-lo Ho. Gobi rivers terminate in salt lakes or disappear in the sand. Trees are almost nonexistent, although xerophytic shrubs such as saxaul may be found as well as stunted willows and tamarisk near streams and wells. Although the water table is high and water often may be found within 20 ft. of the surface, the water may be brackish. In the Gobi Altai which rises to over 9,300 ft. and in other similarly high mountains, desert steppe grass covers the entire lower two-thirds of the slopes. Above this, there appears a mountain variant of feather grass.

The animal life of the Gobi include the Djejran gazelle and the Dzeren antelope. Marmots or ground squirrels feed on grass seeds, and their holes are numerous in the steppelands. Sheep and goats are the most important domestic animals, constituting 57% of the total, followed by cattle (24%). Horses form only about 4% and with the cattle are concentrated in the moister southeast. Some 15% are the two-humped camels that comprise the desert transport animals. In the southeast, Chinese farmers long have invaded the nomad grasslands. Under the Communist regime nomad and farmer alike were regimented. State directed collectives were organized both in Outer Mongolia and in the Inner Mongolian Autonomous Region for livestock breeding and, in the latter, in mechanized farming. The Chinese Communist collectives were changed to communes in 1958, the latter being similar in character to the former state farms.

Soviet-Mongol exploration located coal deposits at Tawan-Tolgoi and an oil field at Sayn Shanda on the Trans-Mongolian railroad. In the western Gobi, exploitation of the Yu-men oil field was expanded by the Chinese Communists in the late 1950s. The extension of the Kansu railroad to the oil field brought large population increases to the oases towns in the southwest Gobi sections of the Kansu corridor. *See* also MONGOLIA. (*H. J. Ws.*)

GOBINEAU, JOSEPH ARTHUR, COMTE DE (1816–1882), French man of letters who in his career as a diplomat formed ideas on social and racial behaviour reflected in his ethnological, historical and imaginative writings, was born at Ville-d'Avray, near Paris, on July 14, 1816, of a Bordeaux family. Educated by private tutors and at a college in Switzerland, he developed an enthusiasm for languages, both European and oriental, and, after failing to enter the military academy at St. Cyr, settled in Paris, where he was received into the aristocratic circles of the Faubourg St. Germain. He wrote some *romans-feuilletons,* married (1845) and, in 1849, was appointed *chef de cabinet* by Alexis de Tocqueville during the latter's brief period as foreign minister. Subsequently he was first secretary to the French legation at Bern (1851), held posts at Hanover and at Frankfurt and, in 1855, was sent to Teheran, where he remained for four years. After a period in France he was sent hack to Teheran as minister (1861), then to Athens (1864) and to Rio de Janeiro (1869). Absent without leave in 1870, he witnessed the France-German War and the Paris Commune. His last diplomatic post was at Stockholm (1872). His liaison with the comtesse de La Tour (Marie Mathilde Ruinart), separating him from his wife and children, led to his retirement in 1877. Thenceforward he lived mainly in Italy. He died at Turin on Oct. 13, 1882.

Gobineau's reputation as a writer has passed through two phases. At first he was acclaimed as an ethnologist for his *Essai sur l'inégalité des races humaines,* 4 vol. (1853–55; partial Eng. trans., *The Moral and Intellectual Diversity of Races,* 1856, and *The Inequality of Human Races,* 1915). In the second half of the 20th century, however, he was chiefly respected for a novel, *Les Ple'iades* (1874; Eng. trans., *The Pleiads,* 1928). The *Essai* proposed that Aryan racial purity could be maintained only by the preservation and strengthening of its Nordic strains. This theory became fashionable in German intellectual circles, and its latent anti-Semitism was exaggerated to produce that *gobinisme* which Gobineau himself regarded as a distortion of his views.

In the years that followed the appearance of this essay Gobineau had the liberating experience of Persia. He continued to be the gifted amateur, publishing such works as the *Traitk des écritures cunéiformes,* 2 vol. (1864), and the *Histoire des Perses,* 2 vol. (1869). The formative influence on him, however, was *The Thousand and One Nights,* from which he took over the figure of the "king's son," using it as the central inspiration of *Les Ple'iades:* "the book of an aristocrat," he wrote, "which opposes the conversation of exceptional beings to the confused clamour of the masses." The three young men, his heroes, are "king's sons"; they travel, they converse, they tell each other stories and they are happy. Apart from *Les Ple'iades,* the best works of Gobineau's last years were *Souvenirs de voyage* (1872; Eng. trans., *The Crimson Handkerchief,* 1929), *Les Nouvelles asiatiques* (1876; Eng. trans.. *The Dancing Girl of Shamakha,* 1926, and *Tales of Asia,* 1947) and *La Renaissance* (1877; Eng. trans., 1913 and 1928), the latter a volume of dialogues in which, through such figures as Cesare Borgia and Michelangelo, Gobineau proclaimed his unchanging creed of individualism. There are critical editions of *Les Pléïades* and of *La Renaissance* by Jean Mistler (1946 and 1947).

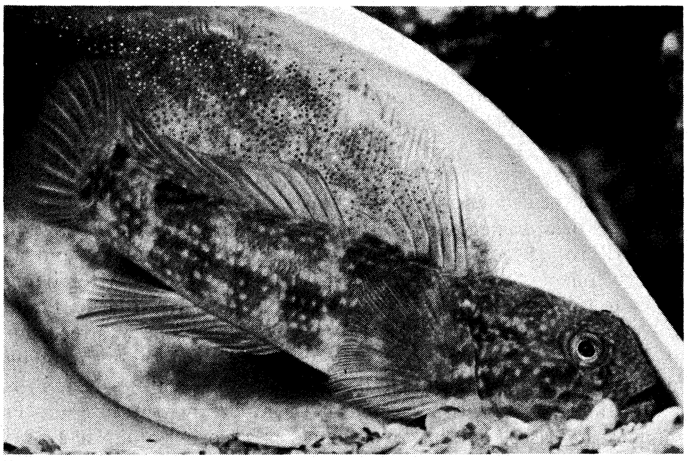
GOBLET, RENÉ (1828–1905), French politician, was born at Aire-sur-la-Lys, Pas de Calais, Nov. 26, 1828, and was educated for the law. He held a minor government office in 1879, and in 1882 became minister of the interior in the Freycinet cabinet He was minister of education, fine arts and religion in Henri Brisson's first cabinet in 1885, and again under Freycinet in 1886 He sat in the chamber on the extreme left. All through his life he mas frequently in conflict with his political associates, from Gambetta donnnard.

On the fall of the Freycinet cabinet in December he formed a cabinet in nhich he reserved for himself the portfolios of the interior and of religion The Goblet cabinet was unpopular from the outset, and it was with difficulty that anybody could be found to accept the ministry of foreign affairs which was finally given to Flourens.

Then came what is known as the Schnaebele incident, the arrest on the German frontier of a French official named Schnaebele, which caused immense excitement in France. For several days Goblet took no definite decision, but left Flourens, who stood for peace to fight it out with General Boulanger, then minister of war, who nas for the dispatch of an ultimatum. Although he finally intervened on the side of Flourens. and peace was preserved his neakness in face of the Boulangist agitation became a national danger.

Defeated on the budget in May 1887, his government resigned. In 1888 he nas foreign minister in the radical administration of Charles Floquet. He was defeated at the polls by a Boulangist candidate in 1889, and sat in the senate from 1891 to 1893, when he returned to the popular chamber. He died in Paris on Sept. 13, 1905.

GOBY, generally. any one of a numerous group—the Gobioidei —of largely marine and warm-water spiny-rayed fishes. characterized by having a few (usually six) flexible spines in the separate first dorsal fin: the pelvic fins are either set close together (in the family Eleotridae, known as "sleepers") or united into a sucking disc (in the Gobiidae, or gobies proper). Most of the several hundred known species range in length from one to four inches,



W N TAVOLGA

MALE FRILLFIN GOBY (BATHYGOBIUS SOPORATOR) GUARDING EGGS ATTACHED TO AN EMPTY BIVALVE SHELL

but a few of the sleepers exceed one foot; some, like *Pandaka pygmaea* of the Philippines, are the smallest known vertebrates. only about one-half inch long. Male gobies guard encapsulated oval eggs, which are attached at one end by short adhesive threads, in a layer on discarded shells or in crevices. Most gobies are bottom dwellers; many. *e.g., Bathygobius* species, are limited to the edge of tropical shores.

Well-known species include: a ten-inch rock-pool inhabiting species of Europe, *Gobius capito;* the mudskippers (*Periophthalmus*), bulging-eyed little fishes that inhabit mud Bats around the Indian ocean and the East Indian region, usually resting with the front parts out of water; the very hardy, burrow-inhabiting mudsucker, or long-jawed goby (*Gillichthys mirabilis*), the chief bait fish of southern California, with the upper jaw prolonged in the adult to beyond the gill opening; and a blind, pink species, *Typhlogobius californiensis,* which lives with a blind shrimp (a *Callianassa* species) in burrows under stones between tide marks along the shores of southern California. *See* also FISHES: *Sculpin-Like Fishes and Gobies.* (C. L. Hs.)

GOD, the common Teutonic word for a personal object of religious worship. It is thus, like Gr. *Theos* and Lat. *deus,* applied to all superhuman beings of heathen mythologies who exercise power over nature and man; and also to images of supernatural beings or trees, pillars, etc., used as symbols.

The word "god," on the conversion of the Teutonic races to Christianity, was applied to the one Supreme Being, and to the Persons of the Trinity.

Popular etymology has connected the word with "good." This is exemplified by the corruption of "God be with you" into goodbye. In Gothic it is *Guth;* Dutch has the same form as English; Danish and Swedish have *Gud,* German *Gott.* According to the *Oxford* English *Dictionary,* the original may be found in two Aryan roots, both of the form *gheu,* one of which means "to invoke," the other "to pour"; the last is used of sacrificial offerings. The word would thus mean the object either of religious invocation or of religious worship by sacrifice.

See RELIGION; JUDAISM; THEISM; etc.

GOD, CHURCHES OF, a group of 20 or more pentecostal denominations that developed from the so-called Latter Rain revival early in the 20th century. They adhere to the ultraconservative or fundamentalist theology, including holiness as a work of grace subsequent to conversion or justification, and "speaking in other tongues as the Spirit gives utterance."

The revival began in the Great Smoky mountains in 1886 under the leadership of R. G. Spurling and his son, Baptists, and W. F. Bryant, a Methodist. It was taken over by A. J. Tomlinson, a colporteur, who convened an assembly in 1906 at Camp creek in Cherokee county, N.C. Two years later he established headquarters at Cleveland, Tenn., under the name of Church of God. He promoted the movement with vigour, and churches were established in various parts of the country.

Splits began to occur in 1917 when the Chattanooga congregation seceded and took the name of the Original Church of God. Other divisions followed and numerous independent groups mere formed. The causes were not theological but were due to rivalries among local leaders and opposition to Tomlinson's absolute power as general overseer. He was virtually deposed in 1922.

On Tomlinson's death in 1943 disputes between his sons led to further schisms. Homer A. Tomlinson set up the Church of God, World Headquarters, at Queen's Village, N.Y., and his brother became head of the Cleveland group known as the Church of God Over Which M. A. Tomlinson Is General Overseer. Another Cleveland body is the Church of God (Cleveland, Tenn.), called the Elders' Church, from the form of government by a committee of elders.

Among the sects growing out of the Tomlinson movement are the Mountain Assembly Church of God; Church of God. Incorporated; Church of Jesus; Bishop Poteat's Church of God; Bible Church of God; Jesus and Watch Mission; Churches of Our Lord Jesus Christ of the Apostolic Faith; Remnant Church of God; Apostolic Church of Jesus Christ; Non-Digressive Church of God; Justified Church of God; Holstein Church of God; Church of God of the Bible; Glorified Church of God; and several others.

The Church of God (Anderson, Ind.) is not a pentecostal body and repudiates speaking in unknown tongues. The Church of God (Oregon. Ill.) is an Adventist body.

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(E. T. CL.)

GODALMING, a municipal borough of Surrey, Eng., lies across the river Wey on the old London-Portsmouth road, 33 mi. S.W. of London by road. Pop. (1961) 15.771. It is a residential town with an attractive shopping centre in the rather crowded High street. The church of SS. Peter and Paul is principally Early English and Perpendicular, built of local Bargate stone which is no longer quarried. A fine old group of almshouses, dating from 1622, is administered by the Carpenters' company. Westbrook house, home of Gen. James Edward Oglethorpe, founder of the colony of Georgia, is now the Meath Home for Incurables. The old town hall, built in 1814 on the site of market house, is now a local history museum. Public open spaces include the Phillips Memorial ground, with a cloister to the memory of Jack Phillips, wireless operator of S.S. "Titanic." Charterhouse school, 1 mi. N. of Godalming, was transferred from Charterhouse square, London, in 1872 and has 120 ac. of grounds with spacious buildings in the Gothic style. *(See* also CHARTERHOCSE.) Godalming's industries include woolen manufactures and light engineering.

Local excavations have revealed evidences of a former Romano-British settlement. Godalming (Godelminge) belonged to King Alfred and was a royal manor at the time of Domesday. It was granted to the see of Salisbury by Henry II but reverted to the crown in the reign of Henry VIII. In 1563 it was constituted a market town by Elizabeth I who granted it a charter of incorporation with powers to hold a market, annual fair and a court of piepowder or piepoudre (a summary court of record formerly held at fairs and markets to administer justice in transactions) in 1575. This charter was confirmed in 1620 and a new charter granted by Charles II in 1666. Extensions were made to the borough in 1892, 1928 and 1933. (S. C. D.)

GODARD, BENJAMIN LOUIS PAUL (1849–189j), French composer of operas. light piano pieces and songs. Born in Paris, Aug. 18, 1849, he was a child prodigy on the violin. He studied composition under Henri Réber and in his youth wrote symphonies, concertos, chamber music and piano pieces. His opera, *Pédro de Zalaméa* (1884), was produced at Antwerp, and his *Symphonie legendaire,* Op. 100, was performed in Paris in 1886. His other operas include *Jocelyn* (1888), long-known for its "Berceuse," and *Lu Vivandière* (1895). Godard's music is slender and sentimental, showing at its best an affinity with Chopin and Schumann. He died of tuberculosis at Cannes, Jan. 10, 1895.

See M. Clavie, *Benjamin Godard* (1905). (E. LR.)

GODAVARI, a river of central India, flows across the northern Deccan from the Western Ghats to the Bay of Bengal. Its source is within 80 mi. of Bombay. near the Thal Ghat where the main railway from that city to the lower Ganges basin crosses the Ghats. Its general course is somewhat south of east. With its main southern tributary, the Manjra, it drains the larger part of the former state of Hyderabad, now partly in Maharashtra, partly in Andhra Pradesh. Near the 80th meridian it is joined by the Pranhita bringing from the north the drainage of the Mahadeo hills. Above this point the main river flows in a wide valley and frequently breaks up into several channels. At the Pranhita junction it leaves the lava plateau country and enters a trough of easily eroded rocks that extends to the sea. It is this feature which accounts for the wide break in the Eastern Ghats and the great depth of the coastal plain at the mouths of the Godavari and Krishna. Sixty miles from the sea it leaves the trough and breaks through the Ghats in a magnificent gorge only 200 yd. wide. The extensive delta is virtually continuous with that of the Krishna and is connected with that river by canal.

The upper river is almost dry during winter and spring and is almost useless for irrigation. The delta on the other hand is one of the richest rice-growing regions in India. The water is derived from the Godavari by an anicut—a low dam directing the stream flow into the head of the canal system. The Godavari is one of the rivers sacred to Hindus. (T. HER.; L. D. S.)

GODAVARI, EAST AND WEST, two districts of Andhra Pradesh, India, which were formerly part of Madras, comprising three dissimilar natural regions: the Agency tract in the northwest, underdeveloped and infertile; the exceedingly rich and fertile delta of the Godavari along the coast which is the largest rice granary of south India; the intermediate upland taluks. The Godavari river, after which they are named, divides the districts. Forty miles from the sea, at Dowlaishwaram, is the famous anicut (dam) nearly $2\frac{1}{2}$ mi. in length, constructed by Sir Arthur Cotton in 1890, which has made the delta a perennial rice field.

At the beginning of the 16th century this region was overrun by the Muslims. At the end of the struggle with the French in the Carnatic, Godavari with the Northern Circars was conquered by the British and finally in 1765 ceded to them, except for the small territory of Yanam (6 sq.mi.) which remained a French possession till 1954, when it was transferred to India. The districts were created in 1925 from the old Godavari and Krishna districts.

EAST GODAVARI district has an area of 5.773 sq.mi. and a population (1961) of 2,609,311. The present headquarters. Kakinada, lies on one of the mouths of the river, while Rajahmundry was the old capital. The port facilities at Kakinada are poor because of the heavy silting of the Godavari and ships must lie several miles offshore. There is an engineering college and a medical college. Rajahmundry has also an arts college, a government training college and two oriental colleges (one exclusively for women), all affiliated to Andhra university. At Samalkot, in the heart of the sugar-growing tract of the delta, is a large distillery and sugar refinery.

WEST GODAVARI district has an area of 2,988 sq.mi. and a population (1961) of 1,978,434. The district was carved out of the Krishna district in 1925. Its capital is at Eluru, noted for its woolen carpets, the dyes and wool for which are produced locally. Both districts were once famous for the manufacture of fine cotton cloths, especially saris, at such centres as Peddapur in East Godavari and Palakollu. (G. KN.)

GODDARD, CALVIN HOOKER (1891–1955), U.S. army officer, military historian and criminologist who is chiefly remembered for his pioneering work in scientific crime detection and for his writings on the history of firearms, was born in Baltimore. Md., Oct. 30, 1891. He graduated from the Johns Hopkins University school of medicine in 1915, served with the U.S. army medical corps in World War I (becoming a major in 1918), with the ordnance department in World War II, and with the corps of military police in the Korean war. He was promoted to the rank of colonel in 1950. A lifelong interest in guns. combined with medical knowledge, qualified Goddard as an expert witness in many famous legal cases of the 1920s and led him in 1930 to organize a scientific crime detection laboratory in Chicago, 111. He developed instruments and techniques for identifying the weapon from which a given bullet was fired. A talented writer, he contributed scores of articles to military and scientific publications. He died in Washington. D.C., on Feb. 22, 195j. (H. C. T.)

GODDARD, RAYNER GODDARD, BARON, OF ALDBOURNE (1877–), lord chief justice of England whose work in controlling the crime wave that followed World War II was of outstanding social importance at that time. He was born in London on April 10, 1877, and educated at hlarlborough college and at Trinity college, Oxford, where he graduated in 1898. After being called to the bar at the Inner Temple he became recorder of Poole in 1917 and took silk in 1923. From 192j to 1928 he was recorder of Bath, and from 1928 to 1932 recorder of Plymouth, being raised to the bench as a judge of the high court (king's bench division) in 1932. At the bar his most important practice was in commercial cases. but his experience as recorder doubtless laid the foundation of his wide knowledge of the criminal law, with which the general public learned chiefly to associate his name. In 1938 Goddard became a lord justice of appeal and in 1944 a lord of appeal in ordinary, being also in that year created a life peer. The most distinguished part of his career, however. started when, in 1936 and near an age when many judges contemplate retirement, he was appointed lord chief justice. He found himself confronted with a wave of crime following the end of World War II. and, by a combination of a certain measure of severity with a scrupulous regard for legal proprieties, he was the inspiration of the judiciary and magistracy in bringing this situation under control. He retired in 1958. (W. T. WS.)

GODDARD, ROBERT **HUTCHINGS** (1882–1945), the father of American rocketry. was born Oct. j, 1882, at Worcester, Mass. As a student at Worcester Polytechnic institute he began to speculate on means of reaching the fringes of outer space by the use of rockets. After taking his Ph.D. at Clark university in Worcester in 1911 he became a member of the Clark faculty and later attained the rank of full professor.

In 1919 the Smithsonian institution published Goddard's now classic report entitled "A Method of Reaching Extreme Altitudes" and provided funds for his rocket research. During the 1920s he turned from solid to liquid propelianrs and in 1926 fired his first liquid fuel rocket. Supported by Clark university and the Guggenheim foundation. he continued his experiments with liquid fuel rockets and gyroscopic controls at a desert site near Roswell. New Mexico. He demonstrated that rockets operated in a vacuum as well as in air and developed the theory of step rockets consisting of several stages as a means of reaching the moon. Progress was slow and few people recognized the potential importance of his work.

During World War II the U.S. naw employed Goddard to develop missile motors and jet-assisted take-off devices (JATOs) for aircraft and moved his laboratory to Annapolis, Md. He was engaged in this work at the time of his death on Aug. 10, 1945. Goddard deplored the use of rockets as military weapons but foresaw clearly the possibility of the rocket as a means of extending man's knowledge of the universe.

See Robert *H.* Goddard, *Rocket Development,* ed. *by* Esther C. Goddard and G. Eduard Pendray (1948). (S. P J.)

GODDARD AND TOWNSEND, tuo families of cabinetmakers of Newport, R.I.. during the 17th and 18th centuries. Both families were Quakers of English ancestry and they intermarried. In four generations, 20 Goddard and Townsend craftsmen are known, and the high point of their excellent productivity was reached during the early and mid-18th century. These cabinetmakers were especially noted for furniture in the Queen Anne and Chippendale styles, identified by an original type of shell carving, and a surface treatment called blocking No exact European prototypes existed for their innovations. Many of the best-known pieces. high chests of drawers and secretary bookcases, generally executed in mahogany from the West Indies or South America, have well-documented histories.

Noted individual craftsmen were Christopher Tounsend (1701–1792) and his son John (1732–1809); Job Townsend (1699–1765) and his sons Job, Jr. (1726–1778), and Edmund (1736–1811); and John Goddard (1724–178j) and his son Townsend (1750–1790).

See Wendell *D.* Garrett, "The Newport Cabinetmakers a Corrected Check List," *Antiques,* 73:558–561 (June 1958). (J. T. Br)

GODEFROY (Gothofredus), a French noble family which numbered among its members several distinguished jurists and historians. The family claimed descent from Symon Godefroy. who was born at Mons about 1320 and was lord of Sapigneulx near Berry-au-Bac, now in the *département* of Aisne.

Denis Godefxoy (Dionysius Gothofredus; 1549–1622), jurist, son of Léon Godefroy, lord of Guignecourt, was born in Paris on Oct. 17. 1549, and died at Strasbourg on Sept. 7, 1622. He studied law in the Low Countries and in Germany, and embraced Calvinism. This change of faith led to his residence abroad, first at Geneva (1580–89), where he became professor of law, and then at Heidelberg (1600), where he was head of the faculty of law and was employed from time to time on diplomatic missions by the Elector Palatine. His most important work u-as the *Corpus juris civilis* (Geneva and Lyons. 1583), which went through 20 editions. the most valuable of them being that printed by the Elzevirs at Amsterdam in 1663 and the Leipzig edition of 1740.

His eldest son, Théodore Godefroy (1580–1649), was born at Geneva on July 17, 1580. He abjured Calvinism and was called to the bar in Paris. He became historiographer of France in 1617 and was employed from time to time on diplomatic missions. He was employed at the congress of Miinster. where he remained after the signing of peace in 1648 as chargé d'affaires until his death on Oct. 5 of the next year.

The second son of Denis, Jacques Godefroy (1587–1652), jurist, was born at Geneva on Sept. 13. 1587. He was educated in France but returned to Geneva, where he held various important public offices. He died on June 22, 1652. His edition of the *Codex Theodosianus* (4 vol., Lyons, 1665; 6 vol., Leipzig. 1736–45), on which he worked for 30 years, became a standard authority on the decadent period of the western empire. Jacques Codefroy was held to be the most learned jurist of his time. Among his numerous other works were several dealing with historical and political questions.

Denis Godefroy (1615–81), eldest son of Théodore, succeeded his father as historiographer of France.

GODFREY of Bouillon (Godefroy de Bouillon) (*c.* 1060–1100), a leader in the first crusade, was the second son of Eustace II, count of Boulogne, by his marriage with Ida, daughter of Duke Godfrey II of Lower Lorraine. He was designated by Duke Godfrey as his successor; but the emperor Henry IV gave him only the mark of Antwerp, in which the lordship of Bouillon was included (1076). He fought for Henry. however, both on the Elster and in the siege of Rome, and he was invested in 1082 with the duchy of Lower Lorraine. His career as duke was not especially distinguished, hut he seems to have been notably pious. and when the first crusade was preached, he soon joined the expedition at considerable personal sacrifice. He sold to the bishop of Verdun his rights and possessions in that county and pledged his county and castle of Bouillon to the bishop of Liège.

Godfrey began his march in Aug. 1096. Accompanied by his brothers Eustace and Baldwin (the future Baldwin I of Jerusalem, *q.v.*) he led a body of perhaps 15,000 crusaders from the lands of the Meuse and the lower Rhine. He took the route through Hungary and the Balkans and arrived at Constantinople on Dec. 23, 1096. As the first of the crusading princes to arrive he had the difficult problem of reaching a satisfactory relationship with the emperor Alexius. Godfrey was at first unwilling to swear the oath of allegiance that the emperor required, but was prevailed upon to do so in April 1097. His example was followed by the other princes. From this time until the beginning of 1099 Godfrey appears as one of the minor princes, while men like Bohemund and Raymond, Baldwin and Tancred were determining the course of events.

In 1099 he came once more to the front. The mass of the crusaders were weary of the political factions that divided some of their leaders, and. Godfrey, who was more of a pilgrim than a politician, became the natural representative of this feeling. He was thus able to play his part in prevailing upon the reluctant Raymond of Toulouse to march southward to Jerusalem, and he was prominent in the siege, his division being the first to enter when the city was captured. It was natural therefore that. when Raymond refused the offered dignity, Godfrey should be elected ruler of Jerusalem (July 22. 1099). He refused the title of king, assuming that of "advocate" of the Holy Sepulchre. The new dignity proved more onerous than honourable, and during his short reign of a year Godfrey had to combat the Arabs of Egypt and the opposition of Raymond and the patriarch Dagobert. He was successful in repelling the Egyptian attack at the battle of Ascalon (Aug. 1099), but he failed to acquire the town of Ascalon after the battle; the citizens would surrender only to Raymond, and Godfrey refused to accept these terms.

Left alone. at the end of the autumn, with an army of about 2,000 men, Godfrey was yet able, in the spring of 1100, probably with the aid of nen pilgrims, to exact tribute from towns like Acre, Askalon. Arsuf and Caesarea. But already at the end of 1099 Dagobert. archbishop of Pisa. had been substituted as patriarch for Arnulf (who had been acting as vicar) by the influence of Bohemund; and Dagobert. whose vassal Godfrey had at once piously acknowledged himself, seems to have forced him to an agreement in April 1100, by which he promised Jerusalem and Jaffa to the patriarch, in case he should acquire in their place Cairo or some other town, or should die without issue. Thus were the foundations of a theocracy laid in Jerusalem; and when Godfrey died (July 1100) he left the question to be decided, whether a theocracy or a monarchy should be the government of the Holy Land.

Because he had been the first ruler in Jerusalem, Godfrey was idolized in later saga. He was depicted as the leader of the crusades, the king of Jerusalem, the legislator who laid down the assizes of Jerusalem. He was none of these things. Bohemund was the principal leader of the crusade; Baldwin was the first king; the assizes were the result of a gradual development. In reality he would seem to have been a quiet, pious, hard-fighting knight, who was chosen to rule in Jerusalem because he had no dangerous qualities and no obvious defects.

Godfrey was the principal hero of two French chansons de geste dealing with the crusade, the *Chanson d'Antioche* (ed. by P. Paris, 2 vol., 1848) and the Chanson de *Jérusalem* (ed. by C. Hippeau, 1868). In addition, the parentage and early exploits of Godfrey were made the subject of legend. His grandfather was said to be Helias, knight of the Swan, one of the brothers whose adventures are well known, though with some variation, in the familiar fairy tale of "The Seven Swans," almost identical with the Lohengrin (*q.v.*) legend. See also CRUSADES.

BIBLIOGRAPHY.—Godfrey is made the central figure of the first crusade in the history of that expedition by Albert of Aix, written c. 1130. For modern work see J. C. Andressohn, The Ancestry and *Life of* Godfrey of Bouillon (1947); S. Runciman, History of the Crusades, vol. i (1951); H. Pigeonneau, Le Cycle de la croisade et de la *famille* de Bouillon (1877); A. Hatem, Les *Poèmes épiques* des croisades (1932). Two later and interesting attempts to reassess Godfrey's character and achievement are H. Glaesener, "Godefroid de Bouillon était-il 'un médiocre,'" Revue d'histoire *ecclésiastique,* vol. xxxix (1943), and M. Lobet, Godefroid de Bouillon: Essai de biographie antilégendaire (1943).

GODFREY OF VITERBO (c. 1120–*c.* 1196), chronicler, probably an Italian by birth, passed some of his early life at Viterbo, where he also spent his concluding days, but he was educated at Bamberg. About 1140 he became chaplain to the German king Conrad III; but the greater part of his life mas spent as secretary (notarius) in the service of the emperor Frederick I, who employed him on many diplomatic errands. The only part of Godfrey's voluminous work which is valuable is the Gesta Friderici I, verses relating events in the emperor's career from 1155 to 1180. Concerned mainly with affairs in Italy, the poem tells of the sieges of Milan, of Frederick's flight to Pavia in 1167. of the treaty with Pope Alexander III at Venice, and of other episodes with which the author was intimately acquainted, and many of which he had witnessed. Attached to the Gesta Friderici is the Gesta *Heinrici VI,* a shorter poem which is often attributed to Godfrey, although W. Wattenbach and other authorities thought it was not written by him. His other works are *Speculum Regum* and the popular *Memoria saeculorum,* rewritten as Pantheon.

GODFREY, SIR EDMUND BERRY (1621–1678), English magistrate and politician, was born on Dec. 23, 1621, and educated at Westminster school and Christ Church, Oxford. After entering Gray's Inn he became a prosperous dealer in wood. He was made a justice of the peace for the city of Westminster, and in Sept. 1666 was knighted as a reward for his services during the great plague.

In Sept. 1678 Titus Oates (*q.v.*) and two other men appeared before him with written information about the alleged "popish plot" to kill the king, and swore to the truth of their statements. During the excitement which followed the magistrate expressed a fear that his life was in danger, but took no precautions. On Oct. 12 he did not return home as usual, and on the 17th his body was found on Primrose hill, Hampstead. The evidence proved that he had been murdered, and the excited populace regarded the deed as the work of the Roman Catholics. In Dec. 1678 Miles Prance, under arrest for conspiracy, confessed to having been present at Godfrey's murder, the deed being done by Robert Green, Lawrence Hill and Henry Berry, at the instigation of Roman Catholic priests. The three men were hanged in 1679, but Prance's confession was subsequently proved false, and he pleaded guilty to perjury. The secret of Godfrey's death was never solved.

GODIVA (c. 1040–*c.* 1080) was the wife of Leofric, earl of Mercia and lord of Coventry, and the benefactress of several religious houses.

Legend says that, the people of Coventry suffering grievously under Leofric's oppressive taxation, Lady Godiva appealed to her husband, who said he would grant her request if she would ride naked through the crowded market place. This she did, clothed only in her long hair. Her husband kept his word and abolished the obnoxious taxes.

A later version says that Godiva issued a proclamation that all persons should keep within doors and shut their windows. One person disobeyed her proclamation, a tailor, ever afterward known as Peeping Tom, who is said to have been struck blind. Still another version says that Godiva was made invisible. The oldest form of the legend is given in *Flores* historiarum by Roger of Wendover (d. 1237), who quoted from an earlier writer.

The Godiva procession, which was instituted May 31, 1678, as part of Coventry fair, was celebrated at intervals until 1826. The "Peeping Tom" in Hertford street, Coventry, was perhaps an image of St. George.

GODKIN, EDWIN LAWRENCE (1831–1902), Anglo-U.S. editor and founder of the Nation, was born in Moyne, County Wicklow, Ire., Oct. 2, 1831. After graduating in 1851 from Queen's college, Belfast, and studying law in London, he was special correspondent for the London Daily News in the Crimean War. After editorial work on the *Belfast* Northern Whig, he went to America late in 1856, writing letters descriptive of a southern tour for the London Daily News. He continued his connection with this journal while studying law in New York. He was admitted to the bar in 1858. and because of his impaired health he and his wife, Frances Elizabeth Foote, traveled in Europe 1860–62. At about this time Godkin was offered a partnership in the New York Times by its editor, Henry Jarvis Raymond; but although attracted by the offer, he in 1865 carried out a long-cherished dream by founding the Nation. This quickly became the foremost review in the country—as James Russell Lowell put it, because of the "ability, information and unflinching integrity" of the editor. Indeed, the periodical was so superior that Charles Dudley Warner, editor of the Hartford Courant, styled it the "weekly judgment day." In 1881 Godkin sold the Nation to Henry Villard, owner of the New York Evening Post, of which paper the Nation became the weekly edition. Godkin himself became associate editor of the Post, succeeding Carl Schurz as editor in chief, 1883–99, and shaping the policy of that journal. Under his leadership the Post broke with the Republican party in the presidential campaign of 1884, when Godkin's opposition to Blaine did much to create the so-called Mugwump party (see MUGWUMP), and his organ became completely independent. He consistently advocated currency reform, the gold basis, a tariff for revenue only, and civil service reform, rendering the greatest aid to the last cause. His attacks on Tammany Hall were so frequent and so fearless that he was several times sued for libel because of biographical sketches of certain leaders in that organization, but the cases were dismissed. His opposition to "jingoism" and to imperialism was able and forcible.

Godkin retired from his editorial duties in 1899 and died in Greenaay, Devonshire, England, May 21, 1902.

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GODMANCHESTER, a municipal borough in the Huntingdonshire parliamentary division of Huntingdonshire, Eng., on the right bank of the Ouse, 1 mi. S.S.E. of Huntingdon (its twin town) and 15 mi. S.E. of Cambridge by road. Pop. (1951) 2,502. Area 7.7 sq.mi. A Romano-British settlement occupied the site of Godmanchester. The town (Godmundcestre) belonged to the king before the Conquest and in 1213 King John granted the manor to the men of the town at a fee farm of £120 yearly. James I granted an incorporation charter in 1605, which recited that the burgesses were chiefly engaged in agriculture, and granted them a fair, which is now discontinued. The spire of the beautiful Perpendicular church of St. Mary the Virgin is a landmark for miles over the fens; it contains miserere stalls, traditionally from Ramsey abbey, Huntingdonshire. The 13th-century stone bridge over the river, on which swans are seen, connects the town with Huntingdon; the two Huntingdon arches are decorated, Godmanchester's are plain. The Elizabethan grammar school is one of many Tudor houses in Godmanchester and of these and the Georgian buildings, 77 were listed (1956) for preservation. The trade is agricultural, but many people find employment in Huntingdon. Many old customs survive, including the ringing of curfew: The court leet of the freemen appoints a swanherd and pinder (an officer who impounds stray beasts).

GODOLPHIN, SIDNEY (1610–1643), English Royalist and poet, born at Godolphin hall, Cornwall, was baptized on Jan. 15, 1610. Educated at Exeter college, Oxford. he became intimate with Ben Jonson, Thomas Hobbes and other men of letters. He was a member of parliament for Helston from 1628. A staunch Royalist, he was one of the last to leave the house of commons when the king ordered his supporters to withdraw. He joined the Royalist forces under Sir Ralph Hopton and on Feb. 9, 1643, was killed in action at Chagford, Devonshire.

The earl of Clarendon pays a notable tribute to Godolphin in his *History* and Hobbes praises him in *Leviathan.* A few of his poems were published in the 17th century; of these the chief is *The Passion of Dido for Aeneas,* a translation from the *Aeneid,* apparently unfinished at his death and completed and published by Edmund Waller (1658). Other poems survived in manuscript collections. Godolphin's best lyrics have a fine strength and delicacy.

The first complete edition was by *G.* Saintsbury, in *Minor Poets* of *the Caroline Period,* 3 vol. (1905–21). *See* also *Poems,* ed. by *W.* Dighton (1931), with a biographical introduction. (V. DE S. P.)

GODOLPHIN, SIDNEY GODOLPHIN, EARL OF (1645–1712), English statesman. was a cadet of an ancient Cornish family. In 1662 he was introduced into the royal household by Charles II, with whom he became a favourite, and in 1668 he entered the house of commons as member for Helston. Although he seldom addressed the house, he acquired a reputation as its chief financial authority. In March 1679 he was appointed a commissioner of the treasury and in Feb. 1680 a privy councillor; and by the following autumn he, with Hyde (afterward earl of Rochester) and Sunderland,—the "chits"—were regarded as the king's chief advisers. Though he voted for the Exclusion bill in 1680, he was continued in office after the dismissal of Sunderland. In April 1684 he became one of the secretaries of state, and in September he was created a baron and succeeded Rochester as first lord of the treasury. After the accession of James II he was made chamberlain to the queen and, uith Rochester and Sunderland, enjoyed the king's special confidence.

In 1687 Godolphin was again named a commissioner of the treasury. He was one of the council of five appointed by James to represent him in London when he went to join the army after the landing of William of Orange in England. and was afterward appointed a commissioner to treat with the prince. Under William III he was reappointed as a commissioner of the treasury (April 1689) and became first lord in Nov. 1690, but maintained, in conjunction with Marlborough. a treacherous intercourse with James II. After Sir John Fenwick's confession in 1696 regarding the attempted assassination of William III, Godolphin was prevailed upon to resign; but when the Tories came into power in 1700 he was again appointed lord treasurer and retained office for about a year. Though not a favourite with Queen Anne, he was, after her accession, appointed to his old office on the recommendation of Marlborough. He was made an earl in 1706. He played an active part in bringing about the union with Scotland. As the Spanish succession war developed he was driven more and more into alliance with the Whigs, He thus lost the support of Robert Harley and the Tories; and Harley began to supplant his influence and that of the Marlboroughs with the queen. After the Tory reaction which followed the impeachment of Henry Sacheverell, the queen abruptly dismissed Godolphin from office on Aug. 7, 1710. He died on Sept. 15, 1712. He married Margaret Blagge, whose life was written by John Evelyn, in 1675, She died in 1678.

See H. Elliott, *The Life of Sidney, Earl of Godolphin* (London, 1888) ; *Dictionary of National Biography,* vol. xxii (London, 1890).

GODOWSKY, LEOPOLD (1870–1938), Polish-American musician and composer, was born at Vilna on Feb. 13, 1870. He made his debut as a pianist there as a child of nine, and then toured Russia, Poland, Germany and the United States. After 1912 most of his tours were confined to the latter country. His compositions included 53 original studies after the *études* of Chopin, a sonata in E minor and many compositions for piano and violin. He died in New York city, Nov. 21, 1938.

GODOY, MANUEL (1767–1851), DCKE OF ALCUDIA and PRINCE OF THE PEACE, Spanish royal favourite and statesman. Born of a minor noble family in Badajoz on May 12, 1767, he entered the royal bodyguard in 1784 and soon established himself as the lover of Maria Louisa of Parma, whose husband became king as Charles IV in 1788. Godoy, clever enough to win the king's as well as the queen's favour, was created duke of Alcudia in April 1792 and eventually made prime minister (November). His support of the king's Bourbon sentiments in interceding for Louis XVI of France led to the French republic's declaring war in 1793, but after the French victories in Catalonia he negotiated the peace of Basle (July 179j), in which he ceded San Domingo but for which he was rewarded with the title "prince of the peace." A disastrous war with England followed the Franco-Spanish treaty of San Ildefonso (Aug. 1796). The archbishop of Seville and the grand inquisitor were exiled for plotting against Godoy in March 1797, and he was married to Maria Teresa, countess of Chinchón, a natural daughter of the king's uncle, in September, but in March 1798 envy of his position at court, together with the French Directory's mistrust, drove Godoy from office. Yet he remained influential and returned to office in 1801. He personally commanded the Spanish troops in the War of the Oranges. which won Olivenza from Portugal. War with England having been renewed after the peace of Amiens, his relations with Napoleon gradually deteriorated. though under the secret treaty of Fontainebleau (Oct. 27, 1807) Godoy was offered the kingdom of the Algarves for himself. Meanwhile the prince of Asturias, the future King Ferdinand VII, was plotting to displace him; Godoy had Ferdinand arrested (Oct. 29); but after Ferdinand's release, as French troops were overrunning Spain, popular resentment culminated in the riots of Aranjuez (March 1808), which enabled Ferdinand to arrest Godoy. Sent then on Napoleon's orders to Bayonne, Godoy stayed with Charles IV till the latter's death in Rome (1819). Having failed to recover his confiscated estates even after Ferdinand's death (1833), he had to live as Louis Philippe's pensioner till Isabella II restored them in 1847. He died in Paris on Oct. 4, 1851. (J. G. R.-S.)

GODUNOV, BORIS FEDOROVICH, tsar of Muscovy (c. 1552–1605), the most famous member of an ancient, now extinct Russian family of Tatar origin, which migrated from the Horde to Muscovy in the 14th century. Boris's career of service began at the court of Ivan the Terrible. He is mentioned in 1570 as taking part in the Serpeisk campaign as one of the archers of the guard. In 1571 he strengthened his position at court by his marriage with Maria, the daughter of Ivan's favourite, Malyuta Skuratov. In 1580 the tsar chose Irene, the sister of Boris, to be the bride of the tsarevich Theodore, on which occasion Boris was promoted to the rank of *boyar.* On his death-bed Ivan appointed Boris one of the guardians of his son and successor, Theodore. who was of somewhat weak intellect. The reign of Theodore began with a rebellion in favour of the infant tsarevich Demetrius, the son of Ivan's fifth wife Marie Nagaya, a rebellion resulting in the banishment of Demetrius, with his mother and her relations, to their appanage at Uglich. On the occasion of the tsar's coronation (May 31, 1584), Boris was loaded with honours and riches, yet he held but the second place in the regency during the lifetime of his co-guardian Nikita Romanovich, on whose death, in 1585, he was left without any serious rival. A conspiracy against him of all the other great *boyars* and the metropolitan Dionysy, which sought to break Boris's power by divorcing the tsar from Godunov's childless sister, only ended in the banishment or tonsuring of the malcontents.

Henceforth Godunov was omnipotent. The direction of affairs passed entirely into his hands, and he corresponded with foreign princes as their equal. His policy was generally pacific, but always most prudent. In 1595 he recovered from Sweden the towns lost during the former reign. Five years previously he had defeated a Tatar raid upon Moscow, for which service he received the title of *slugar,* an obsolete dignity even higher than that of *boyar.* Towards Turkey he maintained an independent attitude, supporting an anti-Turkish faction in the Crimea, and furnishing the emperor with subsidies in his war against the sultan. Gadunov encouraged English merchants to trade with Russia by exempting them from tolls. He civilized the north-eastern and south-eastern borders of Muscovy by building numerous towns and fortresses to keep the Tatar and Finn tribes in order. Samara, Saratov, and Tsaritsyn and a whole series of lesser towns owe their existence to him. He also re-colonized Siberia, which had been slipping from the grasp of Muscovy, and formed scores of new settlements, including Tobolsk and other large centres. It was during his government that the Muscovite Church received its patriarchate, which placed it on an equality with other eastern churches and emancipated it from the influence of the metropolitan of Kiev. It was Boris's internal policy to support the middle classes at the expense of the old nobility and the peasants, hence the ukase (1587) forbidding the peasantry to transfer themselves from one landowner to another, thus binding them to the soil, and leading to the institution of serfdom in its most grinding form. The sudden death of the tsarevich Demetrius at Uglich (May 1j, 1591) has commonly been attributed to Boris.

On the death of the childless tsar Theodore (Jan. 7 1598), a *Zemsky Sobor,* or national assembly, unanimously elected Boris tsar on Feb. 21. The Romanov family, who had been his chief rivals, were disgraced and banished. Boris was the first tsar to import foreign teachers on a great scale, the first to send young Russians abroad to be educated, the first to allow Lutheran churches to be built in Russia. He also felt the necessity of a Baltic seaboard, and attempted to obtain Livonia by diplomatic means. That Boris was one of the greatest of the Muscovite tsars there can be no doubt. But his great qualities were overbalanced by an incurable suspiciousness. He encouraged informers and persecuted suspects on their unsupported statements. The Romanov family in especial suffered severely from these delations. In 1603 a pretender appeared in Poland, who claimed to be the murdered tsarevich Demetrius, and, with the support of King Sigismund of Poland, he was leading a small army, reinforced by the Don Cossacks, into south-west Russia, when Boris died suddenly (April 13 1605), leaving one son, Theodore II., who succeeded him for a few months and then was foully murdered by the enemies of the Godunovs.

See Platon Vasilievich Pavlov, *On the Historical Significance of the Reign of Boris Godunov* (Rus.), (1850); Sergyei Mikhailivich Soloviev, *History of Russia* (Rus.), (2nd ed., vols. vii.–viii., 1897).
(R. N. B.)

GODWIN, FRANCIS (1562–1633), English divine, son of Thomas Godwin, bishop of Bath and Wells, was born at Hannington, Northamptonshire, and studied at Christ Church, Oxford. After holding two Somersetshire livings he was in 1587 appointed subdean of Exeter, bishop of Llandoff (1601) and of Hereford (1617). His *Catalogue of the Bishops of England since the first planting of the Christian Religion in this Island* (1601; 2nd ed., 1615; Latin ed., 1616) was republished, with a continuation by William Richardson, in 1743. In 1616 Godwin produced *Rerum Anglicarum, Henrico VIII., Edwardo VI. et Maria regnantibus, Annales,* afterwards translated and published by his son Morgan under the title *Annales of England* (1630). His *The Man in the Moone, or a Discourse of a Voyage thither, by Domingo Gonsales,* written apparently between 1599 and 1603 and published posthumously in 1638, was imitated in several important particulars by Cyrano de Bergerac, from whom, if not from Godwin direct, Swift borrowed in writing of Gulliver's voyage to Laputa. Another work of Godwin's, *Nuncius inanimatus Utopiae* (1629), seems to have been the prototype of John Wilkins's *Mercury, or the Secret and Swift Messenger,* which appeared in 1641.

GODWIN, MARY WOLLSTONECRAFT (1759–1797), English miscellaneous writer, was born probably at Hoxton, London. Her family was of Irish extraction. Her father, Edward John Wollstonecraft, after dissipating the greater part of his patrimony, tried to earn a living by farming, which only plunged him into deeper difficulties, and he led a wandering, shifty life. The family roamed from Hoxton to Edmonton, to Essex, to Beverley in Yorkshire, to Lougharne, Pembrokeshire, and back to London.

After Mrs. Wollstonecraft's death in 1780, soon followed by her husband's second marriage, the three daughters, Mary, Everina and Eliza, sought to earn their own livelihood. Mary, the eldest, went in the first instance to live with her friend Fanny Blood, a girl of her own age, whose father, like Wollstonecraft, was addicted to drink. Mary helped Mrs. Blood to earn money by taking in needlework, while Fanny painted in water-colours. Everina went to live with her brother Edward, and Eliza made a hasty and, as it proved, unhappy marriage with a Mr. Bishop. A legal separation was afterwards obtained, and the sisters, together with Fanny Blood, took a house, first at Islington, afterwards at Newington Green, and opened a school, which was carried on with indifferent success for nearly two years. During their residence at Newington Green, Mary was introduced to Dr. Johnson, who, as Godwin tells us, "treated her with particular kindness and attention."

In 1785 Fanny Blood married Hugh Skeys, a merchant, and went with him to Lisbon, where she died in childbed after sending for Mary to nurse her. "The loss of Fanny," as she said in a letter to Mrs. Skeys' brother, George Blood, "was sufficient of itself to have cast a cloud over my brightest days. . . . I have lost all relish for pleascre, and life seems a burden almost too heavy to be endured." Her first novel, *Mary, a Fiction* (1788), was intended to commemorate her friendship with Fanny. After closing the school at Newington Green, Mary became governess in the family of Lord Kingsborough, in Ireland. Her pupils were much attached to her, especially Margaret King, afterwards Lady Mountcashel; and indeed, Lady Kingsborough gave the reason for dismissing her after one year's service that the children loved their governess better than their mother. Mary now resolved to devote herself to literary work, and she was encouraged by Johnson, the publisher in St. Paul's churchyard, for whom she acted as literary adviser. She also undertook translations, chiefly from the French. *The Elements of Morality* (1790) from the German of Salzmann, illustrated by Blake, an old-fashioned book for children, and Lavater's *Physiognomy* were among her translations. Her *Original Stories from Real Life* were published in 1791, and, with illustrations by Blake, in 1796. In 1792 appeared *A Vindication of the Rights of Woman,* the work with which her name is always associated.

It is not among the least oddities of this book that it is dedicated to M. Talleyrand Périgord, late bishop of Autun. Mary Wollstonecraft still believed him to be sincere, and working in the same direction as herself. In the dedication she states the "main argument" of the work, "built on this simple principle that, if woman be not prepared by education to become the companion of man, she will stop the progress of knowledge, for truth must be common to all, or it will be inefficacious with respect to its influence or general practice." In carrying out this argument she used great plainness of speech, and it was this that caused all, or nearly all, the outcry. For she did not attack the institution of marriage, nor assail orthodox religion; her book was really a plea for equality of education, passing into one for State education and for the joint education of the sexes. It was a protest against the assumption that woman was only the plaything of man, and she asserted that intellectual companionship was the chief, as it is the lasting, happiness of marriage. She thus directly opposed the teaching of Rousseau, of whom she was in other respects an ardent disciple.

Mrs. Wollstonecraft, as she now styled herself, desired to watch the progress of the Revolution in France, and went to Paris in 1792. Godwin, in his memoir of his wife, considers that the change of residence may have been prompted by the discovery that she was becoming attached to Henry Fuseli, but there is little to confirm this surmise; indeed, it was first proposed that she should go to Paris with Fuseli and his wife, nor was there any subsequent breach in their friendship. She remained in Paris during the Reign of Terror, when communication with England was difficult or almost impossible. Some time in the spring or summer of 1793 Capt. Gilbert Imlay, an American, became acquainted with Mary—an acquaintance which ended in a more intimate connection. There was no legal ceremony of marriage, and it is doubtful whether such a marriage would have been valid at the time; but she passed as Imlay's wife, and Imlay himself terms her in a legal document, "Mary Imlay, my best friend and wife." In Aug. 1793 Imlay was called to Havre on business, and was absent for some months, during which time most of the letters published after her death by Godwin were written. Towards the end of the year she joined Imlay at Havre, and there in the spring of 1794 she gave birth to a girl, who received the name of Fanny, in memory of the dear friend of her youth. In this year she published the first volume of a never completed *Historical and Moral View of the French Revolution.* Imlay became involved in a multitude of speculations, and his affection for Mary and their child was already waning. He left Mary for some months at Havre. In June 1795, after joining him in England, Mary left for Norway on business for Imlay. Her letters from Norway, divested of all personal details, were afterwards published. She returned to England late in 1795 and found letters awaiting her from Imlay, intimating his intention to separate from her, and offering to settle an annuity on her and her child. For herself she rejected this offer with scorn: "From you," she wrote, "I will not receive anything more. I am not sufficiently humbled to depend on your beneficence." They met again, and for a short time lived together, until the discovery that he was carrying on an intrigue under her own roof drove her to despair, and she attempted to drown herself by leaping from Putney bridge, but was rescued by watermen. Imlay now completely deserted her, although she continued to bear his name.

In 1796, when Mary Wollstonecraft was living in London, supporting herself and her child by working, as before, for Mr. Johnson, she met William Godwin. A friendship sprang up between them—a friendship, as he himself says, which "melted into love." Godwin states that "ideas which he is now willing to denominate prejudices, made him by no means willing to conform to the ceremony of marriage"; but these prejudices were overcome, and they were married at St. Pancras church on March 29, 1797. And now Mary had a season of real calm in her stormy existence. Godwin, for once only in his life, was stirred by passion, and his admiration for his wife equalled his affection. But their happiness was of short duration. The birth of her daughter Mary, afterwards the wife of Percy Bysshe Shelley, on Aug. 30, 1797, proved fatal, and Mrs. Godwin died on Sept. 10 following. She was buried in the churchyard of Old St. Pancras, but her remains were afterwards removed by Sir Percy Shelley to the churchyard of St. Peter's, Bournemouth.

Her principal published works are as follows:—Thoughts on the Education of Daughters, . . . (1787); Mary, a Fiction (1788); The Female Reader (selections) (1789); An Historical and Moral View of the Origin and Progress of the French Revolution, and the effects it has produced in Europe, vol. i. (no more published) (1790); Original Stories from Real Life (1791); Vindication of the Rights of Woman (1792); Vindication of the Rights of Man (1793); Letters written during a Short Residence in Sweden, Norway and Denmark (1796); Posthumous Works (4 vols., 1798). It is impossible to trace the many articles contributed by her to periodical literature.

A memoir of her life was published by Godwin in 1798. A large portion of C. Kegan Paul's work, William Godwin, his Friends and Contemporaries, was devoted to her, and an edition of the Letters to Imlay (1879), of which the first edition was published by Godwin, is prefaced by a somewhat fuller memoir. See also E. R. Pennell, Mary Wollstonecraft Godwin (1885), in the Eminent Women Series; E. Dowden, The French Revolution and English Literature (1897) pp. 82 et seq.; E. R. Clough, A Study of Mary Wollstonecraft and the Rights of Woman (1898); an edition of her Original Stories (1906), with William Blake's illustrations and an introduction by E. V. Lucas; the Love Letters of Mary Wollstonecraft to Gilbert Imlay (1908), with an introduction by Roger Ingpen; M. Linford, Mary Wollstonecraft (1924).

GODWIN, WILLIAM (1756–1836), English political and miscellaneous writer, son of a Nonconformist minister, was born on March 3, 1756, at Wisbech, Cambridgeshire. Both parents were strict Calvinists. William Godwin was educated for his father's profession at Hoxton Academy, where he was under Andrew Kippis the biographer and Dr. Abraham Rees of the *Cyclopaedia,* and was at first more Calvinistic than his teachers, becoming a Sandemanian, or follower of John Glas (*q.v.*), whom he describes as "a celebrated north-country apostle who, after Calvin had damned ninety-nine in a hundred of mankind, has contrived a scheme for damning ninety-nine in a hundred of the followers of Calvin." He then acted as a minister at Ware, Stowmarket and Beaconsfield. At Stowmarket the teachings of the French philosophers were brought before him by a friend, Joseph Fawcet, who held strong republican opinions. He came to London in 1782, still nominally a minister, to regenerate society with his pen—a real enthusiast, who contemplated, in theory, the complete overthrow of all existing institutions, political, social and religious. He believed, however, that calm discussion was the only thing needful to carry every change, and from the beginning to the end of his career he deprecated every approach to violence. He was a philosophic radical in the strictest sense of the term.

His first published work was an anonymous *Life of Lord Chatham* (1783). Under the inappropriate title *Sketches of History* (1784) he published under his own name six sermons on the characters of Aaron, Hazael and Jesus, in which, though writing in the character of an orthodox Calvinist, he enunciates the proposition "God Himself has no right to be a tyrant." Introduced by Andrew Kippis, he began to write in 1785 for the *Annual Register* and other periodicals, producing also three novels now forgotten. The "Sketches of English History" written for the *Annual Register* from 1785 onward still deserve study. He joined a club called the "Revolutionists," and associated with Lord Stanhope, Horne Tooke and Holcroft. His clerical character was now completely dropped.

In 1793 Godwin published his great work on political science, *The Inquiry concerning Political Justice, and its Influence on General Virtue and Happiness,* an inquiry into the principles of society, of government and of morals. For many years Godwin had been "satisfied that monarchy was a species of government unavoidably corrupt," and from desiring a government of the simplest construction, he gradually came to consider that "government by its very nature counteracts the improvement of original mind." Believing in the perfectibility of the race, that there are no innate principles, and therefore no original propensity to evil, he considered that "our virtues and our vices may be traced to the incidents which make the history of our lives, and if these incidents could be divested of every improper tendency, vice would be extirpated from the world." All control of man by man was more or less intolerable, and the day would come when each man, doing what seems right in his own eyes, would also be doing what is in fact best for the community, because all will be guided by principles of pure reason. In a day when the penal code was still extremely severe, he argued gravely against all punishments, not only that of death. Property was to belong to him who most wanted it; accumulated property was a monstrous injustice. Hence marriage, which is law, is the worst of all laws, and as property the worst of all properties. Perhaps no one received the whole teaching of the book. But it gave cohesion and voice to philosophic radicalism. Godwin himself in after days modified his communistic views, but his strong feeling for individualism, his hatred of all restrictions on liberty, his trust in man, his faith in the power of reason remained.

In May 1794 Godwin published the novel of *Caleb Williams, or Things as they are,* dramatized by the younger Colman as *The Iron Chest.* A theorist who lived mainly in his study, Godwin yet came forward boldly to stand by prisoners arraigned of high treason in that same year—1794. The danger to persons so charged was then great; and he deliberately put himself into this same danger for his friends. But when his own trial was discussed in the privy council, Pitt sensibly held that *Political Justice,* the work on which the charge could best have been founded, was priced at three guineas, and could never do much harm among those who had not three shillings to spare.

In 1797, the intervening years having been spent in strenuous literary labour, Godwin married Mary Wollstonecraft (*see* GODWIN, MARY WOLLSTONECRAFT). Since both held the same views regarding the slavery of marriage, and since they only married at all for the sake of possible offspring, the marriage was concealed for some time, and the happiness of the avowed married life was very brief; his wife's death on Sept. 10 left Godwin prostrated by affliction, and with a charge for which he was wholly unfit—his infant daughter Mary, and her stepsister, Fanny Imlay, who from that time bore the name of Godwin. His unfitness for the cares of a family, far more than love, led him to contract a second marriage with Mary Jane Clairmont in 1801. She was a widow with two children, one of whom, Clara Mary Jane Clairmont, became the mistress of Byron. The second Mrs. Godwin was energetic and painstaking, but a harsh stepmother; and it may be doubted whether the children were not worse off under her care than they would have been under Godwin's neglect.

Godwin's second novel, *St.* Leon, appeared in 1799. It is chiefly remarkable for the beautiful portrait of Marguerite, the heroine, drawn from the character of his own wife. His opinions underwent a change in the direction of theism, influenced, he says, by his acquaintance with Coleridge. Study of the Elizabethan dramatists led to the production in 1800 of the Tragedy of Antonio. Kemble brought it out at Drury Lana, but the failure of this attempt made him refuse Abbas, King of Persia, which Godwin offered him in the next year. He was more successful with his Life of Chaucer, for which he received £600.

The events of Godwin's life were few. Under the advice of the second Mrs. Godwin, and with her active co-operation, he carried on business as a bookseller under the pseudonym of Edward Baldwin, publishing several useful school books and books for children, among them Charles and Mary Lamb's Tales from Shakespeare. But for many years Godwin struggled with constant pecuniary difficulties, for which more than one subscription was raised by the leaders of the Liberal Party and by literary men. He became bankrupt in 1822, but during the following years he accomplished one of his best pieces of work, The *History* of the Commonwealth, founded on pamphlets and original documents, which still retains considerable value. In 1833 the Government of Earl Grey conferred upon him the office known as yeoman usher of the exchequer, to which were attached apartments in Palace Yard, where he died on April 7, 1836.

In his own time, by his writings and by his conversation, Godwin had a great power of influencing men, and especially young men. Though his character would seem, from much which is found in his writings, and from anecdotes told by those who still remember him, to have been cold and unsympathetic, it was not so understood by enthusiastic young people, who hung on his words as those of a prophet. The most remarkable of these was Percy Bysshe Shelley, who in the glowing dawn of his genius turned to Godwin as his teacher and guide. The last of the long series of young men who sat at Godwin's feet was Edward Lytton Bulwer, afterwards Lord Lytton, whose early romances were formed after those of Godwin, and who, in Eugene *Aram,* succeeded to the story as arranged, and the plan to a considerable extent sketched out, by Godwin, whose age and failing health prevented him from completing it. Godwin's character appears in the worst light in connection with Shelley. His early correspondence with Shelley, which began in 1811, is remarkable for its genuine good sense and kindness; but when Shelley carried out the principles of the author of Political Justice in eloping with Mary Godwin, Godwin assumed a hostile attitude that would have been unjustifiable in any case, and was ridiculous in the light of his professions. He was not, moreover, too proud to accept £1,000 from his son-in-law, and after the reconciliation following on Shelley's marriage in 1816, he continued to demand money until Shelley's death. His character had no doubt suffered under his long embarrassments and his unhappy marriage.

BIBLIOGRAPHY.—Godwin's more important works are—The *Enquiry concerning Polztical Justice, and its Influence on General Virtue and Happiness* (1793); *Things as they are, or the Adventures of Caleb Williams* (1794); *The Enquirer, a series of Essays* (1797); *Memoirs of the Author of the Rights of Woman* (1798); *St. Leon, a Tale of the Sixteenth Century* (1799); *Antonio, a Tragedy* (1800); *The Life of Chaucer* (1803); *Fleetwood, a Novel* (1805); *Faulkener, a Tragedy* (1807); *Essay on Sepulchres* (1809); *Lives of Edward and John Philips, the Nephews of Milton* (1815); *Mandeville, a Tale of the Times of Cromwell* (1817); *Of Population,* an answer to Malthus (1820); *History of the Commonwealth* (1824–1828); *Cloudesly,* a *Tale* (1830); *Thoughts on Man, a series of Essays* (1831); *Lives of the Necromancers* (1834). A volume of essays was also collected from his papers and published in 1873, as left for publication by his daughter Mrs. Shelley. Many other short and anonymous works proceeded from his ever busy pen, but many are irrecoverable, and all are forgotten. Godwin's life was published in 1876 in two volumes, under the title *William Godwin, his Friends and Contemporaries, by C.* Kegan Paul. The best estimate of his literary position is that given by Sir Leslie Stephen in his *English Thought in the 18th Century* (ii. 264–281, 3rd ed., 1902). *See* also the article on William Godwin in W. Hazlitt's *The Spirit of the Age* (1825), and "Godwin and Shelley" in Sir L. Stephen's *Hours in a Library* (vol. iii., ed. 1892); H. Roussin, *William Godwin* (1913); F. K. Brown, *The Life of William Godwin* (1926).

GODWIN-AUSTEN, ROBERT ALFRED CLOYNE (1808–1884), English geologist, the eldest son of Sir Henry E. Austen, was born on March 17, 1808. He was educated at Oriel College, Oxford, of which he became a fellow in 1830. He afterwards entered Lincoln's Inn. In 1855 he brought before the Geological Society of London his paper "On the possible Extension of the Coal-Measures beneath the South-Eastern part of England." In this paper he supported the theory of the fresh-water origin of the Old Red Sandstone, and discussed the relations of that formation, and of the Devonian, to the Silurian and Carboniferous. He was elected F.R.S. in 1849. He died at Shalford House near Guildford on Nov. 25, 1884. Mt. Godwin-Austen (K2 or Dapsang) 28,250 ft., in the Himalayas, is named in honour of his eldest son.

GODWINE (d. 1053), earl of the West-Saxons and the leading Englishman of his day, was the son of Wulfnoth, whose identity is uncertain. Of Godwine's youth, nothing is known except that he soon became a personal favourite of Canute, who, about 1018, conferred upon him the rank of earl—probably of some one shire in Wessex. In 1019 Godwine accompanied the king on his visit to Denmark, and shortly afterwards was given in marriage Gytha, sister of Ulf, and raised (1020) to the dignity of earl of all Wessex. On Canute's death in 1035, he assisted Queen Emma in supporting the claims of her son, Hardicanute, in opposition to those'of Harold Harefoot for whom the Witan at Oxford, led by Leofric, had declared (see HARDICANUTE). Meanwhile Aelfred, son of Emma by her former husband Aethelred II., had landed in England with the hope of gaining the crown, but, falling into Godwine's power, he was handed over to Harold and killed.

On the death of Hardicanute in 1042, after a reign of less than two years, Godwine secured an English succession to the throne by his promotion of the election of Edward the Confessor, the surviving son of Emma and Aethelred. He was now the first man in the kingdom, and though he had powerful rivals in the earl Leofric of Mercia and earl Siward of Northumbria, he secured the marriage of his daughter Eadgyth to the king (1045), an earldom in the Severn valley for his son Sweyn, one in East Anglia for his son Harold, and a third in the Chilterns for his nephew Beorn. Nevertheless, his opposition to the Norman favourites of the king, particularly to Robert, abbot of Jumieges,. who in 1051 became archbishop of Canterbury, and his attempt to cover up the misdeeds of his son Sweyn (d. 1052), was bringing the earl into disfavour. The climax came with his refusal to punish the men of Dover for stirring up a riot amongst the retinue of Eustace, Count of Boulogne, who was on a visit to the king in 1051. Godwine and his sons gathered their forces in Gloucestershire, and the earls of Mercia and Northumbria hastened to the assistance of the king Though war was averted by mediation, Godwine and his family were outlawed (see EDWARD THE CONFESSOR). In the following year, however, the suspicions of the English thegns having been aroused by a visit of Edward's kinsman, William, diike of Normandy, Godwine was enabled to return in triumph. Some six months later, the earl was taken ill while at the king's table, and died on April 15, 1053.

GODWIT, the name of wading birds of the genus *Limosa,* much esteemed for the table. The black-tailed godwit, *L. limosa,* or yarwhelp, formerly bred in the English fens. It is now only a visitor there but breeds commonly from Sweden over Russia and (L. *l.* melanuroides) in northeastern Asia. The bird is the size of a large pigeon but with long legs and bill, the latter slightly upturned; the winter plumage is grayish-brown but the breeding dress is marked by bright bay. The tail is white for a third of its length and then black with a white margin. As in many waders, in spring the males circle in the air and utter a special call or song. The bar-tailed godwit (L. *lapponica*) breeds in northern

Europe and Asia, its race the Pacific godwit (L. l. *baueri)* in northeastern Asia and western Alaska. The species is smaller than the preceding and the tail is barred with black and white throughout its length. The marbled godwit *(L. fedoa)* is very large and breeds from southern Alberta and Manitoba to South Dakota; the smaller Hudsonian godwit (L. *haemastica*) breeds in Alaska and Canada, migrating south to the Straits of Magellan. The Pacific godwit and Siberian black-tailed godwit uinter south to Australia and New Zealand. (G. F. Ss.)

GOEBBELS, JOSEF (1897–1945), German politician, was born at Rheydt in the Rhineland on Oct. 29. 1897. He was educated locally and at various universities, receiving the degree of doctor of philosophy at Heidelberg in 1920. In 1922 he joined the National Socialist party, then in its infancy, and took a leading part in organizing the student movement. In 1926 he was placed by Hitler in charge of the party organization for greater Berlin, and in 1929 became head of the entire party propaganda. In 1930 he entered the *Reichstag.* In 1933, after the advent to power of his party, he received the newly created post of *Reich* minister of enlightenment and propaganda. In that post he exercised strict control over the German press. radio and every other possible outlet for public information and used his control to promote the ideas of Adolf Hitler.

After the period of German victories in World War II had ended and the tide had turned in favour of the Allies. Goebbels employed the channels of information at his command to keep the morale of the German people aligned behind the war effort. During 1944 he repeatedly promised that new and marvelous secret weapons would snatch Germany from the abyss of almost certain defeat and result in ultimate triumph. He alternated these glowing promises with dire warnings to the German people that complete ruin and destruction faced the *Reich* if it failed to win the war. In April 1945, as Russian forces neared Berlin, he broadcast an appeal to the people of that city to hold out until reinforcements could arrive to defend the capital. He reportedly committed suicide just prior to the fall of Berlin in May 1945. (C. A M.; X.)

GOEBEL, KARL (IMMANUEL EBERHARD) VON (1855–1932), a leading German botanist of the 19th century, author of a celebrated work on the organs of plants, was born in Billigheim, Baden, March 8, 1855. He studied under Wilhelm Hofmeister, Heinrich Anton de Bary and Julius von Sachs, receiving a doctorate in 1877. After holding teaching positions at various places, in 1891 he was appointed professor at Munich. where in 1909–14 he built the Botanical institute and garden in Nymphenburg. He was devoted to objective research rather than speculation, and to observation of living plants in all their great variety. He traveled extensively, in the Indies, South America. Australia, New Zealand and the United States. His crowning publication was the great *Organography of Plants* (1898–1901), of which three editions appeared in German and one in English. He died in Munich on Oct. g, 1932, having retired as emeritus professor the year before. (H. W. Rt.)

GOEBEN, AUGUST KARL VON (1816–1880), Prussian general of infantry. was born at Stade, Hanover, on Dec. 10. 1816. He first saw active service with the Carlist army in Spain after uhich he re-entered the Prussian service. Transferred to the staff of the 4th army corps in 1848. he formed a lasting friendship with his immediate superior, Von Moltke. In 1860 he was with the Spanish troops in Morocco, and took part in the battle of Tetuan. He became major general commanding the 26th infantry brigade in 1863. Von Goeben distinguished himself at Rackebull and Sonderburg in 1864. In 1866. commanding the 13th division. he won further laurels at Dermbach. Laufach, Kissingen Aschaffenburg, Gerchsheim. Tauber-Bischofsheim and Würzburg. In 1870 he commanded the 8th (Rhineland) army corps, and was victorious at Spicheren (Xug. 6) and Gravelotte (Aug. 18). On Jan. 8, 1871, he succeeded Manteuffel in the command of the 1st army, and a fortnight later brought the war in northern France to a brilliant conclusion by the decisive victory of St. Quentin (Jan. 18 and 19, 1871). He commanded the 8th corps at Coblenz until his death there on Nov. 13. 1880.

Goeben's memoirs are to be found in his works *Vier Jahre in Spanien* (Hanover. 18.41). *Reise-und Lagerbriefe aus Spanien und vom spanischen Heere in Marokko* (Hanover, 1863) and in the Darmstadt *Allgemeine Militärzeitung.* The cruiser "Goeben" bore his name.

See G. Zernin, *Das Leben des Generals August von Goeben,* 2 vol. (1895–97), *A. von Goebrn in Seinen Briefen* (1903); *H.* Barth, *A. von Goeben* (1906); and for his share in the mar of 1870–71: H. Kunz, *Der Feldzug im N. und N.W. Frankreichs 1870–1871* (1889), and the 14th monograph of the Great General Staff (1891).

"GOEBEN" AND "BRESLAU." The escape of the German battle cruiser "Goeben" and light cruiser "Breslau" from Messina on Aug. 6, 1914, their flight to the Aegean sea and the bold decision to make for Constantinople turned what was for them a desperate situation into one of material advantage to Germany. Their arrival at the Sublime Porte undoubtedly had a considerable influence when Turkey was hesitating whether or not to cast in its lot with the Central Powers.

Position in **Aug. 1914.**—When World War I broke out, the naval forces of the powers concerned in the Mediterranean were as follows:

British forces under Vice-Adm. Sir A. Berkeley Milne:
Battle cruisers: "Inflexible." "Indomitable." "Indefatigable."
Armoured cruisers under Rear-Adm. E. C. Troubridge:
"Defence." "Black Prince." "Duke of Edinburgh." "Warrior." Light cruisers: "Chatham," "Dublin," "Gloucester," "Weymouth." Destroyers: 16.

French forces under Vice-Adm. de Lapeyrere:
Battleships: 1 dreadnought, 15 older type. Armoured cruisers: 6. Destroyers: 24.

Italian forces:
Battleships: 3 dreadnoughts, **3** older type.

Austrian forces:
Battleships: 3 dreadnoughts. 3 older type.

German forces under Rear-Adm. Souchon:
Battle cruiser: "Goeben."
Light cruiser: "Breslau."

The preliminary warning sent out on July 27 to Admiral Milne, then at Alexandria. directed him to return to Malta and, after completing with fuel and stores, to remain there for the purpose of watching the entrance to the Adriatic.' These orders were subsequently overridden by a series of telegrams from the admiralty. The first task given to Milne was to assist the French in transporting their African army. A lack of international cooperation is evident, because the French commander in chief knew nothing of these plans. Then followed orders to prevent the "Goeben" entering the Adriatic; to guard British trade in the east Mediterranean and to watch any Austrian ships which emerged from the Adriatic.

On July 31 the Italian government announce'd its intention to remain neutral, but this important fact was not communicated to Milne until Xug. 4, when he was further instructed to observe, strictly, the neutrality and allow no British warship to approach within six miles of the coast of Italy—a severe handicap to any operation in or near the Straits of Messina.

"Goeben's" Activities.—Admiral Souchon left Messina at 1 A.M. Xug. 3 and made a dash to the African coast where, on the following morning, he fired a fen. shots into the towns of Bona and Philippeville. He then made off to the east and, by a stroke of luck, narrowly missed meeting the French 1st squadron, but he was sighted and followed by the "Indomitable" and "Indefatigable." No hostile action could be taken, however, since war with Germany had not then been declared by Great Britain. Superior speed, aided by hazy weather, enabled Souchon to evade the British ships, and he returned to Messina where British ships could not follow if Italian neutrality was to be strictly observed.

Declaration **of** War.—At 7.02 P.M. on Aug. 4, Milne was informed the ultimatum would expire at midnight. When hostilities commenced at that hour the "Indomitable" and "Indefatigable" were between Sicily and Sardinia; the "Inflexible" was in the Malta channel steering to join her consorts; Troubridge, with the armoured cruisers, was near Cephalonia and the "Goeben" was approaching Messina, where she arrived, with the "Breslau." at 4 A.M. Aug. 5. Her presence there became known to Milne at 5:30 P.M. Aug. 5, and during that night the British battle cruisers patrolled between Bizerte and Sardinia.

"Goeben's" Escape.—Since Austria still hesitated to declare war against Great Britain. Souchon was given permission to act as he thought best. About 6 P.M. Aug. 6. Milne decided to close the northern entrance of the Straits of Messina. and. when off the northwest point of Sicily, he received news from the "Gloucester," that the "Goeben" and "Breslau" were leaving Messina by the southern entrance. Souchon made the bold decision to run for the Dardanelles. He steered to the northward, as if for the Adriatic, until 11 P.M., and then shaped a course for Cape Matapan, being shadowed throughout the night and the next day by the "Gloucester."

Troubridge steered north to intercept the German ships, but at midnight, realizing that their first course was only a feint. turned and proceeded south at full speed. Troubridge had decided not to risk his cruisers against the "Goeben's" 11-in. guns in a daylight action and, finding it impossible to intercept her before daylight, he abandoned the chase.

Milne took his battle cruisers to Malta, coaled and left again at midnight, Aug. 7, for the Aegean. A false alarm of war with Austria, sent out by the admiralty. induced Milne to alter his dispositions and wasted 24 hours. When the chase was resumed it was too late to overtake the "Goeben" and "Breslau," which ships, having coaled at the island of Denusa, reached the Dardanelles at about 5 P.M. Aug. 10. (J. E. T. H.)

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GOEDEKE, KARL (1814–1887), German literary historian, born at Celle, April 5, 1814, was responsible for the compilation of the indispensable *Grundriss zur Geschichte der deutschen Dichtung,* 3 vol. (1857–81). A new edition was begun in 1884. Volume four, on the classical period, appeared in a third edition, 1910–16; and a supplement to it, a bibliography of the subject down to the death of Goethe, was begun in 1957. A continuation for the period 1830–80 by G. Minde-Pouet and E. Rothe was begun in 1955. Goedeke was a professor at Gottingen from 1873, and died there Oct. 27, 1887. He published many other works, among them a critical edition of Schiller.

GOEJE, MICHAEL JAN DE (1836–1909), Dutch orientalist, was born in Friesland in 1836. He devoted himself at an early age to the study of oriental languages and became especially proficient in Arabic, under the guidance of Dozy and Juynboll, to whom he was afterwards an intimate friend and colleague. He took his degree of doctor at Leyden in 1860 and then studied for a year in Oxford, where he examined and collated the Bodleian manuscripts of Idrisi (part being published in 1866, in collaboration with R. P. Dozy, as *Description de l'Afrique et de l'Espagne*). About the same time he wrote *Mémoires de l'histoire et de la gtographie orientales,* and edited *Expugnatio regionum.* In 1883, on the death of Dozy, he became Arabic professor at Leyden, retiring in 1906. He died on May 17, 1909. He wielded a great influence during his long professoriate, not only over his pupils, but over theologians and eastern administrators who attended his lectures, and his many editions of Arabic texts have been of the highest value to scholars, the most important being his great edition of Tabari.

Among his chief works are *Fragmenta historicorurn Arabicorum* (1869–71); *Diwan of Moslim-ibn-al-Wālid* (1875); *Bibliotheca geographorum Arabicorum* (1870–94); *Annals of Tabari* (1879–1901); edition of Ibn Qutaiba's biographies (1904); of the travels of Ibn Jubaye (1907, 5th vol. of Gibb Memorial). He was also the chief editor of the *Encyclopaedia of Islam* (vols. i.–iii.) and contributed many articles to periodicals. He wrote for the 9th and the 11th editions of the *Encyclopædia Britannica.*

GOES, HUGO VAN DER (1440?–1482), Flemish painter known to G. Vasari and posterity by a single picture in a Florentine monastery, "The Adoration of the Shepherds," was probably born at Ghent. As agent of the Medici at the port of Bruges Tommaso Portinari (a lineal descendant, it was said, of Folco. the father of Dante's Beatrix) ordered an altarpiece of Hugo van der Goes and commanded him to illustrate the sacred theme of *Quem genuit adoravit.* In the centre of a vast triptych, comprising numerous figures of life size, Hugo represented the Virgin kneeling in adoration before the newborn Christ attended by shepherds and angels. On the wings he portrayed Tommaso and his two sons in prayer under the protection of St. Anthony and St. Matthew, and Tommaso's wife and two daughters supported by St. Margaret and St. Mary Magdalen. The triptych, which has suffered much from decay and restoring. was for over 400 years at Sta. Maria Kuova, and is now in the Uffizi gallery.

ALINARI

CENTRE PANEL OF PORTINARI ALTARPIECE BY HUGO VAN DER GOES. IN THE UFFIZI GALLERY. FLORENCE

There are also pieces in public galleries which claim to have been executed by Van der Goes: the "Madonna" at Frankfurt and the diptych representing the "Fall" and the "Deposition" at Vienna. These are probably early works. To a maturer period may be ascribed the precious little triptych in the Liechtenstein collection representing the "Adoration of the Magi"; the two wings of an altarpiece at the National gallery of Scotland (on loan from Holyrood palace); the "Death of the Virgin" at Bruges; the "Adoration of the Shepherds" at Wilton house. To his last years are ascribed two fine pictures painted on a large scale acquired by the Berlin gallery from Spain representing the "Nativity" and the "Adoration of the Magi." Van der Goes, however. was not only a painter of easel pieces. He made his reputation at Bruges by producing coloured hangings in distemper. After he settled at Ghent. and became a master of his guild in 1467, he designed cartoons for glass windows. He also made decorations for the wedding of Charles the Bold and Margaret of York in 1468, for the festivals of the rhetoricians and papal jubilees on repeated occasions, for the solemn entry of Charles the Bold into Ghent in 1471–72 and for the funeral of Philip the Good in 1474. About the year 1475 he retired to the monastery of Rouge Cloître near Brussels. There, though he still clung to his profession, he seems to have taken to drinking. and at one time to have shown symptoms of insanity. But he was cured of his intemperance. He died in 1482.

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GOES, a town in the province of Zeeland, Netherlands, on the island of South Beveland. $11\frac{1}{2}$ mi. E. of Rliddelburg by rail. Pop. (1957 est.) 14,353. The town had its origin in the castle of Oostende and received a charter early in the 15th century from Jacoba of Bavaria. countess of Holland, who frequently stayed at the castle. It is connected by a short canal with the East Scheldt, and has a good harbour (1819) defended by a fort. The principal buildings are the Gothic church (1423) and the old town hall (restored 1771). It is a centre of the linen industry and a market for wheat. Germany occupied Goes in May 1940.

GOETHALS, GEORGE WASHINGTON (1858–1928), American engineer and U.S. army officer known as the builder of the Panama canal. Born in Brooklyn, N.Y., June 29, 1858, he was graduated from the U.S. Military academy, West Point, in 1880. In the same year he was commissioned in the corps of engineers, U.S army. From 1880 to 1907 he obtained valuable training in canal, river and harbour construction work while on various assignments in connection with the civil works program of the army engineers. He also served as an instructor at the U.S. Military academy. In 1907 he was called to the White House by Pres. Theodore Roosevelt and told of his selection as chairman and chief engineer of the Isthmian Canal commission, succeeding John F. Stevens. In Jan. 1908 he was placed in complete charge of construction work and government in the Canal Zone by an executive order signed by President Roosevelt. "Now, I have both feet on the ground and I'll build the canal," he told the president.

In 1914 the Panama canal was declared open to commercial traffic; Pres. Woodrow Wilson appointed Colonel Goethals the first governor of the Panama canal, and the National Geographic society presented him with a special medal as "builder of the Panama Canal." In March 1915 he was promoted to major general and received the thanks of congress for distinguished service in building the Panama canal. In 1916 he retired from the army at his own request and in Jan. 1917 resigned as governor of the Panama canal. In Dec. 1917 he was recalled to active duty with the army, serving until March 1919, when he was relieved at his own request. From 1919 to 1928 he was president of the engineering firm of George W. Goethals and company and served as adviser to the Port of New York authority. The latter named a bridge in its area after the famous canal builder.

Goethals died at his home in New York city on Jan. 21, 1928 In March 1954 a monument of heroic size was dedicated in Balboa, Canal Zone, as a memorial to General Goethals. The monument mas authorized by congress in 1935. Pres. Dwight D. Eisenhower, in a message read at the dedication, said:

"During my own service in the Canal Zone, I came to appreciate the magnitude of the Panama Canal as an engineering triumph and the importance of its operations to international traffic. It is indeed fortunate that the nation was able to call upon a leader of General Goethals' stature to supervise our construction forces and to set the pattern for the Canal's successful operation."

(E. C. I.)

GOETHE, JOHANN WOLFGANG VON (1749–1832), greatest of German poets, was born at Frankfurt-on-Main. He came, on his father's side, of Thuringian stock, his great-grandfather, Hans Christian Goethe, having been a farrier at Artern-on-the-Cnstrut, about the middle of the 17th century. Hans Christian's son, Georg Friedrich, was brought up to the trade of a tailor, and in this capacity settled in Frankfurt in 1687. A second marriage, however, brought him into possession of the Frankfurt inn, "Zum Weidenhof," and he ended his days as a well-to-do innkeeper. His son, Johann Kaspar, the poet's father (1710–1782), studied law at Leipzig, and subsequently travelled in Italy. He hoped, on his return to Frankfurt, to obtain an official position in the government of the free city, but he had not sufficient personal influence to attain this end. In his disappointment he resolved never again to offer his services to his native town, and retired into private life. In 1742 he acquired, as a consolation for the public career he had missed, the title of kaiserlicher Rat, and in 1748 married Katharina Elisabeth (1731–1808), daughter of the Schultheiss or *Bürgermeister* of Frankfurt, Johann Wolfgang Textor. The poet was the eldest son of this union. Of the later children only one, Cornelia (b. 1750), survived the years of childhood; she died as the wife of Goethe's friend, J. G. Schlosser, in 1777. The best elements in Goethe's genius came from his mother's side; of a lively, impulsive disposition, and gifted with remarkable imaginative power, Frau Rat, who was hardly 18 when her son was born, was the ideal mother of a poet. From his father, whose stem, somewhat pedantic nature repelled warmer feelings on the part of the children, Goethe inherited, besides an unamiable stiffness of manner which grew on him with the years, that stability of character which brought him unscathed through temptations and passions, and held the balance to his all too powerful imagination.

Unforgettable is the picture which the poet has left us of his childhood spent in the large house with its many nooks and crannies in the Grosse Hirschgraben at Frankfurt. Books, pictures, objects of art, antiquities, reminiscences of Rat Goethe's visit to Italy, above all a marionette theatre, kindled the child's quick intellect and imagination. His education was conducted in its early stages by his father, and was later supplemented by tutors. Meanwhile the varied and picturesque life of Frankfurt was in itself a liberal education. In 1759, during the Seven Years' War, the French, as Maria Theresa's allies, occupied the town, and, much to the irritation of Goethe's father, who was a stanch partisan of Frederick the Great, a French lieutenant, Count Thoranc, was quartered on the Goethe household. The foreign occupation also led to the establishment of a French troupe of actors, and to their performances the boy, through his grandfather's influence, had free access. One of Goethe's most vivid memories was the picturesque coronation of the emperor Joseph II. in the Frankfurt Romer or town hall in 1764; he also dwells at some length in his autobiography on his first love affair. The object of this passion was a certain Gretchen, who seems to have taken advantage of the boy's interest in her to further the dishonest ends of one of her friends. The discovery of the affair and the investigation that followed cooled Goethe's ardour and caused him to turn his attention seriously to the studies which were to prepare him for the university. Meanwhile his literary instinct had begun to show itself; we hear of a novel in letters—a kind of linguistic exercise, in which the characters carried on the correspondence in different languages—of a prose epic on the subject of Joseph, and various religious poems of which one, Die Hollenfahrt *Christi,* found its way in a revised form into the poet's complete works.

In Oct. 1765, Goethe, then a little over 16, left Frankfurt for Leipzig, where a wider life awaited him. He entered upon his university studies with zeal, but his education in Frankfurt had not been the best preparation for the scholastic methods which still dominated the German universities; of his professors, only Gellert seems to have won his interest, and that interest was soon exhausted. The literary beginnings he had made in Frankfurt now seemed to him worthless; he committed them to the flames; and, under the guidance of E. W. Behrisch, a genial, if somewhat eccentric comrade, he turned over a new leaf; he acquired the art of writing those light Anacreontic lyrics which appealed to the taste of the polite Leipzig society of the day. Artificial as this poetry is, Goethe was, nevertheless, inspired by a real passion in Leipzig, namely, for Anna Katharina Schonkopf, the daughter of a wine-merchant at whose tavern he dined. She is the "Annette" after whom the collection of lyrics discovered in 1897 was named, although it must be added that neither these lyrics nor the Neue Lieder, published in 1770, let us see very much of Goethe's real feelings for Käthchen Schonkopf. To his Leipzig student-days belong also two small plays in Alexandrines, Die *Laune* des Verliebten, a comedy in one act, which reflects the lighter side of the poet's love affair, and Die Mitschuldigen (published in a revised form, 1769), a more sombre production, in which comedy is incongruously mingled with tragedy. In Leipzig Goethe also had time for what remained one of the abiding interests of his life, for art; he regarded A. F. Oeser (1717–1799), the director of the academy of painting in the Pleissenburg, who gave him lessons in drawing, as the teacher by whom he was most influenced in Leipzig. His art studies were also furthered by a short visit to Dresden. His stay in Leipzig came, however, to an abrupt conclusion; the distractions of student life proved too much for his strength; a sudden haemorrhage supervened, and he lay long ill, first in Leipzig, and, after it was possible to remove him, at home in Frankfurt. These months of slow recovery were a time of serious introspection for Goethe. He still corresponded with his Leipzig friends, but the tone of his letters changed; life had become more serious for him. He pored over books on occult philosophy; he busied himself with alchemy and astrology. A friend of his mother's, Susanne Katharina von Klettenberg, who belonged to pietist circles in Frankfurt, turned the boy's thoughts to religious mysticism.

On his recovery his father resolved that his legal studies should be completed at Strasbourg, a city, which although then outside the German empire, was, in respect of language and culture, wholly German. From the moment Goethe set foot in the narrow streets of the Alsatian capital, in April 1770, the whole current of his thought seemed to change. The Gothic architecture of the Strasbourg minster became to him the symbol of a national and German ideal, directly antagonistic to the French tastes and the classical and rationalistic atmosphere that prevailed in Leipzig. An event of the first importance in Goethe's Strasbourg period was his meeting with Herder, who spent some weeks in Strasbourg undergoing an operation. In this thinker, who was his senior by five years, Goethe found the master he sought; Herder taught him the significance of Gothic architecture, revealed to him the beauty of nature unadorned, and inspired him with enthusiasm for Shakespeare and the *Volkslied.* Meanwhile Goethe's legal studies were not neglected, and he found time to add to his knowledge in other fields. notably medicine. Another factor of importance in Goethe's Strasbourg life was his love for Friderike Brion, the daughter of an Alsatian village pastor in Sesenheim. Even more than Herder's precept and example, this passion showed Goethe how trivial and artificial had been the Anacreontic and pastoral poetry, which had occupied him in Leipzig; and the lyrics inspired by Friderike, such as *Kleine Blumen, kleine Blafter* and *Wie herrlich leuchtet mir die Natur!* mark the beginning of a new epoch in German lyric poetry. The idyll of Sesenheim, as described in *Dichtung und Wahrheit,* is one of the beautiful love-stories in the literature of the world. From the first, however, it was clear that Friderike Brion could never become the wife of the Frankfurt patrician's son; an unhappy ending to the romance was unavoidable, and, as is to be seen in passionate outpourings like *Wanderers Sturmlied,* and in the bitter self-accusations of *Clavigo,* it left deep wounds on the poet's sensitive nature.

In Strasbourg Goethe probably planned his first important drama, *Gotz von Berlichingen.* In estimating this drama we must bear in mind Goethe's own life, and the turbulent spirit of his age, rather than the historical facts, which the poet found in an autobiography of his hero published in 1731 The latter supplied only the rough materials; the Gotz von Berlichingen whom Goethe drew. with his humane ideals of justice and his enthusiasm for freedom. is a very different personage from the unscrupulous robber-knight of the 16th century. There is no historical justification for the vacillating Weisslingen in whom Goethe executed poetic justice on himself as the lover of Friderike, or for the women of the play, the gentle Maria, the heartless Adelheid. But there is genial, creative power in all the characters, and a vigorous dramatic life in the play's action, irresistible in its appeal even to a modern audience. With *Gotz von Berlichingen* the Shakespearian form of drama was established on the German stage, and the literary movement known as *Sturm und Drang* inaugurated.

Having received his licence to practice as an advocate, Goethe returned home in Aug. 1771, and began his initiation into the routine of his profession In the following year, in order to gain further experience in the practical side of his calling, he spent four months at Wetzlar, where the imperial law-courts mere established. But Goethe's professional duties had only a small share in the eventful years which lay between his return from Strasbourg and that visit to Weimar at the end of 1775, which turned the whole course of his career, and resulted in his permanent attachment to the Weimar court. Goethe's life in Frankfurt was a round of stimulating literary intercourse; in J. H Merck (1741–1791), an army official in the neighbouring town of Darmstadt, he found a friend and mentor, whose irony and common sense served as a corrective to his own exuberance of spirits Wetzlar brought new friends and another passion, that for Charlotte Buff, the daughter of the *Amtmann* there—an episode which has been immortalized in *Werthers Leiden;* again the young poet was obsessed by a love which was this time strong enough to bring him to the brink of that suicide which forms the culmination of the novel. A visit to the Rhine, where new interests and the attractions of Maximiliane von Laroche, a daughter of Wieland's friend, the novelist Sophie von Laroche, brought partial healing, his intense preoccupation with literary work on his return to Frankfurt did the rest. In 1775 Goethe was attracted by still another type of woman, Lili Schönemann, whose mother was the widow of a wealthy Frankfurt banker. A formal betrothal took place, and the beauty of the lyrics which Lili inspired leaves no room for doubt that here was a passion no less genuine than that for Friderike or Charlotte. But the gay, social world in which Lili moved was not congenial to him. A visit to Switzerland in the summer of 1775 may not have weakened his affection for her, but he began to see that marriage would impose intolerable fetters upon him, and without tragic consequences on either side, the engagement was allowed to lapse. Goethe's departure for Weimar in November brought about the final break.

The period from 1771 to 1775 was, in literary respects, the most productive of the poet's life. It had been inaugurated with *Gbtz von Berlichingen* and a few months later this tragedy was followed by another, *Clavigo,* peopled with equally living figures, and reflecting even more faithfully than *Gotz* the emotional experience Goethe had gone through in Strasbourg. Again poetic justice is effected on the unfortunate hero who is persuaded to choose his own personal advancement in preference to his duty to the woman he loves; more pointedly than in *Gotz* is this moral enforced; Clavigo's tragic end is due not so much to this defiance of moral laws, as to his vacillation and want of character With *Die Leiden des jungen Werthers* (1774), the literary precipitate of the author's own experiences in Wetzlar, Goethe succeeded in attracting, as no German had done before him, the attention of Europe. Once more it was the gospel that the world belongs to the strong in will, which lay beneath the surface of this romance. This, however, was not what Goethe's contemporaries read out of it; nor did they appreciate the wide range of spiritual experience which the book contains. *Werther* was to them merely a sentimental story of a lovelorn youth whose burden becomes too great for him to bear. While *Gbtz* inaugurated the manlier side of the *Sturm und Drang* literature, *Werther* was responsible for its sentimental excesses. In *Stella,* "a drama for lovers" (1776), the poet again reproduced, if with less fidelity than in *Werther,* certain aspects of his own love troubles. A lighter vein is to be observed in various dramatic satires written at this time such as *Gdtter, Helden und Wieland* (1774), *Hanswursts Hochzeit, Fastnachtsspiel vom Pater Brey, Satyros,* and in the *Singspzele, Erwin und Elmire* (1775) and *Claudine von Villa Bella (1776);* while to the *Frankfurter Gelehrte Anzeiger* (1772–73), Goethe contributed vigorous and provocative criticism. The exuberance of the young poet's genius is also to be seen in the many unfinished fragments of this period; at one time we find him occupied with dramas on *Caesar* and *Mahomet,* at another with an epic on *Der ewige Jude,* and again with a tragedy on *Prometheus,* of which a magnificent fragment has passed into his works. Greatest of all the torsos of this period, however, was his dramatization of the legend of *Faust.* Thanks to a manuscript copy of the play in its earliest form—discovered as recently as *1887,* and known as the *Urfaust*—we now know exactly how much of *Faust* was the immediate product of the *Sturm und Drang*, and are able to understand the intentions with which the young poet began his masterpiece. Goethe's hero changed with the author's riper experience and with his new conceptions of man's place and duties in the world, but the Gretchen tragedy was taken over into the finished poem, practically unaltered, from the earliest draft of the poem. With these wonderful scenes, the most intensely tragic in German literature, Goethe's poetry in this period reaches its climax. Still another important work, however, was conceived, and in large measure written at this time, the drama of *Egmont,* which was not published until *1788.* This work may, to some extent, be regarded as complementary to *Faust;* it presents the lighter, more cheerful and optimistic side of Goethe's outlook on liie in these years; Graf Egmont, the most winning and fascinating of the poet's heroes, is endowed with that "daimonic" power over the sympathies of men and women, which Goethe himself possessed in so high a degree. But *Egmont* is but an indifferent drama: it has little plot and its interest depends almost solely on two characters, Egmont himself and Klärchen, the young girl of the people whom he loves.

In Dec. 1774 the young "hereditary prince" of Weimar, Karl August, passing through Frankfurt on his way to Paris, came into touch with Goethe, and invited the poet to visit him in Weimar. In Oct. 1775 the invitation was repeated, and on Nov. 7 Goethe arrived in the little Saxon capital which was to remain his home for the rest of his life. During the first few months in Weimar the poet gave himself up to the pleasures of the moment as unreservedly as his patron; indeed, the Weimar court even looked upon him for a time as a tempter who led the young duke astray. But the latter, although himself a mere stripling, had implicit faith in Goethe's judgment, and enlisted his services in the government of the duchy. Goethe was not long in Weimar before he was entrusted with responsible state duties, and events justified the duke's confidence. Goethe displayed as minister of state, both energy and foresight. He interested himself in agriculture, horticulture and mining.. which were of paramount importance to the welfare of the duchy, and these interests led to his preoccupation with the natural sciences which took up so much of his time in later years. The inevitable love-interest was also not wanting. As Friderike had fitted into the background of Goethe's Strasbourg life, Lotte into that of Wetzlar, and Lili into the gaieties of Frankfurt, so now Charlotte von Stein, the wife of a Weimar official, was the appropriate muse of Goethe's Weimar life. We possess only the poet's share of his correspondence with Frau von Stein, but it may be inferred from it that, of all Goethe's loves, she was intellectually the most worthy of him. Frau von Stein was a woman of refined literary taste and culture, seven years older than he and the mother of seven children. She dominated the poet's life for 12 years, until his journey to Italy in 1786–1788. Of other events of this period the most notable were two winter journeys, the first in 1777, to the Harz mountains, the second, two years later, to Switzerland—journeys which gave Goethe opportunity for that introspection and reflection for which his Weimar life had left him little time. On the second of these journeys he revisited Friderike in Sesenheim, saw Lili, who had married and settled in Strasbourg, and made the personal acquaintance of J. R. Lavater in Zurich.

The literary results of these years cannot be compared with those of the preceding period; they are virtually limited to a few wonderful lyrics, such as *Wanderers Nachtlied, An den Mond, Gesang der Geister über den Wassern*, ballads, such as *Der Erlkonig, a* delicate little drama, *Die Geschwister* (1776), in which the poet's relations to both Lili and Frau von Stein seem to be reflected, a dramatic satire, *Der Triumph der Empfindsamkeit* (1778), and a number of *Singspiele, Lila* (1777), *Die Fischerin, Scherz, List und Rache,* and *Jery und Bately* (1780). But greater works were in preparation. A religious epic, *Die Geheimnisse*, and a tragedy *Elpenor,* did not, it is true, advance much further than plans; but in 1777, under the influence of the theatrical experiments at the Weimar court, Goethe began to write a novel of the theatre on a large scale which was to have borne the title *Wilhelm Meisters theatralische Sendung. A* manuscript copy of the novel in this early form was discovered as recently as 1910. In 1779 he himself took part in a representation before the court at Ettersburg, of his drama *Iphigenie auf Tauris.* This *Iphigenie* was, however, in prose; in the following year Goethe refashioned it in iambics, but it was not until he went to Italy that it received the form we know.

In Sept. 1786 Goethe set out from Carlsbad where he had been on holiday—secretly and stealthily, his plans known only to his servant—on that memorable journey to Italy, to which he had looked forward with such intense longing; he could not cross the Alps quickly enough, so impatient was he to set foot in Italy. He travelled by way of Munich, the Brenner and Lago di Garda to Verona and Venice, and from thence to Rome, where he arrived on Oct. 29, 1786. Here he gave himself up unreservedly to the new impressions which crowded on him, and he was soon at home in the circle of German artists there. In the spring of 1787 he extended his journey to Naples and Sicily, returning to Rome in June 1787, where he remained until his final departure for Germany on April 2, 1788. It is difficult to exaggerate the importance of Goethe's Italian journey. He himself regarded it as a kind of climax to his life; never before had he attained such complete understanding of his genius and mission as a poet; it afforded him a vantage-ground from which he could renew the past and make plans for the future. In Weimar he had already felt that he was no longer in sympathy with the *Sturm und Drang,* but it was Italy which first initiated him into that neo-classicism which superseded *Sturm und Drang* in German poetry. To the modern reader, impressed by Goethe's extraordinary sensitiveness to impressions, it may seem strange that his interests in Italy were so limited; for, after all, he had eyes for comparatively little of what Italy had to offer. He went to Rome in Winckelmann's footsteps; it was the antique he sought, and he was interested in the artists of the Renaissance only in so far as he saw in them the heirs of antiquity. The calm beauty of Greek tragedy is seen in the new iambic version of *Iphigenie auf Tauris* (1787); the classicism of the Renaissance gives the ground-tone to the drama of *Torquato Tasso* (1790), in which the conflict of poetic genius with the prosaic world is transmuted into imperishable poetry. Classic, too, in this sense, were the plans of a drama on *Iphigenie auf Delphos* and of an epic, *Nausikaa.* Most interesting of all. however, is the reflection of the classic spirit in works already begun in earlier days, such as *Egmont* and *Faust.* The former drama was finished in Italy, the latter was brought a step forward, part of it being published as a *Fragment* in 1790.

Disappointment in more senses than one awaited Goethe on his return to Weimar. He came back from Italy with a new philosophy of life, a philosophy at once classic and pagan, and with new ideals of literary beauty. But Germany had not advanced; in 1788 his countrymen were still admirers of that *Sturm und Drang* from which the poet had fled. The times seemed to him more out of joint than ever, and he withdrew into himself. Even his relations to the old friends were changed. Frau von Stein had not known of his flight to Italy until he had been several weeks there; but he looked forward to her welcome on his return. The months of absence, however, the change he had undergone, and, doubtless, lighter loves which had beguiled his leisure in Rome, weakened the Weimar ties; if he left Weimar as Frau von Stein's lover he returned only as her friend; and she naturally resented the change. Goethe, meanwhile, continuing the freer customs to which he had adapted himself in Rome, took into his household Christiane Vulpius (1765–1816), a young girl who could offer him no kind of intellectual companionship. But Christiane gradually filled a gap in the poet's life; she gave him, unobtrusively, without making demands on him, the comforts of a home. She was not accepted by court society; she was indifferent to the fact that even Goethe's intimate friends ignored her; but she, who had suited the poet's whim when he desired to shut himself off from all that might dim the recollection of Italy, became with the years an indispensable helpmate to him. On the birth in 1789 of his son, Goethe had some thought of legalizing his relations with Christiane, but this intention was not realized until 1806, when the invasion of Weimar by the French made both life and property insecure.

The period of Goethe's life which succeeded his return from Italy was restless and unsettled; relieved of his state duties, he returned in 1790 to Venice, only to be disenchanted with the Italy he had loved so intensely a year or two before. A journey with the duke of Weimar to Breslau followed, and in 1792 he accompanied his master on that campaign against France which ended ingloriously for the German arms at Valmy. In later years Goethe published his account of this *Campagne in Frankreich* as also of the *Belagerung von Mainz,* at which he was present in 1793. His literary work naturally suffered under these distractions. *Tasso,* and the edition of the *Schriften* in which it was to appear, had still to be completed on his return from Italy; the *Römische Elegien,* perhaps the most Latin in form and content of all his works, were published in 1795, and the *Venezianische Epigramme,* the result of the second visit to Italy, in 1796. The French Revolution, in which all Europe was engrossed, was in Goethe's eyes only another proof that the passing of the old régime meant the abrogation of law and order, and he gave voice to his antagonism to the new democratic principles in the dramas *Der Gross-Cophta* (1792), *Der Burgergeneral* (1793), and in the unfinished fragments *Die Aufgeregten* and *Das Madchen von Oberkirch.* The spirited translation of the epic of *Reineke Fuchs* (1794) he took up as a relief and an antidote to the perplexing state of the time. Two new interests, however, strengthened the ties between Goethe and Weimar—ties which the Italian journey had threatened to sever: his appointment in 1791 as director of the ducal theatre, a post which he occupied for 22 years, and his absorption in scientific studies. In 1790 he published his important *Versuch, die Metamorphose der Pflanzen zu erklaren,* which was even more fundamental for the new science of comparative morphology than his discovery some six years earlier of traces of a structure in the human jaw-bone analogous to the intermaxillary bone in apes; and in 1791 and 1792 appeared two parts of his *Beiträge zur Optik.*

Meanwhile, however, Goethe had again taken up the novel of the theatre which he had begun years before, with a view to its inclusion in the edition of his *Neue Schriften* (1792-1800). *Wilhelm Meisters theatralische Sendung* became *Wilhelm Meisters Lehrjahre;* the novel of purely theatrical interests was widened out to embrace the history of a young man's apprenticeship to life. The change of plan explains, although it may not exculpate, the formlessness and loose construction of the work. A hero, who was probably originally intended to demonstrate the failure of the vacillating temperament when brought face to face with the problems of the theatre, proved ill-adapted to demonstrate those precepts for the guidance of life with which the *Lehrjahre* closes; unstable of purpose, *Wilhelm Meister* is not so much an illustration of the author's life-philosophy as a lay-figure on which he demonstrates his views. *Wilhelm Meister* is, however, a work of extraordinary variety, its scenes ranging from the commonplace realism of the troupe of strolling players to the poetic romanticism of Mignon and the harper; its pages of intuitive criticism—notably of *Hamlet—add* to its value as a *Bildungsrontan* in the best sense of rhat word. Of all Goethe's works, this exerted the most immediate and lasting influence on German literature; it served as a model for the best fiction of the next 30 years.

In completing *Wilhelm Meister,* Goethe found a sympathetic critic in Schiller, to whom he owed in great measure his renewed interest in poetry. After years of tentative approach on Schiller's part, years in which that poet was not even himself clear that he desired a friendly understanding with Goethe, the favourable moment arrived. It was in June 1794, when Schiller was seeking collaborators for his new periodical *Die Horen;* and his invitation addressed to Goethe was the beginning of a friendship which continued unbroken until the younger poet's death. The friendship of Goethe and Schiller, of which their correspondence is a priceless record, had, however, its limitations; it was essentially a literary friendship, a certain barrier of personal reserve being maintained to the last. As far as actual work was concerned, Goethe went his own way as he had always been accustomed to do; but the mere fact that he devoted himself with increasing interest to literature was due to Schiller's stimulus. It was Schiller who induced him to undertake those studies on the nature of epic and dramatic poetry which resulted in the epic of *Hermann und Dorothea* and the fragment of the *Achilleis;* without the friendship there would have been no *Xenien* and no ballads, and it was again, his younger friend's encouragement which induced Goethe to betake himself once more to the "misty path" of *Faust,* and bring the first part of that drama to a conclusion.

Goethe's. share in the *Xenien* (1796) may be briefly mentioned. This collection of distichs, written in collaboration with Schiller, was prompted by the indifference and animosity of contemporary criticism, and its disregard for what the two poets regarded as the higher interests of German poetry. The *Xenien* succeeded as a retaliation on the critics, but the masterpieces with which both poets justified their attack, were in the long run a more effective antidote to the prevailing mediocrity. The collection of stories, *Unterhaltungen deutscher Ausgewanderten* (1797) was unworthy of Goethe's genius, and the translation of Benvenuto Cellini's *Life* (1796–1797) was only a translation. But in 1798 appeared *Hermann und Dorothea,* one of Goethe's most perfect poems. It is indeed remarkable—when we consider by how much theoretic discussion the composition of the poem was preceded and accompanied—that it should make upon the reader so simple and unsophisticated an impression; in this respect it is the triumph of an art that conceals art. Goethe has here taken a simple story of village life, mirrored in it the most pregnant ideas of his time, and presented it nith a skill which may well be called Homeric; but he has discriminated with the insight of genius between the Homeric method of reproducing the heroic life of primitive Greece and the same method as adapted to the commonplace happenings of 18th century Germany. In this respect, he was guided by a forerunner who had depicted the life of the German people in the epic manner and in hexameters, J. H. Voss, the author of *Luise.* Hardly less imposing in their calm, placid perfection are the poems with which, in friendly rivalry, Goethe seconded the more popular ballads of his friend; *Der Zauberlehrling, Der Gott und die Bayadere, Die Braut von Korinth, Alexis und Dora, Der neue Pausias* and *Die schöne Müllerin*—the latter a cycle of poems in the style of the *Volkslied*—are among the masterpieces of Goethe's poetry. On the other hand, even the friendship with Schiller did not help him to add to his reputation as a dramatist. *Dze naturliche Tochter* (1803), the first part of a trilogy, in which he proposed to embody his ideas of the Revolution on wide canvas, did not get beyond this. Goethe's abstract classic principles, when applied to the swift, direct art of the theatre, were ineffective, and *Die natürliche Tochter,* notwithstanding its good theoretic intention, remains the most lifeless and shadowy of all his dramas. Even less in touch with the living present were the various prologues and *Festspiele,* such as *Paläophron und Neoterpe* (1800), *Was wir bringen* (1802), which in these years he composed for the Weimar theatre.

Goethe's classicism brought him into inevitable antagonism with the new Romantic movement which had been inaugurated in 1798 by the *Athenäum,* edited by the brothers Schlegel. The sharpness of the conflict was, however, blunted by the fact that, without exception, the young Romantic writers looked up to Goethe as their master; they modelled their fiction on *Wilhelm Meister;* they regarded his lyrics as the highwater mark of German poetry; Goethe, Novalis declared, was the "Statthalter of poetry on earth." With regard to painting and sculpture, however, Goethe felt that a protest was necessary, if the ideas propounded in works like Wackenroder's *Herzensergiessungen* were not to bring back the confusion of the *Sturm und Drang;* and, as a rejoinder to the Romantic theorists, Goethe, in conjunction with his Swiss friend, Heinrich Meyer (1760–1832), published from 1798 to 1800 an art review, *Die Propyläen.* In *Winckelmann und Sein Jahrhundert* (1805) Goethe defended the classical ideal of beauty in art. But in the end he himself proved the greatest enemy to the strict classical doctrine by the publication in 1808 of the completed first part of *Faust,* a work which was accepted by contemporaries as a triumph of Romantic art. *Faust* is a patchwork of many colours. With the aid of the vast body of *Faust* literature which has sprung up in recent years, and the many new documents bearing on its history—above all, the so-called *Urfaust,* to which reference has already been made—we are able now to discriminate between the various phases of the work; on the original *Sturm und Drang* hero of the opening scenes and of the Gretchen tragedy—the brother of Gotz, and Clavigo—is superimposed, in the completed poem, a Faust of calmer moral and intellectual ideals, who corresponds to Hermann and Wilhelm Meister, in Goethe's work. In its first form the poem was concerned with very definite personai problems; in the years of Goethe's friendship with Schiller it was widened to embody the higher strivings of 18th-century humanism; ultimately, in the second part, it became a vast allegory of human iife and activity. Thus the elements of which *Faust* is composed were even more difficult to blend than were those of *Wilhelm Meister;* but the very want of uniformity is one source of the perennial fascination of the tragedy, and has made it in a peculiar degree the national poem of the German people, a mirror in which the national life and poetry are reflected, from the outburst of *Sturm und Drang* to the tranquil classicism of Goethe's maturity.

The third and final period of Goethe's long life may be said to have begun after Schiller's death. He never again lost touch with literature as he had done in the years which preceded his friendship with Schiller; but he stood in no active or immediate connection with the literary movement of his day. His life moved on comparatively uneventfully. Even the era of Napoleonic oppression, 1806–1813, disturbed but little his equanimity. Goethe, the cosmopolitan *Weltburger* of the 18th century, had himself no very intense feelings of patriotism, and, having seen Germany flourish as a group of small states under enlightened despotisms, he had little confidence in the dreamers of 1813 who hoped to see the glories of Barbarossa's empire revived, Napoleon, moreover, he regarded not as the scourge of Europe, but as the defender of civilization against the barbarism of the Slavs; and in the famous interview between the two men at Erfurt the poet's admiration was reciprocated by the French conqueror. Thus Goethe had no great sympathy for the war of liberation which in 1813 kindled young hearts from one end of Germany to the other; and when the national enthusiasm rose to its highest pitch he buried himself in those optical and morphological studies, which, with increasing years, occupied more and more of his time.

The events and writings of the last 25 years of Goethe's life may be briefly summarized. In 1805, as we have seen, he suffered an irreparable loss in the death of Schiller; in 1806, Christiane became his legal wife, and to the same year belongs the magnificent tribute to his dead friend, the *Epilog zu Schillers Glocke.* Two new friendships about this time kindled in the poet something of the passion of younger days. Bettina von Arnim came into touch with Goethe in 1807, and her *Briefwechsel Goethes mit einem Kinde* (published in 1835) is, in its mingling of truth and fiction, one of the most delightful products of the Romantic mind; but the episode was of less importance in Goethe's eyes than Bettina would have us believe. On the other hand, his interest in Minna Herzlieb, foster-daughter of the publisher Frommann in Jena, was of a warmer nature, and has left its traces on the novel, *Die Wahlverwandtschaften* and on his sonnets.

In 1808, as we have seen, appeared the first part of *Faust,* which in 1809 was followed by the novel just mentioned. That novel, hardly less than the drama, effected a change in the public attitude towards the poet. Since the beginning of the century the conviction had been gaining ground that Goethe's mission was accomplished, that the day of his leadership was over; but here were two works which not merely re-established his position, but proved that the old poet was in sympathy with the movement of letters, and keenly alive to the change of ideas which the new century had brought with it. The intimate study of four minds, which forms the subject of the *Wahlverwandtschaften,* was an essay in a new type of psychological fiction and pointed out the way for developments of the German novel after the stimulus of *Wilhelm Meister* had exhausted itself. Less important than *Die Wahlverwandtschaften* was *Pandora* (1810), the final product of Goethe's classicism and the most uncompromisingly classical and allegorical of all his works. And in 1810, too, appeared his treatise *Zur Farbenlehre.* In the following year the first volume of his autobiography was published under the title *Aus meinem Leben, Dichtung und Wahrheit.* The second and third volumes of this work followed in 1812 and 1814; the fourth, bringing the story of his life up to the close of the Frankfurt period in 1833, after his death. Goethe felt, even late in life, too intimately bound up with Weimar to discuss in detail his early life there, and he shrank from carrying his biography beyond the year 1775. But a number of other publications—descriptions of travel, such as the *Italienische Reise* (1816–17), the materials for a continuation of *Dichtung und Wahrheit* collected in *Tag-und Jahreshefte* (1830) are important additions to the documents of his life. Meanwhile, no less valuable biographical materials were accumulating in his diaries, his voluminous correspondence and his conversations, as recorded by J. P. Eckermann, the chancellor F. von Miiller and F. Soret. Several periodical publications, *Über Kunst und Altertum* (1816-32), *Zur Naturwissenschaft überhaupt* (1817-24), *Zur Morphologie* (1817-24), bear witness to the extraordinary width of Goethe's interests in these years. Art, science, literature—little escaped his ken—and that not merely in Germany: English writers, Byron, Scott and Carlyle, Italians like Manzoni, French scientists and poets, could all depend on friendly words of appreciation and encouragement from Weimar.

With *Westöstlicher Diwan* (1819), Goethe had another surprise in store for his contemporaries; this is a collection of lyrics, matchless in form and more concentrated in their apophthegmatic expression than those of earlier days; it was suggested by a German translation of the Persian poet, Hafiz. And, again, an actual passion—that for Marianne von Willemer, whom he met in 1814 and 1815—had rekindled in him the lyric fire. Meanwhile the years were thinning the ranks of Weimar society: Wieland, the last of Goethe's greater literary contemporaries, died in 1813, his wife in 1816, Charlotte von Stein in 1827 and Duke Karl August in 1828. Goethe's retirement from the direction of the theatre in 1817 meant for him a break with the literary life of the day. In 1822 a passion for a young girl, Ulrike von Levetzow, whom he met at Marienbad, inspired the fine *Trilogie der Leidenschaft,* and between 1821 and 1829 appeared the long-expected and long-promised continuation of *Wilhelm Meister, Wilhelm Meisters Wanderjahre.* The latter work, however, was a disappointment: perhaps it could not have been otherwise. Goethe had lost the thread of his romance, and it was difficult for him to find it again. Problems of the relation of the individual to society and industrial questions were to have formed the theme of the *Wanderjahre;* but after the French Revolution these problems had entered on a new phase and demanded a method of treatment which it was not easy for the old poet to acquire. Thus his intentions were only partially carried out, and the volumes were filled out by irrelevant stories, written at widely different periods.

But the crowning achievement of Goethe's literary life was the completion of *Faust.* The poem had accompanied him since early manhood and was the repository for the fullest "confession" of his life; it is the poetic epitome of his experience. The second part is far removed from the impressive realism of the *Urfaust* or even the classicism of the first part. It is a phantasmagory; a drama the actors in which are not creatures of flesh and blood, but shadows in an unreal world of allegory. The lover of Gretchen had, as far as poetic continuity is concerned, disappeared with the close of the first part. In the second part it is virtually a new Faust who, accompanied by a new Mephistopheles, goes out into a world that is not ours. Yet behind the elusive allegories of an imperial court with its financial difficulties, behind the classical *Walpurgisnacht,* the fantastic creation of the Homunculus, the noble Helena episode and the impressive mystery-scene of the close, where the centenarian Faust finally triumphs over the powers of evil, there lies a philosophy of life, a ripe wisdom born of experience, such as no other modern European poet has given us. *Faust* has been well called the "divine comedy" of 18th-century humanism.

The second part of *Faust* forms a worthy close to the life of Germany's greatest man of letters, who died in Weimar on March 22, 1832. His was the last of those universal minds which have been able to compass all domains of human activity and knowledge; for he stood on the brink of an era of rapidly expanding knowledge which has made forever impossible the universality of interest and sympathy which distinguished him. As a poet, his fame has undergone many vicissitudes since his death, ranging from the indifference of the "Young German" school to the enthusiastic appreciation of the closing decades of the 19th century—an enthusiasm to which we owe the Weimar *Goethe-Gesellschaft* (founded in 1885) and a vast literature dealing with the poet's life and work. That Goethe is Germany's greatest poet and the master of her classical literature has never been seriously questioned. The intrinsic value of his poetic work, regarded apart from his personality, may be smaller in proportion to its bulk than is the case with some lesser German poets and with the great poets of other literatures. But Goethe was a new type of literary man; a poet whose supreme greatness lay in his subjectivity. Only a small fraction of his poetical work sprang from what might be called a purely artistic and objective impulse; by far the larger—and the better—part is the immediate precipitate of his thought, emotions, and experiences.

It is as a lyric poet that Goethe's supremacy is least likely to be challenged; he has given his nation, whose highest literary expression has in all ages been essentially lyric, its greatest songs. No other German poet has succeeded in attuning feeling, sentiment and thought so perfectly to the music of words as he; none has expressed so fully that subtle spirituality in which the strength of German lyrism lies. Goethe's dramas, on the other hand, have not, in the eyes of his nation, succeeded in holding their own beside Schiller's; but the reason is rather because Goethe refused to be bound by the conventions of the theatre, than because he was deficient in the cunning of the dramatist. For, as a creator and interpreter of human character, Goethe is without a rival among modern poets, and there is not one of his plays that does not contain scenes and characters which bear indisputable testimony to this mastery. *Faust* is Germany's most national drama, and it remains perhaps for the theatre of the future to prove itself capable of popularizing psychological masterpieces like *Tasso* and *Iphigenie*. As a novelist, Goethe has suffered most by the lapse of time. The *Sorrows of Werther* no longer maintains its hold upon us, and even *Wilhelm Meister* and *Die Wahlverwandtschaften* require more understanding for the conditions under which they were written than do *Faust* or *Egmont*. Goethe could fill his prose with rich wisdom, but he was the perfect artist only in verse.

Less attention is nowadays paid to Goethe's work in other fields, work which he himself in some cases prized more highly than his poetry. It is only as an illustration of his many-sidedness and his manifold activity that we now turn to his achievement as a statesman, as a practical political economist, as a theatre-director. His art-criticism is symptomatic of a phase of European taste to which the growing individualism of Romanticism was repugnant. His scientific studies and discoveries now possess only an historical interest. We marvel at the obstinacy with which he, with inadequate mathematical knowledge, opposed the Newtonian theory of light and colour; and at his championship of "Neptunism," the theory of aqueous origin, as opposed to "Vulcanism," that of igneous origin of the earth's crust. Of real importance was, on the other hand, his foreshadowing of the Darwinian theory in his works on the metamorphosis of plants and on biological morphology. Indeed, the deduction to be drawn from Goethe's contributions to botany and anatomy is that he, as few of his contemporaries, possessed that type of scientific mind which, in the 19th century, has made for progress; he was Darwin's predecessor by virtue of his enunciation of what has now become one of the commonplaces of natural science—organic evolution. Modern, too, was the outlook of the aging poet on the changing social conditions of the age and on its new political ideals; unexpectedly sympathetic his attitude towards modern industry, which steam was just beginning to establish on a new basis. The Europe of his later years was very different from that of the enlightened autocracies of the 18th century, in which he had spent his best years; yet Goethe was at home in it too.

From the philosophic movement, in which Schiller and the Romanticists were deeply involved, Goethe stood apart. Comparatively early in life he had found in Spinoza the philosopher who responded to his needs; and for the subtle dialectic of later thinkers he had neither liking nor understanding. As a convinced realist he took his standpoint on nature and experience, and could afford to look on with indifference at the battles of the metaphysicians. Of Kant's work, however, he was not ignorant, and under Schiller's stimulus he learned from him; but of the younger thinkers, only Schelling, whose mystic nature-philosophy was akin to Spinoza's thought, touched a sympathetic chord in his nature. As a moralist and a guide to the conduct of life—an aspect of Goethe's work which Carlyle, viewing him through the coloured glasses of Fichtean idealism, emphasized and interpreted not always justly—Goethe was a powerful force on German life in years of intellectual and political depression. It is difficult even still to get beyond the maxims of practical wisdom he scattered so liberally through his works and the lessons to be learned from *Meisfer* and *Faust;* the calm optimism which never deserted Goethe, and was so completely justified by the tenor of his life, is still an uplifting element of his thought. If the philosophy of Spinoza provided the poet with a religion which made individual creeds and dogmas seem unnecessary, Leibnitz's doctrine of predestinism supplied the foundations for his faith in the divine purpose of human life.

Goethe's many-sided activity is a tribute to the greatness of his mind and personality; we may see in him merely the embodiment of his particular age, or we may regard him as a poet "for all time"; but with one opinion all who have felt the power of Goethe's genius are in agreement—the opinion which was condensed in Napoleon's often cited words, uttered after the meeting at Erfurt: *Voilà un homme!* Of all modern men of genius, Goethe is the most universal. It is the full, rich humanity of his personality—not the art behind which the artist disappears, or the definite pronouncements of the thinker or the teacher—that constitutes his claim to a place in the front rank of men of letters. His life was his greatest work.

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(*b*) Biography.—Goethe's autobiography, *Aus meinem Leben: Dichtung und Wahrheit,* appeared in three parts between 1811 and 1814; part iv. in 1833 (Eng. trans., 1846); it is supplemented by other

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(*c*) *Criticism.*—H. G. Graf, *Goethe über seine Dichtungen* (1901–14); J. W. Braun, *Goethe im Urteile seiner Zeitgenossen* (1883–85); T. Carlyle, *Essays on Goethe* (1828–32); X. Marmier, *Études sur Goethe* (1835); W. von Biedermann, *Goethe-Forschungen* (1879–99); J. Minor and A. Sauer, *Studien zur Goethe-Philologie* (1880); H. Düntzer, *Abhandlungen zu Goethes Leben und Werken* (1881); A. Schöll, *Goethe in Hauptzügen seines Lebens und Wirkens* (1882); V. Hehn, *Gedanken über Goethe* (1884, 7th ed., 1909); W. Scherer, *Aufsätze über Goethe* (1886); Sir J. R. Seeley, *Goethe reviewed after Sixty Years* (1894); E. Dowden, *New Studies in Literature* (1895); É. Rod, *Essai sur Goethe* (1898); M. Morris, *Goethe-Studien* (1897–98; 2nd ed., 1902); A. Luther, *Goethe, sechs Vorträge* (1905); R. Saitschik, *Goethes Charakter* (1898); W. Bode, *Goethes Lebenskunst* (1900; 3rd ed., 1903); by the same, *Goethes Ästhetik* (1901); T. Vollbehr, *Goethe und die bildende Kunst* (1895); E. Maas, *Goethe und die Antike* (1912); E. Lichtenberger, *Etudes sur les poésies lyriques de Goethe* (1878); T. Achelis, *Grundzüge der Lyrik Goethes* (1900); B. Litzmann, *Goethes Lyrik* (1903); R. Riemann, *Goethes Romantechnik* (1901); R. Virchow, *Goethe als Naturforscher* (1861); E. Caro, *La Philosophie de Goethe* (1866; 2nd ed., 1870); R. Steiner, *Goethes Weltanschauung* (1897); E. A. Boucke, *Goethes Weltanschauung* (1897); F. Siebeck, *Goethe als Denker* (1902); F. Baldensperger, *Goethe en France* (1904); C. Schrempf, *Goethes Lebensansehauung* (1905–7); H. Loiseau, *L'Évolution morale de Goethe* (1911); B. Croce, *Goethe* (Bari, 1919; Eng. trans., 1923); K. J. Obenauer, *Goethe in seinem Verhältnis zur Religion* (1921); P. Fischer, *Goethes Altersweisheit* (1921); H. A. Korff, *Die Lebensidee Goethes* (1925).

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(*d*) *Bibliographical Works, Goethe-Societies &c.*—S. Hirzel, *Verzeichnis einer Goethe-Bibliothek* (1884), to which G. von Loeper and W. von Biedermann have supplied supplements. Goedeke's *Grundriss zur Geschichte der deutschen Dichtung* (vol. iv., 3rd ed., 1910–13); and the bibliographies in the *Goethe-Jahrbuch* (1880–1913). Also K. Hoyer, *Zur Einführung in die Goethe-Literatur* (1904). On Goethe in England *see* E. Oswald, *Goethe in England and America* (1899; 2nd ed., 1909); J. M. Carré, *Goethe en Angleterre* (1921); W. Heinemann, *A Bibliographical List of the English Translations and Annotated Editions of Goethe's Faust* (1886).

A *Goethe-Gesellschaft* was founded at Weimar in 1885; its publications include the annual *Goethe-Jahrbuch* (1880–1913); now *Jahrbuch der Goethe-Gesellschaft* (1914 ff.), and a series of *Goethe-Schriften*. A *Goethe-Verein* has existed in Vienna since 1887, and an English Goethe society since 1886 (*Publications*, 1880–1910; new series 1924 ff). (J. G. R.)

GOETHITE, a very common iron mineral consisting of hydrated iron oxide, the principal component of rusted iron. Goethite is the stable iron mineral under the hydrous, oxidizing conditions near the earth's surface. It occurs as a direct precipitate (*e.g.*, in bogs), and as a weathering product of other iron minerals, sometimes making an important ore of iron, as in Alsace. In most deposits goethite is very fine-grained, occasionally as fibrous radiating masses. The name goethite was originally given, in honor of the poet and natural philosopher Johann Goethe, to a less common iron mineral (now known as lepidocrocite) of identical composition but different structure. Ordinarily the two minerals can be distinguished only by X-ray diffraction; undifferentiated fine-grained material is usually called limonite (*q.v.*). The composition of goethite is FeOOH, equivalent to the chemical compound $\alpha-Fe_2O_3.H_2O$. The structure is based on a nearly close-packed arrangement of large oxygen or hydroxyl ions, with ferric ions between alternate layers. The packing gives a symmetry of structure and form that is pseudohexagonal (orthorhombic) and the weak interlayer bonding results in one perfect cleavage and in a tabular or prismatic external form. The colour is blackish brown in single crystals, ranging through all shades of brown and yellow as the size of crystals decreases. The hardness is 5 and specific gravity 4.2. (W. T. HR.)

GOG, a hostile power that is to manifest itself in the world immediately before the end of things (Ezek. xxxviii *sq.*, Rev. xx), Magog who is joined with Gog in the latter passage is the name of Gog's origin in the former. In Gen. x, 2 (and Ezek. xxxviii, 2) Magog appears to represent a locality in Armenia.

The legends attached to the gigantic effigies (dating from 1708 and replacing those destroyed in the Great Fire) of Gog and Magog in Guildhall, London, are of unknown date. According to the *Recuyell des histoires de Troye*, Gog and Magog were the survivors of a race of giants descended from the 33 wicked daughters of Diocletian; after their brethren had been slain by Brute and his companions, Gog and Magog were brought to London (Troynovant) and compelled to officiate as porters at the gate of the royal palace.

Effigies similar to the present existed in London as early as the time of Henry V.

GOGH, VINCENT WILLEM VAN (1853–1890), the greatest and most revolutionary Dutch painter after Rembrandt, was born on March 30, 1853, the eldest of six children of a Protestant pastor, at Groot Zundert (Brabant). The artistic career of Vincent van Gogh was extremely short, lasting only ten years

(1880–90); during the first part he was acquiring technical proficiency and confined himself almost entirely to drawings and water colours. His first productive period of oil painting begins in 1884. During the ensuing six years. he produced about 700 drawings and 800 oils, only one of which was sold during his lifetime. Vincent was always desperately poor. but he was sustained by faith in the urgency of what he had to communicate, and by a younger brother. Theo (1857–1891), who believed implicitly in his genius and provided for him out of his own meagre earnings. The letters which Vincent wrote to Theo (from 1872 on) give a graphic account of his aims and beliefs, hopes and disappointments, of his fluctuating physical and mental state. of his pictorial methods and of his daily life. Van Gogh expressed himself so vividly and analyzed things so acutely that his *Collected Correspondence* ranks not merely as a great autobiographical record but as great literature. Vincent's working life can be roughly divided into two periods. The first (1873–85), during which he wrestled with temperamental difficultiesand sought his true means of self-expression, was a period of repeated apprenticeships, failures and changes of direction. The second (1886–90) was a period of dedication, rapid development and fulfillment, until his progress was interrupted by a succession of mental crises (1889–90) ending in an attempted suicide on July 27, 1890, and his death two days later.

Vincent's early years in his father's parsonage uere happy, and he loved wandering in the countryside At 16. he was apprenticed to the art dealers Goupil and Co., of which his uncle was a partner. Vincent began at their branch in The Hague, going later to London (1873–74) and Paris (1874–75). Daily contact with works of art aroused Van Gogh's artistic sensibility and he soon formed a taste for Rembrandt, Hals. J. van Ruisdael, C. Troyon. Jules Dupré and J. Maris, although his preference mas for Millet and Corot, whose influence was to last throughout his life. Vincent disliked art dealing; moreover, his approach to life darkened when his love was rejected by a London girl (1874), for his burning desire for human affection had been thwarted. From then on he became increasingly solitary. He became a language teacher and lay preacher (England), and later (1877) a bookseller in Dordrecht. Impelled by a longing to give himself to his fellow men, Vincent envisaged entering the ministry and took up theology, but abandoned this project for short-term training as an evangelist in Brussels (Aug. 1878). A conflict with authority ensued, for Vincent disputed the orthodox doctrinal approach. failed to get a nomination and after three months left to do missionary work among the mining population of the Borinage. There he experienced the first great spiritual crisis of his life (winter, 1879–80). He was sharing the life of the poor completely, but in an impassioned moment gave away all his worldly goods and was thereupon dismissed for too literal an interpretation of Christian teaching. Penniless and with his faith destroyed, he sank into despair. cut himself off from everyone and began seriously to draw, thereby discovering (Aug. 1880) his true vocation. Vincent decided that his mission from then on would be to bring consolation to humanity through art, and this realization of his creative powers restored his self-confidence. He immediately went to study drawing at the Brussels academy, then in April 1881 moved to his father's parsonage at Etten and began to work from nature.

Van Gogh worked hard and methodically but soon perceived the difficulty of self-training and sought the guidance of more experienced artists. In Jan. 1882 he settled at The Hague to work with Anton Mauve; he made visits to museums and had meetings with painters such as Van Rappard and G. Breitner. Vincent thus extended his technical knowledge and experimented (summer 1882) with oil paint. In Sept. 1883 the urge to be "alone with nature" and the peasants took him to Drenthe. a desolate part of northern Holland frequented by Mauve, Van Rappard and Max Liebermann. where he spent three months before returning home, uhich was now at Nuenen. Vincent remained at Nuenen from Dec. 1883 till Nov. 1885 and during these years his art grew bolder and more assured. He painted three types of subject—still life, landscape and figure—all interrelated by their reference to the peasants' daily life, to the hardships they endured and the countryside they cultivated. Emile Zola's *Germinal* had greatly impressed Van Gogh, and in many of his pictures, *e.g.,* "Weavers" and "The Potato Eaters." sociological criticism is implicit. Eventually Vincent felt too isolated in Nuenen. His understanding of the possibilities of painting was evolving rapidly; through studying Hals he saw that academic "finish" destroys the freshness of a visual impression, while Veronese and Delacroix taught him that "colour expresses something by itself." This led to enthusiasm for Rubens and a sudden departure for Antwerp, where the revelation of Rubens' "simple means," of his direct notation. and of his ability to "express a mood . . . by a combination of colours" proved decisive. Simultaneously, Van Gogh "discovered" Japanese prints and began to use pure colours. His refusal to follow academic principles led to rows at the Antwerp academy, where he was enrolled, and after three months of hard work and near-starvation he left precipitately (early March 1886) to join Theo in Paris. There, still concerned with improving his drawing, Vincent worked for three months under F. Cormon, in whose studio he met Toulouse-Lautrec and Emile Bernard, who opened his eyes to the latest developments in French painting and subsequently introduced him to Paul Gauguin; at the same time, Theo showed him Impressionist paintings at Goupil's and introduced him to Camille Pissarro, Georges Seurat and others of the group. By this time Vincent was ready for such revelations, and the changes which his painting underaent in Paris (1886–88) led to the expansion of his personal idiom. His palette at last became colourful in a series of "Flower Still Lifes" (summer 1886) executed under the influence of Adolphe Monticelli; thereafter his vision became less traditional and his tonalities lighter (first views of Montmartre) until (spring 1887) the Impressionist influence became paramount (more views of Paris). Later (summer 1887), in outdoor views of Montmartre, Suresnes, Asnières and Chatou, Vincent was painting in pure colours and using a broken brushwork which is at times pointillistic. Finally his post-Impressionist style crystallized (Dec. 1887–Feb. 1888) in some interpretations of prints by Hiroshige and in masterpieces such as "Portrait of Père Tanguy" and "Self-Portrait in Front of an Easel."

BY COURTESY OF MUSEUM FOLKWANG, ESSEN, GERMANY

"PORTRAIT OF ARMAND ROULIN" BY VINCENT VAN GOGH (IN THE MUSEUM FOLKWANG, ESSEN)

After two years, Van Gogh was tired of city life, physically exhausted, and longing "to look at nature under a brighter sky," because he realized that the veiled light of the north obliged him to "respect tonal values," whereas his passion was for "the Japanese way of feeling and drawing" and for "a full effect of colour." He left Paris on Feb. 20, 1888, for Arles. In his pictures of the following 12 months—his first great period—Vincent strove to respect the external, visual aspect of a figure or a landscape. but found himself unable to suppress his own feelings about the subject. These found expression in vivid formal simplifications or exaggerations and an almost arbitrarily intense use of colour. Vincent's pictorial conception is thus partly expressionist and partly symbolist. His procedure was not scientific or calculated, however, but spontaneous and instinctive, for he worked with great speed and intensity, determined to capture an effect or a mood uhile it possessed him. His Arles subjects include blossoming fruit trees, views of the town and surroundings, self-portraits, portraits of Roulin the postman and his family and other friends, interiors and exteriors of his house, a series of sunflowers and a "starry night." Van Gogh knew that his approach to painting was revolutionary and individualistic, but he also knew that some tasks are beyond the power of isolated individuals to accomplish In Paris he had hoped to form a separate Impressionist group with Gauguin, Toulouse-Lautrec, Bernard and Anquetin. whom he supposed to have similar aims. He rented and decorated "a yellow house" in Arles with the intention of persuading them to join him and found a working community of "Impressionists of the South." Gauguin arrived on Oct. 20, 1888, and for two months they worked together; but while each influenced the other to some extent, their relations rapidly deteriorated because they had opposing ideas and were temperamentally incompatible. On Christmas eve, 1888, Vincent broke under the strain and cut off part of his left ear. Gauguin left and Van Gogh was taken to a hospital; he returned to the "yellow house" a fortnight later and resumed painting: "Self-Portrait With a Bandaged Ear," still lifes, "La Berceuse." Within a month he was back in the hospital. At the end of April 1889, fearful of losing his "capacity for work," which he felt returning and regarded as a guarantee of sanity, he asked to be "temporarily shut up" in the asylum at St. Rémy de Provence in order not to be alone and to be under supervision. Vincent stayed there for 12 months, haunted by recurrent attacks, alternating between calm and despair and working intermittently ("Garden of the Asylum," "Cypresses," "Olive Trees," "Les Alpilles," portraits of doctors, interpretations of Rembrandt, Delacroix, Millet). The keynote of this phase (1889–90) is fear of losing touch with reality and a certain sadness. Confined for long periods to his cell or the asylum garden and having no choice of subjects. Van Gogh fought against having to work from memory; his inspiration depended on direct observation and he distrusted Gauguin's process of "abstraction." At St. Rémy, Vincent toned down his violent colour contrasts of the previous summer and tried to be calmer; but as he repressed his excitement he involved himself more imaginatively in the drama of the elements and of natural growth and decay, developing a style based on dynamic forms and a vigorous use of line (line often equated with colour). The best of his St. Rémy pictures are thus bolder, more moving and more visionary than those of Arles.

Vincent himself brought this period to an end. Oppressed by homesickness—he painted souvenirs of Holland—and loneliness, he longed to see Theo and the north once more and arrived in Paris on May 16, 1890. Four days later he went to stay with Dr. Gachet, a friend of Pissarro and Paul Cézanne, at Auvers-sur-Oise. Back in a village community such as he had not known since Nuenen (1885), Van Gogh worked enthusiastically and his choice of subjects (fields of corn, the river valley, peasants' cottages, the church, the town hall) reflects his spiritual relief. A modification of his style follows; natural forms are less contorted, pale fresh tonalities, the brushwork is broader and more expressive, the vision of nature more lyrical. Everything in Van Gogh's pictures seems to be moving, living. But this phase was short. Quarrels with Gachet, feelings of guilt at his inescapable dependence on Theo (now married and with a son) and inability to succeed, despair of ever overcoming his loneliness or of being cured, drove him to suicide (July 1890). Six months later Theo, too, was dead (Jan. 25, 1891).

The name of Van Gogh was virtually unknown when he took his life. He had exhibited a few canvases at the Salon des Indépendants (1888–90) and at Les XX in Brussels (1890), and both *salons* showed small commemorative groups of his work in 1891; but his first one-man shows were posthumous (1892). Only one article on him appeared during his lifetime (Albert Aurier in *Mercure de France*, Jan. 1890). His fame was made largely by other painters (E. Bernard, M. Denis) and dates from the early years of the 20th century; since then his reputation has never ceased to grow and he has exerted a powerful influence on the development of modern painting (Matisse, Derain, Vlaminck, the German Expressionists, Picasso), especially in the field of colour. See also PAINTING: *The Netherlands*.

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GOGOL, NIKOLAI VASILIEVICH (1809–1852), Russian novelist and dramatist, was born at Sorochintsky, province of Poltava, on March 31, 1809, of a family of Ukrainian Cossack gentry. Educated at the Niezhin gymnasium, he there started a manuscript periodical, *The Star*, and wrote several pieces including a tragedy, *The Brigands*. In 1829 he went to St. Petersburg, where he tried the stage but failed. In 1830 he obtained a clerkship in the department of appanages, but soon resigned it. In 1829 he published anonymously a poem called *Italy*, and, under the pseudonym of V. Alof, an idyll, *Han Küchelgarten*, which was so ridiculed that Gogol bought up all the copies ne could and burnt them. He was terribly disheartened, and thought of emigrating to America. Indeed, he got as far as Liibeck, but then returned to St. Petersburg, and entered the civil service. He made his way in literary circles, and was well received by Pushkin, whom he met in 1831.

In 1831 appeared *Evenings in a Farm near Dikanka: by Rudy Panko*, a volume of stories of Ukrainian life, which was enthusiastically received. Gogol then planned a history of Little-Russia of the middle ages, to be completed in eight or nine volumes. This remained a plan only, but served to win for him a chair of history in the university of St. Petersburg. His lectures were a failure, and he resigned in 1835. Meanwhile he had published his *Arabesques*, a collection of essays and stories; his *Taras Bulba*, the best known of the *Cossack Tales* translated into English by George Tolstoi (1860) and by J. Cournos (Everyman Edition, 1906), and a number of other short stories, including *Old World Gentlefolks*, a sketch of the tranquil life led in a quiet country house, also *The Cloak*, a description of the petty miseries endured by an ill-paid clerk in a government office, the great object of whose life is to secure the "cloak" from which his story takes its name. On April 19, 1836, his famous comedy, the *Revizor* (Eng. trans. by C. Garnett, *The Government Inspector*, 1926,) was produced. The *Revizor* is the greatest of Russian comedies; it is a brilliant satire on bureaucracy, which was received with enthusiasm by the intelligentsia and with horror by the official classes. But it is an error to look on its historical and political significance as its principal claim to rank among the great European comedies. Even when played in another language (and Gogol more than any other Russian author loses in translation), it is recognised as pure and universal comedy. The plot is very simple. A traveller who arrives with an empty purse at a provincial town is taken for an inspector whose arrival is awaited with fear, and he receives all the attentions and bribes which are meant to propitiate the dreaded investigator of abuses.

After the production of the *Revizor*, Gogol went abroad, and for twelve years (1836–48) lived mainly in Rome, while paying occasional short visits to Russia. Rome left a deep impression on his mind, but during his residence there he was occupied with purely Russian subjects. There he wrote the classic novel, *Mertvuiya Dushi*, or "Dead Souls," the first part of which appeared in 1842. The hero of the story is an adventurer who goes about Russia making fictitious purchases of "dead souls," *i.e.*, serfs who have died since the last census, with the object of pledging his imaginary property to the government. His adventures provide the occasion for a series of unforgettable pictures of Russian provincial life, and of types of Russian society. These amazingly vivid pictures are a fundamental part of the experience of all Russian students of their own language. Gogol had an individual vision which presented his types with a force and truth of the kind attained by Dickens at his best. No one can fully appreciate Gogol's merits as a humorist who is not intimate with the language in which he wrote, but there are good English versions by C. Garnett (1922) and by D. J. Hogarth (Everyman Edition, 1906). To the period of his residence in Rome belong also the recasting of *Taras Bulba* and his second comedy, *Marriage*.

Dead Souls was published in 1842; Gogol lived ten years longer. He was still a young man, only 43, and it was reasonable to expect that the creator of the *Revizor* and of *Dead Souls* would produce other great imaginative works. He was a great artist and though both the comedy and the novel were "events" in the history of Russia, they are what they are because of the imaginative genius of the author. Gogol the man found himself the hero of those who would regenerate Russia, and he seems at this point to have stifled his natural genius because of his conviction that he had a mission. However that may be, he began to work on the second part of his epic of *Dead Souls*, with the idea of showing the redemption of Chichikov and his kind. He failed, and destroyed the draft, but he wrote what he conceived to be his message to Russia in his *Selected Passages from a Correspondence With Friends* (1847). It called forth some bitter replies, especially from Belinsky, who accused him of "falsifying Christianity for the profit of those in power" (*see* D. Mirsky, *Hist. of Russ. Lit.*). Gogol felt the rebuff deeply, and sought compensation in a religious experience that was denied to him. In vain he went on pilgrimage to the Holy Land (1848). On his return he fell under the influence of a fanatic, Father Matthew Konstantinovsky, who persuaded him that his imaginative work was sinful. He fell into melancholy and destroyed some of his manuscripts. He died on Feb. 21, 1852.

The works of Gogol, translated by C. Garnett, are available. *See* Shenrok, *Materials for the Biography of Gogol* (in Russian) (1897); N. Bazhenov, "Illness and Death of Gogol," *Russkaya Muisl* (Jan. 1902); J. Lavrin, *Gogol* (1926); M. Theiss, *Nikolaus W. Gogol und seine Bühnenwerke* (1922).

GOGRA, a river of northern India. It rises in Tibet near Lake Manasarowar, not far from the sources of the Brahmaputra and the Sutlej, passes through Nepal as the Karnali and becomes the most important waterway in Uttar Pradesh. It joins the Ganges at Chapra after a course of 600 mi. Its tributary, the Rapti, is also commercially important. The Gogra is also called the Sarju, and in its lower course the Deoha.

GOHIER, LOUIS JEROME (1746–1830), French politician, son of a notary, was born at Semblançay (Indre-et-Loire) on Feb. 27, 1746. He practised law at Rennes. He was minister of justice (March 1793–April 1794), and in June 1799 succeeded Treilhard in the Directory. His wife was intimate with Josephine Bonaparte, and when Bonaparte returned from Egypt in Oct. 1799 he tried to gain over Gohier, who was then president of the Directory. Refusing to resign after the coup d'état, Gohier was detained for a time and on his release retired to Eaubonne. In 1802 Napoleon made him consul general at Amsterdam. He died at Eaubonne on May 29, 1830.

His *Me'moires d'un vétéran irre'prochable de la Révolution* was published in 1824, and his report on the papers of the civil list preparatory to the trial of Louis XVI is printed in *Le Procès de Louis XVI* (Paris, an III) and elsewhere.

GOHRDE, a forest of Germany, in the *Land* of Lower Saxony, immediately west of the Elbe, between Wittenberg and Liineburg. It has an area of about 85 sq.mi. and is famous for its oaks, beeches and game preserves. It is memorable for the victory gained there on Sept. 16, 1813, by the allies, under Wallmoden, over the French forces commanded by Pecheur, and on account of the constitution of Göhrde promulgated there in 1719.

GOIÂNIA, capital of the state of Goiás in Brazil, is about 70 mi. S.E. of Goiás. Pop. (1950) 39,871. Goiás, the old capital, is a mining town on a small tributary of the Rio Araguaia. Gold was discovered there in 1682 by Bartholomeu Bueno, the first European explorer of this region, and the settlement founded by him was called Santana, which is still the name of the parish. The site of the town is a barren, rocky mountain valley, 1,900 ft. above sea level, in which the heat is oppressive at times and the nights are unpleasantly cold. There is regular air service.

The state contains the area selected for a possible future federal capital on the plateau about 130 mi. N.E. of the city of Goibnia.

GOIÁS, an inland state of Brazil, formerly spelled Goyaz and Goiaz, is bounded by the states of Maranhão on the north, Mato Grosso and Pará on the west, Maranhão, Bahia and Minas Gerais on the east, and Minas Gerais and Mato Grosso on the south. Its area is 240,333 sq.mi. Its population (1950) was 1,209,368. The chief cities are Goibnia, the capital since 1937, Goiás, the old capital, Anápolis, Ipameri, and Catalão, all located in the southern part of the state.

Goiás lies wholly within the Brazilian highlands. In the south it occupies the larger part of the *planalto central*, or central plateau, the vast level surface of which stands between 2,500 and 3,000 ft. above sea level. A few rounded ridges stand higher than this, the highest being the Chapada dos Veadeiros (5,505 ft.). The *planalto central* forms the divide between three of Brazil's largest river systems: to the south Goiás is drained through the Paranaiba, a tributary of the Paraná; to the east it is drained by tributaries of the São Francisco; and the greater part of the state is drained northward through the Araguaia and the Tocantins. None of these rivers is navigable except for short distances. The southern part of the state is covered with a woodland savanna known in Brazil as *campo cerrado*. To the north, where the Araguaia and Tocantins have eroded deep valleys, the land is covered uith tropical rain forest, or selva. The whole area enjoys moderate temperatures, except in the deeper valleys which are warm enough to permit survival of malaria mosquitoes. The year is divided into a rainy season (October–March) and a dry season (April–September).

The first Portuguese exploration of this interior part of Brazil was carried on by expeditions from São Paulo in the 17th century. In a few places gold and diamonds were found in the stream gravels; one of the chief mining areas was in a tributary of the Araguaia and there the old colonial town of Goiás was located. In 1744 this large inland area, much of it still unknown by white men, was made a captaincy general, and in 1822 it became a province of the empire of Brazil. It became a state in 1889.

The greater part of Goiás is still very thinly populated. Only a few isolated settlements are scattered throughout the northern two-thirds of the area. The chief concentration of settlement is in the southeast, across the border from Minas Gerais. Anápolis, reached by rail from Rio de Janeiro and São Paulo, is a rapidly-growing frontier town, serving the new zone of pioneer settlement in an "island" of forest to the northwest, the Mato Grosso de Goiás. Farm settlement has also moved into smaller forested areas along the valleys of the southeast. The open campos, however, offer only poor pasturage, and their use for agriculture remains uncertain. The state produces quartz crystals, diamonds, titanium, nickel, and chromium. (P. E. J.)

GOIDÀNICH, PIER GABRIELE (1868–1953), Italian linguist, whose main scholarly interest was in the Romance languages, Old Latin and Indo-European, was born on July 30, 1868, in Volosca (Istria). He obtained his doctorate at the University of Pisa, where he also was professor of the comparative history of the classical and neo-Latin languages from 1899 to 1906. He then was transferred to the University of Bologna, where he remained until his retirement.

A prolific writer, he was, in philosophy and methods, in continued disagreement with the neolinguistic school, created and guided by his compatriot Bartoli. Goidànich's arguments can be seen in his "Neolinguistica o linguistica senza aggettivo?" *Archivio glottologico italiano* (AGI), vol. 21, pp. 59–105 (1927), and "Il mio insegnamento di glottologia," AGI, vol. 30. pp. 1–51 (1938), the latter of which, written in the year of his retirement, is his scholarly testament. He was editor of the AGI from 1910 to 1926, and coeditor from 1926 to 1953 (until 1946 with his rival Bartoli). In this journal he published numerous articles. Goidànich died on Nov. 1. 1953, at Bologna. (E. PM.)

GOIDELIC DIALECTS: *see* CELTIC LANGUAGES.

GÓIS, DAMIÃO DE (1502–1574), among the most outstanding of Portuguese humanists, was born of a patrician family at Alenquer on Feb. 2, 1502. Under King John III he was employed abroad after 1523 on diplomatic and commercial missions, and he traveled widely in Europe. He knew many leading scholars intimately, was acquainted with Luther and Melanchthon and in 1532 became the pupil and friend of Erasmus. Góis took his degree at Padua in 1538. He married in Flanders and settled at Louvain, then the literary centre of the Low Countries, where he was living in 1542 when the French besieged the town. Taken prisoner, he was confined for nine months in France, but was rewarded later for his services by a grant of arms from Charles V. He returned to Portugal in 1545 and in 1548 was appointed chief keeper of the archives and royal chronicler. In 1558 he was commissioned to write a history of the reign of King Manuel, and the first part appeared in 1566.

Damião de Góis was a man of wide culture and genial manners, and a skilled musician. He wrote both Portuguese and Latin with classic strength and simplicity. His portrait, by Albrecht Diirer, shows an open, intelligent face, and the record of his life proves him to have been upright and fearless. But his historical work gave offense to the great families; a denunciation to the Inquisition in 1545 was taken up later! and in 1j71 he was arrested. He was sentenced to a term of strict reclusion at the monastery of Batalha. Later he seems to have returned to Alenquer where he died suddenly on Jan. 30, 1574. (E. P.; A. B.; N. J. L.)

BIBLIOGRAPHY.—Gois's Portuguese works include the *Crdnica do felicissimo rei Dom Emanuel,* 4 pt. (1566–67), also ed. by D. Lopes and J. M. Teixeira de Carvalho in 4 vol. (1926); *Crdnica do principe Dom Jodo* (1567), ed *by* A. J. Gonçalves Guimarães (1905). Among his major Latin works are *Fides, religio, moresque Aethiopum* (1540) and *Deploratio Lappiae Gentis* (1540). Some of his Latin treatises are available in Portuguese translation in *Opúsculos histdricos de Damido de Gdis* (1945). *See* also G. *J.* C. Henriques, *Inéditos Goesianos,* 2 vol. (1896–98); J. de Vasconcelos, *Damião de Gdis* (1897); F. M. de Sousa Viterbo, *Estudos sobre Damido de Gdis* (1900); *M.* Lemos, "Damião de Góis," in *Revista da Historia,* vol. ix and x (1920–22); M. Bataillon, "Le Cosmopolitisme de Damião de Góis," in *Études sur le Portugal au temps de l'humanisme* (1952); *A.* F. G. Bell, "Damião de Góis, a Portuguese Humanist," in *Hispanic Review* (1941). (N. J. L.)

GOITRE. A goitre is an enlargement of the thyroid gland which is located in the neck just beneath the larynx. (See THYROID; ENDOCRINOLOGY: Thyroid Gland; HORMONES: Thyroid.) Goitres are usually confined to the neck but occasionally they are also found within the thorax. The normal thyroid weighs 20–30 g.; goitres may reach a size of 1 kg. The goitrous gland may exhibit a diffuse symmetrical hypertrophy, or the excessive growth may be nodular or adenomatous, disturbing the gross architecture of the gland. Most adenomatous growths are benign, but a small minority are or become malignant. The thyroid is also enlarged in the inflammatory disease, thyroiditis.

Endemic goitre occurs in a large proportion of the population in those areas of the world in which the iodine content of drinking water and food is exceedingly low. Switzerland and the Great Lakes region in the U.S. are notable in this regard. Iodine is an integral part of the hormonally active amino acid thyroxin and closely related compounds secreted by the thyroid. When the iodine is not supplied in sufficient quantity the gland hypertrophies, presumably in its effort to produce an optimum amount of hormone. At first there may be a diffuse enlargement of the gland, but eventually nodular growths evolve. When the iodine deprivation has been extreme for years, hypothyroidism develops and the children of such individuals may be cretins. (See CRETINISM.) Supplementing the usual iodine intake by the addition of iodide to table salt has been shown to prevent goitres effectively in endemic areas.

Nodular goitres also occur in nonendemic areas. The pathogenesis of these sporadic goitres is uncertain. However, the enlargement of the thyroid that occurs as a normal accompaniment of pregnancy and the fact that about 80% of these nodular goitres occur in women have suggested that cyclic variations in ovarian and pituitary activity may alternately stimulate and inhibit the thyroid and thus play a role in the genesis of nodular enlargements. It is also possible that goitrogenic chemicals found in small quantities in some foodstuffs (*i.e.,* cabbage) may be provocative in this regard.

Some drugs, most notably thiocyanates and thiourea derivatives, also possess goitrogenic properties. Thiocyanates inhibit the iodide trapping mechanism of the gland; the thioureas actually block the synthesis of the hormone. In either case thyroid hypertrophy results. Thiourea derivatives are frequently employed in the treatment of hyperthyroidism. Although the thyroid may enlarge during the administration of these drugs, this is seldom a contraindication to continued therapy.

Hyperthyroidism may occur with diffuse or nodular goitres. Graves' disease is characterized by the association of hyperthyroidism, exophthalmos (protrusion of the eyes) and a diffuse enlargement of the thyroid (exophthalmic goitre). Exophthalmos is rare indeed when nodular goitres become hyperactive. The diagnosis of thyrotoxicosis in patients with nodular goitre is especially difficult due to the usual insidious onset in these cases. Toxic goitres can be treated in one of several ways. The surgical removal of most of the gland, subtotal thyroidectomy, is the treatment of choice in younger patients. Such surgery must be preceded by medical control of the hyperthyroidism, which is conveniently carried out by combined treatment with iodine (Lugol's solution) and one of the thiourea derivatives such as 6-propylthiouracil. In older patients surgery can be avoided by employing radioactive iodine (I^{131}). This isotope, which can be given orally, is taken up by the thyroid cells which are then destroyed by the radioactive emanations. The dosage can be so regulated that a sufficient remnant of undamaged thyroid tissue remains to maintain normal thyroid function. In occasional patients with Graves' disease protracted treatment with one of the thiourea compounds alone has been successful in inducing lasting remissions.

Nodular goitres should be removed surgically whenever they interfere with the function of neighbouring organs. Tracheal compression which may embarrass respiration, and impaired deglutition due to oesophageal involvement are the most frequent indications. A relatively rapid growth of the tumour suggests the possibility of malignancy, and hence also calls for a subtotal thyroidectomy.

Carcinomas of the thyroid appear to develop with unusual frequency in nodular goitres, especially those with only a single nodule or adenoma. Despite the considerable frequency of goitres, the incidence of carcinoma of the thyroid is not great, being among the least frequent of malignancies. Nevertheless the low morbidity and mortality which attend thyroidectomies have persuaded many physicians to advise the removal of almost all solitary adenomas as a prophylactic measure. X-ray treatment of the head, neck and chest in children has been shown to be one of the causes of carcinoma of the thyroid.

Hashimoto's struma and Riedel's struma are chronic inflammatory disorders of the thyroid which may simulate other goitres. These are rare diseases of unknown aetiology which often terminate with the destruction of active thyroid tissue and the production of hypothyroidism. Acute thyroiditis is more readily distinguished because the enlarged gland is exquisitely tender and painful.

See Sidney C. Werner (ed.), *The Thyroid* (New York, 1955; London, 1956). (R. L. L.)

GOKALP, ZIYA (pseudonym of MEHMED ZIYA) (1875–1924), Turkish sociologist, writer and nationalist leader, was born in Diyarbekir. He entered the Istanbul Veterinary school in 1896 but his active membership in a secret revolutionary society led to imprisonment and then "exile" to his home town. After the Young Turk revolution (1908) Gokalp took part in a committee conference of the secret Society of Union and Progress in Salonika and, settling there, played an important part in the activities of the committee which later virtually ruled the country. His contributions to the literary periodical Gench *Kalemler* gave impetus to the campaign for language reform. When the Balkan War broke out he was appointed to the chair of sociology at Istanbul university, soon becoming the intellectual leader of the Nationalist movement. After the 1918 armistice, he was exiled to Malta with a number of leading Turkish politicians. Freed after the Nationalist victory, he went to Diyarbekir, publishing there the periodical *Küchük* Mecmua. Later he moved to Ankara, worked in the ministry of education and was elected member of parliament in 1923. He died in Istanbul on Oct. 25, 1924.

An ardent ideologist of Pan-Turanism, Gokalp greatly influenced the politicians and writers of his generation.

See Z. Fahri, *Ziya Gokalp, sa vie et sa sociologie* (1936); U. Heyd, *Foundations of Turkish Nationalism* (1950). (F. I.)

GOKCHA (Gok-Chai; Armen. Sevanga; anc. Haosravagha), a lake in Armenian S.S.R., U.S.S.R., 40° 20' N. and 45° 35' E., altitude 6,279 ft., triangular in shape, measures 45 mi. N.W.–S.E., max. width 25 mi., max. depth 325 ft., area 540 sq.mi. It is surrounded by barren mountains of volcanic origin 12,000 ft. high. Its outflow is the Zanga, a tributary of the Aras (Araxes); it never freezes, and its level undergoes periodical oscillations. It contains four species of *Salmonidae,* and two of *Cyprinidae,* peculiar to the drainage area of this lake.

GOKHALE, GOPAL KRISHNA (1866–191j), Indian politician, was born at Kolhapur. Graduating at the Elphinstone college, Bombay, in 1884, he became professor of history and political economy at the Fergusson college, Poona. He remained on the staff, finally as principal, until 1902.

He was associated with the Indian National congress from the beginning and was for some years its joint secretary. In 1902 he became a member of the Bombay legislature and was then elected to represent the nonofficial members thereof in the viceregal legislature. In 1905, although opposed by the extremist section of congress, he became president of that body. In the same year he founded at Poona his Servants of India society, whose members take vows of poverty and lifelong service to their country in a religious spirit. In the enlarged viceregal legislature set up in 1910, Gokhale was the commanding Indian figure. His quickness in debate, the attractive literary style of his speeches, his studied moderation, and the care which he took to master his subjects made him a most effective critic of the government, though he disclaimed the title of the leader of an opposition party.

He specialized as a critic of Indian official finance and was particularly brilliant in his handling of the annual budgets. He promoted measures for compulsory education on a basis of local option but did not survive to see this principle introduced from 1918 onwards in all the large provinces. His last public duty was to serve as a member of the Indian Public Services commission (1912–15). His death at Poona on Feb. 19, 1915, was a severe blow to the Constitutional party at a critical moment in India's political history. He was one of the last and greatest of the old school of congress politicians before the age of nonco-operation.

See *Speeches of the Honourable Mr. G. K. Gokhale* (Madras 1908, 3rd ed., 1920); R. P. Parāñjpye, *Gopal Khrishna Gokhale* (1915).

GOLASECCA is a village of Italy on the river Ticino, a few miles below the point at which it issues from Lago Maggiore. Extensive cemeteries of the iron age have been found all over this district, and the name Golasecca has come to be applied indiscriminately to the whole series, occupying an area of nearly forty square kilometres. Some of them are situated on the left bank of the Ticino at Somma, Vergiate, Sesto Calende and Golasecca itself; others on the right bank at Castelletto Ticino and the Lazzaretto of Borgo Ticino. After the first quarter of the 19th century all these sites were despoiled by excavators, very often unauthorized, and the objects found in them were broken up or scattered over the world. The only collection of any size or importance is in the museum at the Sforza castle in Milan. There may be seen the contents of the Sesto Calende tomb illustrated in the accompanying drawing, as well as the collection formed by Castelfranco, the only archaeologist of the 20th century to make any comprehensive study of the region.

All the cemeteries of the Somma plateau were of the cremation rite. The tombs were very simple, each containing a single cinerary urn, often enclosed in the centre of a circle of rough stones. In several instances these circles were approached by a corridor of similar stones. The most perfect example of this kind is a circle 17 metres in diameter enclosing a smaller circle 43 metres in diameter approached by a corridor 30 metres long. One burial was found within the small circle and three more within the outer circle. Castelfranco observed traces of about 50 stone enclosures and it is probable that there had been many more. Castelfranco, whose explorations were fairly extensive and systematic, states that he invariably found a tomb in the centre of every circle that he explored, and that the tombs found within the circles contained precisely the same pottery as those which stood isolated from any enclosure. The construction of the graves. moreover, was precisely the same whether enclosed within a circle or not. There were four varieties, viz.: (1) plain round holes in which the ossuary was placed without any protection; (2) a heap of small stones surrounding the ossuary, which rested in a bed of similar stones and was sometimes covered with a rough slab; (3) rough slabs forming an oblong protection; (4) regular cists made of several slabs. These four methods of grave-making are precisely those employed by the other cremating peoples of Italy, which shows that the Golaseccans belonged to the same original family as the Comacines, Atestines and Villanovans. The contents of the ossuaries were poor, consisting at most of one or two fibulae or weapons, or small objects of bronze, iron, amber or glass. Outside the cinerary urn itself were sometimes smaller jars and bowls.

It was principally upon a study of this pottery that Castelfranco based his division of the Golasecca antiquities into two periods. It expresses a theory which cannot be maintained. There are undoubtedly two schools of pottery-making represented at Golasecca, the one characterized by rough jars with incised ornamentation, the other by a finer ware with striped decoration obtained by double-burnishing. But the two styles were sometimes found together in a single tomb and are certainly not mutually exclusive. Similarly the attempt to establish the existence of two periods by the evidence of fibulae has broken down under analysis, so that there is only one period in all the Golasecca cemeteries.

As to the chronology there were for some time great divergencies of opinion, caused chiefly by the different interpretations given to the warrior's tomb of Sesto Calende.

The tomb of the warrior Sesto Calende is the most important single discovery in the Golasecca area. It was found by a farmer in the process of ploughing his field in 1867, and was described by Biondelli in the same year. Discussion as to the date centred upon the situla made of plates of hammered bronze ornamented with rudely executed figures and scenes. These are not embossed or engraved as on the fine situlae of the Etruscans or Atestines but outlined by the very primitive process of pointillé, that is to say with small consecutive dots. The technique is so infantile and the execution so poor that it was natural to suppose the situla to be a very archaic work. Actually, however, comparisons have shown that though childish art it is not primitive. For an attentive examination of the scenes brings out the fact that they are derivations with a good deal of travesty and misunderstanding from a well-known Etruscan original. And from the date of this original it is possible to fix the date of the Sesto Calende situla, which can be very little if at all earlier than 500 B.C. The theory therefore that this is the grave of some very early Celtic warrior, with all its implications of a Gaulish invasion in the early Iron Age, must be finally abandoned. Nor is there any reason for attributing the burial to a Celt even of the 5th century, for the weapons and accessories are not distinctively Gaulish; in fact the tomb, though richer than the average, is a fair representation of the usual Golasecca civilization.

The entire subject thus becomes much clearer. The Sesto Calende warrior and his famous situla find their natural place at the end of the Golasecca period. There are not two periods, as Castelfranco supposed, but only one, which ranges from 750 or 700 to 500 B.c., as the fibulae plainly show. The Golasecca period therefore is precisely conterminous with the Amoaldi period of Bologna.

The amount of material available for a study of Golasecca, though lamentably meagre, shows that in the 7th and 6th centuries B.C. that branch of the cremating invaders which had made its way by stages from the eastern Alps to a home on Lago Maggiore was backward in its civilization. The Golaseccans are far behind the Atestines and the Villanovans of the same period; they are distinctly poor relations, living in a remote province on the outskirts of the more progressive nations. They were not of much importance in the development of early Italy. There seems, however, to have been a trade system which extended all through the pre-Alpine region from the Ticino to Trieste, by which the products of the Adriatic filtered to this distant corner. And perhaps it is possible to detect in some of the metalwork and in the individual character of the pottery the beginnings of a native local style which is independent although barbaric. The Golaseccans, however, form only a part of the early population of Lombardy with neighbours and kinsmen living round Varese and Como. In this region the records begin earlier and the material though scattered is more abundant.

BIBLIOGRAPHY.—The Gaulish theory of Bertrand is given in his book written with S. Reinach in 1894, *Les Celtes dans les vallées du Po et du Danube*. D. Randall-MacIver, *The Iron Age in Italy* (1927), gives all the original references. The articles by de Mortillet and Castelfranco are out of date, though the latter has a certain value as an original record. The old-fashioned dissertation of the Abbé Giani

has been usefully summarized by Montelius, *La Civilisation primitive en Italie,* col. 231–247, with plates, reproducing the best of his drawings as well as those of Castelfranco and Biondelli. Déchelette, *Manuel d'Archéologie,* vol ii[2], pp 730–743, is useful Hoernes has a good discussion of the situla in his *Urgeschichte der bildenden Kunst.*

GOLCONDA, a fortress and ruined city of India, in the Deccan, 5 mi. W. of Hyderabad city. From 1512 to 1687 Golconda was the capital of a powerful Shi'ah kingdom, one of the five Moslem sultanates established in the Deccan after the disintegration of the Bahmani kingdom. Its rulers, the Kutb Shahis, were overthrown by Aurangzeb in 1687 whereupon Golconda was annexed to the Mogul empire.

The fortress of Golconda, on a granite ridge, is extensive and strong and contains many enclosures, but is commanded by the summits of the enormous and massive mausoleums of the ancient kings about 600 yd. distant. Golconda has given its name in English literature to the diamonds which were found in other parts of the dominions of the Kutb Shahi dynasty, and cut at Golconda.

See W. H. Moreland (ed.), *Relations of Golconda* (1931).

GOLD is an extremely dense, valuable, bright yellow metal. with a resplendent lustre. Because of its brilliant appearance, unalterability and occurrence in the native condition, gold was one of the first metals to attract the attention of man. It was known and highly valued by the earliest civilizations, Egyptian, Minoan, Assyrian and Etruscan, and from all these periods ornaments of great variety and of beautiful and elaborate workmanship survived, many of them being as perfect as when they were first made several thousand years ago. (See SILVERSMITHS' AND GOLDSMITHS' WORK.)

The making of gold from base metals by means of the philosopher's stone, and discovery of the elixir of life were the chief aims of the alchemists of the middle ages, and many of the advances in early chemistry were the direct outcome of such experiments. In this atomic age the transmutation of base metals into isotopes of gold is regarded as scientifically possible. The chemical symbol for gold is Au; its atomic number is 79 and atomic weight 197.0. (W. E. CL.)

Gold is of chief interest physically for its great density (19.3 times the weight of an equal volume of water), remarkable ductility and malleability, and high resistance to corrosion. A cubic foot of solid gold weighs about 1,200 lbs., and the standard gold "brick," or bullion bar contains 1,000 troy ounces (nearly 70 lb. avoirdupois). Gold can be drawn into extremely fine wire and beaten into the well-known gold leaf. With the exception of hot aqua regia, the alkali cyanides and free chlorine, gold will not readily combine with other chemical elements or compounds.

Gold has been the symbol of wealth in all of the great civilizations of which we have any record. Throughout history men have fought and toiled for this beautiful and enduring metal. Yet, it is estimated that the greater part of all the gold won from the earth in the last 10,000 years could still be accounted for in the bank and government vaults. and in the widely distributed wealth of ornaments, jewelry and other artifacts throughout the world. No other possession in all time has been so zealously and effectively guarded. (F. L. BI.)

Occurrence. — Gold is generally found in the native or uncombined state since it is the least chemically active of the metals. It is widely disseminated throughout igneous rocks in extremely small percentages, but hydrothermal waters have effected some concentration of it in quartz veins. As various other minerals, such as iron pyrites (FeS_2), galena (PbS) and chalcocite (Cu_2S), have been geochemically precipitated in underground fissures, gold has been deposited in association therewith, much of the gold being as the element or with sulfides. A minor occurrence of gold is in the mineral calaverite ($AuTe_2$). As weathering and stream erosion of earth masses containing gold in rock matrix have taken place, alluvial or placer gold has resulted. Because gold particles are about seven times as heavy as like-sized siliceous particles, an accumulation of gold as nuggets, flakes and specks has taken place in certain water-deposited gravels and sands near bedrock; water flow has carried away the bulk of the siliceous land mass in which the gold was originally deposited. Placer mining has the purpose of recovering this stream-deposited gold, whereas lode mining aims at obtaining gold from veins or reefs (hard-rock mining). The mother lode is a fictional vein which men seek and is said to be fabulously rich; it supposedly is the source of gold that has given rise to rich placer deposits in downstream channels. Many articles have been written about gold in sea water, and more than 30 patents have been issued on processes for recovery of gold from the sea. As methods for analysis for gold in sea water became more exacting, it was found that there is less than 0.1 mg. of gold in a metric ton of sea water and it is not considered an economically feasible project to try to recover this less than $0.0001 of gold per metric ton from sea water.

Naturally occurring metallic gold usually has variable amounts of silver, copper, platinum, palladium or certain other elements admixed with it. Purity of gold is reported as fineness, parts of gold per 1,000; pure gold is called 24 carat, whereas alloy gold may be 12, 14, 16, 22, etc., carat depending on the percentage of gold in the alloy. A 12-carat gold alloy is 50% gold.

The era of gold production that followed the discovery of America was in all probability the greatest the world had witnessed to that time. The exploitation of mines by slave labour and the looting of palaces, temples and graves in Central and South America resulted in an influx of gold that unbalanced the economic structure of Europe and disturbed its political structure. From the discovery of America by Columbus in 1492 to 1600 more than 8,000,000 oz. of gold came from South America, which was 35% of the world production during that time. That amount of gold would have the bulk of an 8-ft. cube and a value of $160,000,000. Although it seemed of fabulous value to people of the 16th century, it was small compared with money values involved in 20th-century world finance. South American mines (especially Colombian mines) continued in the 17th and 18th centuries to account for 61% and 80%, respectively, of world gold production; 48,000,000 oz. were mined between 1700 and 1800.

During the second era of intensive gold production, the 25 years following 1850, more gold was produced in the world than in the 358 years immediately previous, chiefly because of discovery of gold in California and Australia. A third marked increase in world gold recovery was in the period from 1890–1915, when gold discoveries in Alaska. the Yukon and on the Rand in Transvaal, U. of S. Af., were made. A big factor was the introduction of the cyanide process for recovery of gold from low-grade ores and ores containing minute particle-size gold.

Throughout the years gold production increased, until just prior to World War II the average yearly gold production was greater than production between 1493–1600 or 1600–1700. The 1954 world output, for example, was 35,100,000 oz., having a value of $1,228,500,000 (at $35 per oz.). This amount of gold stacked as gold bricks would make a 13-ft. cube. Since most mined gold goes through countinghouses and mints, a fairly accurate account of all gold mined since 1493 is recorded. The world production from 1493 to 1955 closely approximates 1,730,000,000 oz., which at a value of $35 per oz. amounts to $60,550,000,000. This gold would have the total bulk of a 50-ft. cube, which is indeed a small volume of matter to have so influenced the toil and destiny of so many people. (W. E. CL.)

GOLD MINING AND REFINING

The earliest mining work of which traces remain was on gold ores in Egypt, and gold washing is depicted on monuments of the 4th dynasty (2900 B.C.). The legend of the Golden Fleece, stripped of its heroic dress, describes an expedition (about 1200 B.C.) to seize gold which was being laboriously washed out of the river sands with the aid of sheepskins by the people of Armenia. It is interesting to note here, as an example of the value of some old ideas, that modern practice in the Transvaal frequently includes the use of corduroy blankets.

Ore Deposits. — Gold occurs in minute quantities in almost all rocks. It exists in association with most copper and lead minerals and although the quantity present is often extremely small, the gold is readily recovered as a by-product in the electrolytic or fire refining of the base metals.

Disseminations throughout large masses of rock rich enough to be called ores are unusual, and gold is generally obtained from quartz lodes or veins, or from deposits derived from them by denudation; *e.g.*, river gravels and the "banket" or conglomerate of the Transvaal. The origin of vein enrichment is not fully known, but it is believed that the gold was carried up from great depths with other minerals, at least partly in solution, and later precipitated. The mineral most commonly associated with gold, other than quartz, is iron pyrites, the yellow sulfide of iron, which is often mistaken for gold on casual examination. Others include copper pyrites, arsenical pyrites, zinc blende and stibnite, the antimony sulfide. Thus, where these sulfides have weathered to oxides at or near the surface of the ground, rich deposits of gold are sometimes encountered.

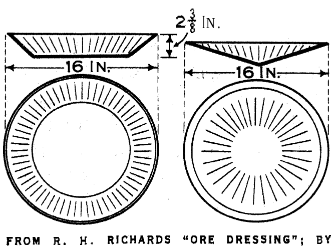
The gold in ores is generally in the free or "native" state, and rarely in chemical combination with other elements, the tellurides being an exception. Even the gold in iron pyrites is metallic, consisting of minute inclusions within the crystals or as thin films along their cleavage planes. For the most part the gold in rock is invisible to the naked eye, but sometimes it occurs in grains or flakes large enough to be seen, and more rarely, in "specimen rock!" in considerable masses. Crystals an inch or more across (belonging to the cubic system) have been found in alluvial deposits in California. Tellurides are found principally in western Australia and Colorado. The mineral calaverite, a bronze-yellow telluride, contains 40% gold; and sylvanite, a steel-gray mineral, contains up to 28% gold combined with some silver.

Alluvial deposits or "placers" are the sands, gravels and detritus of ancient or existing streams derived from the disintegration of auriferous veins or rocks. They were the most prolific source of gold in the past, although by 1927 they had become of little importance, with lode mining predominating. The gold, which may occur in the form of "gold dust," larger grains and irregularly shaped masses or occasional "nuggets," is dispersed through the sand or caught in crevices of the rocks. Sometimes the deposits are covered by thick beds of barren detritus or even lava flows, and can be reached only by sinking shafts and driving tunnels. The largest nugget on record was the "Welcome Stranger," weighing 2,500 oz., which was found in 1869 in Victoria, Austr., only a few inches deep in a rut made by a cart.

Among the most productive gold fields in ancient times were those in Egypt, where in the deep mines the labourers were cruelly maltreated, and in Asia Minor, the source of the riches of Croesus. The Romans obtained their gold in part from Transylvania. After the discovery of America the main supplies to Europe came from that continent.

In 1850–60 the gold diggings of California and Australia were at their zenith and at the end of the 19th century the "placers" of the Klondike and Alaska, the last-named a beach deposit, were famous for a short time. Soon after the turn of the century the Transvaal became the richest and most extensive gold field in the world, a position it continues to hold.

Placer Prospecting and Mining. — Prospecting and one-man mining operations still employ the miner's pan and batea (fig. 1 and 2). A few handfuls of the "dirt" are stirred and shaken with water in the pan to enable the gold to settle to the bottom. The upper layers are gradually washed away by dipping the pan into water and pouring it off, while imparting a twisting motion. Eventually only the gold and heavy minerals are left. The "cradle" or rocker (fig. 3), which resembled a child's cradle, was used to process larger quantities of earth and was more profitable. The gravel was shoveled onto the perforated iron plate and water poured on. The finer material dropped through onto the apron which distributed it across the "riffles," rocking being continuous. The gold was caught in these riffles,–which were cleaned out after enough had accumulated. This device is largely obsolete, though the riffle itself, which is any strip, bar or groove placed at right angles to the flowing stream to provide a protected spot where gold can settle. is still widely used in sluice boxes (fig. 4) and corduroy tables. The latter consist of wide, sloping plates with shallow sides on which are placed a commercial (coarser) form of the familiar corduroy cloth. Periodically the corduroy is removed and washed by hand in boxes partly filled with water, and the gold-rich concentrates further treated by amalgamation (*q.v.*).



FROM R. H. RICHARDS "ORE DRESSING"; BY COURTESY OF ENGINEERING AND MINING JOURNAL

FIG. 1 AND 2. — SIDE AND TOP VIEWS OF (LEFT) GOLD MINERS' PAN AND (RIGHT) BATEA. BOTH ARE USED FOR SEPARATING GOLD FROM RIVER GRAVEL BY WASHING WITH WATER

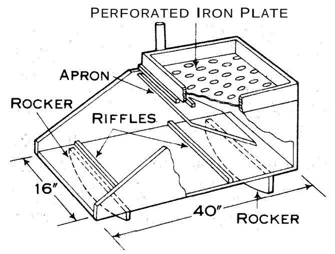


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FIG. 3. — ISOMETRIC DRAWING OF CRADLE OR ROCKER. USED FOR WASHING AURIFEROUS GRAVEL ON A SMALL SCALE

In California, thick beds of gravel on hillsides were extensively worked by hydraulic mining. Powerful jets of water at hundreds of pounds per square inch pressure were passed through giant swivel-mounted nozzles to break down the gravel banks and wash the material through lines of sluices. Great volumes of water were required and many miles of pipes and flumes. The cost of treatment was only a few cents per cubic yard and poor ground could be treated at a profit. The millions of tons of tailings, however, which were washed into the Yuba and Feather rivers had such an adverse effect on farming farther down the valleys that an injunction was obtained against the hydraulic miners in 1880 and their work thereafter was strictly limited.

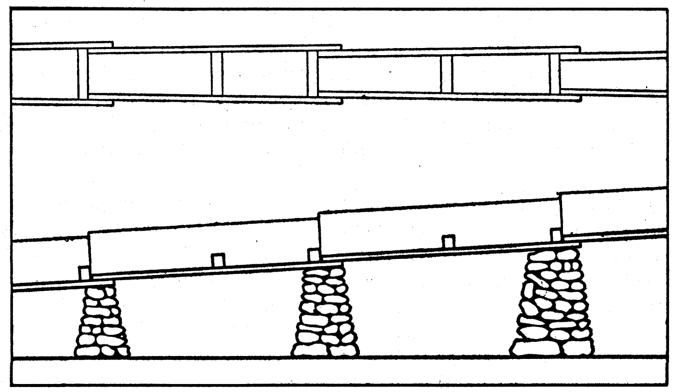


FIG. 4. — SLUICE BOXES, INCLINED WOODEN TROUGHS FOR SEPARATING GOLD FROM GRAVEL, SHOWING PLAN (TOP). GRAVEL. CONTAINING GOLD, IS CARRIED DOWN THE SLUICE BY A STREAM OF WATER. THE GOLD SINKS TO THE BOTTOM AND LODGES BEHIND THE CROSS-BARS

In the period 1900–15 dredging became the most important branch of placer working. The chain bucket dredge generally used is similar to those employed in deepening harbours and rivers. An endless chain of buckets provided with hardened steel lips is supported by heavy steel cables from a bridge across the foredeck of the vessel, and can be raised or lowered to suit the contours of the deposit. The gravel brought up by the buckets is broken up in revolving screens. Only the fine sands, containing the gold, pass through to the sluices or jigs. The coarser rock and fine tailings (after dewatering) are run out over the stern on a belt conveyor and stacked on the bank. Dredging originated in New Zealand and attained its greatest popularity on the rivers there and in California.

"Paddock dredging," a later development in the western U.S., enables all placer ground to be treated even if not in or near a river bed. The dredger floats in a pond continuously extended by its digging equipment at one end while the pond is filled up by the waste at the other. In this way the dredger moves across country taking its pond, or reservoir with it. By piling more gravel around the reservoir and increasing the water level, the dredger can be made to work its way up hill. In 1910 there were 72 operating dredges in California, but by 1945 only a few remained in operation. A typical large dredge weighs 2,500 tons, can dig to a depth of 70 ft. below water level and stack waste 165 ft. away; its yearly capacity is about 5,000,000 cu.yd.

Vein Mining and Ore Treatment. — The methods of mining and exploration of gold deposits are similar to those used for other metals (see MINING, METAL). Immense tonnages of gold ore are treated throughout the world. In the Transvaal alone 75,000,000 tons are treated annually. A typical treatment plant with a capacity of 4,000 tons per day employs hundreds of men and its buildings, storage bins and tanks cover many acres of ground. Gravity concentration, amalgamation, the cyanide process (*q.v.*) and various combinations of these methods are employed, depending upon the nature of the ore. Where much of the gold is closely associated with sulfides. the flotation process may also be a part of the treatment, and the enriched sulfide "concentrate" selectively treated (see METALLURGY: Ore Treatment). The first step is the crushing and wet grinding of the ore to a particle size such that the gold is sufficiently released from the enclosing minerals to be attacked and dissolved by the cyanide solution. Following separation of the waste solids from the 'clear gold-bearing solution, the latter is treated with zinc dust and the gold is precipitated in the form of a black powder, which is dried and melted with suitable fluxes. In some instances concentrated portions of the ore must be roasted before the gold can be extracted.

Refining. — Gold bars produced at the mines and gold dust and nuggets from placers are impure, containing about 90% gold with 8%–9% silver and smaller quantities of other metals. The gold is often brittle and is refined to make it suitable for use in industry. The ancients refined gold by "cementation." Plates of gold were stacked in an earthen pot and were surrounded and separated by powdered porous stone or brick dust, mixed with common salt and sulfate of iron. The pot was covered and heated to redness, but the temperature was not high enough to melt the gold. The silver and other impurities in the gold were gradually converted into chlorides, which melted and oozed out of the gold and were absorbed by the brick dust, and the gold was purified. Nitric acid was in use for refining gold in the 16th century. The gold was melted with at least three times its weight of silver (process of "inquartation"), and granulated by pouring into water. The granules were boiled in nitric acid which dissolved the silver and left the gold unchanged.

A chlorine process, invented in 1869 in Australia where acid was expensive, has become the usual method of refining. The gold is melted in clay pots and a stream of chlorine gas is bubbled through it (fig. 5). The chlorine reacts chemically with the silver which is present, and the silver chloride which is formed rises to the surface of the molten metal where it is skimmed off. The silver is recovered by electrolysis in another vessel. Most of the other metals react with chlorine like silver; but the gold is not attacked until nearly all the silver has been removed. Platinum is not recovered by the process and, if present, remains in the gold, but the impurities which cause brittleness in minting are always removed.

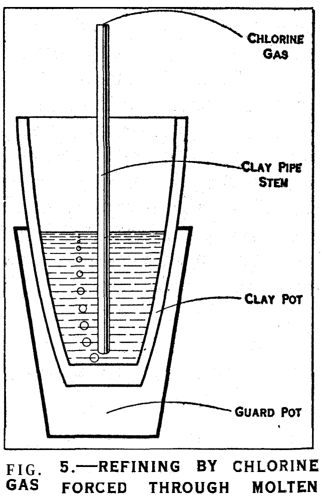


FIG. 5.—REFINING BY CHLORINE GAS FORCED THROUGH MOLTEN GOLD CONTAINED IN CLAY POT. REMOVING IMPURITIES. WHICH RISE TO THE SURFACE, PURIFYING THE GOLD

In U.S. mints the electrolytic process, introduced there in 1902, has since been in general use. The gold is cast into thick plates which are suspended on gold or silver hooks in a porcelain cell filled with a solution of gold chloride containing some hydrochloric acid. The hooks are hung on metal rods and the whole series of plates and hooks are connected and are made the anode (fig. 6). A series of thin rolled plates of pure gold are suspended in the cell alternately with the impure plates and connected to form the

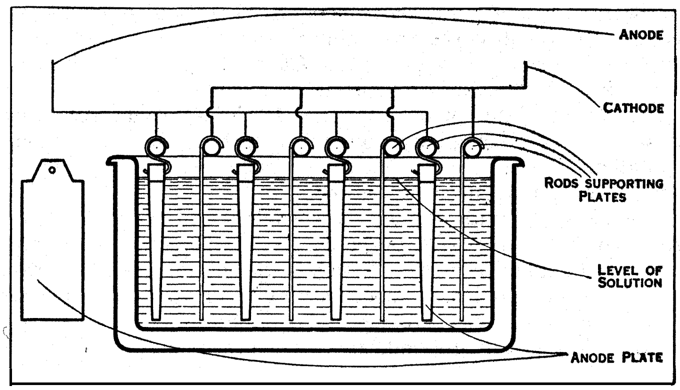


FIG. 6.— ELECTROLYTICREFINING, IN WHICH ANODE PLATES OF IMPURE GOLD HUNG BY HOOKS IN HOT ACID, WASTE AWAY BY THE ACTION OF A CURRENT OF ELECTRICITY PASSING FROM THEM THROUGH THE LIQUID TO THE THIN CATHODE PLATES, WHERE PURE GOLD IS DEPOSITED

cathode. The liquid in the cell is heated to about 60° C., and is continuously stirred. A current of electricity is passed from the anode plates to the cathode through the liquid. The gold is dissolved from the anodes and is precipitated on the cathodes. At the end of the run it is stripped off the cathode plates and melted into bars. The silver is converted into insoluble chloride which falls to the bottom of the cell, and other metals, including platinum, dissolve in the liquid and remain in solution. The platinum is, however, subsequently recovered and sometimes pays for the whole operation. The process is somewhat slow, occupying three or four days, but the cathode gold is over 999 fine.

Alloys of Gold. — Gold can be alloyed with silver in all proportions and the alloys are soft, malleable and ductile. The colour of gold gradually changes from yellow to white as the proportion of silver increases. When the silver is over 70% the alloys are white. "Green gold" (gold 75%, silver 25%) is used in jewelry. Gold-silver alloys are used to make trial plates, or standards of reference, with which the fineness of gold wares and coins are compared. Copper hardens gold and forms alloys of reddish-yellow colour at conveniently low melting points. These alloys blacken when heated, but the discoloration is removed by sulfuric acid. The triple alloys of gold, silver and copper are malleable and ductile, with a rich gold colour. They are much used for the production of gold wares. Some zinc is often present in 9-carat gold. Hot nitric acid attacks all but the richer alloys of gold with silver or copper or both, and if the proportion of gold is no more than 33%, practically the whole of the silver and copper are removed in solution. Some of the gold-palladium and gold-platinum alloys are ductile and fit for use in jewelry. The alloys containing 10%–20% of palladium are nearly white. Amalgams are alloys of gold and mercury. A piece of gold rubbed with mercury is immediately penetrated by it, turning white and becoming exceedingly brittle. The ductility is not always restored on driving off the mercury by heat. Solid amalgam contains 40% or more of gold, but any excess of mercury over 60% makes the amalgam pasty. The amalgam produced in gold mills is not a true amalgam but a collection of little nuggets of gold, coated and partly saturated with mercury. Gold is extracted from molten lead by adding zinc. The zinc and gold form a solid crust which floats on the surface of the lead. Advantage is taken of these properties in smelting. Gold forms alloys with many other metals but most of them are brittle, and none is of metallurgical importance. Even a minute quantity (0.02%) of tellurium, bismuth or lead makes gold brittle. (T. K. R.; F. L. BI.)

PROPERTIES

In the finely divided state the colour of gold is variable, depending upon the size of the particles. The usual colour of precipitated gold is brown, but black, purple, blue and pink shades are known. In very thin sheet or leaf, gold is translucent and transmits a greenish light. When pure, it is the most malleable and ductile of all the metals; it can be beaten to not more than 0.00001 mm. in thickness (see GOLDBEATING), and a single gram has been drawn into a wire 2 mi. long. Traces of other metals reduce considerably the malleability and ductility, lead being especially injurious in this respect. Cadmium, tin, bismuth, antimony, arsenic, tellurium and zinc act in like manner.

Gold is one of the softest metals, its hardness varying according to treatment and being between 2.5–3.0 on the Mohs' scale. Gold crystallizes in the face-centred cubic system, with a unit cell dimension of 4.0701 angstrom units.

The specific gravity of gold varies slightly and is dependent on treatment. For practical purposes the specific gravity of pure gold may be taken as 19.3, and such is the specific gravity of cast gold. Distilled gold has a specific gravity of 19.26, drawn gold 19.25, cold rolled sheet 19.296 and gold precipitated by CH_2O 19.39. This last figure indicates that precipitated gold has a greater specific gravity and that this property varies with the precipitant employed and the temperature of precipitation.

The melting point of gold is 1,063° C. and constitutes a fixed point for pyrometry. Liquid gold just above its melting point has a specific gravity of 17.1. Gold is comparatively easily volatilized at high temperatures; at its melting point the loss is insignificant but becomes appreciable at high temperatures, and at 1,250° C. it is 2.6 parts per 1,000 per hour (T. K. Rose). In all mints and gold refineries the flues are carefully swept periodically, and considerable quantities of the metal are thus recovered. Liquid gold boils at 2,600° C. and yields a purplish vapour. The heat of fusion of gold is 13.3 kilojoules per gram atom and the heat of vaporization is 368.0 kilojoules per gram atom.

The mean specific heat of gold is 0.0312, a number which agrees well with the law of Pierre Dulong and Alexis Petit. Its coefficient of linear expansion is about 0.000014 for 1° C.

The spark spectrum of gold is complicated; the most prominent lines in the visible spectrum lie at 6,278 and 5,957 in the orange and red, 5,837 and 5,656 in the yellow, 5,065 in the green, 4,793 and 4,437 in the blue and 4,065 and 3,898 in the violet.

The electrical conductivity of gold is greatly influenced by traces of impurities. The electrical resistance, which is the converse of conductivity, is 2.44×10^{-6} ohm/cm. for pure gold at 20° C; for silver and copper the values are 1.59×10^{-6} and 1.72×10^{-6} ohm/cm., respectively, at zo° C. The electrical resistance steadily diminishes with a lowering of the temperature, and at the boiling point of helium in *vacuo* (*i.e.*, below 5° K.) it has practically disappeared (H. K. Onnes), or, in other words, gold is then a perfect conductor of electricity.

The ionization potential of gaseous gold atoms is 9.18 volts. The potential of the electrode $Au = Au^+ + e^-$ compared with the hydrogen electrode as zero is -1.68 volts. The radius of gold ion in solids is 1.37×10^{-8} cm. Gold crystallizes in the isometric system as is true of many metals. The electron structure for a gold atom is designated as follows:

$$1s^2;\ 2s^2,\ 2p^6;\ 3s^2,\ 3p^6,\ 3d^{10};\ 4s^2,\ 4p^6,\ 4d^{10},\ 4f^{14};\ 5s^2,\ 5b^6,\ 5d^{10};\ 6s^1,$$

thus accounting for its atomic number of 79. It is evident gold will exhibit a chemical valence of one, and possibility of valence of two or three. One stable form of gold (mass number 197) and several radioactive isotopes of mass numbers 187–189 and 191–203 are known.

Chemical Properties. — The position of gold in B group of family I of the periodic table along with copper and silver, and the placement of gold at the bottom of the electromotive series of the metals. best indicates the general chemical properties of the element. Its characteristic valence is plus one in aurous compounds and plus three in auric compounds. Gold ions will receive electrons from any other metal to resume the metallic state, viz., $3\ Pt + 2Au^{+++} \rightarrow 3\ Pt^{++} + 2Au$. Gold exhibits a co-ordination number of four which helps to explain its complex compounds. It is insoluble in nitric, hydrochloric or sulfuric acids, but soluble in hot selenic acid forming gold selenate. Hot telluric acid also dissolves it. The usual solvent for gold is aqua regia (*q.v.*)—a mixture of three volumes of concentrated hydrochloric acid with one volume of concentrated nitric acid. which in practice is always diluted with a considerable volume of water. The ionic equation for this dissolution is:

$$Au + 5H^+ + 4Cl^- + NO_3^- = HAuCl_4 + NO + 2H_2O$$

The product is chlorauric acid which is the precursor of such salts as $NaAuCl_4.2H_2O$, which is used in toning photographic prints. Gold will also dissolve in aqueous solutions of alkaline sulfides and thiosulfates. Alkali cyanides, even in dilute solution, attack finely divided gold in slow chemical change if oxygen is available in the solution:

$$2Au + 4CN^- + \tfrac{1}{2}O_2 + H_2O = 2Au(CN)_2^- + 2OH^-$$

Gold and Oxygen.—Gold and oxygen do not combine directly under any conditions; hence, all oxides and hydroxides have to be made by indirect methods. When aurous chloride is treated with dilute potassium hydroxide, a violet-black powder is formed which is AuOH or hydrated Au_2O; it is also possible that the Au_2O changes to a mixture of spongy gold and Au_2O_3. If this violet-black powder is heated to about 200° C., it loses water, giving a violet-brown powder, which at 250° C. decomposes into gold and oxygen. The oxide and hydroxide have feebly basic properties and are capable of forming salts with halogen acids. When an excess of KOH is added to the violet-black powder obtained as KOH is added to AuCl, gold metal and AuO_2^- results.

Auric hydroxide is produced by precipitating a solution of auric chloride or of chlorauric acid, $HAuCl_4$, with a limited amdunt of caustic alkali. The hydroxide thus prepared cannot be entirely freed from alkali by washing, and the precipitation is preferably effected with magnesia or zinc oxide, excess of the precipitant being removed with dilute nitric acid. Auric hydroxide is a brownish-black powder which, on drying over phosphoric oxide, forms a brown powder of auryl hydroxide, AuO (OH), dehydrated at 140° C. to trioxide, and this oxide on further heating to 170° C. is said to lose oxygen and form the oxide Au_2O_2, which at a higher temperature reverts into oxygen and metal. Auric oxide is capable either of forming salts with halogen acids or of acting as an acidic anhydride by combining with strong bases to form aurates. Potassium aurate, $KAuO_2.3H_2O$, is a yellow crystalline compound; $Ba(AuO_2)_2$ is a yellow precipitate.

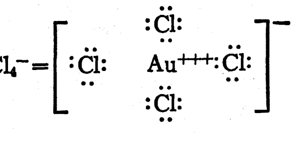
Halogen Compounds. — Fluorine does not act on gold in the cold, but only at a dull red heat whence a yellowish deposit is formed. The gold fluoride is completely hydrolyzed by water.

The chlorides of gold are known with certainty, aurous chloride, AuCl, and auric chloride, $AuCl_3$. The identity of an intermediate chloride, Au_2Cl_4, is doubtful. Aurous chloride is almost always formed by heating auric chloride. The optimum temperature is about 175° C., and several days are required to complete the reaction. If a higher temperature is used, complete decomposition into gold and chlorine occurs. This decomposition of auric into aurous chloride takes place to some extent even in hot aqueous solution.

Aurous chloride is a yellowish-white solid insoluble in cold water, but undergoing slow decomposition into gold and soluble auric chloride.

Auric chloride can be obtained either by heating chlorauric acid to 200° C. in a stream of chlorine, or by dissolving gold in chlorine water, preferably in darkness. It is obtained as a reddish-brown powder or as ruby-red crystals; it slowly decomposes in light, but can be sublimed unchanged in a stream of chlorine.

Gold ions, like many other metallic ions, have the capacity to accept electron pairs to form co-ordination valency compounds. The auric ion has the general tendency to accept four electron pair bonds and thus its co-ordination number of four. This tendency is typified in the formation of the chloraurate ion:

$Au^{+++} + 4Cl^- = AuCl_4^- =$ 

The aurous ions more commonly have a co-ordination number of two, and thus account for chloraurous ion, $AuCl_2^-$. Co-ordination valency explains the existence of chloraurous, $HAuCl_2$, and chlorauric, $HAuCl_4$, acids, and also the salts of these acids. As chlorauric acid crystallizes from solution as a brown deliquescent substance, it has the formula $HAuCl_4.3H_2O$, which on ionization would form $H_3O^+ + AuCl_4.2H_2O^-$, the gold in this case having a co-ordination valence of six. The salts of this acid such as $NaAuCl_4.2H_2O$ in water yield $Na^+ + AuCl_4.2H_2O^-$.

If gold is dissolved in aqua regia and the resulting solution freed from nitric acid by evaporation with further quantities of hydrochloric acid to the crystallizing point, brownish crystals of chlorauric acid are formed, having a strongly acid reaction. These crystals always contain a small amount of aurous chloride unless chlorine has been passed through the solution during evaporation. They are also frequently contaminated nith small amounts of silver chloride since this substance is soluble in strong solutions of auric chloride and is only precipitated therefrom by considerable dilution with water. Various chloraurate salts may be obtained either by neutralizing the acid with the metallic base or by treating the acid with the equivalent amount of the metallic chloride. The chloraurates of lithium, potassium and sodium are very soluble in water; those of rubidium and especially cesium are much less soluble. Furthermore, chlorauric acid combines with the chlorides of many organic bases to form well-defined crystalline chloraurates, frequently used in identifying and purifying such bases.

Two bromides of gold are known, AuBr and $AuBr_3$, corresponding with the two chlorides; the tribromide, prepared by the action of bromine water on finely divided gold. forms dark brownish-red crystals and in its reactions resembles the corresponding chloride; the monobromide is obtained by heating the tribromide or $HAuBr_4$ to 105°–200° C. Auric bromide forms bromaurates, $MAuBr_4$, similar to the chloraurates. These salts have been used in determining the atomic weight of gold.

On mixing aqueous solutions of potassium iodide and $AuCl_3$ or $HAuCl_4$, some auric iodide, AuI_3, is produced, but being somewhat unstable. it decomposes to a large extent into aurous iodide, AuI, and free iodine. The latter reaction is complete on warming. Although unstable by itself, in combination with alkali and alkaline-earth iodides, auric iodide forms a stable series of complex iodoaurates. The potassium salt, $KAuI_4$, crystallizes in black, lustrous prisms. Iodine in aqueous, or preferably aqueous-alcoholic. solution combines with metallic gold to produce aurous iodide, AuI, a white or lemon-yellow powder insoluble in water.

Other Compounds. — Cold Cyanides. — In the presence of air, gold dissolves in aqueous solutions of potassium or sodium cyanide to form potassium or sodium cyanaurite, $KAu(CN)_2$ or $NaAu(CN)_2$, and on precipitating this solution with dilute hydrochloric acid, aurous cyanide, AuCN, is deposited in yellow, insoluble. microscopic, hexagonal plates. Auric cyanide, $Au(CN)_3$, has not been isolated with certainty, but stable complex salts are known with alkali and other cyanides. Potassium cyanaurate, $KAu(CN)_4.3H_2O$, forms colourless efflorescent crystals. The silver salt, $AgAu(CN)_4$, is formed by precipitating a solution of $KAu(CN)_4$ with silver nitrate. From this salt cyanauric acid, $HAu(CN)_4.3H_2O$, is obtained by removing the silver with hydrochloric acid and crystallizing the solution.

Auric nitrate and sulfate hydrolyze so extensively that auric oxide will dissolve only in concentrated solutions of nitric or sulfuric acid. The yellow metal will not combine directly with sulfur but does readily form $AuTe_2$.

Fulminating Cold. — When auric oxide or a gold solution is treated with concentrated ammonia, a black powder is formed called fulminating gold ($2AuN.NH_3.3H_2O$). When dry it is a powerful explosive, since it detonates either by friction or on heating to about 145° C.; it should always be handled with great caution.

Purple of *Cassius.*—When a solution of auric chloride is precipitated with a solution of stannous chloride. a reddish or purplish precipitate is produced containing both metallic gold and tin hydroxide. The composition of this precipitate is as variable as is its colour. Formation of this purple precipitate is a delicate test for gold. Purple of Cassius is used in the preparation of ruby glass.

Analysis for Gold. — Gold will dissolve in sodium polysulfide forming sodium thioaurate, $NaAuS_2$, and thus is with arsenic and antimony in subgroup of group II in qualitative analysis. As the solution of $NaAuS_2$ along with such as Na_3AsS_4 is acidified with HCl, the gold precipitates as a sulfide (some free Au) along with arsenic sulfide. The sulfides are rendered soluble with Cl_2 and thence NH_4OH would give a solution of NH_4AuCl_4 with $(NH_4)_3AsO_4$. From this solution $H_2C_2O_4$ will selectively precipitate spongy gold and not precipitate arsenic.

The usual qualitative test for gold ion free from interfering metals is the formation of red-purple colloidal gold by adding some reducing agents such as $FeSO_4$, $SnCl_2$, HCHO or various organic compounds. Readily identifiable red crystals may be obtained by use of gold ion plus cocaine hydrochloride.

The prospector or expert with a gold pan can estimate the value of placer gold per cubic yard of stream-deposited gravel or sand by counting and evaluating the size of gold specks residual in panning a quantity of the deposit. Accurate determination of the gold content in rock is accomplished by a fire assay process which involves a fusion of a weighed quantity of the ground ore with fluxes to form a slag with the siliceous part of the rock and formation by chemical change in the fusion melt of a rain of metallic lead which dissolves and collects gold and silver. After solidification of the fusion mixture the glassy slag is cracked from the gold-silver containing lead button. which is again put in the furnace on a cupel from which the lead melts and oxidizes to liquid lead oxide as air is allowed to enter through the partially opened door of the furnace. The liquid lead oxide seeps into the semiporous cupel and leaves a silver-gold bead on the cupel which may be cooled and weighed. The silver may be parted from the gold by dissolving the silver in dilute nitric acid and leaving spongy gold which after annealing may be weighed. (W. E. Cl.)

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GOLDBEATING. The art of goldbeating is of great antiquity, being referred to by Homer; and Pliny (N.H. 33.19) states that 1 oz. of gold was extended to 750 leaves. each leaf being four fingers (about 3 in.) square; such a leaf is three times as thick as the ordinary leaf gold of the present time. In all probability the art originated among the eastern nations, where the working of gold and the use of gold ornaments have been distinguished characteristics from the most remote periods. On Egyptian mummy cases specimens of original leaf-gilding are found, where the gold is so thin that it resembles modern gilding (*q.v.*). The minimum thickness to which gold can be beaten is not known with certainty. According to Mersenne (1621), 1 oz. was spread out over 105 sq.ft.; Réaumur (1711) obtained $146\frac{1}{2}$ sq.ft.; other values are 189 sq.ft. and 300 sq.ft. Its malleability is greatly diminished by the presence of other metals, even in very minute quantity. In practice the average degree of tenuity to which the gold is reduced is not nearly so great as the last example quoted above. A "book of gold" containing 25 leaves measuring each $3\frac{1}{4}$ in.. equal to an area of 264 sq.in. generally weighs from four to five grains.

The gold used by the goldbeater is variously alloyed, according to the colour required. Fine gold is commonly supposed to be incapable of being reduced to thin leaves. This, however, is not the case, although its use for ordinary purposes is undesirable on account of its greater cost. It also adheres on one part of a leaf touching another, thus causing a waste of labour by the leaves being spoiled; but for work exposed to the weather it is much preferable. as it is more durable, and does not tarnish or change colour. The external gilding on many public buildings, *e.g.*, the Albert memorial in Kensington gardens, London, is done with pure gold. The following is a list of the principal classes of leaf recognized and ordinarily prepared by British beaters, with the proportions of alloy per ounce they contain.

Name of leaf	Proportion of gold	Proportion of silver	Proportion of copper
	Grains	Grains	Grains
Red	456–460	..	20–24
Pale red	464	..	16
Extradeep	456	12	12
Deep	444	24	12
Citron	440	30	10
Yellow	408	72	..
Pale yellow	384	96	..
Lemon	360	120	..
Green or pale	312	168	..
White	240	240	..

Method of Manufacture.—The process of goldbeating is as follows: The gold, having been alloyed according to the colour desired, is melted in a crucible at a higher temperature than is necessary simply to fuse it, as its malleability is improved by exposure to a greater heat; sudden cooling does not interfere with its malleability, gold differing in this respect from some other metals. It is then cast into an ingot. and flattened, by rolling between a pair of powerful smooth 'steel rollers, into a ribbon $1\frac{1}{2}$ in. wide and 10 ft. in length to the ounce. After being flattened it is annealed and cut into pieces of about 63 grs. each, or about 75 per ounce, and placed between the leaves of a "cutch." which is about $\frac{1}{2}$ in. thick and 33 in. square, containing about 180 leaves of a tough paper. Formerly fine vellum was used for this purpose, and generally still it is interleaved in the proportion of about one of vellum to six of paper. The cutch is beaten on for about 20 minutes with a 17-lb. hammer, which rebounds by the elasticity of the skin, and saves the labour of lifting, by which the gold is spread to the size of the cutch; each leaf is then taken out and cut into four pieces and put between the skins of a "shoder," 43 in. square and $\frac{3}{4}$ in. thick, containing about 720 skins, which have been worn out in the finishing or "mold" process. The shoder requires about two hours' beating upon with a 9-lb. hammer. As the gold will spread unequally, the shoder is beaten upon after the larger leaves have reached the edges. The effect of this is that the margins of larger leaves come out of the edges in a state of dust. This allows time for the smaller leaves to reach the full size of the shoder, thus producing a general evenness of size in the leaves. Each leaf is again cut into four pieces, and placed between the leaves of a "mold," composed of about 950 of the finest goldbeaters' skins, 5 in. square and $\frac{3}{4}$ in. thick, the contents of one shoder filling three molds.

The material has now reached the last and most difficult stage of the process; and on the fineness of the skin and judgment of the workman the perfection and thinness of the leaf of gold depend. During the first hour the hammer is allowed to fall principally upon the centre of the mold. This causes gaping cracks upon the edges of the leaves, the sides of which readily coalesce and unite without leaving any trace of the union after being beaten upon. At the second hour, when the gold is about 150,000th part of an inch in thickness, it for the first time permits the transmission of the rays of light. Pure gold, or gold but slightly alloyed, transmits green rays, gold highly alloyed with silver transmits pale violet rays. The mold requires in all about four hours' beating with a 7-lb. hammer, when the ordinary thinness for the gold leaf of commerce will be reached. A single ounce of gold will at this stage be extended to $75\times4\times4=1{,}200$ leaves, which will trim to squares of about $3\frac{1}{4}$ in. each. The dryness of the cutch, shoder, and mold is a matter of extreme delicacy. The finished leaf is taken out of the mold. and the rough edges are trimmed off by slips of the ratan fixed in parallel grooves of an instrument called a wagon, the leaf being laid upon a leather cushion. The leaves thus prepared are placed into "books" capable of holding 25 leaves each, which have been rubbed over with red ochre to prevent the gold clinging to the paper. Dentist gold is gold leaf carried no farther than the cutch stage, and should be perfectly pure gold.

Silver is also beaten by the above process, but not so thin, the inferior value of the metal not rendering it commercially desirable to bestow so much labour upon it. Copper, tin, zinc, palladium, lead, cadmium, platinum and aluminum can be beaten into thin leaves, but not to the same extent as gold or silver.

Goldbeaters' Skin.—The fine membrane called goldbeaters' skin, used for making up the shoder and mold, is the outer coat of the caecum or blind gut of the ox. It is stripped off in lengths about 25 or 30 in. and freed from fat by dipping in a solution of caustic alkali and scraping with a blunt knife. It is afterward stretched on a frame; two membranes are glued together, treated with a solution of aromatic substances or camphor, in isinglass, and subsequently coated with white of egg. Finally it is cut into squares of 5 in. or $5\frac{1}{2}$ in.; and to make up a mold of 950 pieces, the gut of about 380 oxen is required, about $2\frac{1}{2}$ skins being obtained from each animal. A skin will endure about zoo beatings in the mold, after which it is fit for use in the shoder alone.

GOLDBERG, a town in former German Silesia, now in Wroclaw province, Pol. Renamed Zlotoryja. it is 14 mi. S.W. of Liegnitz by rail, on the Katzbach. Pop. (1950) 5,305. Goldberg owed its origin and name to a gold mine in the neighbourhood, abandoned after the Hussite wars. The town obtained civic rights in 1211. It suffered from the Tatars in 1241, from the plague in 1334. from the Hussites in 1428 and from various armies during the Thirty Years' War. The principal buildings are an old church dating from the beginning of the 13th century and the classical school (founded in 1524), which was famous in the 17th century. The chief manufactures are woolen cloth, gloves, stockings, cigars and beer. The town was incorporated into Poland in 1945.

GOLD COAST (GHANA), a former British colony in west Africa, comprised of the Gold Coast colony, Ashanti, the Northern Territories protectorate and the Trust Territory of Togoland administered under the Gold Coast, lying between 4° 45' and 11° 10' N. lat. and 1° 12′ E. and 3° 15′ W. long. On March 6, 1957, the Gold Coast became independent as the state of Ghana within the commonwealth; in 1960 it became the Republic of Ghana (*q.v.*). Its area is 92,100 sq.mi. The country has six administrative divisions, the northernmost being the Northern region. To the south of this is Brong-Ahafo. Ashanti lies between this and the former colony which has been subdivided into the Eastern and western regions. The Volta region is the sixth unit. The country is bounded on the south by the Atlantic ocean, by the Ivory Coast and Upper Volta republics on the west and north, respectively, and by Togo on the east.

PHYSICAL FEATURES

Geography.—The central feature of the country is a hilly plateau lying more than 500 ft. above sea level, approximately triangular in shape. with its apex close to the Volta river in the east. To the north the plateau is bounded by the Kwahu scarp, which runs southeast to join a range of hills running southwest from Togoland into Akwapim. The only area of even moderately high ground in the colony is there, the highest hills lying between 2,000 and 3,000 ft. The plateau is covered by thick tropical forest. North of the Kwahu scarp the land is undulating savanna country drained by the Black and White Volta rivers. After the junction of these two streams, the combined river flows 310 mi. in a southerly direction to the sea, passing through a narrow gap in the Togo-Akwapim hills at Ajena. The forest comes close to the sea in the west, but east of Takoradi there is a coastal belt of scrub vegetation which merges into grassy plains about the Volta mouth.

Apart from occasional rocky headlands, the 334 mi. of coast line are sandy and low-lying. Only the Volta. Pra and Ankobra rivers permanently pierce this sand barrier; lesser rivers generally terminate in brackish lagoons. There are no natural harbours and sand bars impede the navigation even of the major rivers.

(J. D. F.)

Geology.—The following summary of the rocks is based on the publications of the geological survey: Tertiary and Recent: sands, gravels, clays, laterite, bauxite, etc.; Cretaceous: sands, clays, shales, limestones; Devonian or Carboniferous: sandstones, shales, conglomerates, etc., of the Sekondi series; Devonian: sandstones, shales, etc., of the Accraian; Lower Palaeozoic-? Silurian: sandstones, shales, etc., of the Voltaian; Pre-Cambrian: shales, sandstones, quartzites, phyllites, graywackes, lavas, schists, gneisses, migmatites, granites.

The Pre-Cambrian is further subdivided into Buem, Akwapimian, Tarkwaian, Birrimian and Archaean. The intrusive igneous rocks include granites and granitic rocks, migmatites and mixed gneisses, basic and ultrabasic igneous rocks and alkaline rocks. Two distinct granites have been recognized in the past—the Cape Coast granite with micas and the Dixcove granite with hornblende.

Around Lake Bosumtwe there are thick well-bedded clays with fossil remains of fish and plants. Their exact age was not known at mid-century, but they are comparatively recent. (W. J. M.)

Climate.—The climate is governed by three air masses: (1) moist and relatively cool monsoon air coming from the southwest across the Atlantic; (2) hot and dry air (the harmattan) coming from the northeast across the Sahara; (3) the Inter-Tropical Convergence zone (I.T.C.Z.), formed by the mixing of the monsoon and harmattan air masses.

Seasonal variation in weather is caused by the oscillation in latitude of the I.T.C.Z., which reaches its most northerly point north of the colony in August and its most southerly, 7° N. (over the forest), in January.

The harmattan is dominant north of the forest. The months from November to March are dry, with hot days and cool nights. From March onward the influence of the approaching I.T.C.Z. results in a gradually increasing number of days with rainfall. The wet season reaches its peak in August and September and thereafter sharply recedes. The weather of the forest zone is more continually influenced by the I.T.C.Z. There are two rainy seasons, with peaks in May-June and October. The harmattan is felt from December to February. and July and August are relatively dry and cool months. In the coastal regions the harmattan is felt only about January; for the rest of the year the monsoon is dominant. Mean temperatures are low for the latitude and, though the atmosphere is humid and often cloudy, rainfall is moderate except in the extreme southwest, the area of the highest rainfall in the colony. There are two rainy seasons: a primary season with a peak in May–June and a subsidiary season, with its peak in October, which is rarely effective on the Accra plains, the driest area of the colony. (J. D. F.)

Vegetation.—The natural vegetation has been much changed by man. Most of the virgin forest has been replaced by secondary forest. throughout which are scattered permanent cocoa farms and more or less temporary mixed farms where banana, plantain, oil palm, maize and market garden crops are cultivated. Around villages mango, pawpaw, avocado, citrus and kola are common. On poor soils cassava is extensively grown.

Large trees are conspicuous throughout the forest zone, but the most luxuriant vegetation is found in the statutory forest reserves. There giant trees, such as silk cotton, which may be 200 ft. tall, overtop successive canopies of smaller trees and shrubs. Many climbers reach to the upper canopy and have stems of great thickness which, as their support plants die or are cut down, fall to lie in great coils on the ground. Herbaceous plants, especially ferns and orchids, occur as epiphytes on the high branches of the trees, and on the ground broad-leaved flowering plants abound amid saplings and low shrubs. Grasses are very few. In the swampy parts of the forest *Raphia*, bamboo and climbing plants and ferns are common. Useful forest timbers include African mahogany and cedar, odum, wawa (obeche), ofram and *Antiaris*.

The Accra plains are characterized by grassland with scattered *Elaeophorbia* and *Antiaris* trees and clumps of bush inhabiting old termite mounds. All savanna grasslands are subjected to regular dry season burning.

True Guinea savanna, with small, widely spaced trees or thin woodland and abundant grasses, occurs around the lower Volta, on the Afram plains and over almost all the Northern region. In the marginal areas around the forest fan palms are a conspicuous feature. In northern Ashanti and the Northern region yams and groundnuts are widely grown, as also are sorghum millet and Guinea corn. Such indigenous plants as *Parkia*, shea butter, *Landolphia* and *Strophanthus* are preserved near habitations for their various uses, and baobab, akee apple, *Acacia albida* and *Khaya senegalensis* are commonly planted. (C. D. A.)

Fauna.—The fauna, formerly rich but now much depleted, includes leopards, hyenas, potto lemurs, antelopes, elephants, buffaloes, wild hogs and many kinds of monkeys, including the chimpanzee and the black and white colobus. Among the snakes are pythons, cobras, horned and puff adders, green mambas and boomslange. Crocodiles and a diminishing remnant of manatees and otters frequent the rivers and lagoons and hippopotamuses are found in the Volta. Lizards of brilliant hue, tortoises and great snails are common. Birds, which are very numerous, include parrots and hornbills, kingfishers, ospreys, herons, crossbills, curlews, woodpeckers, doves, pigeons, storks, pelicans, swallows, vultures and plantain eaters. Shoals of herring frequent the coast seasonally; the other fish include mackerel, sole, skate, mullet, bonito, flying fish, fighting fish and shynose. Sharks abound at the mouths of the rivers. Edible turtles are fairly common, as are the swordfish, dolphin and sting ray. Oysters are numerous on rocks running into the sea and on the exposed roots of mangrove trees; of other invertebrates spiders are particularly numerous. Insect life is muititudinous; beetles, ants, fireflies, butterflies and jiggers abound. Mosquitoes, tsetse flies and simuliids transmit malaria, yellow fever, trypanosomiasis and onchocerciasis, which are among the endemic diseases of the country.

HISTORY

The Trading Companies.—The first Europeans to come to the Gold Coast were the Portuguese, who reached the country in 1471 in the course of their maritime expansion along the coast of west Africa. The Portuguese developed such a profitable gold trade with the coastal peoples that in 1482 they erected the castle of São Jorge da Mina (Elmina) on land rented from a coastal tribe. In subsequent years other forts were built, the most important of which were at Axim and Shama. The forts were intended to help the Portuguese to monopolize the sea-bone trade of the country, for merchants of other nations were soon attracted by the gold trade. At first Portugal's chief competitors were Castilians, but after 1530 French, Flemish, English and Dutch merchants began to appear on the scene. Though the increasing activity of these merchants made it impossible for the Portuguese to secure the monopoly they wanted, none of Portugal's competitors were strongly enough organized to challenge the Portuguese system of coastal forts until the appearance of the Dutch West India company after 1621. Beside building its own forts, between 1637 and 1642 the Dutch company captured all the Portuguese strong posts, established their headquarters at Elmina and emerged as by far the strongest European power on the coast.

By this time the motives for European interest in the Gold Coast had changed. Though gold was still an important attraction, European footholds on the coast were now chiefly valued as bases for the trade in African slaves which was fast developing to meet the labour needs of the sugar plantations which Europeans were establishing in the West Indies. This slave trade, which the Dutch pioneered, was extremely lucrative, and in the 17th and 18th centuries the Gold Coast became one of the chief west African sources of slave exports. The Dutch were soon joined by Swedish, Brandenburger, Danish and English trading companies, all of whom built forts on the coast during the 17th century. Ground rent for these forts (most of which were still in existence at mid-20th century) was paid to the coastal nations. By the 18th century, the Swedes and the Brandenburgers had dropped out and the Danes had limited their activities to the coast east of Accra. The English merchants, who had first visited the Gold Coast in 1553 and had built their first fort (at Kormantine) in 1631, were from 1618 to 1820 organized in a series of chartered west African monopoly or regulated companies. In 1662 the English established their headquarters at Cape Coast (*q.v.*), a few miles east of Elmina, and thereafter they offered strong competition to the Dutch. During the maritime wars of the 17th century the forts were constantly changing hands, but during the 18th century the Dutch held an average of 11 forts and the English commonly about 8. Nevertheless, the English secured the bulk of the trade, which by 1785 amounted to an export of about 10,000 slaves a year.

Domestic slavery was common among the Gold Coast peoples, but the effect of the European demand for slaves in large numbers was greatly to extend the practice of enslavement and to provide new mercenary grounds for intertribal warfare. The British trade in slaves was abolished in 1807, the Danish trade in 1804 and the Dutch in 1814, with the result that the export of slaves from the Gold Coast by sea had practically ceased by the middle of the 19th century.

But the general effectof European trade still remained disruptive of native society on the coast. Population moved to the coastal states and new towns sprang up around the European forts, inhabited by men and women of many different tribes, some with their share of European blood. These towns, and even some of the smaller states, became identified with the interests of the particular traders, Dutch or English, who held forts on their shores, and in some cases real authority came to rest with the Europeans rather than with the traditional rulers.

The interests of the coastal states as middlemen denied access to the interior to Europeans. There the Ashanti union had by the end of the 18th century developed into a widespread and powerful military force desiring to subordinate the coastal states and obtain direct access to European trade (*see* ASHANTI). The result was the seven Ashanti wars of the 19th century. The first three were waged for the most part only between the Ashanti and the southern states they were trying to dominate. But the close association between the commercial communities of these states and .the European merchants, and the desire of the latter for peace and order so that their trade could prosper, inevitably brought the Ashantis into conflict with the Europeans.

British Ascendancy. — The Dutch and the Danes gradually lost interest in the Gold Coast in the 19th century, but Britain and its merchants remained active, the government because it wanted to stamp out the vestiges of the slave trade and the merchants because they wanted to develop legitimate trade in place of the trade in slaves. In 1821 the British forts were transferred from the control of the merchants to that of the governor of the crown colony of Sierra Leone.

The new governor, Sir Charles McCarthy, determined to destroy the Ashanti threat to the coastal states. The result was his defeat and death in battle in 1824. Although the military situation was redeemed two years later, this reverse decided the British government to withdraw from the Gold Coast and in 1828 it handed over such of the British forts as were still in use to a committee of London merchants trading with west Africa.

From 1830 to 1843 the committee entrusted the direction of its affairson the coast to Capt. George Maclean, a man of outstanding ability who was determined to use British influence to bring peace and good order to the country. Maclean negotiated a firm peace treaty with Ashanti and began to exercise an informal jurisdiction over the coastal peoples. As a result of the improved conditions, imports through the British settlements on the Gold Coast increased threefold in ten years to an annual value of £400,000. Legally, however, Maclean's authority was restricted to the British settlements (*i.e.*, the forts), and his wider activities, though acceptable to the Fanti chiefs and people as bringing them some of the benefits of European civilization, led to criticism in England.

Consequently in 1843 the crown resumed control of the Gold Coast settlements, though the value of Maclean's work was recognized by his appointment as judicial assessor in the new administration. In 1844–45 Maclean's extraterritorial jurisdiction was given formal recognition through the negotiation of a series of treaties (called "bonds") with the leading coastal chiefs.

After Maclean's death in 1847, British relations both with Ashanti and the Fantis steadily deteriorated. The aspirations of the Ashantis could not be held in check, while it was proving difficult to gratify the Fanti desire for European-style amenities. Apart from the work done by the Christian missions. particularly in the educational field (the pioneers were the Basle mission in 1827 and the Wesleyan Methodists in 1835), roads, hospitals, schools. etc., could hardly be provided because there was no real means of raising money to pay for them. The people could not be taxed directly, since they were not British subjects, and an attempt at levying taxes through the co-operation of the indigenous authorities proved unsuccessful. Effective customs duties could not be imposed until the British controlled all the coastal forts and, though they purchased the Danish forts in 1850, the Dutch still retained theirs, interspersed with those in British hands.

In these circumstances the British government once again decided that responsibility on the Gold Coast was unrewarding and in 1865, as a preliminary to their eventual abandonment, the British settlements there were again subordinated to Sierra Leone. This policy led to increased trouble with the Fantis, who found the British officials hostile to the arrangements they were making for their own government. At length in 1872 the British acquired the Dutch forts, but difficulties connected with the transfer of Elmina led to another Ashanti invasion of the coastal states.

The British government now determined to take matters in hand. In 1874 Sir Garnet Wolseley led a punitive expedition into Ashanti, and Kumasi. the capital, was destroyed. The result was the treaty of Fomena. in which the Ashantis promised to pay an indemnity and to refrain from invading British protected territory. In the same year the territory under British protection as a result of the bonds was declared to be a British colony and given an administration independent of Sierra Leone. This decision was to give rise to difficulties. The boundaries of the colony were not defined, and its inhabitants protested that their relations with Britain ought still to be governed by the bonds.

The Ashantis did not accept the dictated Fomena treaty as a permanent settlement and remained a threat to the coastlands. After prolonged negotiations, the British sent an ultimatum to Kumasi in 189j charging Ashanti with failure to keep the treaty. The ultimatum was followed by a further military expedition. the enforced dissolution of the Xshanti union and the declaration of a British protectorate over the country. The need to preserve the commercial hinterland of Ashanti from occupation by the advancing French and Germans, and also to combat the activities of the notorious slave raider Samori, led during 1896–99 to the further extension of British influence to the north of Ashanti.

In 1901 orders in council defined the boundaries of the Gold Coast Colony, Xshanti and the Northern Territories. and declared the first to be a British colony by settlement, the second a British colony by conquest and the third a British protectorate. In 1914 British and French colonial troops occupied the German colony of Togoland and in 1922 the western portion of this territory was entrusted by the League of Nations to the United Kingdom as a class B mandate. In Dec. 1946 Togoland was placed under GN trusteeship and in Dec. 1956 it was integrated nith the Gold Coast which. on March 6, 1957, became an independent state within the commonwealth and changed its name to Ghana.

Constitutional Development. — The constitutional development of the Gold Coast as a British colony may be said to have begun in 1850 when executive and legislative councils were instituted for the British settlements. In 1853 a supreme court mas set up for the settlements. Until 1874, when the legislative council was empowered to legislate for the newly proclaimed colony, the British authorities did not concern themselves with the administration of Africans outside the settlements, though in the territories under British protection since 1844 British justice was administered by the judicial assessor, usually sitting with a panel of chiefs. The legislative council contained a majority of officials and a number of unofficialmembers appointed by the governor. The first African unofficial member was appointed in 1888. Even after 1874 relations with the native chiefs remained ill-defined. though the central government instituted a system of direct rule through district officers and in 1895 a beginning was made nith municipal government for the larger towns—Accra (after 1877 the capital), Cape Coast and Sekondi.

When British governments were set up for Ashanti and the Northern Territories, they were separate from that of the Colony. The new provinces were administered by commissioners responsible to the governor of the Gold Coast, but the competence of the legislative council at Accra remained limited to the Colony. The governor was the sole legislator for Ashanti until 1946 and for the Northern Territories until 1951, though he commonly applied to these territories laws passed for the Colony by its legislative council. However, in 1934 and 1935 respectively the competence of the executive council and of the supreme court at Accra was extended to Ashanti and the Northern Territories.

In 1925 three provincial councils of chiefs were instituted for the Colony, each electing two members of the central legislative council. Three members directly elected by the coastal municipalities were also added to the council, though the official majority was retained. In subsequent years efforts were made to introduce the principles of indirect rule through traditional native authorities into the Colony. Ashanti and the Northern Territories. In the Colony a joint provincial council developed out of the three smaller ones. and in 1935 the restoration of the Ashanti confederacy permitted the establishment of a similar council of chiefs for Ashanti. A council for the Northern Territories was instituted in 1946. In 1956 both Ashanti and the Northern Territories petitioned for independence.

In 1946 the legislative council was enlarged to include a majority of African elected members. including representatives from Ashanti. But the executive council, which since 1942 had included two nominated unofficial African members, remained responsible to the governor and not to the legislature. It soon became apparent that this system of representative government was inadequate to meet the political aspirations of a country in which the processes of social and economic change had been greatly accelerated by the effects of World War II. Elements in the European-educated urban communities, led by members of the professional classes, were not satisfied by the increased representation (principally of the traditional native authorities) accorded by the 1946 constitution, and pressed for complete self-government in which the executive would be responsible to a legislature wholly elected on a democratic franchise.

The organization of active political groups in defense of African interests dates in the Colony from 1897 if not earlier. But such groups had been mainly organized for specific and largely temporary ends, and in general their continued existence had been impeded by differences between the traditional rulers and the European-educated professional classes about ultimate political objectives. However, in 1947 the United Gold Coast convention (U.G.C.C.). led by J. B. Danquah, a barrister member of the legislative council, was founded with the object of securing complete self-government for the Gold Coast at the earliest opportunity. In 1948 there were riots in Accra and other towns, in which ex-servicemen and unemployed were principally involved, and the leaders of the U.G.C.C. were removed for a time to the Northern Territories. The subsequent commission of inquiry (Watson commission) recommended. among other things, further political advances for the colony. During 1949 an all-African committee. under the chairmanship of Henley Coussey, was appointed to draft a new constitution on the lines indicated in the Watson report.

The 1951 Constitution.—The Coussey recommendations formed the basis for a new constitution which became law in 1951. The legislative council was replaced by an assembly of 84 members. Seventy-five elected members represented the whole of the colony, including the Northern Territories: five of these members were directly elected by adult suffrage in urban constituencies and the remainder by various forms of indirect election in the rural areas. In addition there were six representatives of European economic interests and three nominated officials. The latter, together with eight members of the assembly elected by the assembly on the nomination of the governor and removable by it, formed the executive council, each member of which was responsible to the assembly for a group of administrative departments. One of the elected members was "leader of government business" in the assembly. The old system of local government through a combination of administrative officers and traditional native authorities was to give way to a system of elected councils on the British model.

But for the presence of the three irremovable officials (who controlled defense and external affairs, finance and justice), and reserve powers retained by the governor to veto legislation and, in emergency, to legislate without the assembly. the new executive council represented an appreciable step toward the nationalist goal of a responsible ministry. It was accepted as a reasonable step by all the political leaders except an element in the U.G.C.C. led by Kwame Nkrumah, the party's organizing secretary. This element seceded and formed a new party, the Convention People's party (C P P.), which denounced the new constitution as bogus and during 1950 tried to enforce its demand for full self-government by a campaign of "positive action," which resulted in the arrest and imprisonment of its principal leaders. However. at the general election in Feb. 1951 the C P.P. won a decisive victory; Nkrumah and his colleagues were released and became the leading members of the new executive council. In 1952 Nkrumah became the first prime minister of the Gold Coast.

The **1954** Constitution.—The C.P.P. policy was to achieve full self-government as quickly as possible by constitutional means As a further step toward this end, Nkrumah's government secured a new constitution in 1954. The Europeans disappeared from the assembly and the executive council, and the latter became a cabinet of African ministers responsible to an assembly of 104 members —all directly elected by nationwide single member constituencies —for all matters except defense. external affairs and control of the judiciary and civil service, which were entrusted to the governor or to special commissions. The governor's reserve poaers were retained, but it should be noted that they were never used during 1951–57. As the C.P.P won 71 seats in the assembly at the 1954 general election, the Nkrumah government was free to proceed with its plans for complete independence of British control. In the 1950s, however, a new opposition party, the National Liberation movement, emerged demanding a federal form of government to offset what it believed to be an undue growth of the power of the central government to the detriment of local interests and the traditional authorities. particularly in Ashanti and the Northern Territories. Thus. when the Gold Coast government issued a proposed constitution in May 1956 the British government replied that a resolution calling for full independence passed by the Gold Coast assembly would only be acceptable if supported by public opinion in an election.

In the general election of July 1956 the C.P P. obtained an overall majority which cleared the way for attainment of full independence. This was achieved on March 6, 1957, when the Gold Coast with British Togoland (which had been combined with it in 1956) became an independent state within the commonwealth and changed its name to Ghana. On July 1,1960, it became the Republic of Ghana.

POPULATION

The population of the country according to the 1948 census was 4,118,450, divided as shown below; and was 6,690,730 at the 1960 census.

The chief towns (mun. pop. 1960 census) are Accra (388,231), Kumasi (220,922) and Sekondi-Takoradi (120,793).

Native Peoples.—The native peoples are all of Segro stock. The greater part of the inhabitants of the coast regions and Ashanti belong to the Akan family, which can be divided today linguistically into two main and closely related groups, the Fanti and the Twi. Twi is the language of Ashanti and of the Akan nations such as the Denkera. Akim and Akwapim. Fanti is spoken by the inhabitants of the coastal zone from Sekondi to Winneba. East of the Pra there are a number of peoples, such as the Nzima, Ahanta and Evalue, who speak languages related to Twi and Fanti. The Accra plains are inhabited by peoples speaking variants of Ga, the Ga themselves to the west and the Adangme to the east. East of the Volta are found the westernmost elements of the Ewes who inhabit most of Togoland and Dahomey.

All these peoples seem to be comparatively recent arrivals in the country. The Akan immigration from the northwest was a long process which began about the 12th century and was virtually complete by about 1600. The Ga-Adangme came from Nigeria about the beginning of the 16th centurv. and the Ewes arrived. also from the east. during the 17th century.

Although tradition presents these movements as mass migrations, it seems more probable that they were really movements of comparatively small numbers who imposed their rule, and ultimately their language and much of their culture, on other Negro peoples already living in the country.

The majority of the inhabitants of the Northern region belong either to the great Moshi-Dagomba group of Voltaic peoples or to the Gonja, who seem to have some affinity with the Akan.

Social Conditions. — The mode of life of the Gold Coast peoples before the coming of Europeans was primarily subsistence agriculture. North of the forest cattle were kept, while the coastal peoples engaged in fishing. Alluvial gold and iron were mined and worked; goldsmiths, potters and woodcarvers produced work of considerable merit. Gold and kola nuts were exported from the forest to the markets of the western Sudan and there exchanged for manufactures brought from across the Sahara.

The rapid economic development which took place in the 20th century involved the increasing replacement of a system of self-sufficient tribal communities by a nation of individual wage earners and peasant farmers producing cash crops for the world economy. The value of land rose greatly, especially as a result of the extension of cocoa farming, and it tended to be treated as alienable private property rather than as tribal land. The decline of subsistence farming and the great increase of trade led to the growth of large urban communities of a kind which traditional tribal society could hardly encompass. and where in consequence problems of social morality and organization became complex and serious.

Religion. — The majority of the people are animists, though there is a general belief in a supreme deity. The leading Christian communities are Methodist. Presbyterian and Roman Catholic, and there is a substantial Moslem element.

Education.--With the increase of wealth and urbanization, the demand for social amenities and education in particular, on the European model, grew enormously. European education was pioneered by the missionary societies, but after 1882 government grants were made to schools achieving recognized standards. Later native authorities also sponsored schools. Increasingly the tendency was for the central government to pay more and more of the cost of recognized schools and also to sponsor schools directly. The University College was instituted in 1948 and in 1951 a college of technology was opened at Kumasi. In 1950 there were 204,253 children in the 1,952 primary schools recognized by the government and 2,776 pupils in 12 recognized secondary schools. The provision of schools by the recognized education authorities was lagging behind the demand for them, and it was estimated that there were about 65,000 children attending about 1,500 unrecognized primary schools. In 1952 the Nkrumah administration introduced free primary education.

ECONOMICS

Economic Development. — Before 1874 European commercial relations with the Gold Coast were confined to the coast. There was no penetration or development of the interior. The staple exports of the country, principally gold and slaves. were brought to the European forts by African merchants and there exchanged for European commodities, principally cloth. hardware, trinkets, spirits, arms and ammunition. Trade did not develop during the first three-quarters of the 19th century; Europeans ceased to purchase slaves, the alluvial gold deposits worked by the natives began to be exhausted, while the Ashanti wars created a situation of chronic unrest. In 1840 imports through the British settlements were £423,000 and exports £325,000; the figures for 1878 were £394,000 and £393,000 respectively.

The extension of British administration after 1874 brought the peace and order essential for the development of the interior and also offered inducements for the investment of European capital. The consequent expansion of external trade may best be illustrated in the following table:

Value of Products Imported and Exported by Sea, 1900-50
(In thousands of pounds)

Year	Imports	Exports		
		Total	Cocoa	Minerals
1900	1,099	852	27	38
1913	3,510	5,014	2,489	1,656
1927	11,703	14,186	11,728	1,922
1936	8,531	12,240	7,660	4,248
1947	22,584	27,420	16,632	8,184
1954	71,647	113,283	84,599	19,515

By far the greater part of this commercial expansion resulted from the exploitation of cash crops by African peasant farmers. The role of European enterprise and capital was to provide facilities for the purchase of native-grown crops, to distribute the manufactures imported in exchange, to exploit the mineral resources of the country and to provide the transport facilities essential for the expansion of trade and production.

The first cash crop exported on a large scale was rubber collected by the natives from wild rubber trees. In 1900 exports of rubber were worth £328,000 and accounted for 39% by value of all exports. Overcropping and the competition of rubber of better quality from plantations in Malaya and elsewhere led to the decline of the trade.

After 1911 cocoa became the most valuable single export from the Gold Coast and, indeed, the mainstay of the country's economy. The crop was introduced from Fernando Po in 1879 and first cultivated in the eastern part of the colony. Cultivation of cocoa on farms of less than five acres spread rapidly throughout the forest zone of the colony and into Ashanti. Cocoa was first exported in 1891 and by 1913 annual exports of the crop were averaging 50,000 tons and 50% by value of the country's total exports. The peak production period mas 1934–37 when annual exports averaged 287,000 tons. In 1954 214,152 tons of cocoa were exported worth £84,599,000 (74.7% of the total value of exports).

After 1930 the cocoa trees suffered increasingly from swollen-shoot disease, particularly in the areas where cocoa had been longest cultivated. The only proved treatment is to cut out the diseased trees and to plant anew. Since a diseased tree will continue to bear fruit for several years, the enforcement of a policy of systematic cutting-out proved unpopular with cocoa farmers despite the payment by the government of compensation and replanting grants. A large-scale cutting-out campaign was begun in 1945 and, by 1951, 1,431,553 ac. of cocoa had been surveyed and 11,856,802 trees cut out on 51,668 infected acres, but in the worst-affected districts the disease was still not under control. However, the high prices paid for cocoa in the postwar years kept the industry buoyant and encouraged a great extension of cocoa farming in Ashanti, where swollen-shoot had slight effect.

Though Ghana produces more cocoa than any other country in the world, the quality of the crop is not as consistently high as that grown elsewhere under plantation conditions. In 1947 the purchase of all cocoa for export was entrusted to a statutory marketing board, which, besides shielding the peasant producer from extreme fluctuations of the world price for cocoa, operated grading schemes and financed research to improve the quality of the crop.

The most important nonmineral export after cocoa is hardwood timber, chiefly mahogany, from the forest zone. Both Africans and Europeans engaged in the timber export trade.

The first mineral to be exploited by European enterprise in the Gold Coast was gold. Gold-mining concessions in the western part of the colony were taken up by European companies after 1877, but the industry did not prosper until after 1902, when the mining areas could be linked to the coast by rail. In 1908 exports of gold were worth £1,152,000 (49.5% by value of all exports). Exports in 1954 were 787,900 fine ounces, worth £9,822,000 (8.7% of all exports). The principal mines are at Tarkwa in the Colony and at Bibiani and Obuasi in western Ashanti. Mining of manganese ore at Nsuta, near Tarkwa, was begun during World War I. Bauxite mining began during World War II.

In 1954, 2,126,000 carats of diamonds worth £4,273,000 were exported; approximately half came from African diggers working on their own account.

The chief commodities imported in 1954 were cotton piece goods, motor vehicles and parts and oils and petroleum products.

There was little industry in the early 1950s though the government-sponsored Industrial Development corporation (set up in 1945), besides undertaking some manufactures itself, provided finance for the establishment of secondary industries. It also encouraged handicrafts which the import of European manufactures tended to destroy.

Transport. — The development of mechanized mining and of the cocoa and timber industries would have been impossible without the provision of modern transport facilities. Two main railways run from the coast to Kumasi, from Sekondi via Tarkwa (170 mi., completed 1903), and from Accra (189 mi.. completed 1923). A 99-mi. branch of the Sekondi line eastward through the centre of the Colony (opened 1927) was in 1956 extended to meet the Accra line 20 mi. from Accra, thus affording a direct link from Sekondi to Accra (189 mi.). The railways are of 3 ft. 6 in. gauge and are state owned and operated; 624 route miles were open to traffic in 1956.

After about 1930, road transport played an increasingly important role in the economic life of the country. In 1954 the central government maintained 3,633 mi. of trunk roads.

Port facilities tended to lag behind the development of internal transport. Until 1928 all goods entering or leaving the country by sea were handled by surfboats over open beaches, but in that year an artificial harbour at Takoradi was opened to traffic.

After extensions made in 1949–55, the harbour had five deep-water berths for general cargo and four for mineral traffic, plus moorings for a further eight ships. Construction of a second artificial harbour at Tema, to serve the eastern part of the Colony, was begun in 1955 and was expected to lead to the elimination of the surviving surf-ports at Accra, Cape Coast and Winneba.

Accra airport was one of the termini for the London-\Vest Africa service of the British Overseas Airways corporation and a calling point for U.S., French and Portuguese services.

Finance. — The provision of schools, medical services, railways, roads, water and electricity supplies, etc., was largely. financed by the government out of the great increases in revenue available to it after 1900.

In 1902 revenue was £492,000 (77.8% from customs duties) and expenditure was £523,000 (1.75% going to education). By 1926–27 the figures were revenue, £4,365,000 (55.1% customs); expenditure, £4,328,000 (4.67, on education). The figures for 1954–55 were revenue £80,566,000 (79% from customs, especially export duty on cocoa; 10% from direct taxation, income tax having been introduced in 1944); expenditure £79,860,000 (6% on education, about 10% on all social services).

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GOLDCREST or GOLDEN-CRESTED KINGLET is the type of a small family Regulidae, related to old world warblers. The goldcrest (Regulus regulus) is the smallest of British birds, its whole length being about 3½ in., and its weight some 5 grams. Generally of an olive-green colour, the top of its head is bright yellow, deepening into orange, and bounded on either side by a black line. The wing coverts are dull black with a whitish bar. The cock has a pleasant but weak song, which has been compared to the squeaking of young mice. The nest is of moss, wool and spiders' webs, lined with feathers, and usually built under and near the end of the branch of a yew, fir or cedar, supported by the interweaving of two or three twigs. The six to ten eggs are dull white, sometimes freckled with reddish-brown. The species lives most of the year in family parties often in company with titmice. It breeds over most of Europe, well to the north, south to the Pyrenees, Italy, Asia Minor and Syria, with local races in the British Isles (R. *r.* anglorum), the Azores, the western Canaries, on Corsica and Sardinia, and others in the Caucasus and Asia. The rather similar diminutive golden-crowned kinglet, olive-green with a black-bordered yellow crown (R. satrapa), breeds from Alaska and southern Canada to the northern states, south in higher mountains to North Carolina, New Mexico and California. The ruby-crowned kinglet (R. calendula), with a tiny bright-red crown patch in the male and a beautiful little song, breeds in Alaska and Canada south in the western mountains to Arizona and Lower California. The firecrest (R. *ingnicapillus*), of temperate Europe and North Africa to Asia Minor, has a similar red patch, bordered with black. (G. F. Ss.)

GOLDEN BULL, the general designation of any charter decorated with a golden seal or *bulla*. The name, however, has become practically restricted to a few documents of unusual political importance, the golden bull of the empire, the golden bull of Brabant, the golden bull of Hungary, and the golden bull of Milan — and of these the first is undoubtedly the golden bull par excellence. The main object of the golden bull was to provide a set of rules for the election of the German kings, or kings of the Romans, as they are called in this document. Since the informal establishment of the electoral college about a century before (see ELECTORS), various disputes had taken place about the right of certain princes to vote at the elections, these and other difficulties having arisen owing to the absence of any authoritative ruling. Under these circumstances the emperor Charles IV determined by an authoritative pronouncement to make such uncertainty impossible in the future, and at the same time to add to his own power and prestige, especially in his capacity as king of Bohemia. In its first form the bull was promulgated at the diet of Nuremberg on Jan. 10, 1356, but it was not accepted by the princes until some modifications had been introduced, and in its final form it was issued at the diet of Metz on Dec. 25 following.

The text of the golden bull consists of a prologue and of 31 chapters. The early chapters are mainly concerned with details of the elaborate ceremonies which are to be observed on the occasion of an election. The number of electors is fixed at seven, the duke of Saxe-Wittenberg, not the duke of Saxe-Lauenburg, receiving the Saxon vote, and the count palatine, not the duke of Bavaria, obtaining the vote of the Wittelsbachs. The electors were arranged in order of precedence thus: the archbishops of Mainz, of Trier and of Cologne, the king of Bohemia, the count palatine of the Rhine, the duke of Saxony and the margrave of Brandenburg. The work of summoning the electors and of presiding over their deliberations fell to the archbishop of Mainz, but if he failed to discharge this duty the electors were to assemble without summons within three months of the death of a king. Elections were to be held at Frankfort; they were to be decided by a majority of votes, and the subsequent coronation at Aix-la-Chapelle was to be performed by the archbishop of Cologne. During a vacancy in the empire the work of administering the greater part of Germany was entrusted to the count palatine of the Rhine, the duke of Saxony being responsible, however, for the government of Saxony, or rather for the districts *ubi Saxonica jura* servantur. The chief result of the bull was to add greatly to the power of the electors. To these princes were given sovereign rights in their dominions, which were declared indivisible and were to pass according to the rule of primogeniture. Except in extreme cases, there was to be no appeal from the sentences of their tribunals, and they were confirmed in the right of coining money, of taking tolls, and in other privileges, while conspirators against their lives were to suffer the penalties of treason. One clause gave special rights and immunities to the king of Bohemia, who, it must be remembered, at this time was Charles himself, and others enjoined the observance of the public peace. Provision was made for an annual meeting of the electors, to be held at Metz four weeks after Easter. This arrangement, however, was not carried out, although the electors met occasionally. Another clause forbade the cities to receive *Pfahlbürger, i.e.,* forbade them to take men dwelling outside their walls under their protection. It may be noted that there is no admission whatever that the election of a king needs confirmation from the pope.

GOLDEN CLUB (Orontium aquaticum), a North American aquatic plant of the arum family (Araceae), found in shallow ponds and less frequently in swamps from Massachusetts to Florida, chiefly near the coast. It is a somewhat fleshy perennial, with thick oblong, ascending, or floating leaves, five to ten inches long, and bearing in early spring a narrow but dense cluster (spike) of small bright yellow flowers, terminating a flattened stalk, six inches to two feet long, which rises above the water. This handsome aroid, the only species of the genus, is sometimes transplanted in water gardens. See ARACEAE.

GOLDENEYE, a diving duck (Bucephala or Glaucionetta), breeding in far northern regions, from where it migrates south in winter. It nests in hollow trees and in burrows along banks of inland water. The adult male is mainly black above, with a round, white eye patch and white scapulars; the lower parts are white, the legs orange; in the female, dark brown replaces black. An elaborate courtship during which the drake may dive and bob up just in front of the female, occurs in the early spring. They are known also as whistlers, from their swift whistling flight.

The European goldeneye (B. clangula clangula) breeds across the northern half of Europe and Asia to the limit of trees. the American goldeneye (B. c. americana) in Canada and the plains border states and the Barrow's goldeneye (B. islandica), which has a crescent-shaped instead of a round white spot in front of the eye, in the mountains from Alaska to Colorado, and in Labrador, Greenland and Iceland. They winter south to the Mediterranean and Burma, South Carolina and California, rarely to the Gulf of Mexico. (G. F. Ss.; X.)

GOLDEN FLEECE, in Greek mythology, the fleece of the ram on which Phrixus and Helle escaped. (See ARGONAUTS.) For the knighthood of the Golden Fleece see KNIGHTHOOD AND CHIVALRY: Orders of Knighthood.

GOLDEN GATE, THE, a strait in California, U.S., connecting San Francisco bay with the Pacific ocean, and separating San Francisco from Marin county. The Gate is about three miles long and from one to two miles wide. Its channel is more than 300 ft. deep. In an earlier geologic period, the strait was the lower end of a river which poured fresh water into the Pacific, but subsidence of land in the region and a rise in the ocean level brought invasion by sea water and the formation of the present magnificent bay. The Gate may have been seen by Sir Francis Drake in 1579, but the effective discovery was made by Spanish explorers (1769–75). The name apparently originated with John C. Frémont and became popular during the gold rush period.

Although the strait is the ocean gateway to San Francisco and its harbour, it constituted a barrier to land travel in the area until the construction (1933–37) of the famous Golden Gate bridge at a cost of $35,000,000. A suspension bridge, with a central span of 4,200 ft. and towers that rise 746 ft. above the water, it was built by Joseph B. Strauss for a special bridge district consisting of six counties; it was financed by bonds secured by revenues from tolls and also by the general taxing powers of the district. The opening of the Golden Gate bridge on May 27, 1937, came only six and a half months after the opening of the San Francisco-Oakland Bay bridge. The latter, built by the state with federal aid at a cost of $77,000,000, consists of two suspension bridges over the west channel, a tunnel through Yerba Buena Island and a cantilever span over the east channel. Double-decked, it is over four miles long (over eight miles long counting approaches). In 1939 San Francisco celebrated these great achievements in bridge building at its Golden Gate exposition on Treasure Island. (D. E. F.)

GOLDEN GLOW, a double-flowered cultivated variety (Rudbeckia laciniata hortensis) of a tall coneflower, native to North America, widely grown in the United States, Canada and England as an ornamental plant. It is a showy summer bloomer, usually four feet to seven feet high, with smooth, much-branched stems, more or less divided leaves and numerous flowering heads $2\frac{1}{2}$ to $3\frac{1}{2}$ in. across, crowded with brilliant golden-yellow much-doubled ray flowers.

Originally derived from a weedy herb common from Quebec to Florida and westward, the cultivated golden glow has become ubiquitous in the garden. It has propensity to spread. To gardeners the plant is a coarse, invasive perennial. (N. TR.)

GOLDEN HORDE, a body of Tatars who in the middle of the 13th century overran a great portion of eastern Europe and founded in Russia the Tatar khanate, known as the empire of the Golden Horde or Western Kipchaks. They invaded Europe about 1237 under the leadership of Batu Khan, a grandson of Genghis Khan, passed over Russia with slaughter and destruction, and penetrated into Silesia, Poland and Hungary, finally defeating Henry II, duke of Silesia, at Liegnitz in the battle known as the Wahlstatt on April 9, 1241. So costly was this victory, however, that Batu, finding he could not reduce Neustadt, retraced his steps and established himself in his magnificent tent (whence the name "golden") on the Volga. The new settlement was known as Sir Orda ("Golden Camp," whence "Golden Horde"). Rapidly the powers of Batu extended over the Russian princes, and so long as the khanate remained in the direct descent from Batu nothing occurred to check the growth of the empire. But the death of Janibeg, in 1357, threw everything into confusion until in 1378 Toktamish of the Eastern Kipchaks ousted all rivals. For a short time the glory of the Golden Horde was renewed, but it was finally crushed by Timur in 1395. See MONGOLS.

GOLDEN MOLE, a burrowing molelike animal. species of which belong to the south African family Chrysochloridae, order Insectivora (*q.v.*). They are named from the bright metallic bronze to violet lustre of their fur. Although resembling true moles (*q.v.*) in habits and, to some extent, in appearance, they dig by means of enormous claws on the two middle digits of the forelimbs. an adaptation to the hard soil.

GOLDEN-RAIN TREE, a Chinese tree, *Koelreuteria paniculata*, uidely grown as an ornamental. It has leaves with 7–15 leaflets that are arranged alternately or in pairs along a central stalk and are toothed, lobed or divided into smaller leaflets. The yellow summer-blooming flowers, borne in clusters terminating the branches, produce three-angled, inflated, papery capsules about two inches long, containing three to six round, brown to black seeds.

The tree, which grows to 40 ft. tall and attains a trunkdiameter of 2 ft., is easily raised from seed. It does well in ordinary soil, prefers full sun and is hardy as far north as northern Illinois. In some areas it is called "pride-of-India," a name properly belonging to *Melia* azedarach, the Chinaberry or China-tree. The golden-rain tree is a member of the soapberry family (Sapindaceae). (J. W. TT.)

GOLDENROD, the popular name for plants of the botanical genus Solidago, of the family Compositae (*q.v.*), comprising about 120 species, natives chiefly of North America, a few, however, occurring in the old world and in South America. They are erect perennial herbs. mostly from two to eight feet high, often unbranched or slightly branched, uith undivided, toothed or entire, sessile or almost sessile leaves and very numerous small heads of brilliant yellow (rarely white) flowers arranged in conspicuous terminal or axillary clusters. Hybridization between closely related species occurs freely in nature, making species identification difficult.

The European goldenrod (S. *virgaurea*), the only British species, bearing a long cluster of showy flower heads, is found in woods and thickets. It is one of the best garden plants of the genus, many other species of which are cultivated for ornament, especially *S.* canadensis, *S. cutleri* and the seaside goldenrod, S. *sempervirens*. The goldenrods are characteristic plants in eastern North America, where about 60 species occur. They are found almost everywhere—in woodlands, swamps, on mountains, in fields and along roadsides.

With the asters, whose bright colours they complement, the goldenrods form one of the chief floral glories of autumn from the Great Plains eastward to the Atlantic. While numerous handsome species occur in the Rocky mountain region and on the Pacific coast, they are less abundant and conspicuous than in the eastern states. Among the best-known eastern species are the early goldenrod (*S. juncea*), the late goldenrod (*S. gigantea*), the tall goldenrod (*S. altissima*), the Canada goldenrod (*S. canadensis*), the dwarf goldenrod (*S. nemoralis*), the wreath goldenrod (*S. caesia*), the pale goldenrod or silverrod (*S. bicolor*), the sweet goldenrod (*S.* odora) and the showy goldenrod (*S. speciosa*). Among the western species are *S.* occidentalis, found from the Rocky mountains westward: *S. californica*, the *oreja* de *liebre* ("rabbit's ear") of the Spanish Californians; and the coast goldenrod (*S. spathulata*) of central Californian shores. The copious pollen of most species is responsible for many cases of hay fever. (N. Tr.)

GOLDEN ROSE, an ornament made of wrought gold and set with gems, generally sapphires, which is blessed by the pope on the fourth Sunday in Lent and sent, as one of the highest honours he can confer, to some distinguished individual, ecclesiastical body or religious community or. failing a worthy recipient, kept in the Vatican. Many of these historical examples of the goldsmith's art, being of great value, have been melted down; of the few remaining, one of the 14th century, sent to the bishopric of Basel by Clement V, is in the Musée de Cluny, and another, one of the 17th century, bestowed by Alexander VII on his native city, Siena, is in the Museo dell'opera della metropolitana di Siena. The origin of the custom is obscure, the first reliable accounts dating from the 11th century. Of more symbolic than material significance, the rose was usually sent, like the papal cap and sword, for political as well as religious reasons, together with an explanatory letter. Three were sent to Henry VIII of England, the first in 1510 by Julius II seeking support against Louis XII of France. In 1684 one was sent to the wife of John Sobieski, who aided Vienna against the Turks. Princess Charlotte of Nassau, who became grand duchess of Luxembourg in 1919, was accorded the golden rose in 1956.

See Sir C. Young, Ornaments and Gifts Consecrated by the Roman *Pontiffs* (1864).

GOLDENWEISER, ALEXANDER (1880–1940), U.S. anthropologist whose interests embraced a broad spectrum of cultural problems, was born on Jan. 29, 1880, in Kiev, Russia, and went to the United States in 1900. He studied anthropology under Franz Boas at Columbia university, where he took his Ph.D. in 1910 and lectured in anthropology from 1910 to 1919. He subsequently taught at the Rand School of Social Science, the New School for Social Research, the university of Oregon and Reed college.

Goldenweiser did field research among the Iroquois and published the first American textbook in anthropology (Early Civilize*tion*, 1922; rev. ed., Anthropology, 1937). In *Totemism* (1910) he stressed the psychological factors common to different tribal cultures. In dealing with problems of diffusion *v.* independent invention of culture traits he introduced the principle of limited possibilities, showing that in many cases this principle explained similarities in a satisfactory manner. He pointed out that diffusion was not a mechanical process but depended partly on the receptivity of cultures to proffered traits. He was interested in primitive man's knowledge and in primitive science, theoretical and applied. He noted the tendency toward overelaboration of a trait or a complex, especially in art, which he called "involution." His analyses and interpretations of cultural problems ranged widely, encompassing intellectual movements in psychology and psychoanalysis. He died on July 6, 1940, in Portland, Ore.

For bibliography, see Wilson D. Wallis, "Alexander Goldenweiser," American Anthropologist, vol. 43, no. 2, pp. 252–253 (April–June, 1941). (W. D. Wa.)

GOLD FERN, a handsome American fern (*Pityrogramma triangularis*), native to the Pacific coast region from Alaska to Lower California, so called because the leaves (fronds) are coated beneath with a bright orange-coloured powder. The dark-brown, glossy leafstalks (stipes), 6 in. to 12 in. high, rise from the rootstock in tufts, and bear triangular-shaped, somewhat leathery leaves, three to four inches long and broad, more or less deeply cut into rounded lobes. A tropical American species, P. *calomelanos,* popular in greenhouse cultivation, with golden-yellow powder on the undersurface of the fronds, is also called gold fern.

GOLDFIELD, a mining ghost town in the desert in southwestern Nevada, U.S., is the seat of Esmeralda county. Rich gold ore was discovered there in 1902 and the ensuing rush resulted in a city with an estimated population of 40,000. The mining boom lasted from 1903 to 1918, although the production of the mines started dropping off at the end of 1910, when production of ore reached an all-time high valued at more than $11,000,000. The mines were the scene of a bitter labour struggle in 1907 and 1908, with federal troops being sent to the area.

After 1918, Goldfield's population decreased rapidly to less than 200. The 200-room Goldfield hotel was closed, although it was reopened briefly during World War II to accommodate the servicemen stationed at nearby Tonopah air force station. In the second half of the 20th century tourists kept the few people still living in Goldfield in business. (D. W. Ds.)

GOLDFINCH, *Carduelis carduelis,* a well-known and beautiful bird found over the greater part of Europe and north Africa, and eastwards to Persia and Turkistan. It is a favourite cagebird. As a songster it is surpassed by other species, but its docility and attachment to its master or mistress make up for any defect in its vocal powers. Less than 5 in. long, it has a bright-red face, bordered white, with nape, tail, and wings black, with broad yellow wing-band. Though goldfinches may be observed in the coldest weather, most leave Britain in autumn, returning in spring, and resorting to gardens and orchards to breed. The nest is beautifully neat, generally well hidden by the leafy bough on which it is built. When the broods leave the nest they frequent pastures, commons, heaths and downs in flocks. The goldfinch is very fond of the seeds of thistles and other weeds. It has been introduced into New Zealand, where it has firmly established itself (see Thomson, *Naturalisation* of *Animals* and Plants in New Zealand). The American goldfinch (*Spinus tristis*) breeds from southern Canada to northern parts of the gulf states and California. It has a yellow body with black wings and tail, a black cap, undulating flight, and a plaintive call. It is duller, more brownish and greenish, in winter. The Arkansas goldfinch (*S. psaltria*) of the Rockies and Mexico has upper parts mostly black in the adult male, the allied green-backed goldfinch (*S. p. hesperophilus*) occurring along the Pacific coast and east to New Mexico. Lawrence's goldfinch (*S. lawrencei*), of California, is greenish- ello ow above, ellow below. (See FINCH.) (G. F. Ss.)

GOLDFISH (*Carassius auratus*), a cyprinid fish, like the carp, a native of eastern Asia, but introduced into many other parts of the world. It is closely related to the crucian carp of Europe and northern Asia; both species resemble the common carp in having a long dorsal fin, but differ from it in having no barbels. The goldfish flourishes in ponds and feeds on weeds and small invertebrates. In a wild state the coloration is generally greenish-brown, but specimens may occur with the brown or black pigment absent or restricted to some spots and patches, and bright orange in colour. These golden fish have been bred by the Chinese for centuries, and many strange and even monstrous types have been produced. Fish with silvery patches, or even pure white, are not uncommon; the telescope-fish, with protruding eyes, no dorsal fin and a large trilobed tail-fin, is one of the most extraordinary forms. Goldfish were introduced from China into Japan, and for hundreds of years they have been cultivated in ponds by the Japanese, who have produced new types by cross-breeding; many of these have a long double tail-fin. The most prized variety has a short rounded body, a broad head covered with protuberances, no dorsal fin and a short double tail-fin; as much as £20–£25 may be given for an exceptional pair. Annual exhibits of this breed are held in Tokyo; fish which are entirely bright red are considered best, but white fish with red fins are much admired.

Escaping from ornamental pools in parks and gardens the goldfish has become naturalized in many ponds and streams of the eastern United States, notably in the Potomac river. In some localities it occurs in sufficient abundance to be marketed as a food fish. Upon resuming life under natural conditions it reverts to its original greenish-brown color, and usually attains a length of from 6 to 12 inches.

See S. Matsubara, "Goldfish and their Culture in Japan," Bull. *U.S. Fish Bureau* (1908); *H.* M. Smith *Japanese Goldfish* (Washington, 1909).

GOLDIE, SIR GEORGE DASHWOOD TAUBMAN (1846–1925), English administrator, the founder of Nigeria, was born on May 26, 1846, at the Nunnery, Isle of Man, being the youngest son of Lieut.-Colonel John Taubman Goldie-Taubman, speaker of the House of Keys. Sir George resumed his paternal name, Goldie, by royal licence in 1887. He was educated at the Royal Military academy, Woolwich, and for about two years held a commission in the Royal Engineers. He travelled in all parts of Africa, gaining an extensive knowledge of the continent, and first visited the country of the Niger in 1877. He conceived the idea of adding to the British empire the then little known regions of the lower and middle Niger, and for over 20 years his efforts were devoted to the realization of this conception. The method by which he determined to work was the revival of government by chartered companies within the empire—a method supposed to be buried with the East India company. The first step was to combine all British commercial interests in the Niger, and this he accomplished in 1879 when the United African company was formed. In 1881 Goldie sought a charter from the imperial government (the 2nd Gladstone ministry). Objections of various kinds were raised. To meet them the capital of the company (renamed the National African company) was increased from £125,000 to £1,000,000, stations were founded on the Niger and the French traders established on the lower river were bought out in 1884. Meantime the Niger coast line had been placed under British protection, and over 400 political treaties—drawn up by Goldie—were made with the chiefs of the lower Niger and the Hausa states. The scruples of the British Government being overcome, a charter was at length granted (July 1886), the National African company becoming the Royal Niger company, with Lord Aberdare as governor and Goldie as vice-governor. In 1895, on Lord Aberdare's death, Goldie became governor of the company, whose destinies he had guided from the time of its foundation under its former name.

The building up of Nigeria as a British state had to be carried on in face of further difficulties raised by French travellers with political missions, and also in face of German opposition. From 1884 to 1890, Prince Bismarck was a persistent antagonist, and the strenuous efforts he made to secure for Germany the basin of the lower Niger and Lake Chad were even more dangerous to Goldie's schemes of empire than the ambitions of France. E. R. Flegel, who had travelled in Nigeria during 1882–84 under the auspices of the British company, was sent out in 1885 by the newly-formed German Colonial society to secure treaties for Germany, which had established itself at Cameroon. After Flegel's death in 1886 his work was continued by his companion Staudinger, while Hoenigsberg was despatched to stir up trouble in the occupied portions of the company's territory,—or, as he expressed it, "to burst up the charter." He was finally arrested at Onitsha, and, after trial by the company's supreme court at Asaba, was expelled from the country. Bismarck then sent out his nephew, von Puttkamer, as German consul-general to Nigeria, with orders to report on this affair, and when this report was published in a White Book, Bismarck demanded heavy damages from the company. Meanwhile Bismarck maintained constant pressure on the British government to compel the Royal Niger company to a division of spheres of influence, whereby Great Britain would have lost a third, and the most valuable part, of the company's territory. But he fell from power in March 1890, and in July following Lord Salisbury concluded the famous "Heligoland" agreement with Germany. After this event the aggressive action of Germany in Nigeria entirely ceased, and the door was opened for a final settleinent of the Nigeria-Cameroon frontiers. These negotiations, which resulted in an agreement in 1893, were initiated by Goldie as a means of arresting the advance of France into Nigeria from the direction of the Congo. By conceding to Germany a long but narrow strip of territory between Adamawa and Lake Chad, to which she had no treaty claims, a barrier was raised against French expeditions, semi-military and semi-exploratory, which sought to enter Nigeria from the east. Later French efforts at aggression were made from the western or Dahomeyan side, despite an agreement concluded with France in 1890 respecting the northern frontier.

The hostility of certain Fula princes led the company to despatch, in 1897, an expedition against the Mohammedan States of Nupé and Illorin. This expedition was organized and personally directed by Goldie and was completely successful. Internal peace was thus secured, but in the following year the differences with France in regard to the frontier line became acute, and compelled the intervention of the British government. In the negotiations which ensued Goldie preserved for Great Britain the whole of the navigable stretch of the lower Niger. It was, however, evidently impossible for a chartered company to hold its own against the state-supported protectorates of France and Germany, and in consequence, on Jan. 1, 1900, the Royal Niger company transferred its territories to the British government for the sum of £865,000. The ceded territory together with the small Niger Coast Protectorate, already under imperial control, was formed into the two protectorates of northern and southern Nigeria *(see* further NIGERIA).

In 1903–04, at the request of the Chartered company of South Africa, Goldie visited Rhodesia and examined the situation in connection with the agitation for self-government by the Rhodesians. In 1902–03 he was one of the royal commissioners who inquired into the military preparations for the war in South Africa (1899–1902) and into the operations up to the occupation of Pretoria, and in 1905–06 was a member of the royal commission which investigated the methods of disposal of war stores after peace had been made. In 1905 he was elected president of the Royal Geographical society and held that office for three years. From 1908 to 1919 he was an alderman of the London County Council, on which he served as chairman of the finance committee. Goldie was created K.C.M.G. in 1887, and a privy councillor in 1898. From 1905 to 1914, and from 1915 to 1920 he was president of the National Defence Association. He died in London on Aug. 22, 1925.

GOLDING, ARTHUR (*c.* 1536–*c.* 1605), English translator, son of John Golding of Belchamp St. Paul and Halsted, Essex, one of the auditors of the exchequer, was born probably in London about 1536. In 1549 he was already in the service of Protector Somerset. He seems to have resided for some time in the house of Sir William Cecil, in the Strand, with his nephew, the poet, the 17th earl of Oxford, whose receiver he was, for two of his dedications are dated from Cecil House. His chief work is his translation of Ovid. *The Fyrst Fower Bookes of P. Ovidius Nasos worke, entitled Metamorphosis, translation oute of Latin into Englishe meter* (1565), was supplemented in 1567 by a translation of the 15 books. Strangely enough the translator of Ovid was a man of strong Puritan sympathies, and he translated many of the works of Calvin. Golding translated also the *Commentaries* of Caesar (1565), Theodore Beza's *Tragedie of Abraham's Sacrifice* (1577) and the *De Beneficiis* of Seneca (1578). He completed a translation begun by Sidney from Philippe de Mornay, *A Worke concerning the Trewnesse of the Christian Religion* (1587, 3rd ed., 1604).

See the reissue of Golding's translation of Theodore Beza's *Tragedie of Abraham's Sacrifice* in the University of Toronto Studies, Philological Series (1906), which contains a biographical notice and complete bibliography.

GOLDINGEN (Lettish, *Kuldiga*), a town of western Courland in Latvia, 55 mi. by rail N.E. of Libau, and on Windau river, in 56" 58′ N. and 22° E. Population 6.921. It has several small industries including leather, woolen goods, food products, needles and other metal industries, matches and other products of wood. There are glass works and lime kilns in the neighbourhood, and ruins of a castle of the Teutonic Knights, built in 1248.

GOLDMAN, EMMA (1869–1940), international anarchist, was born in Kovno, Lithuania, on June 27, 1869, daughter of the manager of the subsidized theatre there. Her youth was spent in Konigsberg and St. Petersburg. When she was 17 years old she went to the U.S. and worked in a factory in Rochester. N.Y., and later in New Haven, Conn., where she first became associated with anarchists and espoused their views. In 1889 she went to New York city, where she met Alexander Berkman, who attempted to assassinate Henry C. Frick in Pittsburgh during the Homestead steel strike in 1892.

She resumed the association after Berkman completed a 14-year sentence in prison. She was sent to prison herself in 1893 for inciting a riot. During World War I she and Berkman were convicted of interfering with war preparations and were sentenced to prison. Both were deported from the United States, Dec. 1, 1919. They went to Russia but disapproved of the soviet regime and traveled to England and thence to Canada. She edited anarchist periodicals and was the author of two books on the U.S.S.R. She died in Toronto, May 14. 1940.

GOLDMARK, KARL (1832–1915), Hungarian composer, was born at Keszthely-am-Plattensee, Hungary, on May 18. 1832, the son of a poor cantor in the local Jewish synagogue. On a cheap violin and home-made flute, the future composer first gave rein to his musical ideas. After the revolution of 1848 he was to have been shot for a spy, and was only saved at the 11th hour by the happy arrival of a former colleague. There followed the *Sakuntala* and *Penthesilea* overtures, showing the influence of Wagner, and the delightful *Landliche Hochzeit* symphony. which carried his fame abroad. His first and best opera, *Die Königin von Saba* (Vienna, 18;5), was followed in Nov. 1886, also at Vienna, by *Merlin*, much of which was afterward rewritten. A third opera, a version of Dickens' *Cricket on the Hearth*, was given by the Royal Carl Rosa company in London in 1900.

He died at Vienna on Jan. 2, 1915.

GOLDONI, CARLO (1707–1793), a prolific Italian dramatist and reformer of the traditional Italian comedy of his day, was born at Venice, on Feb. 25, 1707, the son of a doctor. In 1721 he ran away from school at Rimini with a company of players, and was later expelled (1725) from the Collegio Ghislieri, Pavia, for a satire against the ladies of the town. In 1731 Goldoni took a degree in law at Padua university, after which, as well as holding diplomatic appointments and engaging in various theatrical activities, he practised as a lawyer at Venice (1731–33) and Pisa (1744–48).

The desire to write for the stage was always strong in Goldoni, and in 1734, after making a false start with a lyric tragedy called *Amalasunta* (1732), he joined the Imer company at the San Samuele theatre, Venice. *Belisario,* a tragicomedy in verse. pleased the public; and there he also wrote a number of successful interludes *(La birba)* and scenarios *(Le trentadue disgrazie di Arlecchino)* for the *commedia dell'arte* (*q.v.*). However, his belief that comedy ought to "correct defects" made him feel that a radical reform was necessary in the Italian theatre. Wishing to create a comedy of character, he followed the example of Molière and sought to delineate the realities of social life in as natural a manner as possible. His first essays in this style were *Mòmolo cortesan* (1738) and *La donna di gurbo* (1743), in which he suppressed improvisation by writing his parts in full and began to free the actors from the traditional practice of wearing masks on the stage. Other plays followed—some interesting for their subject, others for their characters—and in time Goldoni succeeded in replacing the improvised and frequently licentious farce typical of the comic theatre in Italy in his day with a new. yet essentially Italian, comedy of manners that was both moral in tone and a faithful "mirror of life" *(La vedova scaltra,* 1748; *Il cavaliere e la dama,* 1749; *La locandiera,* written 1752, first performed 1753).

Between 1748 and 1762 Goldoni worked as a professional playwright for the companies of Girolamo Medebac and the patrician Francesco Vendramin at the theatres of Sant'Angelo (1748–53) and San Luca (1753–62) in Venice. During this period he effected his dramatic reform. In one season alone (1750–51) he wrote 16 new plays, including *Il teatro comico, Pamela* and *La bottega del caffè,* embodying his theories. Throughout these years Goldoni's success was opposed by his rivals. Pietro Chiari and Carlo Gozzi, and in 1762 he left Venice for Paris, where he had been invited to direct the Comédie Italienne (1762–64). Goldoni subsequently taught Italian to the French royal princesses, and for the wedding of Louis XVI he wrote in French one of his best-known works. *Le Bourru bienfaisant* (1771). He also wrote his *Mémoires,* between 1783 and 1787, at Versailles. As a result of the Revolution Goldoni lost his pension and he died in poverty in Paris on Feb. 6?, 1793.

Goldoni wrote in both prose and verse, and in Italian, Venetian dialect and French. He composed librettos for the *opera buffa* and a wealth of occasional verse. His best plays are those in Venetian dialect, such as *I rusteghi* (1760). *La casa nova* (1760) and *Sior Todero brontolon* (1762), and especially the vivid "popular" comedies which mirror the elemental and passionate life of the poor (*Il campiello,* 17j6; *Le baruffe chiozzotte,* 1762).

Bibliography.—Goldoni's complete works were published in 44 vol. (1788–95 and 1827). Modern editions are the *Opere complete,* 39 vol. (1907–54), and *Tutte le opere,* ed. by G. Ortolani, 14 vol. (1935–56). *Opere,* ed. by F. Zampieri, is a good selection in one volume (1954). *Mémoires,* in French, Eng. trans. by John Black (1877) *See* also G. Ortolani, *Della vita e dell'arte di C. Goldoni* (1907); H. C. Chatfield-Taylor, *Goldoni* (1913); E. 'Rho, *La missione teatrale di Carlo Goldoni* (1936); M. Dazzi, *Carlo Goldoni e la sua poetica sociale* (1957). (D. M. We.)

GOLD PRODUCTION: *see* Natural Resources: The *Precious Metals.*

GOLD RESERVES. By tradition, currency is metallic. gold, silver, copper or an alloy. The basic coin in most western countries has been gold. Banks issued notes which were a promise to pay gold on demand. Also they accepted deposits withdrawable in gold. For this purpose they held a reserve of gold available at any time for the discharge of these obligations. The reserve was not as large as the corresponding liabilities to pay, for the assumption was that all holders of notes and all depositors would not apply for gold at the same time. A run on a bank meant that such customers, moved by misgivings, applied for payment simultaneously.

National treasuries have issued, or permitted banks to issue, paper money which is valued in terms of gold. As in the case of banks. the assumption was that holders of this money could obtain gold for it at any time by applying in the proper quarter; and gold up to a percentage of currency was held by the treasury or its agents. During and after World War I many governments, financially hard pressed, withheld gold from their own people, who were therefore compelled to use paper as the only alternative. In Great Britain the price of gold rose. and large accumulations of domestic ornaments were brought into the market. Italy (1936) went so far as to help finance her Ethiopian War by appealing to wives to surrender their wedding rings.

As a result of the depression and of the banking crisis, the United States congress passed a law in 1933 enabling the president to devalue the dollar by not over 50%. By presidential action all gold certificates were called in and the dollar devalued by approximately 40%. The gold reserve of the government. then about $2,500,000,000, rose until in the latter 1950s it was more than $22,000,000,000, well over half the world's gold reserves, and much more than the total outstanding currency in the U.S.

GOLDS: *see* Tunguses.

GOLDSBORO, a city in east central North Carolina. C.S.. and the seat of Wayne county. is on the north side of the Neuse river, about 50 mi. S.E. of Raleigh. Settled in 1838 and incorporated in 1847, Goldsboro was an early railway junction and was named after M. T. Goldsborough, a civil engineer for one of the railways. It soon became an important trading and shipping centre for the primarily agricultural North Carolina coastal plain. Though still predominately a railway shipping point and market for the surrounding area in the second half of the 20th century, Goldsboro had a number of small, diversified manufacturing plants, and was one of the larger bright-leaf tobacco markets.

The State Hospital for Negro Insane was established near Goldsboro in 1884. The state Oddfellows Orphans' home and Seymour Johnson Air base, an important training centre in World War II, are located there. In 1917 the city adopted the council-manager form of government.

For comparative population figures, see table in NORTH CAROLINA: *Population*. (DA. ST.)

GOLDSBOROUGH, LOUIS MALESHERBES (1805–1877), U.S. naval officer, was born Feb. 18, 1805, in Washington, D.C. He was senior naval member of a commission that explored California and Oregon in 1849–50, and superintendent of the United States Naval academy, 1853–57. On Sept. 23, 1861, Goldsborough was placed in command of the Atlantic blockading squadron, and on its division later in the year retained command of the North Atlantic squadron, which controlled the Virginia and North Carolina coasts.

His fleet captured Roanoke Island in Feb. 1862 and destroyed Confederate vessels, for which he received the thanks of congress and was promoted to the rank of rear admiral, July 16, 1862. He asked to be relieved of command of the blockading squadron, Sept. 4, 1862, after a dispute over naval participation in the attack on Richmond, and served in Washington until the end of the war. He retired in 1873 and died Feb. 20, 1877. (J. B. HN.)

GOLDSCHMIDT, MEÏR ARON (1819–1887), Danish writer of Jewish descent whose intimate knowledge of the customs and psychology of orthodox Jews in Denmark forms the background of many of his novels and short stories. He was born, Oct. 26, 1819, at Vordingborg, and, after going to school in Copenhagen, planned to study medicine but became a journalist instead. In 1840 he founded *Corsaren*, a satirical weekly expressing his radical. republican ideas. His own witty, and often politically ambiguous, contributions made it influential. A feud with Soren Kierkegaard caused him to give up the paper and go abroad in 1846. His first novel, *En Jode* (1845; Eng. trans., *The Jew of Denmark*, 1852), described the gulf between the Jew and Danish society. It was followed by *Fortællinger* (1846). Returning in 1847, Goldschmidt abandoned radicalism and founded a new periodical. *Novd og Syd*, in which his novel *Hjemlös* (which he himself translated into English as *Homeless*, 1861) was serialized (1853–57). He visited England several times and thought of settling there but decided that he ought to remain a Danish writer. In the 1860s he was regarded as Denmark's most important novelist, but later his conservatism created a gulf with the new radical movement led by Georg Brandes. He died at Copenhagen, Aug. 15, 1887.

Goldschmidt's finest descriptions of Jewish life are to be found in his short novels, included in collections "Maser," "Levi og Ibald," *Avromche Nattergal* (1871) and "Mendel Herz." and in *Ravnen* (1867). one of the outstanding Danish novels of the 19th century. in which Jews are depicted uith an unusual blend of sympathy and irony. Several works, notably "Erindringer fra min Onkels Hus" (in *Fortællinger*, 1846), describe life in a provincial town. *Hjemlös* and *Arvingen* (1865; Eng. trans. *The Heir)* are based on personal reminiscences. Goldschmidt is an equisite stylist, especially in his short stories. His philosophy of retributive justice. or nemesis, underlies most of his novels, and also his memoirs, *Livserindringer og Resultater* (1877).

See H Kyrre, M. Goldschmidt, 2 vol. (1919) ; E. Bredsdorff, Corsaren (1941) (E. L. BF.)

GOLDSCHMIDT, VICTOR (1853–1933), German crystallographer. was born in Mainz on Feb 10, 1853. He studied in the mineral sciences at the Freiberg Mining academy and at Munich, Heidelberg and Vienna. His first major publication was *Index der Krystallformen*, three volumes appearing from 1887 to 1891—a catalogue of the known forms on crystals of all minerals. New tables of angles to meet his new needs were devised, calculated nith vast outlay of energy and published in 1897 as *Krystallographische Winkeltabellen*. Next began the compilation and publication of all published figures of crystals of minerals. This *Atlas der Krystallformen* in nine volumes appeared from 1912 to 1923. His interest in number series appearing in crystal symbols expanded to a philosophic theory of number and harmony which led to an analysis of musical harmony, of colour and the development of the colour sense in man and finally to the spacing of the planets about the sun. He died in Salzburg on May 8. 1933. (C. PE.)

GOLDSMID, the name of a family of Anglo-Jewish bankers, descendants of Aaron Goldsmid (d. 1782), a Dutch merchant who settled in England about 1763. Two sons, Benjamin (1753–1808) and Abraham (1756–1810), became important financial brokers in London during the Napoleonic war. A nephew, Sir Isaac Lyon Goldsmid. Bart. (1778–1859) was a successful financier, chiefly known for his efforts to obtain emancipation for Jews in England. and for founding University college in London. In 1841 he was made the first Jewish baronet. His son, Sir Francis Henry Goldsmid (1808–78), became the first Jewish barrister and was a member of parliament in 1860. A grandson of Benjamin Goldsmid, Sir Frederick John Goldsmid (1818–1908), was director-general of the Indo-European telegraph and helped to settle boundary disputes between Persia and Afghanistan in 1872. (J. R. LT.)

GOLDSMITH, OLIVER (1728–1774), English poet, playwright, novelist and man of letters, came of a Protestant and Saxon family which had long been settled in Ireland. He is usually said to have been born at Pallas or Pallasmore, County Longford; but recent investigators have contended, with much probability, that his true birthplace was Smith-Hill house, Elphin, Roscommon, the residence of his mother's father, the Rev. Oliver Jones. His father, Charles Goldsmith, lived at Pallas, supporting with difficulty his wife and children on what he could earn, partly as a curate and partly as a farmer.

Youth.—While Oliver was still a child his father was presented to the living of Kilkenny West, in the county of West Meath. This was worth about £200 a year. The family accordingly quitted their cottage at Pallas for a spacious house on a frequented road, near the village of Lissoy. Here the boy was taught his letters by a relative and dependent, Elizabeth Delap, and was sent in his seventh year to a village school kept by an old quartermaster on half-pay, who professed to teach nothing but reading, writing and arithmetic, but who had an inexhaustible fund of stories about ghosts, banshees and fairies, about the great Rapparee chiefs, Baldearg O'Donnell and Galloping Hogan, and about the exploits of Peterborough and Stanhope, the surprise of Monjuich and the glorious disaster of Brihuega. This man must have been of the Protestant religion; but he was of the aboriginal race, and not only spoke the Irish language, but could pour forth unpremeditated Irish verses. Oliver early became, and through life continued to be, a passionate admirer of the Irish music, and especially of the compositions of Carolan, some of the last notes of whose harp he heard. It ought to be added that Oliver, though by birth one of the Englishry, and though connected by numerous ties with the Established Church, never showed the least sign of that contemptuous antipathy with which, in his days, the ruling minority in Ireland too generally regarded the subject majority. So far indeed was he from sharing in the opinions and feelings of the caste to which he belonged that he conceived an aversion to the Glorious and Immortal Memory, and, even when George III was on the throne, maintained that nothing but the restoration of the banished dynasty could save the country.

From the humble academy kept by the old soldier, Goldsmith was removed in his ninth year. He went to several grammar-schools, and acquired some knowledge of the ancient languages. His life at this time seems to have been far from happy. He had, as appears from the admirable portrait of him by Reynolds at Knole, features harsh even to ugliness. The smallpox had set its mark on him with more than usual severity. His stature was small, and his limbs ill put together. Among boys little tenderness is shown to personal defects; and the ridicule excited by poor Oliver's appearance was heightened by a peculiar simplicity and a disposition to blunder which he retained to the last. He became the common butt of boys and masters, was pointed at as a fright in the playground, and flogged as a dunce in the school-room. When he had risen to eminence, those who had once derided him ransacked their memory for the events of his early years, and recited repartees and couplets which had dropped from him, and which, though little noticed at the time, were supposed, a quarter of a century later, to indicate the powers which produced the *Vicar of Wakefield* and the *Deserted Village*.

On June 11, 1744, being then in his 16th year, Oliver went up to Trinity college, Dublin, as a sizar. The sizars paid nothing for food and tuition, and very little for lodging; but they had to perform some menial services from which they have long been relieved. Goldsmith was quartered, not alone, in a garret of what was then No. 35 in a range of buildings which has long since disappeared. His name, scrawled by himself on one of its window-panes, is still preserved in the college library. From such garrets many men of less parts than his have made their way to the woolsack or to the episcopal bench. But Goldsmith, while he suffered all the humiliations, threw away all the advantages of his situation. He neglected the studies of the place, stood low at the examinations, was turned down to the bottom of his class for playing the buffoon in the lecture room, was severely reprimanded for pumping on a constable, and was caned by a brutal tutor for giving a ball in the attic story of the college to some gay youths and damsels from the city.

The Continent.—While Oliver was leading at Dublin a life divided between squalid distress and squalid dissipation, his father died, leaving a mere pittance. In Feb. 1749 the youth obtained his bachelor's degree and left the university. During some time the humble dwelling to which his widowed mother had retired was his home. He was now in his 21st year; it was necessary that he should do something; and his education seemed to have fitted him to do nothing but to dress himself in gaudy colours, of which he was as fond as a magpie, to take a hand at cards, to sing Irish airs, to play the flute, to angle in summer and to tell ghost stories by the fire in winter. He tried five or six professions in turn without success. He applied for ordination; but, as he applied in scarlet clothes, he was speedily turned out of the episcopal palace. He then became tutor in an opulent family, but soon quitted his situation in consequence of a dispute about pay. Then he determined to emigrate to America. His relations, with much satisfaction, saw him set out for Cork on a good horse, with £30 in his pocket. But in six weeks he came back on a miserable hack, without a penny, and informed his mother that the ship in which he had taken his passage, having got a fair wind while he was at a party of pleasure, had sailed without him. Then he resolved to study the law. A generous uncle, Mr. Contarine, advanced £50. With this sum Goldsmith went to Dublin, was enticed into a gaming house and lost every shilling. He then thought of medicine. A small purse was made up; and in his 24th year he was sent to Edinburgh. At Edinburgh he passed 18 months in nominal attendance on lectures, and picked up some superficial information about chemistry and natural history. Thence he went to Leyden, still pretending to study physic. He left that celebrated university, the third at which he had resided, in his 27th year, without a degree, with the merest smattering of medical knowledge, and with no property but his clothes and his flute. His flute, however, proved a useful friend. He rambled on foot through Flanders, France and Switzerland, playing tunes which everywhere set the peasantry dancing, and which often procured for him a supper and a bed. He wandered as far as Italy. His musical performances, indeed, were not to the taste of the Italians; but he contrived to live on the alms which he obtained at the gates of convents. It should, however, be observed that the stories which he told about this part of his life ought to be received with great caution; for strict veracity was never one of his virtues; and a man who is ordinarily inaccurate in narration is likely to be more than ordinarily inaccurate when he talks about his own travels. Goldsmith, indeed, was so regardless of truth as to assert in print that he was present at a most interesting conversation between Voltaire and Fontenelle, and that this conversation took place at Paris. Now it is certain that Voltaire never was within 100 leagues of Paris during the whole time which Goldsmith passed on the continent.

In London.—In Feb. 1756 the wanderer landed at Dover, without a shilling, without a friend and without a calling. He had indeed, if his own unsupported evidence may be trusted, obtained a doctor's degree on the continent; but this dignity proved utterly useless to him. In England his flute was not in request; there were no convents; and he was forced to have recourse to a series of desperate expedients. There is a tradition that he turned strolling player. He pounded drugs and ran about London with phials for charitable chemists. He asserted, upon one occasion, that he had lived "among the beggars in Axe Lane." He was for a time usher of a school, and felt the miseries and humiliations of this situation so keenly that he thought it a promotion to be permitted to earn his bread as a bookseller's hack; but he soon found the new yoke more galling than the old one, and was glad to become an usher again. He obtained a medical appointment in the service of the East India company; but the appointment was speedily revoked. Why it was revoked we are not told. The subject was one on which he never liked to talk. It is probable that he was incompetent to perform the duties of the place. Then he presented himself at Surgeons' hall for examination, as "mate to an hospital." Even to so humble a post he was found unequal. Nothing remained but to return to the lowest drudgery of literature. Goldsmith took a room in a tiny square off Ludgate hill, to which he had to climb from Sea-coal lane by a dizzy ladder of flagstones called Breakneck Steps. Green Arbour court and the ascent have long disappeared. Here, at 30, the unlucky adventurer sat down to toil like a galley slave. Already, in 1758, during his first bondage to letters, he had translated Marteilhe's remarkable *Memoirs of a Protestant, Condemned to the Galleys of France for his Religion*. In the years that now succeeded he sent to the press some things which have survived, and many which have perished. He produced articles for reviews, magazines and newspapers; children's books, which, bound in gilt paper and adorned with hideous woodcuts, appeared in the window of Newbery's once far-famed shop at the corner of Saint Paul's churchyard; *An Inquiry into the State of Polite Learning in Europe*, which, though of little or no value, is still reprinted among his works; a volume of essays entitled *The Bee;* a *Life of Beau Nash;* a superficial and incorrect, but very readable, *History of England*, in a series of letters purporting to be addressed by a nobleman to his son; and some very lively and amusing sketches of London society in another series of letters purporting to be addressed by a Chinese traveller to his friends.

All these works were anonymous; but some of them were well known to be Goldsmith's; and he gradually rose in the estimation of the booksellers for whom he drudged. He was, indeed, emphatically a popular writer. For accurate research or grave disquisition he was not well qualified by nature or by education. He knew nothing accurately; his reading had been desultory; nor had he meditated deeply on what he had read. He had seen much of the world; but he had noticed and retained little more of what he had seen than some grotesque incidents and characters which had happened to strike his fancy. But, though his mind was very scantily stored with materials, he used what materials he had in such a way as to produce a wonderful effect. There have been many greater writers; but perhaps no writer was ever more uniformly agreeable. His style was always pure and easy, and, on proper occasions, pointed and energetic. His narratives were always amusing, his descriptions always picturesque, his humour rich and joyous, yet not without an occasional tinge of amiable sadness. About everything that he wrote, serious or sportive, there was a certain natural grace and decorum, hardly to be expected from a man a great part of whose life had been passed among thieves and beggars, streetwalkers and merry-andrews, in those squalid dens which are the reproach of great capitals.

The Man of Letters.—As his name gradually became known, the circle of his acquaintance widened. He was introduced to Johnson, who was then considered as the first of living English writers; to Reynolds, the first of English painters; and to Burke, who had not yet entered parliament, but had distinguished himself greatly by his writings and by the eloquence of his conversation. With these eminent men Goldsmith became intimate. In 1763 he was one of the nine original members of that celebrated fraternity which has sometimes been called the Literary club, but which always disclaimed that epithet, and gloried in the simple name of the Club.

By this date Goldsmith had quitted his miserable dwelling at the top of Breakneck Steps, and, after living for some time at No. 6 Wine Office court, Fleet street, had moved into the Temple. But he was still often reduced to pitiable shifts, the most popular of which is connected with the sale of his solitary novel, the *Vicar* of *Wakefield*. Toward the close of 1764(?) his rent is alleged to have been so long in arrear that his landlady one morning called in the help of a sheriff's officer. The debtor, in great perplexity, dispatched a messenger to Johnson; and Johnson, always friendly, though often surly, sent back the messenger with a guinea, and promised to follow speedily. He came, and found that Goldsmith had changed the guinea and was railing at the landlady over a bottle of Madeira. Johnson put the cork into the bottle and entreated his friend to consider calmly how money was to be procured. Goldsmith said that he had a novel ready for the press. Johnson glanced at the manuscript, saw that there were good things in it, took it to a bookseller, sold it for £60 and soon returned with the money. The rent was paid, and the sheriff's officer withdrew. (Unfortunately, however, for this time-honoured version of the circumstances, it was later discovered that as early as Oct. 1762 Goldsmith had already sold a third of the *Vicar* to one Benjamin Collins of Salisbury, a printer, by whom it was eventually printed for F. Newbery, and it is difficult to reconcile this fact with Johnson's narrative.)

Traveller and Vicar of Wakefield.—But before the *Vicar* of *Wakefield* appeared in 1766, came the great crisis of Goldsmith's literary life. In Christmas week 1764 he published a poem, entitled the *Traveller*. It was the first work to which he had put his name, and it at once raised him to the rank of a legitimate English classic. The opinion of the most skilful critics was that nothing finer had appeared in verse since the fourth book of the *Dunciad*. In one respect the *Traveller* differs from all Goldsmith's other writings. In general his designs were bad and his execution good. In the *Traveller* the execution, though deserving of much praise, is far inferior to the design. No philosophical poem, ancient or modern, has a plan so noble, and at the same time so simple. An English wanderer, seated on a crag among the Alps, near the point where three great countries meet, looks down on the boundless prospect, reviews his long pilgrimage, recalls the varieties of scenery, of climate, of government, of religion, of national character, which he has observed, and comes to the conclusion, just or unjust, that our happiness depends little on political institutions, and much on the temper and regulation of our own minds.

While the fourth edition of the *Traveller* was on the counters of the booksellers, the *Vicar of Wakefield* appeared, and rapidly obtained a popularity which has lasted down to our own time, and which is likely to last as long as the English language. The fable is indeed one of the worst that ever was constructed. It wants, not merely that probability which ought to be found in a tale of common English life, but that consistency which ought to be found even in the wildest fiction about witches, giants and fairies. But the earlier chapters have all the sweetness of pastoral poetry, together with all the vivacity of comedy. Moses and his spectacles, the vicar and his monogamy, the sharper and his cosmogony, the squire proving from Aristotle that relatives are related, Olivia preparing herself for the arduous task of converting a rakish lover by studying the controversy between Robinson Crusoe and Friday, the great ladies with their scandal about Sir Tomkyn's amours and Dr. Burdock's verses, and Mr. Burchell with his "Fudge," have caused as much harmless mirth as has ever been caused by matter packed into so small a number of pages. The latter part of the tale is unworthy of the beginning. As we approach the catastrophe, the absurdities lie thicker and thicker, and the gleams of pleasantry become rarer and rarer.

The success which had attended Goldsmith as a novelist emboldened him to try his fortune as a dramatist He wrote the *Good Natur'd Man*, a piece which had a worse fate than it deserved. Garrick refused to produce it at Drury Lane. It was acted at Covent Garden in Jan. 1768, but was coldly received. The author, however, cleared, by his benefit nights, and by the sale of the copyright, no less than £500, five times as much as he had made by the *Traveller* and the *Vicar of Wakefield* together. The plot of the *Good Natur'd Man* is, like almost all Goldsmith's plots, very ill constructed. But some passages are exquisitely ludicrous—much more ludicrous indeed than suited the taste of the town at that time. A canting, mawkish play, entitled *False Delicacy*, had just been produced, and sentimentality was all the mode. During some years more tears were shed at comedies than at tragedies; and a pleasantry which moved the audience to anything more than a grave smile was reprobated as low. It is not strange, therefore, that the very best scene in the *Good Natur'd Man*, that in which Miss Richland finds her lover attended by the bailiff and the bailiff's follower in full court dresses, should have been mercilessly hissed, and should have been omitted after the first night, not to be restored for several years.

The Deserted Village.—In May 1770 appeared the *Deserted Village*. In mere diction and versification this celebrated poem is fully equal, perhaps superior, to the *Traveller;* and it is generally preferred to the *Traveller* by that large class of readers who think, with Bayes in the *Rehearsal*, that the only use of a plot is to bring in fine things. More discerning judges, however, while they admire the beauty of the details, are shocked by one unpardonable fault which pervades the whole. The fault which we mean is not that theory about wealth and luxury which has so often been censured by political economists. The theory is indeed false; but the poem, considered merely as a poem, is not necessarily the worse on that account. The finest poem in the Latin language—indeed, the finest didactic poem in any language—was written in defense of the silliest and meanest of all systems of natural and moral philosophy. A poet may easily be pardoned for reasoning ill; but he cannot be pardoned for describing ill, for observing the world in which he lives so carelessly that his portraits bear no resemblance to the originals, for exhibiting as copies from real life monstrous combinations of things which never were and never could be found together. What would be thought of a painter who should mix August and January in one landscape, who should introduce a frozen river into a harvest scene? Would it be a sufficient defense of such a picture to say that every part was exquisitely coloured, that the green hedges, the apple trees loaded with fruit, the wagons reeling under the yellow sheaves, and the sunburned reapers wiping their foreheads were very fine, and that the ice and the boys sliding were also very fine? To such a picture the *Deserted Village* bears a great resemblance. It is made up of incongruous parts. The village in its happy days is a true English village. The village in its decay is an Irish village. The felicity and the misery which Goldsmith has brought close together belong to two different countries and to two different stages in the progress of society. He had assuredly never seen in his native island such a rural paradise, such a seat of plenty, content and tranquillity, as his Auburn. He had assuredly never seen in England all the inhabitants of such a paradise turned out of their homes in one day and forced to emigrate in a body to America. The hamlet he had probably seen in Kent; the ejectment he had probably seen in Munster; but by joining the two, he has produced something which never was and never will be seen in any part of the world.

She Stoops to Conquer.—In 1773 Goldsmith tried his chance at Covent Garden with a second play, *She Stoops to Conquer*. The manager was, not without great difficulty, induced to bring this piece out. The sentimental comedy still reigned, and Goldsmith's comedies were not sentimental. The *Good Natur'd Man* had been too funny to succeed; yet the mirth of the *Good Natur'd Man* was sober when compared with the rich drollery of *She Stoops to Conquer*, which is, in truth, an incomparable farce in five acts On this occasion, however, genius triumphed. Pit, boxes and galleries were in a constant roar of laughter. If any bigoted admirer of Kelly and Cumberland ventured to hiss or groan. he was speedily silenced by a general cry of "turn him out," or "throw him over." Later generations have confirmed the verdict which was pronounced on that night.

While Goldsmith was writing the *Deserted Village* and *She Stoops to Conquer,* he was employed on works of a very different kind—works from which he derived little reputation but much profit. He compiled for the use of schools a *History of Rome,* by which he made £250; a *History of England,* by which he made 5500; a *History of Greece,* for which he received £250; a *Natural History,* for which the booksellers covenanted to pay him 800 guineas. These works he produced without any elaborate research, by merely selecting, abridging and translating into his own clear, pure and flowing language what he found in books well known to the world, but too bulky or too dry for boys and girls. He committed some strange blunders, for he knew nothing with accuracy. Thus, in his *History of England,* he tells us that Naseby is in Yorkshire; nor did he correct this mistake when the book was reprinted. He was very nearly hoaxed into putting into the *History of Greece* an account of a battle between Alexander the Great and Montezuma. In his *Animated Nature* he relates, with faith and with perfect gravity, all the most absurd lies which he could find in books of travels about gigantic Patagonians, monkeys that preach sermons, nightingales that repeat long conversations. "If he can tell a horse from a cow," said Johnson, "that is the extent of his knowledge of zoology." How little Goldsmith was qualified to write about the physical sciences is sufficiently proved by two anecdotes. He on one occasion denied that the sun is longer in the northern than in the southern signs It was vain to cite the authority of Maupertuis. "Maupertuis!" he cried, "I understand those matters better than Maupertuis." On another occasion he, in defiance of the evidence of his own senses, maintained obstinately, and even angrily, that he chewed his dinner by moving his upper jaw.

Yet, ignorant as Goldsmith was, few writers have done more to make the first steps in the laborious road to knowledge easy and pleasant His compilations are widely distinguished from the compilations of ordinary bookmakers. He was a great, perhaps an unequalled, master of the arts of selection and condensation. In these respects his histories of Rome and of England, and still more his own abridgments of these histories, well deserved to be studied. In general nothing is less attractive than an epitome; but the epitomes of Goldsmith, even when most concise, are always amusing: and to read them is considered by intelligent children not as a task but as a pleasure.

Personality.—Goldsmith might now be considered as a prosperous man. He had the means of living in comfort, and even in what to one who had so often slept in barns and on bulks must have been luxury. His fame was great and was constantly rising. He lived in what was intellectually far the best society of the kingdom, in a society in which no talent or accomplishment was wanting, and in which the art of conversation was cultivated with splendid success There probably were never four talkers more admirable in four different ways than Johnson, Burke, Beauclerk and Garrick; and Goldsmith was on terms of intimacy with all the four. He aspired to share in their colloquial renown but never was ambition more unfortunate. It may seem strange that a man who wrote with so much perspicuity, vivacity and grace should have been, whenever he took a part in conversation, an empty, noisy, blundering rattle. But on this point the evidence is overwhelming. So extraordinary was the contrast between Goldsmith's published works and the silly things which he said, that Horace Walpole described him as an inspired idiot. "Noll," said Garrick, "wrote like an angel, and talked like poor Poll." Chamier declared that it was a hard exercise of faith to believe that so foolish a chatterer could have really written the *Traveller* Even Boswell could say, with contemptuous compassion, that he liked very well to hear honest Goldsmith run on. "Yes, sir," said Johnson, "but he should not like to hear himself." Minds differ as rivers differ. There are transparent and sparkling rivers from which it is delightful to drink as they flow; to such rivers the minds of such men as Burke and Johnson may be compared. But there are rivers of which the water when first drawn is turbid and noisome, but becomes pellucid as crystal and delicious to the taste, if it be suffered to stand till it has deposited a sediment; and such a river is a type of the mind of Goldsmith. His first thoughts on every subject were confused even to absurdity, but they required only a little time to work themselves clear. When he wrote they had that time, and therefore his readers pronounced him a man of genius; but when he talked he talked nonsense and made himself the laughingstock of his hearers. He was painfully conscious of his inferiority in conversation; he felt every failure keenly; yet he had not sufficient judgment and self-command to hold his tongue. His animal spirits and vanity were always impelling him to try to do the one thing which he could not do. After every attempt he felt that he had exposed himself, and writhed with shame and vexation; yet the next moment he began again.

His associates seem to have regarded him with kindness, which, in spite of their admiration of his writings, was not unmixed with contempt. In truth, there was in his character much to love, but very little to respect. His heart was soft even to weakness: he was so generous that he quite forgot to be just; he forgave injuries so readily that he might be said to invite them, and was so liberal to beggars that he had nothing left for his tailor and his butcher. He was vain, sensual, frivolous, profuse, improvident. One vice of a darker shade was imputed to him, envy. But there is not the least reason to believe that this bad passion, though it sometimes made him wince and utter fretful exclamations, ever impelled him to injure by wicked arts the reputation of any of his rivals. The truth probably is that he was not more envious, but merely less prudent, than his neighbours. His heart was on his lips. All those small jealousies, which are but too common among men of letters, but which a man of letters who is also a man of the world does his best to conceal, Goldsmith avowed with the simplicity of a child. When he was envious, instead of affecting indifference, instead of damning with faint praise, instead of doing injuries slyly and in the dark, he told everybody that he was envious. "Do not, pray, do not, talk of Johnson in such terms," he said to Boswell; "you harrow up my very soul." George Steevens and Cumberland were men far too cunning to say such a thing. They would have echoed the praises of the man whom they envied, and then have sent to the newspapers anonymous libels upon him. Both what was good and what was bad in Goldsmith's character was to his associates a perfect security that he would never commit such villainy. He was neither ill-natured enough, nor long-headed enough, to be guilty of any malicious act which required contrivance and disguise.

The Spendthrift.—Goldsmith has sometimes been represented as a man of genius, cruelly treated by the world, and doomed to struggle with difficulties, which at last broke his heart. But no representation can be more remote from the truth. He did, indeed, go through much sharp misery before he had done anything considerable in literature. But after his name had appeared on the title page of the *Traveller,* he had none but himself to blame for his distresses. His average income during the last seven years of his life certainly exceeded £400 a year, and £400 a year ranked, among the incomes of that day, at least as high as £800 a year would rank a century later. A single man living in the Temple, with £400 a year, might then be called opulent. Not one in ten of the young gentlemen of good families who were studying the law there had so much. But all the wealth which Lord Clive had brought from Bengal and Sir Lawrence Dundas from Germany, joined together, would not have sufficed for Goldsmith. He spent twice as much as he had. He wore fine clothes, gave dinners of several courses, paid court to venal beauties. He had also, it should be remembered, to the honour of his heart, though not of his head, a guinea, or five, or ten, according to the state of his purse, ready for any tale of distress, true or false. But it was not in dress or feasting, in promiscuous amours or promiscuous charities that his chief expense lay. He had been from boyhood a gambler, and at once the most sanguine and the most unskilful of gamblers. For a time he put off the day of inevitable ruin by temporary expedients. He obtained advances from booksellers by promising to execute works which he never began. But at length this source of supply failed. He owed more than £2,000, and he saw no hope of extrication from his embarrassments. His spirits and health gave way. He was attacked by a nervous fever, which he thought himself competent to treat. It would have been happy for him if his medical skill had been appreciated as justly by himself as by others. Notwithstanding the degree which he pretended to have received on the continent, he could procure no patients. "I do not practise," he once said, "I make it a rule to prescribe only for my friends." "Pray, dear Doctor." said Beauclerk, "alter your rule; and prescribe only for your enemies." Goldsmith, now, in spite of this excellent advice, prescribed for himself. The remedy aggravated the malady. The sick man was induced to call in real physicians; and they at one time imagined that they had cured the disease. Still his weakness and restlessness continued. He could get no sleep. He could take no food. "You are worse," said one of his medical attendants, "than you should be from the degree of fever which you have. Is your mind at ease?" "No; it is not," were the last recorded words of Oliver Goldsmith. He died on April 4, 1774, in his 46th year. He was laid in the churchyard of the Temple; the actual spot is unknown, but a stone with a Latin inscription, erected nearby in 1856, notes the fact. The coffin was followed by Burke and Reynolds. Both these great men were sincere mourners. Burke, when he heard of Goldsmith's death, had burst into a flood of tears. Reynolds had been so much moved by the news that he had flung aside his brush and palette for the day.

A short time after Goldsmith's death, a little poem appeared, which will, as long as the language lasts, associate the names of his two illustrious friends with his own. It has already been mentioned that he sometimes felt keenly the sarcasm nhich his wild blundering talk brought upon him. He was, not long before his last illness, provoked into retaliating. He wisely betook himself to his pen; and at that weapon he proved himself a match for all his assailants together. Within a small compass he drew with a singularly easy and vigorous pencil the characters of nine or ten of his intimate associates. Though this little work did not receive his last touches, it must always be regarded as a masterpiece. It is impossible, however, not to wish that four or five likenesses which have no interest for posterity were wanting to that noble gallery, and that their places were supplied by sketches of Johnson and Gibbon, as happy and vivid as the sketches of Burke and Garrick.

Some of Goldsmith's friends and admirers honoured him with a cenotaph in Westminster abbey. Nollekens was the sculptor, and Johnson wrote the inscription. It is much to be lamented that Johnson did not leave to posterity a more durable and a more valuable memorial of his friend. A life of Goldsmith would have been an inestimable addition to the *Lives of the Poets.* No man appreciated Goldsmith's writings more justly than Johnson; no man was better acquainted with Goldsmith's character and habits; and no man was more competent to delineate with truth and spirit the peculiarities of a mind in which great powers were found in company with great weaknesses. But the list of poets to whose works Johnson was requested by the booksellers to furnish prefaces ended with Lyttelton, who died in 1773. The line seems to have been drawn expressly for the purpose of excluding the person whose portrait would have most fitly closed the series. Goldsmith, however, has been fortunate in his biographers. (M.)

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GOLDSMITH BEETLE, a name applied to certain species of the family Scarabaeidae, from their metallic lustre, and especially to *Cotalpa lanigera* of the eastern United States, a large form, nocturnal in habit, concealed often in willow trees, by day. It is allied to the common dung and burying beetles.

GOLDSMITHS' AND SILVERSMITHS' WORK: *see* Silversmiths' and Goldsmiths' Work.

GOLD STANDARD. The gold standard is the monetary system in which the monetary unit is, or is kept at the value of, a fixed weight of gold.

The method by which this result was originally attained was free coinage, free melting and free movement of gold. Under this method anyone had the right (1) to tender gold in unlimited quantities to the monetary authorities and to receive therefor an equal weight of gold in the coinage of the jurisdiction; (2) to melt down coins, of which the weight and fineness was specified and unchanging, for their gold content; and (3) to export or import gold coin or gold bullion at will; all without any, or at least no substantial, governmentally imposed charges.

When convertible paper currency gradually, and eventually in full degree, supplanted the use of coined gold, the same result was attained through an offer by the monetary authorities (1) to buy or sell gold, in unlimited quantities, at a fixed price in convertible paper money per unit of weight of the metal; and (2) to continue to refrain from putting any substantial restraints on the export or import of gold coin or bullion. So long as a two-way market for gold, at a fixed price in paper currency, was thus maintained, a more or less unexceptionable substitute for the free coinage and free melting of the metal was provided. As for free export and import of gold, most countries adhering to the gold standard made no changes in the original procedure. But, under the gold-exchange standard (a variant of the gold standard), a substitute for the export and import of gold was set up in the offer by the monetary authorities to buy and sell bills of exchange, on one or more gold-standard countries, at a fixed price in the paper currency of the country making the offer. This, in effect, provided *abroad,* rather than at home, the necessary two-way market for gold in the currency of the country concerned, but, since the cost of transfer of the metal from the foreign to the home country was negligible in relation to its value, the procedure did not impair the essentials of the gold standard.

It was, for several reasons, much cheaper to maintain a gold-exchange standard than to preserve the unqualified gold standard. The gold-exchange standard was therefore popular in poor countries, especially in the poorer colonies of relatively rich nations. Since, however, it was dangerous to keep monetary reserves in a foreign country, if for no other reason than that international violence might at any time break out, the gold-exchange standard was not widely used by independent nations.

History. — The gold standard was first put into operation in Great Britain in 1821. Prior to that time the principal world monetary metal had been silver. Gold had, for many centuries, been used intermittently as coin in one or another country, but never as the single *reference* metal, or standard, to which all other forms of money were co-ordinated or adjusted. The adoption of gold monometallism in Great Britain in 1821 was not imitated by any important country until the eighth decade of the 19th century. In the intervening period, silver, or a bimetallic regime of gold and silver, was the prevailing standard outside the British Isles. But, in the 1870s, the monometallic gold standard was adopted by Germany, France and the United States. Before the end of the century many other countries had followed the lead of the financially important nations, and the *international* gold standard may be held to have been inaugurated in 1893 when India (hitherto a stronghold of free silver and of the silver standard) adopted a rather imperfect version of the gold-exchange standard. After the turn of the century, only China, Mexico and a few small countries remained as representatives of the—at one time—practically universal use of silver as standard money.

The all but undisputed reign of the international gold standard was short, covering only the two decades from 1894 to the outbreak of World War I. That war saw recourse to inconvertible paper money in nearly every country in the world. Monetary units were then no longer based on a commodity asset, like gold, but were only the uncallable debts of the issuing authorities.

At the close of World War I, and throughout the following decade, there was a general tendency to revert to the gold standard, and by 1928 it was, in fact, widely re-established. But the international gold standard had thus scarcely been set once again upon its feet when, largely as a result of world-wide depression, a new wave of defections began. This went so far that, by 1937, there was left not a single country that could be said to be, fairly and squarely, on the gold standard. Unlike the period immediately following World War I there was now moreover, in many countries, no desire to return to the gold-standard fold. On the contrary, a definite hostility toward the gold standard had developed in several countries which had hitherto been among its strongest adherents. Unless inconvertible paper monetary systems are everywhere grossly abused it seems unlikely, therefore, that the gold standard, in its pristine form, will ever regain its quondam international position.

Theory. — Automatic operation was of the essence of the gold standard. In its heyday there was no attempt at central, or any, regulation of the volume of money in any jurisdiction. The supply of money was left to the action of individuals pursuing what they conceived to be their own interest. Gold was, of right, money, at a fixed price per unit of weight, whenever, and in whatever amount, anyone cared to turn gold into money; and money was, of right, gold, at a fixed weight per unit of price, whenever, and in whatever amount, anyone cared to turn money into gold. Moreover, the money of any one gold-standard country, through melting or redemption, the free export and import of gold, and free coinage or free purchase of gold in the country of destination, was readily convertible at a fixed price into the money of any other. The international gold standard therefore gave to the world an authentic, albeit defective, international medium of exchange and unit of account.

Whatever the virtues of automatism, and they are certainly not to be derided, the gold standard subjected countries adhering to it to wholly capricious movements in price levels. To prevent, in any jurisdiction, sudden changes in the supply of money, as the outcome of vicissitudes in the import or export of gold, certain offsetting techniques, involving substitution on a greater or smaller scale of convertible paper money for gold, were presently developed. London took the lead in this matter but the techniques became standard practice, in various countries, in the latter decades of the 19th century.

These techniques were reasonably successful in forestalling chaotic short-term changes in the supply of money in any given country, but they did nothing to nullify secular changes in the money supply, in all countries, in complete lack of correspondence with the requirements for a stable price-level. As the evil repercussions of secular movements in the money supply and in price levels became more apparent, the caprices of automatism became intolerable and, in the 1920s, a much more rigorous "management" of the gold standard was attempted. Gold was then indefinitely "sterilized" or "fecundized" in its influence on the monetary supply, according to the ideas of monetary authorities as to what was, at any given time, desirable. This managed *soi-disant* gold standard was, in the view of some eminent authorities, not a gold standard at all since the automatism, which was of the essence of that standard, had been removed.

It soon became obvious that something of great importance was now lacking. So long as the egress or ingress of gold had, in the several jurisdictions, been attended by proportionate if somewhat retarded alterations in their relative supplies of money, there was a world integration of the price levels of the various countries. Any tendency for prices in one country to rise above the level which would establish an equilibrium with the rest of the world would operate to increase the ratio of its commodity imports to its commodity exports. The ensuing lack of balance in its international accounts would be covered by an outward movement of gold which would continue until. through a consequent shift in the relationship between the price levels of this and other countries, balance had been restored. Aside from minor and evanescent deviations, the price levels of gold standard countries were thus kept in constant relationship with one another and moved up or down, according as the world supply of monetary gold was redundant or scarce, in the substantial unison necessary to establish equilibrium in international commercial and financial transactions. But when management of the "gold standard" was introduced, with the idea of controlling, in each country, the national price level, the hitherto prevailing constant relationship between national price levels was inevitably disrupted unless, by some all but miraculous chance, the management in the various countries should bring about identical price-level movements in each of them.

This more or less miraculous possibility did not come to pass and it further developed that the original self-adjusting mechanism of the gold standard had been all but reversed. Imports of gold into any country tend to depress the exchange value of its currency and, if the influx of gold is not permitted to affect prices, this operates to enlarge that increase in the ratio of the recipient country's commodity exports to its imports to which the inward movement of gold is attributable. Under the unmanaged gold standard the ensuing rise in the relative price level of a country receiving gold had nullified the effect of the (very minor) exchange rate movement. The movement of relative price levels more than compensated the comparatively small shift in exchange rates between the "gold points," supplanted the rise with a *fall* in the ratio of commodity exports to imports in the gold-receiving country, brought about equilibrium in the commodity flow and counterflow, and thus checked the influx of gold, But since, under the "managed gold standard," the import of gold, instead of reversing that excess of any country's commodity exports over imports which had occasioned the movement of gold to its shores, tended to augment it, the standard operated to maintain disequilibrium and to bring about a *persistent* influx of gold. Stability of prices in any gold-receiving country thereby thrust deflation, in chronic form, on all other gold-standard countries which, if they wished to preserve that standard, were forced to protect themselves, against the complete loss of their gold reserves, by a deliberately induced reduction of the domestic price and wage level. Since any such procedure involved severe unemployment, the conviction was in many countries established, not without reason, that the gold standard (as it had been developed) was a hair-shirt on those that wore it. It was therefore abandoned and was replaced by inconvertible paper money. Adjustments in international transactions were then effected through shifts in exchange rates far beyond the narrow limits set by the gold standard in the (slight) cost of transfer of gold.

In the original gold-standard theory the fixed price of gold, and the automatic injection of gold into monetary use, were indissolubly linked. However much the price level might vary, there could never be too much or too little gold. This was excluded by definition; whatever was was right. Any notion that there was too much or too little monetary gold was an indictment of the gold standard *per se,* for this meant that, by *some criterion other than the available gold,* the supply of money was considered excessive or deficient.

The clear inference was that, if the money supply issuing out of an unmanaged gold standard was unsatisfactory, the gold standard should not be modified, out of all recognition, but should be discarded. Since in any case there was to be management, and an inconvertible paper currency could be managed more easily than gold (to say nothing of being obviously cheaper), the insistent question arose as to why gold should be used at all for money, so far, at least, as domestic transactions were concerned. The only reasonably cogent answer was the allegation that gold furnished a fool-proof currency. Provided simple rules were adhered to, it was asserted that a gold currency could never develop the inflationary aberrations that have characterized many mismanaged paper monetary units. The question at issue thus became whether it was better to have an imperfect standard allegedly not subject to gross mismanagement, or a *potentially* better standard which was, however, open to the gravest abuse.

The case for the gold standard as a fool-proof currency was greatly weakened, however, by the legislated shift in the gold value of the dollar, and other currencies, in the decade preceding World War II. The great virtue of gold had always been held to be the fact that the supply was limited by nature. The rate at which the natural riches appeared, in the discovery of new and productive mines, was of course a matter of chance but it was clearly not possible to alter this rate at will. Such vagaries as there may have been in the supply of gold were at least not the result of arbitrary governmental action. So long as the monetary value of a given weight of gold was inviolably fixed, the production of gold was primarily, therefore, a consequence of natural forces and natural forces only. When, however, the policy of a presumably inviolable price for gold was abandoned, physical conditions became much less important than governmental decisions in the determination of the volume of gold and of money. The level at which a powerful legislature established the money price of gold made a tremendous difference both in the money value of the existing stock of gold and in the profitability of mining. Nature still holds the secret of the world's undeveloped gold resources but men now know that they have the key to the speed with which the known resources will be exploited. The supply of gold coming to the markets of the world is no longer a manifestation of nature's bounty or niggardliness but a consequence of man-made law. What man has once done he can do again, and the supply and money value of gold are now as truly subject to management as are purely fiat currencies. The "tinkering," in the United States and other countries, with the established money price of gold has perhaps therefore banished, once and for all, the belief that the gold (and gold money) supply is determined independently of the action of monetary authorities and that gold provides a fool-proof standard.

Prospect.—The gold standard always operated in the right *direction,* but inadequately and with ill-timed effect. When the general price level was rising the supply of gold coming from the mines tended to decline because of rising money costs of mining, with a fixed price for the product. This operated, slowly, to check the rise in the general price level and, in a situation where the supply of labour tended to be short, permitted the diversion of a small amount of labour to other industries. When, on the other hand, the general price level was falling, the supply of gold coming from the mines tended to increase because of the fall in money costs of mining. This operated, slowly, to check the decline in the general price level and, in a situation where the supply of labour tended to be long, absorbed a small amount of the labour released by other industries. The result, however, was merely to hold the movement of price levels to long cycles, rather than to effect a real price-level stabilization, and to exert nothing but a negligible influence in stabilizing employment.

The use of the accident of the discovery, or lack of discovery, of new gold mines, as the principal factor in "regulating" the world supply of money, was a so wholly irrational procedure as to induce a growing recognition of the fact that a better means of controlling the supply of money was indispensable. The evils of a volatile price level are too glaring to permit of complacency, and most countries are no longer willing to subject their economies to a monetary system which takes control of their money supply out of their own hands. This is one of the most compelling arguments against any truly *international* monetary system, whether or not it is based on gold, and accounts for the reluctance of the countries in question to tie to gold their now independent currencies through a system of fixed exchange rates against gold-standard countries. It is doubtful, therefore, whether an international regime of even approximately fixed exchange rates can count on a very lengthy life. The gold standard may be maintained, by one or another country, but its international hold may well have been permanently broken. The best possibility of restoration lies in effective measures designed to stabilize the purchasing power of gold. If such a stabilization were attained; the present reluctance of many countries to revert to the gold standard might gradually dissolve.

In any case, so long as gold is highly prized by individuals and banking authorities, a certain supply of it will be useful in the conduct of international trade and finance. Nothing else serves so well, in a nationalistic world, for meeting debit balances in international transactions. The project for an international monetary system, submitted for approval to the various governments of the world by the Bretton Woods conference in 1944, may perhaps do something to diminish the importance of gold in international transactions, but gold is still very much in the picture. Gold has ceased to play an important role in the domestic monetary system of most countries, and the gold standard in its earlier and only authentic form may have passed forever, but gold is a tangible asset while fiduciary money is merely a more or less readily collectible promise. In a world of international skepticism, if not active distrust, gold, even though its value now rests almost solely upon the none too secure basis of law and convention rather than deeply in the desires of men, will long be more highly regarded than foreigners' promises subject to repudiation either by the promissors or their governments. Gold, for the time being, possesses in pre-eminent degree the virtue of international vendibility. The prestige of gold is therefore still great enough to insure, for an indefinite period, its retention as international money, on the ground of its salability in international trade, even if it should everywhere lose its status as indefeasible domestic money. In the United States, at least, it is not likely at an early date to lose even this status, if only because of the large stocks of gold in the possession of that country. The British Empire and Russia, by reason of their large output of gold, have also a great stake in the maintenance of gold as money. It seems probable, therefore, that some more or less distant approximation to the original gold standard will for the foreseeable future be maintained in the United States and, perhaps, in many other countries. It should be said, however, that no country with any intention of putting into effect unilaterally, as occasion seems to demand, a change in the gold value of its monetary unit can pretend, in any significant sense, to be a gold-standard country.

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GOLD STICK IN WAITING, an officer of the British royal household who waits in close attendance upon the sovereign and whose emblem of office is an ebony staff or stick with a gold head, engraved with the sovereign's cipher and crown. The office was instituted in 1678 and was held exclusively by "Colonels of the Regiment" of regiments of life guards until 1820 when the honour was extended to officers holding similar appointments in the royal horse guards. *Silver Stick in Waiting* is the officer who stands near the *Gold Stick* "ready to relieve him."

See Sir George Arthur, *The Story of the Household Cavalry* (1909).

GOLDSTUCKER, THEODOR (1821–1872), German Sanskrit scholar, was born of Jewish parents at Konigsberg on Jan. 18, 1821. From 1847 to 1850 he resided at Berlin, but his advanced political views caused the authorities to regard him with suspicion. In the latter year he removed to London, in 1852 he became professor of Sanskrit in University college. He was one of the founders and chief promoters of the Sanskrit Text society. He died in London on March 6, 1872.

GOLDZIHER, IGNAZ (1850–1921), Jewish Hungarian orientalist, was born in Stuhlweissenburg on June 22, 1850. He was educated at the universities of Budapest, Berlin, Leipzig and Leyden, and was the first Jewish scholar to become professor in the Budapest university (1894), and represented the Hungarian government and the Academy of Sciences at numerous international congresses. He received many foreign academic honours. Goldziher investigated pre-Mohammedan and Mohammedan law, tradition, religion and poetry. Among his chief works are: *Beiträge zur Literaturgeschichte der Schi'u* (1874); *Beiträge zur Geschichte der Sprachgelehrsamkeit bei den Arabern* (1871–73); *Der Mythos* bei den *Hebräern* und seine geschichtliche Entwickelung (Leipzig, 1876; Eng. trans. by R. Martineau, 1877); Muhammedanische Studien (Halle, 2 vol. 1889–90).

GOLETTA (LA GOULETTE), a port town on the Gulf of Tunis, south of the ruins of Carthage and on the north side of the ship canal which traverses the shallow Lake of Tunis and leads to the city of Tunis. The town contains many villas, gardens and pleasure resorts, as well as a summer palace of the bey and the old seraglio.

A short canal, 40 ft. broad and 8½ ft. deep, affords communication between the ship canal and a dock or basin 1,082 ft. long and 541 ft. broad. The port was completely destroyed by aerial bombing, from its occupation by the Axis, Nov. 14. 1942, until its capture by Allied forces in May 1943. An electric tramway connects Goletta with the city of Tunis (*q.v.*). Pop. (1956 est.) 26,323 (mun.), mostly Jews and Italian fishermen.

GOLF, a game which originated in Scotland, is played by striking a small ball with various clubs from a teeing ground into a series of holes on a course. The player who holes his ball in the fewest strokes is the winner.

The history and nature of the game are discussed under the following main headings:

I. HISTORY

While golf as the game is known today originated in Scotland, the place and time are obscure. However, it was so popular in the 15th century that the 14th parliament of King James II of Scotland decreed in 1457 that "fute-ball and golfe be utterly cryed downe, and not to be used" because they interfered with the practice of archery, an essential element in the defense of the realm. This legislation provided the first written reference to the playing of golf. That the game was well established is further supported by the fact that two subsequent Scottish parliaments found it necessary to issue similar decrees—in 1471 and 1491—in efforts to suppress the game, and it appears that none of the three was effective. The invention of gunpowder near the end of the 15th century may have contributed to ending the proscription by lessening the importance of archery. At any rate, James IV (1473–1513), whose third parliament had passed the last of the three decrees, developed into an avid golfer. James V of Scotland (1512–42) played golf at East Lothian. His daughter Mary, queen of Scots (1542–87), played golf at St. Andrews and her son James VI of Scotland, later James I of England (1566–1625), played at Blackheath common, London. The earliest rounds of golf, however, apparently had been played on linksland on the eastern coast of Scotland.

1. Precursors of Golf and Related Games. — The family tree of golf may go back to the Roman empire. The Romans played a game in the fields called paganica (from *paganus,* "countryman") in which a club and a ball stuffed with feathers were used. The Roman legions, as they advanced over Europe and into Britain, may have carried paganica with them. If so, that would account for the development of similar games in several European countries: cambuca (cambrel or cammock) in England, *jeu de* mail in France, het kolven in the Netherlands. All of these involved striking a ball across the countryside with a stick. Cambuca (a name also given to the club used in the game) was played in the 13th and 14th centuries and was described in a record of 1363, printed in Thomas Rymer's Foedera, as "the game of a crooked stick or curved club or playing mallet with which a small wooden ball is propelled forward." Coincidentally, cambuca was forbidden in 1363 in an order to the sheriffs of England, in order that man "shall in his sports use bows and arrows, pellets and bolts."

Het kolven, played in the Netherlands, provided some of the important terminology of the game (see *Glossary,* below) and some interesting references in art. The word golf stems from the Dutch kolf, which in turn is related to the German Kolbe and the Danish holbe, meaning "club." The mound on which the Dutchman placed his ball was a tuitje, pronounced "toytee." The hole to which he directed his ball was a put. If anything was in his way, he said, *stuit* mij, pronounced "stytmy" ("it stops me"). There is, too, an old Dutch proverb: "You must play the ball as it lies." The earliest reference to het kolven is in an illuminated Book of Hours, done by Simon Bennink with the assistance of pupils in his studio at Bruges between 1500 and 1520, and now in the British museum. A miniature depicts three players on a green with a hole, each player with a club and ball and one of them attempting to hole out. From the same period, a sketch by David Vinck-Boons and other evidence reflects a similar game played on ice. The Dutch painting "Frost Scene" by A. van de Velde, dated 1668, portrays four "golfers" in competition, two Dutchmen in knickerbockers and two Scots in kilts.

2. Early British Golfers' Associations. — It is generally conceded that the Royal Blackheath Golf club of London is the oldest existing golf club in the world, but its origin is as obscure as that of the game itself. James I, whose reign began in 1603, played golf on Blackheath common, and a society of golfers was formed at Blackheath in 1608. A group of golfers was flourishing there in 1766, for a silver club bears the inscription: "August 16, 1766, the gift of Mr. Henry Foote to the Honourable Company of Goffers at Blackheath." The Royal Burgess Golfing Society of Edinburgh claims to have been founded in 1735. The Company of Gentlemen Golfers, now the Honourable Company of Edinburgh Golfers, was formed in 1744 by a group that played over the five holes of the Leith links. The lord provost, the magistrates and the council of the city of Edinburgh presented to the company a silver club that was first played for in April 1745. The club subsequently transferred its activities to Musselburgh and finally to Muirfield, with which links it has been associated in modern times. The earliest known rules are the 13 recorded in the first minute book of the Honourable Company of Edinburgh Golfers. The first signer was John Rattray, who was captain in 1744, 1745 and 1751. The code, therefore, cannot be more recent than 1751 and more likely was entered in the minute book when the competition for the silver club was instituted, in 1745.

The Royal and Ancient Golf Club. — The Society of St. Andrews, now the Royal and Ancient Golf Club of St. Andrews, Scotland, was formed on May 14, 1754, by a group of 22 golfers who played there. The rules which the society adopted were almost identical with the Edinburgh Gentlemen Golfers' rules. An allusion to scholars' holes and soldiers' lines not constituting hazards indicates that the rules were copied from the Gentlemen Golfers' code when the St. Andrews golfers were playing at Leith, since there were both scholars' holes and soldiers' lines at Leith but no soldiers' lines at St. Andrews. These two clubs played major roles in the development of the game in Scotland. Eventually the Royal and Ancient Golf club (R.A.G.C.) became, by common consent, the oracle on rules. In 1919 it accepted the management of the British open and amateur championships. The R.A.G.C. thus became the governing body for men's golf in the British Isles and throughout most of the Commonwealth. The Musselburgh Golf club offered a prize for a women's competition, Dec. 14, 1810, and a Ladies Golf club was formed at St. Andrews in 1872. The Ladies Golf union, which governs women's golf, was organized in 1893.

3. United States. — Golf or something akin to it may have been played in the new world in the 17th and 18th centuries. The record of a court in Ft. Orange (now Albany, N.Y.) reveals that the sheriff there filed a complaint against three men who had been playing *het kolven* on the ice on a Sunday in 1657. The magistrates of Ft. Orange on Dec. 10, 1659, issued an ordinance to "forbid all persons to play 'het kolven' in the streets." While these documents are sometimes cited as evidence of the earliest playing of golf in the United States, the game does not seem to have been the linksland pastime handed down by the Scots. There seems little doubt, however, that the following advertisement, which appeared in James Rivington's *Gazette* in New York on April 21, 1779, referred to golf: "To the Golf Players: The season for this pleasant and healthy exercise now advancing, gentlemen may be furnished with excellent clubs and the veritable Caledonian balls by enquiring at the Printer's." However, there is no record of golf in New York during the subsequent century. The next evidence appears in the Carolinas. The *South Carolina and Georgia Almanac* of 1793 published, under the heading "Societies Established in Charleston," the following item: "Golf club formed 1786. Dr. Purcell — President. Edward Penman — Vice President. James Gardiner — Treasurer and Secretary." The *Charleston City Gazette and Daily Advertiser* of Sept. 18, 1788, reported: "There is lately erected that pleasing and genteel amusement, the kolf baan. Any person wishing to treat for the same at private sale will please apply to Mr. David Denoon in Charleston, or to the subscriber on the spot." Later notices dated 1791 and 1794 referred to the South Carolina Golf club, which celebrated an anniversary with a dinner on Harleston's green in the latter year. The *Georgia Gazette* of Sept. 22, 1796, carried an announcement of the anniversary of the Savannah Golf club, and one Miss Eliza Johnston was invited to a "Golf Club ball" in Savannah on New Year's Eve, 1811, according to an invitation in the possession of the Johnston family.

Although these fragments constitute the earliest clear evidence of golf clubs in the United States. the clubs appear to have been primarily social organizations that did not survive the War of 1812.

The first permanent golf club in the western hemisphere was the Royal Montreal Golf club, established in 1873. In subsequent years golf was played experimentally at many places in the United States without taking permanent root until. in 1885, it was played in Foxburg, Pa. The Foxburg Golf club has provided strong support for the claim that it was organized in 1887, is the oldest golf club in the United States with a permanent existence and has the oldest U.S. golf course. The course and club came into existence through the interest and generosity of Joseph Mickle Fox of Philadelphia, a summer resident of Foxburg who is believed to have been introduced to golf and to have acquired his first left-handed clubs and gutty balls while in Scotland in 1884. The next oldest course, after Foxburg, may be that of the Middlesborough (Ky.) Golf club which apparently was founded in 1889 by English immigrants. The course is still in existence, but there is a question as to whether play has been continuous on it. The next oldest club, after Foxburg, almost surely is the St. Andrew's Golf club of Yonkers, N.Y., named after the famous Scottish club and organized by John Reid and four friends on Nov. 14, 1888. This club played an outstanding role in channeling the main stream of golf in the United States. The story of its founding bears similarities to the story of Foxburg's less-celebrated origin. Robert Lockhart, a Scot living in New York, shipped home some golf clubs and balls while on one of his annual trips to Scotland. On his return he tried them out on the banks of the Hudson river where 72nd street ends and later used them to introduce the game to his friends, John Reid and John B. Upham, in a pasture across from Reid's home in Yonkers on Feb. 22, 1888. Following the blizzard of March 1888 the men convened again, with other potential converts, in another pasture at the corner of Broadway and Shonnard avenue, Yonkers, laid out a course and played through the summer, and organized as a club in the fall. The club moved several times but has been permanently established at Hastings-on-Hudson, N.Y., since 1897.

The United States Golf Association. — One of St. Andrew's many notable contributions to the welfare of the game was its leadership in organizing the United States Golf association (U.S.G.A.). In 1894, after having completed its links in Yonkers, the club planned a tournament for the amateur championship of the United States, on Oct. 11–12–13, and invitations were sent to the various golf clubs throughout the country. The tournament was to be played according to the rules of the R.A.G.C. and the prizes were diamond and gold, silver and bronze medals. At the same time the Newport (R.I.) Golf club decided to hold a championship in September, the prize to be a silver cup. As a result there were two U.S. championships in 1894. H. O. Tallmadge, secretary of the St. Andrew's club, suggested the formation of a national association to establish uniform rules and conduct tournaments; he was assisted by Laurence Curtis of The Country club of Brookline, Mass. On Dec. 22. 1894, the Amateur Golf Association of the Cnited States was formed by representatives of five of the leading golf clubs of the country. The name was soon changed to the American Golf association and finally to the United States Golf association. The five founding clubs were the St. Andrew's Golf club, the Newport Golf club, the Shinnecock Hills Golf club, Southampton, N.Y., The Country club, Brookline, and the Chicago Golf club. The U.S.G.A., which grew to include more than 2,300 clubs and courses, is a voluntary association of golf clubs whose purpose is to promote and conserve the best interests and true spirit of the game as embodied in its traditions. To this end it adopts, enforces and interprets rules of amateur status and rules of the game; conducts eight national championships (open. amateur, women's amateur. women's open, amateur public links, junior amateur. girls' junior and senior amateur); co-operates in sponsoring four international amateur team matches (Walker cup, Curtis cup, Americas cup and Eisenhower cup); finances turf-grass research and provides a turf-grass advisory service; maintains a golf museum and library in Golf house, its New York headquarters; and, in general, acts as a national authority.

The second oldest national organization in the United States is the Western Golf association. Founded in 1899 as a sectional organization to embrace the territory west of Buffalo, N.Y., it developed as a national authority on caddies and caddie welfare and sponsors the Evans Scholars foundation to assist deserving caddies in obtaining a college education.

Another prominent organization is the Professional Golfers Association of America (P.G.A), organized by professional golfers at the instigation of R. Wanamaker in 1916 to promote interest in the game. elevate the standards of professional golf and advance the welfare of its members. This association has a membership of nearly 3.000 professional golfers. In addition to its P.G.A. championship, it shares in the conduct of an international professional match for the Ryder cup and co-sponsors a series of tournaments for professionals in a circuit that circles the United States throughout the year.

4. **20th** Century. — The most significant growth in golf in the 20th century occurred in senior organizations after 1905, when Horace L. Hotchkiss arranged the first seniors' tournament, for players 55 and older, at the Apawamis club, Rye, N.Y. Hotchkiss, who was more than 60 at the time, attempted to prove that golf was not a young man's game. The tournament was such a success that within ten years the number of contestants had passed the 300 mark and it had become apparent that a senior organization was in order. The United States Seniors' Golf association was organized on Jan. 17, 1917, in New York, with a membership of 400, which within six months increased to 500 and subsequently to 900. The idea spread rapidly. While the United States seniors' tournament is the leading event of its kind, many other membership and invitation events of the same type developed to meet the demand— the American Seniors' Golf association, the Western Seniors' Golf

association, the North and South senior tournament and others. There are at least 46 senior golfing organizations in the United States alone. Members of the United States Senior Women's Golf association play annually. In 1918 the governor general of Canada presented a trophy to be played for annually by the United States Seniors' Golf association and the newly formed Canadian Seniors' Golf association. Another match was initiated with the Senior Golfers' society of Great Britain. After World War II an international team championship in Deauville, France, attracted teams from the United States, Belgium, France, Germany, Great Britain. Italy and Switzerland. In addition, the United States sent senior teams on tours of Sweden and Kenya.

Golf has achieved some popularity in at least 26 countries—the number which sent teams to the international tournament sponsored by John Jay Hopkins, a U.S. industrialist, in London in 1956. The teams represented Argentina, Australia, Belgium, Brazil, Canada, Chile, China, Colombia, Denmark, Egypt, France, Germany. Ireland, Italy, Japan, Korea, Mexico, the Netherlands, New Zealand, the Philippines, South Africa, Spain, Sweden, Switzerland, the United Kingdom and the United States.

The World's Amateur Golf council was organized by officials of the U.S.G.A. and the R.A.G.C. in 1958, and its first tournament, for the Eisenhower cup, was held that year at St. Andrews. The Australian team (Bruce Devlin, Robert Stevens, Doug Bachli and Peter Toogood) won the 18-hole play-off from the U.S. team (Charlie Coe, Billy Joe Patton, Frank Taylor and Bill Hyndman III).

Golf has achieved its greatest popularity in the United States, where more than 3,800,000 men, women and children played at least ten times a year on more than 5,000 golf courses in the second half of the 20th century, according to a survey conducted by the National Golf foundation. The same source estimated that over 500,000 ac. were devoted to golf and the value of the land, buildings and equipment was in excess of $1,300,000,000. Golf equipment represented about 38% of the total of athletic goods and sporting goods sold in the United States, exclusive of hunting and fishing equipment, in the mid-1950s.

II. EQUIPMENT AND THE DEVELOPMENT OF THE GAME

A. The Feather-Ball Era

1. The Feather Ball.—Golf, like *paganica,* was originally played with a leather-covered ball stuffed with feathers, and the principles of the modern rules were developed in this era. The feather ball or feathery remained the standard for at least four centuries, until about 1848. The making of feather balls was a tedious task, and most ball makers could produce only about four "specials" (top-grade balls) a day. The best balls sold for up to five shillings apiece; in bulk, rarely less than £1 for a dozen. In the making, the leather was softened with alum and water and cut into four, three or two pieces. These were stitched together with waxed thread outside in and reversed when the stitching was nearly completed. A small hole was left for the insertion of boiled goose feathers. The ball maker held the leather cover in his hand, in a recessed ball holder, and pushed the first feathers through the hole with a stuffing rod, a tapering piece of wrought iron 16 to 20 in. long and fitted with a wooden crosspiece to be braced against the ball maker's chest. When the stuffing iron failed, an awl was brought into play, and a volume of feathers which would fill the crown of a beaver hat eventually was inserted into the leather cover. The hole was then stitched up and the ball hammered hard and round and given three coats of paint. Feather balls were seldom exactly round. In wet weather they tended to become sodden and fly apart. They were easily cut on the seams and a player was fortunate if his ball endured through two rounds. Originally, there appear to have been ball makers in each golfing community, but in the middle of the 18th century the Gourlay family, of Leith and Musselburgh, became pre-eminent and a "Gourlay" was accepted as the best feather ball on the market. The patriarch of the family was Douglas Gourlay, at Leith, but it was his son, at Musselburgh, who brought the family name its greatest renown. Their principal competitor was Allan Robertson of St. Andrews. son of the noted player Davie Robertson. He turned out 2,456 feather balls in 1844 and was unalterably opposed to the introduction, shortly thereafter, of the gutta-percha ball. When he caught "Old Tom" Morris playing a gutta ball in 1852 they had words, and Morris left St. Andrews, not to return until after Robertson's death in 1858.

2. Early Clubs.—The full, free style known as the St. Andrews swing developed out of the feather-ball period. The clubs, at first rudimentary, tended toward the end of the period to be long, thin and graceful, and the feathery was swept from the ground with a full swing that also tended to be long and graceful. The shafts were whippy and the grips thick. There was a considerable elegance to these clubs. The earliest known club maker was William Mayne of Edinburgh, who received a royal warrant as club maker and spear maker from James VI in 1603. A notebook of that period indicates the nomenclature of clubs Mayne must have made by noting payments for the repair of "play clubis," "bonker clubis" and an "irone club." While there are no known examples of these clubs, their rudimentary nature is known from the art of the times. Among the oldest known clubs is a set of six woods and two irons at Troon Golf club, Scotland; these were found in Hull, Eng., with a copy of a Yorkshire paper dated 1741. All six are shafted with ash. Only one wood and one iron have grips. The woods are weighted with lead and faced with bone, the lead extending from near the toe two-thirds of the way to the heel.

Club making reached its zenith in the last century of the feather-ball era, with the advent of the real artists—Simon Cossar of Leith; the successive generations of McEwans of Leith and Musselburgh; Hugh Philp and James Wilson of St. Andrews; White of St. Andrews. Cossar, Philp, Wilson and the McEwans were noted for their woods; Cossar, Wilson and White for irons. White is credited with giving Robertson and "Young Tom" Morris such refined irons that they were able to introduce a wide range of new strokes into the game. Douglas McEwan made his club heads from small cuts of hedge thorn that had been planted horizontally on sloping banks so that the stems grew at an angle at the root and created a natural bend for the neck. The shafts, spliced onto the heads, were made of split ash.

By the first half of the 19th century, clubs had come to be divided into four classes: drivers, spoons, irons and putters. Drivers were distinguished by their long, tapering, flexible shafts and their small raking heads. They comprised "play clubs," which had little loft and were designed for use over a safe ground only, and "grassed drivers," which had more loft and were designed to lift a ball from a heavy or downhill lie or over a hazard. Spoons were of four types: long spoons, middle spoons, short spoons and baffing or baffy spoons, the distinction being in the degree of loft. For a time there was also a fifth spoon, variously known as a cleek and a niblick, a well-lofted club with a small head designed to drive a ball out of a rut. There were three irons: driving irons, irons known as cleeks and having narrow lofted faces and long shafts, and bunker irons. Driving putters were used for approach work over unencumbered terrain and green putters, on putting greens. With these sets, players negotiated their feather balls over holes measuring 80 to 400 yd. In the era of the feather ball there were no championships, but four of the great players of the period returned the following card in a feather-ball match at St. Andrews in 1849:

Out

Willie and Jamie Dunn	6	5	4	6	6	6	4	4	5	46
Allan Robertson and Tom Morris, Sr.	6	5	6	5	5	5	5	4	4	45

In

Willie and Jamie Dunn	5	3	5	6	5	5	5	6	6	46	92
Allan Robertson and Tom Morris, Sr.	6	4	5	6	5	5	5	6	6	48	93

B. The Gutta-percha Era

1. The **Gutta** Ball.—Gutta-percha is the evaporated milky juice or latex produced by various trees. It is hard and non-brittle, becomes soft and impressible at the temperature of boiling water and retains its shape when cooled. It is not affected by water except at boiling temperature.

The first gutta-percha ball is believed to have been made in 1845 by the Rev. Robert A. Paterson from gutta-percha packing which had been used around a statue of Vishnu sent from India. The earliest such balls, produced under the name "Paterson's patent," were brown in colour and were handmade by rolling the gutta-percha on a flat board. They had smooth surfaces lined to simulate the seaming of a feather ball, and ducked quickly in flight until they had been marked and cut in play. They were not introduced into the game generally until 1848, when the makers had learned to apply effective permanent markings or indentations to the surface so that the balls would fly properly.

Gutta balls were far easier to make than featheries, since they consisted solely of the single lump of molded gutta-percha. The best-known balls were the hand-marked private brands of the club makers, such as the Auchterlonies, Old Tom Morris and Robert Forgan, and the bramble-marked and patent brands such as the Eureka, Melfort, White Melfort (of white gutta-percha), White Brand, Henley. O.K., Ocobo, Silvertown No. 4, A.1, Clan, Thornton, Park's Special and Agrippa. The Agrippa, with bramble marking, became a great favourite. The A.1 floated, but most guttas did not. The gutta remained the standard ball until 1901–02, when the rubber ball replaced it.

The introduction of the gutta ball occasioned one of the great rejuvenations in the history of the game. Its lower cost, longer life, improved flight, truer run on the greens and the fact that it did not fall apart in the rain attracted an enormous number of new players, and the feathery was quickly replaced. The influx of new players, in turn, forced the conversion of the old course at St. Andrews to a full 18 holes. Until the gutta ball was developed, golfers played out along what later became known as the left-hand course, until they reached the end hole. There they turned around and played in to the same holes. If two groups approached a green simultaneously, preference was given to those playing out. However, as golfers multiplied with the advent of the gutta ball, the links proved to narrow to accommodate them, and about 1857 they were widened sufficiently to turn the greens into double ones so that two holes could be cut in each one.

Calibre of play improved greatly with the advent of the gutta ball. Robertson, when finally won over to it, shattered all precedent by scoring a 79 at St. Andrews in 1858, and this record stood until Young Tom Morris made a 77 in 1869.

2. Clubs.—The gutta-percha ball was harder than the feather ball and put considerable strain on the slender clubs with which feather balls had been stroked. Thus wooden heads gradually became shorter and squatter in shape. Hard thorn was discarded for the softer apple, pear and beech in the heads, and leather insets appeared in the faces. Hickory, originally from Russia and later from Tennessee, replaced ash in the making of shafts. Iron clubs increased in number and variety and became vastly more refined. The superlative play of Young Tom Morris at St. Andrews (see Outstanding Players, below) is credited with popularizing the iron clubs he used so deftly. A full range of clubs at the zenith of the gutta-ball period consisted of seven woods—driver, bulger driver (a wood with a convex face), long spoon, brassie, middle spoon, short spoon and putter—and six irons—cleek, midiron, lofting iron, mashie, niblick and cleek putter. From these the golfer usually selected about eight. The range of clubs that Willie Park, Jr., had in winning the British open championships of 1887 and 1889 was bulger driver. straight-faced driver, spoon, brassie niblick, wooden putter, cleek, iron, mashie, iron niblick and Park's patent putter.

The increase in the number of clubs brought about anotlier innovation in the early 1890s, the introduction of a simple sailcloth bag in which to carry them. Previously, the few clubs a player might need had been carried loose under the arm. The introduction of the gutta ball did not change the identity of the club makers, but required them to develop new designs and materials. Douglas McEwan lived until 1896 and bridged the periods of the feathery and the gutta. He was followed by his son Peter and by his four grandsons, who constituted the fifth generation of club-making McEwans. James Wilson. who had made clubs for the feather ball under Hugh Philp, set up shop at St. Andrews in 1652, and Philp then took in his nephew, Robert Forgan. Forgan and his son Thomas continued the business under their own name after Philp's death. R. Forgan was the first to appreciate the merit of hickory shafts and T. Forgan produced the bulger driver and the ebony putter. Old Tom Morris, the Andersons and the Auchterlonies were other noted club makers of St. Andrews. and there were Ben Sayers at North Berwick, Willie Park, Sr. at Musselburgh, the Simpsons at Carnoustie and many more.

In 1891 Willie Dunn, son of Willie of the famed Dunn twins of Scotland, arrived in the United States to lay out the course at Southampton, N.Y., for the Shinnecock Hills Golf club and remained to make clubs. Other Scottish professionals crossed the Atlantic in the 1890s and contributed to the establishment of U.S. club making. The trade itself was little changed. Wooden heads were cut out of a block, filed, spoke shaved, chiseled, gouged, leaded, boned, smoothed with glass paper (*q.v.*), sometimes stained and treated with a hare's-foot dipped in a mixture of oil and varnish. Whereas the club heads used by Robertson were only $\frac{5}{16}$ in. deep, the depth gradually increased to 1 in. and, for a time, 2 in. Iron heads were hand forged from a bar of mild iron, heated, hammered, tempered, emery wheeled and polished, and the socket was pierced for the rivet and nicked. Hickory shafts were seasoned, then cut, filed, planed, scraped and glass-papered down to the required length, shape and degree of whippiness, which was the real art. Shafts for wooden heads were finished in a splice, glued onto the heads and whipped with tarred or waxed twine. Shafts for irons were finished with a prong to fit into the socket and holed for the iron cross rivet. Strips of untanned leather, shaped with a chisel, were nailed to the top of the shafts. wound on spirally over a cloth foundation similarly applied, rolled tight between two polished boards and nailed at the bottom. Both ends of the grip were bound with twine and the whole grip was then varnished.

C. The Era of the Rubber Ball

1. Development of the Ball.—The rubber ball was the invention of Coburn Haskell, a golfer of Cleveland, O., in association with Bertram G. Work of the B. F. Goodrich company. In 1698 Haskell adapted the art of winding rubber thread produced by Goodrich under tension on a solid rubber core to produce a ball far livelier than the gutta. The earliest covers were of black gutta-percha, lightly lined by hand. Paint tended to fill the indentations, causing the ball to duck in flight just as the first, smooth gutta balls had. Dave Foulis, a Chicago professional, put a rubber ball in an Agrippa mold and produced the bramble marking that was common to both the late gutta and early rubber balls. Haskell balls, placed on the market in 1899, became known as "bounding billies." It is estimated that they could be hit about 25 yd. farther than the gutta. just as the gutta was about 25 yd. longer than the feathery. The consensus at first, however, was that the distance gained did not offset the difficulty of controlling the lively ball on the green. Walter J. Travis of New York, considered the best putter of his day, resolved this debate by using a Haskell ball from an Agrippa mold in winning the U.S. amateur championship in Sept. 1901. Thereafter, the gutta became a relic of the past, and the game was again revolutionized and popularized as it had been with the advent of the gutta.

The day of the ball made by hand in the professional's shop was ending. A. G. Spalding & Bros., at Chicopee, Mass., a manufacturer of sporting goods, had undertaken production of gutta balls in 1898 and obtained a licence to produce its first rubber ball, the Spalding Wizard, in 1903. Soon thereafter the balata cover was developed for Spalding, and its improved adhering qualities made it an important innovation. Earliest experiments with the rubber ball concerned the core. It was determined that, for resilience, mobile cores were best, offering the least resistance to the distortion to the ball caused by club-head impact. Operating on this theory, the Kempshall Golf Ball company produced the Kempshall water core, in which a small sac of water was substituted for solid rubber. The competition to produce a ball that could be driven longer distances was under way. Manufacturers tried lead in solution in an effort to combine weight with a mobile core, but this proved potentially injurious to curious children and animals. Zinc oxide was substituted, but the pigment tended to settle and unbalance the ball. In the 1920s true solutions involving glue, glycerin and water mere developed for the first-line balls.

More telling improvements were made in winding, the critical factor in the modern ball. Machines replaced men and were constantly improved. The object of the winding process is to obtain the greatest tension and closest possible approach to the breaking point of the rubber thread. The earliest thread mas of wild rubber from the Amazon basin; development of plantation rubber led to greatly improved quality.

Early rubber balls were made with the bramble and reverse-mesh markings of the gutta ball, but experiments led to improvements as they revealed the best relationship of both depth and area of indentation to the ball's total surface. William Taylor, in England, reversed the markings on his molds to produce the dimple, in contrast to the bramble, in 1908. The mesh, in contrast to the original reverse mesh, was a natural aftermath. Haskell balls at first were light and large, about 1.55 oz. in weight and 1.71 in. in diameter, and they floated. In the absence of regulations governing size or weight, manufacturers pursued one another's leads in the quest for the most efficient combination. Heavy solutions in the core increased the weight to about 1.72 oz. in the first decade. Then both size and weight underwent a gradual reduction to 1.62 oz. and 1.63 in. about the time the Haskell patent expired in 1915. Expiration of this patent increased the competition. which had tended to make courses obsolete. Therefore, in 1920 the U.S.G.A. and the R.A.G.C. agreed that after May 1, 1921, balls used in their championships must weigh not more than 1.62 oz. and measure not less than 1.62 in, and the two organizations would take such steps as were deemed necessary to limit the power of the ball. The ball actually was unchanged by this regulation; it continued to measure 1.63 in., .01 in. above the minimum. In 1923 the U.S.G.A. decided that the power should be reduced. A series of experiments under William C. Fownes, Jr., of Pittsburgh and Herbert Jaques, Jr., of Boston led to the introduction in the United States in 1930 of the so-called "balloon ball," weighing not more than 1.55 oz. and measuring not less than 1.68 in. in diameter. This ball, with no regulation of its velocity, became standard in the United States on Jan. 1, 1931, and was the first deviation from the British ball. It proved too light to hold on line in flight in a wind or on a green as it lost momentum, and it survived only one year. The slightly heavier ball, weighing not more than 1.62 oz. and measuring not less than 1.68 in., became standard in the U.S. on Jan. 1. 1932. The velocity of this ball was not regulated: however, until the U.S.G.A. completed a satisfactory testing machine in 1941. After Jan. 1, 1942, the U.S.G.A. required that the velocity of the ball be not greater than 250 ft. per second as measured on the association's machine under specified conditions.

2. Modern Clubs.—Golf was being overtaken by the industrial revolution when the rubber ball came into the game at the beginning of the 20th century. These two factors wrought major changes in the clubs and the methods by which they were produced as craftsmanship moved out of the individual professional's shop and into the factory. The harder rubber ball brought about the use of persimmon and, later, laminated club heads. Hard insets appeared in the faces. Increased demand led to the adaptation of shoe-last machine tools for the fashioning of wooden club heads. Sockets were bored in the club heads, and shafts were inserted rather than spliced. Drop forging completely replaced hand forging in the fashioning of iron clubs, and faces were deepened to accommodate the livelier ball and were machine lined to increase the spin on the ball in flight. Stainless steel replaced carbon steels. Seamless steel shafts took the place of hickory. Composition materials were developed as an alternative to leather in grips, and the grip foundations were molded in so many ways that they mere regulated in 1947. Inventive minds created novel clubs, not only centre-shafted and aluminum putters and the sand wedge but also types that were such radical departures from the traditional form and make that they could not be approved by the U.S.G.A. or the R.A.G.C. Modern club making in the United States began when Julian W. Curtiss of A. G. Spalding & Bros. purchased some clubs in London in 1892 for resale in his company's retail stores. Two years later, Spalding employed some Scottish club makers and began producing its own clubs. Hand modeling of woods and hand forging of irons did not long survive the demands of factory production. Within the first decade the Crawford. McGregor & Canby company in Dayton, O., a maker of shoe lasts. was turning out wooden heads; foundries were converting drop-forging processes to iron heads; and Allan Lard in Chicopee was experimenting with perforated steel rods for shafts. A. W. Knight of the General Electric company joined this inventive movement and produced an aluminum-headed putter with the shaft attached near the centre rather than at the heel. Travis used this "Schenectady" putter in winning the British amateur championship in 1904.

The importance of these developments was such that, in promulgating its revised code of rules in Sept. 1908, the R.A.G.C. appended the notation that it would not sanction any substantial departure from the traditional and accepted form and make of golf clubs. This principle has been invoked many times in an effort to preserve the original form of the game. When Jock Hutchison won the British open in 1921 with deeply slotted faces on his pitching clubs, the R.A.G.C. immediately banned such faces and the U.S.G.A. concurred with a regulation governing markings which became effective in 1924. After Horton Smith had so effectively used a sand wedge with a concave face designed by E. M. MacClain of Houston, Tex., the principle of concavity was banned in 1931. However, Gene Sarazen developed a straight-faced sand wedge and used it so well in winning the British and U.S.G.A. opens in 1932 that he completed the revolution of bunker play. Experiments with steel shafts went through several phases. Lard's perforated steel rod was no substitute for hickory, and the locked-seam shaft proved not to be the answer either. although the C.S.G.A. approved such shafts in 1924. However, in 1924 the Union Hardware company of Torrington, Conn., drew a seamless shaft of high-carbon steel which could be heat-treated and tempered. This came into the game in the late 1920s, was approved by the R.A.G.C. in 1929 and substantially replaced hickory in the early 1930s.

Improvement of the steel shaft was accompanied by the general introduction of numbered rather than named clubs, and by the merchandising of matched sets rather than individual clubs; clubs had become more numerous and more finely graduated than the names which had been applied to them and shafts could be manufactured to specifications for flexibility and point of flex. Whereas formerly a golfer seeking new clubs went through a rack of mashies until he found one that "felt right" and then tried to find other clubs of similar feel, he later bought a whole set manufactured to impart the same feel. The merchandising aspect of this development was. perhaps, something more than a happy coincidence for the manufacturers. In any case, the merchandising opportunities inherent in the numbered and matched sets were carried to an extreme. and in 1938 the U.S.G.A. limited the number of clubs a player might use in a round to 14. The R.A.G.C. concurred in a similar edict the next year.

III. OUTSTANDING PLAYERS

1. Great Britain.—As golfing associations. or clubs, developed, there arose a group of professionals who made golf balls, fashioned and repaired clubs and gave lessons. Many of them were great players. The first of these was Allan Robertson (1815–58) of St. Andrews nho, legend states, was never beaten in a stake (money) match played on even terms (that is, not giving his opponent a handicap). His apprentice was the man eventually known as Old Tom Morris (1821–1908), professional, greenkeeper and patriarch of St. Andrews. When Old Tom was 30, he moved to the Prestwick Golf club which offered a belt as a challenge trophy for an open championship in 1860. Willie Park, Sr. (1864–1925), one of the famous golfing brothers from Musselburgh, non it with a 36-hole score of 174; but Old Tom won in 1861, 1862, 1864 and 1867 His son, Young Tom Morris (1850–75). succeeded him and won for three successive years, retiring the prize belt. Young Tom won his first professional tournament at the age of 16. He was 18, 19 and 20 when he won his three successive open championships. In the absence of a prize, there was no championship in 1871, but a cup which has been in competition ever since was put up in 1872 by the Prestwick Golf club, the R.A.G.C. and the Honourable Company of Edinburgh Golfers and Young Tom won it to score a fourth successive victory. Shortly thereafter he died, at the age of 25.

The British amateur championship was not started until 1885 after the Royal Liverpool Golf club at Hoylake, Eng., had proposed a tournament "open to all amateur golfers." The tournament attracted nearly all the best amateurs of the time and the winner was Allan F. MacFie, but it was not immediately recognized as the championship. The following year, the Royal Liverpool suggested to the R.A.G.C. that the tournament be established as the amateur championship, and 24 clubs joined together to purchase a trophy and manage the event. Among British players who won the amateur championship at least two times after 1900 were John Ball (1907, 1910 and 1912), H. H. Hilton (1911 and 1913), E. Holderness (1922 and 1924), C. Tolley (1920 and 1929) and J. Carr of Ireland (1953 and 1958).

The Ladies Golf union was formed rather late, in 1893, and the first British women's championship was held that year, at St. Anne's, Eng., and won by Lady Margaret Scott, as were the next two championships.

One of the first outstanding woman golfers was Dorothy Campbell, who won the British women's championship in 1909 and 1911, was runner-up in 1908 and semifinalist in 1904, 1905 and 1906. She won the U.S. championship in 1909, 1910 and 1924 and the Canadian championship in 1910, 1911 and 1912. Twice married, she was Mrs. John V. Hurd, then Mrs. Edward Howe. She became a resident of the U.S. early in the century. She won more than 750 prizes in golf.

Another British woman, Joyce Wethered, won the women's open championship in 1922, 1924, 1925 and 1929, the English women's title five years in a row, 1920–24, and represented Britain in numerous international matches. In 1935 she toured the United States as a professional representing a London store, and competed most creditably against the best men and women golfers. She became Lady Heathcoat-Amory. Other British women's championship winners of note have included Enid Wilson, who won in 1931, 1932 and 1933; Mrs. Andrew Holm, in 1934 and 1938; Pamela Barton, in 1936, in which year she also won the U.S. championship, and 1939; Miss F. Stephens (Mrs. Roy Smith), in 1949 and 1954; and Mrs. G. Valentine, in 1955 and 1958.

At the end of the 19th century golf had taken hold in the United States and was soon played in almost every country in the world. Meanwhile England was producing great players. J. H. Taylor and H. Vardon, together with J. Braid, a Scotsman, won the open championship 16 times between 1894 and 1914. Vardon, the greatest player that the world had seen up to that time, won the title six times. These three supreme golfers were known as "the great triumvirate" and were primarily responsible for the formation of the Professional Golfers association in 1901. This body (which has about 1,400 members) is responsible for professional tournaments and for the biennial Ryder cup match (for professionals) when it is played in Great Britain.

2. United States.—The first official United States open, amateur and women's amateur championships were held in 1895, and the respective winners were Horace Rawlins, Charles B. Macdonald and Mrs. Charles S. Brown. An unofficial open, at match play. in 1894 was won by Willie Dunn.

After World War I the influence of the many Scottish golfers who had emigrated to the United States became evident. U.S. golfers (principally Walter Hagen and Robert T. (Bobby) Jones, Jr., who achieved the unparalleled performance of winning the open and amateur championships of Great Britain and the U.S. in the same year, 1930j monopolized the British open championship until T. H. Cotton won in 1934, a feat he repeated in 1937 and 1948.

By the early 1930s U.S. dominance of the international scene was growing. From 1933 until 1958 the only victories by British teams in the biennial matches against the United States were in 1938, when the amateurs won the Walker cup, in 1952 and 1956, when the women won the Curtis cup, which they retained in 1958 with a tie, and in 1957, when the professionals won the Ryder cup.

Walter J. Travis was the first great U.S. golfer. He was born in Australia, but his golf was wholly learned in the United States. Of striking appearance, with jet black beard and impeccable garb, he was unpopular with fellow golfers because of his austere, taciturn demeanour. But he proved his ability as a golfer by winning the U.S. amateur in 1900, 1901 and 1903, by reaching the semifinals in five other years and by winning the qualifying medal in 1900, 1901, 1902, 1906, 1907 and 1908. He won the British amateur title the only year he entered this event—1904.

Jerome D. Travers learned his golf at Nassau Country club, Long Island, under the tutelage of Alec Smith, famous Scots professional who went to the U.S. in 1898. Travers was a player with indomitable courage, an ability to outgame an opponent at match play and nerve that rarely failed him in a crisis. He won the amateur championship in 1907, 1908, 1912 and 1913, and was finalist in 1914; he won the open title in 1915; and he won a long list of sectional championships.

Francis D. Ouimet became a national hero in 1913 when, unknown as a golfer except around Boston, he tied Vardon and Ted Ray, two of the best British professionals, at 304 strokes for 72 holes in the U.S. open, held at Brookline, and defeated them in a play-off, enabling the U.S. to retain the title. The following year Ouimet won the amateur, and he repeated 17 years later, in 1931. He was a semifinalist in 1923, 1924, 1926 and 1927; and was runner-up in 1920. He was a member of the United States team against Great Britain for the Walker cup from the first of these international matches in 1922 to 1949, serving as captain in 1932, 1934, 1936, 1938, 1947 and 1949.

Charles ("Chick") Evans, Jr., first showed promise as a golfer around Chicago in the period 1906–10. He was runner-up in the U.S. amateur of 1912 and the U.S. open of 1914, winning the western amateur title in both those years and also in 1909 and 1915. In 1916 he became the first golfer to win the U.S. amateur and open in the same year; his score of 286 in the open stood as the record low for 20 years, until Tony Manero scored 282 in the 1936 open. In 1942, at the age of 52, Evans fought his way against excellent competition to the final of the Chicago city championship, where he was defeated by a youthful opponent. Evans competed in the open championship at Baltusrol Golf club, Springfield, N.J., in June 1954, where he had the honour of being the oldest contestant at the age of 64.

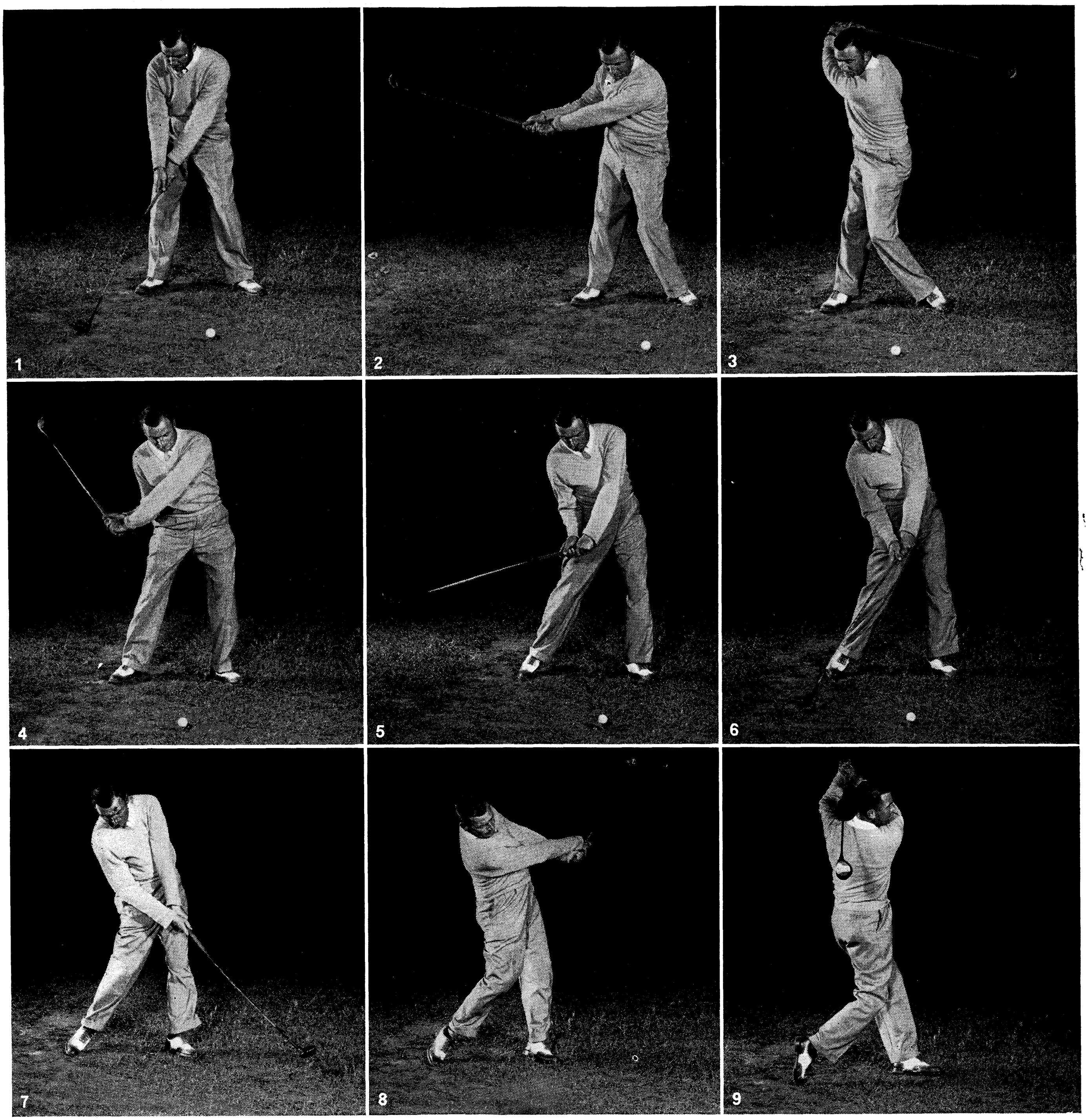
Bobby Jones is regarded as the greatest amateur golfer of modern times. His career was brilliant from his debut in national competition in the U.S. amateur of 1916 until his unparalleled performance in 1930 of winning all four of the world's most difficult titles—the British amateur, the British open, the U.S. amateur and the U.S. open. This feat became known as Jones's "grand slam." During his golfing career Jones won the British open three times, the British amateur once, the U.S. open four times and the U.S. amateur five times. He played for the U.S. against Britain in the Walker cup team matches in 1922, 1924, 1926, 1928 and 1930.

W. Lawson Little, Jr., first appeared in national competition in the 1929 U.S. amateur, where he was defeated in the semifinal round by Francis Ouimet. In 1934 he won both the United States and British amateur titles and the following year repeated his victories in both events. Little turned professional in 1936, won the Canadian open that year and the U.S. open in 1940.

Among other U.S. players who won the amateur championship have been H. Whigham (1896, 1897), C. Egan (1904, 1905), M. Ward (1939, 1941), W. Turnesa (1938, 1948) and H. Ward, Jr. (1955, 1956).

Professional golfers contributed richly to the history of the game in the United States, and while it was well into the 20th century before there was a native-born champion among them, the over-all record of the pros was remarkable. No other country produced so many able players; Walter Hagen and Gene Sarazen were particularly outstanding.

Walter Hagen first appeared on the national scene in the 1913 U.S. open at Brookline, where he gave an excellent account of himself, considering his competitive inexperience, and placed fourth



PHOTOGRAPHS. FRANK J. SCHERSCHEL

STROBO-FLASH PHOTOGRAPHS OF A WELL-EXECUTED FULL TEE-SHOT

1. The iritial movement of the backswing is a turn of the left hip to the right. As the body "winds up," the shoulders, arms, hands and club follow in one co-ordinated movement, with the club-shaft kept in line with a straight (but not tense) left arm. The club-head starts low aiong the ground and follows the body-turn

2. The wrists do not enter the swing in any way until this stage, at which point they begin to "cock," are fully cocked at the top of the swing, and remain so until just before the ball is hit. The greater part of the player's weight has shifted onto his braced right leg, the left side is relaxed, and the left heel has eased very slightly from the ground

3. At the top of the swing, there is a full body-turn, essential for power. The club-shaft has reached the horizontal, with both hands well under the shaft and fully cocked. A full grip is maintained with the left hand, and the left arm is held as straight as possible without tenseness

4. The left hip starts the downswing. As the body uncoils, it pulls the left arm down into the hitting area. The left arm continues to be held straight, with the cock of the wrists preserved. Observe in this and figs. 5 and 6 how the player's weight gradually shifts off the right leg

5. The left hip has turned well out of the way of the shot, clearing the path for the straight left arm. Wrists are uncocking to bring the club again into alignment with the left arm, thus delivering a powerful blow to the ball

6. As the club approaches impact with the ball, the wrists have straightened; so have the legs. There is a feeling of hitting against a firm left side. The whole right hand hits hard, as though slapping a flat object. Left hand grip must be firm enough to support this hit

7. The club-head, after impact, follows the line of flight until the wrists naturally begin to turn. The action is that of centrifugal force, applied from a solidly-grounded triangular foundation composed of the two feet and the head

8. Note that, until this view, the head has been held steady throughout the swing. This position is important in preserving balance. Observe also that, until now, the right elbow has been kept comfortably close to the right hip, to give the swing compactness

9. At the finish of the swing, the body has turned to face the line of flight. The head is not raised, but waits until it is pushed up by contact of the right shoulder on the chin. The player's balance continues to be retained, with most of his weight on his left heel

against an expert field. The following year at Chicago he won the event. His golf, entirely self-taught. was unorthodox; he had no desire to copy the smoother swings of his fellow professionals. He scorned to practise by the hour, as was the practice of other pros. To Hagen, more than to any other golfer, goes the credit for breaking down the barriers between amateurs and professionals. Between 1914 and 1936 Hagen won the U.S. open twice, the British open four times (a feat matched after World War I only by A. D. Locke of South Africa and P. W. Thomson of Australia), the P.G.A. championship five times (including four in a row—1924, 1925. 1926, 1927), the Canadian, French and Belgian opens once each and at least 45 other events of lesser importance. In all he participated in not less than 200 open tournaments and was rarely out of the money. In addition, he played in about 1,500 exhibition matches in the C.S. and other countries, many of them for high fees or stakes. He is said to have earned around $1,000,000 during the 22 years he was rated as a top-flight golfer.

Gene Sarazen reached golfing fame in 1922 by winning the U.S. open at Chicago and proved he was a golfer of more than passing ability by adding the professional title that same year at Oakmont, Pa., and the following year at Pelham. N.Y. No further titles of importance came his way for ten years, but during this period he was a constant competitive threat. In 1932 he reappeared as a champion, winning the British open with a brilliant 283 and the U.S. open with an equally brilliant 286, which tied the then low-scoring record established in 1916 by Chick Evans. In 1933 he won the P.G.A. title for the third time and came within one stroke of winning the British open. In 1940 he tied Lawson Little for the U S. open championship with a score of 287, but lost the play-off with 73 to Little's 70.

As Hagen, Sarazen and Tommy Armour passed their prime, other professionals carried on but it aas not until the late 1930s that the so-called pro circuit, underwritten by civic and club organizations throughout the country, began putting up major prize money for the experts. Robert E. Harlow developed this circuit and was the first tournament manager of the P.G.A. Fred Corcoran succeeded him in 1937. That year. aggregate prize monies totaled $100,000; when Corcoran left the field in 1947, they totaled $650,-000. Tournament purses had grown from a $3,000 minimum in 1937 to a $15,000 minimum after World War II. In the second half of the 20th century the P.G.A. circuit offered approximately $1,000,000 in prizes annually.

Other names in U.S. professional golf history include J. Barnes, who won the professional title in 1916 and 1919, L. Diegel, who won in 1928 and 1929, D. Shute, who won in 1936 and 1937, and R. Guldahl, who won the open title in 1937 and 1938. Byron Nelson, Ben Hogan and Sam Snead, after 1940, combined to win the major portion of prize monies. Following World War II Nelson retired from serious tournament participation. After winning the U.S. open and the P.G.A. title in 1948, Hogan, following his recovery from serious injuries suffered in an automobile accident, returned to the golfing circuit in 1950 and won the U.S. open in that year and in 1951 and 1953, the year he also won the British open to duplicate the historic feats of only two other Americans, Bobby Jones and Gene Sarazen.

After the open. the leading tournament in prestige became, perhaps, the masters, played each spring at Augusta, Ga. Instituted in 1934, the masters tournament, an invitational affair, receives national attention.

In the United States from 1900 to 1930, four women golfers were outstanding. First of these was Margaret Curtis. who won the women's chainpionship in 1907, 1911 and 1912. The next outstanding champion was Alexa Stirling of Atlanta, Ga.. who won her first national title while quite young in 1916 and repeated in 1919 and 1920. She nas runner-up in 1921 and 1923 and in 1925, as Mrs. W. G. Fraser. She also won the Canadian championship in 1920 and 1934.

Another great U.S. woman golfer is Mrs. Glenna Collett Vare, who learned her golf around Providence. R.I., won her first women's title in 1922 and repeated on five occasions—1925, 1928, 1929, 1930 and 1935. She made four attempts at the British crown, but was turned back twice in the final round. Mrs. Vare's extended hold on women's golf was broken when Virginia Van Wie of Chicago replaced her as champion during the three seasons of 1932, 1933 and 1934. Physical inability to continue in tournament play forced Miss Van Wie to forfeit her title without contest in 1935. Betty Jameson won the title twice in a row, in 1939 and 1940.

The greatest names in women's golf after World War II included Mrs. Mildred ("Babe") Didrikson Zaharias, Patty Berg, Louise Suggs and Betsy Rawls, all of whom played professionally. Mrs. Zaharias, an Olympic winner in track and field in 1932, picked up a golf club that year at the invitation of Grantland Rice and from that time played the game with astounding success. She regained her amateur status long enough to win the British women's amateur title in 1947—the first American to do so. She turned pro again and embarked on a series of successful golf tours. The women follow a professional circuit similar to if less demanding than that of their male counterparts. From 1946, when the women started their own open championship, Mrs. Zaharias continued to be the leading woman player until her death in 1956, the most famous competitor since the days of Mrs. Vare.

Television enhanced the popularity of golf, such tournaments as the open, masters and several others being given network coverage on the final day. It mas estimated, for example, that more than 20,000,000 viewers witnessed Lew Worsham's dramatic 104-yd. second shot into the cup on the final hole to win a tournament at Tam O'Shanter in 1953.

IV. THE MODERN GAME

A. Playing the Course

The game consists in playing the ball from a teeing ground into a hole by successive strokes in accordance with the rules. The stipulated round consists of 18 holes, and most golf courses have 18. Standard 18-hole courses measure from 6,500 to 6,800 yd.; individual holes, from 100 to 600 yd. However, some courses have only nine holes and these are played twice in a stipulated round. The clubs are designed for the various positions in which the ball may come to rest and for the various distances to the hole. The objective is to hole the ball in the fewest strokes.

There are two distinct forms of play: match play and stroke (medal) play. In match play the player and his opponent are playing together and competing only against each other, while in stroke play each competitor is competing against every other player in the tournament. In match play, the game is played by holes and each hole is won by the player who holes his ball in the fewer strokes. If both players hole in the same number of strokes, it is halved. When a player has won one more hole than his opponents, he is said to be one up. The match is won by the player who is leading by a number of holes greater than the number of holes remaining to be played, as, for example, three up and two to play. In stroke play, the competitor who holes the stipulated round or rounds in the fewest total strokes is the winner. Amateur championships usually are at match play and professional and open championships at stroke play, over 72 holes.

In both match and stroke play, players can compete as individuals or as partners. When two players compete as partners. each playing his own ball, the better ball on each hole is their score for that hole; this is a four-ball or best-ball match. Two players may compete as partners with two others, each pair playing alternate strokes on a single ball; this is a match foursome.

Players of varying abilities compete against each other by using handicaps. A handicap is the number of strokes a player receives to adjust his score to a common level. The better the player, the smaller his handicap, and the best players have handicaps of zero and are called scratch players. A scratch player whose average score is 70 can have an enjoyable match with a player whose average score is 80 by giving him a handicap of 10 strokes. Handicap golf is limited to amateur competitions, and championship tournaments are played without handicaps.

The starting place for each hole to be played is the teeing ground. The front is indicated by two markers, and the teeing ground is the rectangular space two club lengths in depth directly behind the line indicated by the markers. The player tees his ball anywhere within this space, usually setting it up on a small wooden or plastic peg. and strikes it toward the hole. The stroke from the teeing ground is called the drive.

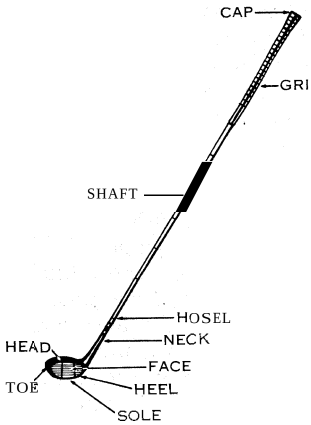


FIG I —PARTS OF A GOLF CLUB

The preferred line to the hole is generally a clear, mowed route called the fairway. The fairway is customarily bordered by longer grass called rough, and farther from the fairway there may be woods. At strategic places along the preferred line to the hole and guarding the putting green are obstacles called bunkers, depressions in the ground filled with sand (sand traps). Some holes require the player to skirt or cross streams or ponds. Both bunkers and bodies of nater are hazards.

The hole itself measures $4\frac{1}{4}$ in. in diameter, is at least 4 in. deep and is set in an area of turf specially prepared and maintained and closely mowed for putting. When the player putts, he uses a straight-faced club and rolls the ball across the putting green toward and eventually into the hole.

An expert player plays most holes in four strokes. a drive of 22j to 250 yd.. a shot to the green and two putts. However. every course contains a few short holes on which the expert might be expected to drive onto the putting green and a few long holes on which the expert might require a drive and two more strokes to reach the putting green. On the former. he would be expected to make 3 and on the latter 5, since two putts on each green is the standard.

Every course in the United States has a par. which is defined as the score an expert would be expected to make, and many courses also have a bogey. which is defined as the score that a moderately good golfer would be expected to make. Both par and bogey are defined by the U.S G.A as errorless play without flukes and under ordinary weather conditions, allowing two strokes on the putting green. However, par is essentially a U S term that came into use in the early 1900s as a base for computing handicaps under the system devised by L. Calkins of Plainfield, N J. Bogey is essentially a British term that came into use in England in 1891 and mas derived from a mythical Colonel Bogey, who was described as uniformly steady but never overbrilliant. As the terms developed, bogey was sometimes. although not always, one stroke higher than par.

Thus. colloquially in the United States, bogey often is used to indicate a score one stroke above par.

B. Clubs

In the average good player's set there are either 3 or 4 wood clubs and 9 or 10 irons (no more than 14 clubs may be carried during a round). No two clubs in a set are the same. There are differences in length and suppleness of shaft, weight, size and shape of head. the angle at which the shaft ends and the head begins (the lie) and the angle of the face of the club from the vertical (the loft). The various clubs are known both by number and by name. The names have come down from the early days of golf; the numbers are a U.S. innovation dating from the early 1920s, when matched sets came in and it was found more practical to indicate club gradations by consecutive numbering than to stamp the name on the club's sole. (See *Equipment* and the Development *of the* Game, above.)

1. Wood **Clubs.**—*Number* One (Driver). — Used from the tee for maximum distance: has a large head and a deep. almost vertical face. For the average player the driver is 42 to 43 in. long and weighs between 13 and 14 oz.

Number Two (Brassie).—So called because the sole of the club originally was covered with a brass plate. Used mostly for long shots from good fairway lies, the club has a slightly smaller and shallower face than a driver but nith more loft.

Number Three (Spoon). — Shorter shaft and shallower face than driver or brassie, but face has considerably more loft. The club is used to play the ball from lies too poor for a brassie, and also for strokes when the use of a driver or brassie would send the ball beyond the green.

Number Four *(Baffy)* — Smaller head, shallower face and more loft than a spoon. It will hit a ball about as far as a number one iron.

Number Five. —A great favourite with players who have an aversion to iron clubs, it replaces the number three or four iron. It has an extremely small and compact head.

2. **Irons.**—*Number* One (Driving Iron or *Cleek).*—A long shaft and very little loft to the club face. Used for tee shots and full shots of 190 to 205 yd. from lies too "heavy" for a wood A difficult club to use, it produces a long, low shot. Note: all distances here and below are calibrated for the medium-hitting player. The professionals get more distance.

Number Two *(Midiron).*—Slightly more loft, for shots from 180 to 190 yd.

Number Three (Mid Mashie). — For 165–175-yd shots.

Number Four *(Mashie* Iron) — For 150–165-yd. shots

Number Five *(Mashie).*—For shots between 140 and 150 yd. Ball pitches high and stops quickly after hitting the ground. This club is also used for pitch-and-run shots from 30 to 50 yd. off the green; the ball travels part of the way through the air, then rolls the rest of the nay.

Number Six (Spade Mashie).—For shots between 130 and 140 yd and also for playing the ball from high grass or difficult lies, when getting out is more important than distance.

Number Seven *(Mashie* Niblick). — Resembles the spade mashie, but has still more loft and head weight. Used for shots between 125 and 135 yd.; puts plenty of backspin on the ball.

Number Eight (Pztchzng *Niblick).*—Still more loft, for shots of from 120 to 130 yd.

Number Nzne (Niblick). — Face has a great deal of loft and the head is heavy. to carry it through long tough grass or heavy sand A ball, properly hit, rises almost vertically and upon hitting the

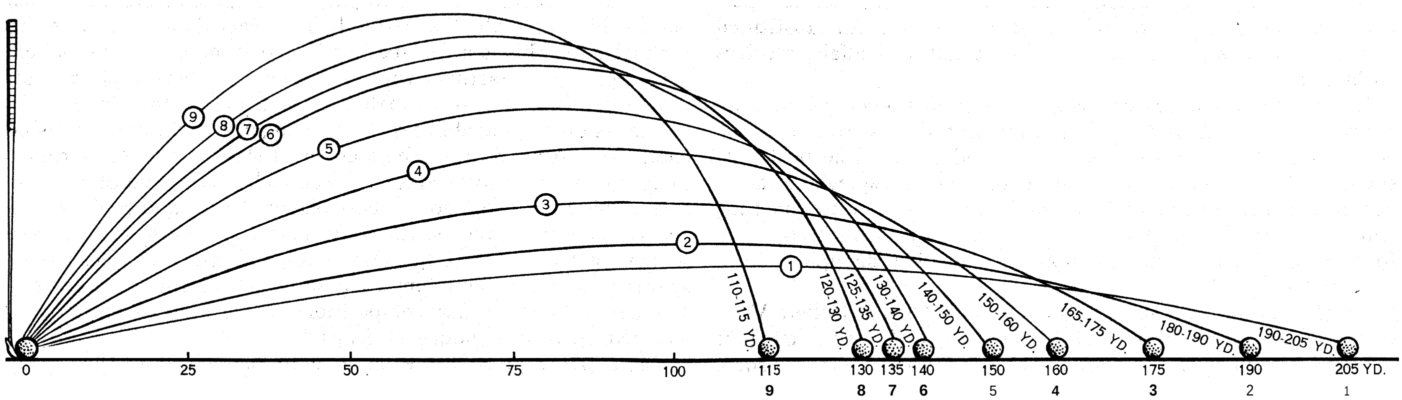


FIG. 2.— DISTANCESAN EXPERT PLAYER GETS WITH VARIOUS IRONS

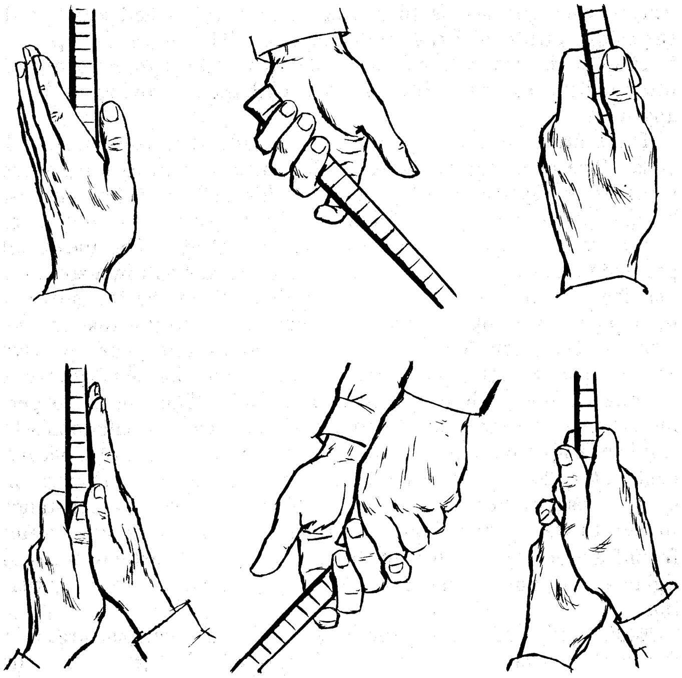


FIG 3 —PROGRESSIVE STAGES IN ASSUMING OVERLAPPING GRIP OF GOLF CLUB

ground may jump backward as a result of the backspin this club imparts.

Number Ten (Wedge).——Face has a great deal of loft, like the niblick, but the club has a broad flange on the sole There are two types of wedges—the sand wedge to use in bunkers and the pitching wedge for pitch shots.

The *Putter*.—A club with a short stiff shaft and a straight or nearly straight face, for rolling the ball on the green. There are many styles of putters.

C. The Grip

While a golf club may be gripped in various nays and satisfactory shots result, the so-called overlapping grip seems to be the most commonly used among expert players and the most frequently taught by golf instructors. Fig. 3 shows the progressive stages of the hands of a right-handed player in assuming this grip, which is used for all clubs except the putter. (For recommended putting grip, see under Putting, below.)

While the overlapping grip is almost universally used among golfers. the interlocking grip has its advocates. This grip differs from the overlapping in only one particular—the little finger of the right hand does not overlap the left forefinger, but instead fits down between the left fore- and middle fingers.

D. Types of Shots

Descriptions are for right-handed players.

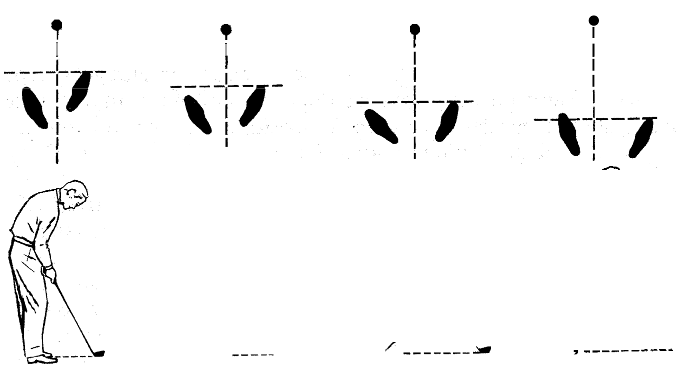


FIG 4 — VARIOUS STANCES LEFT TO RIGHT, CHIP SHOT, MASHIE SHOT, LONG-IRON SHOT. WOOD-CLUB SHOT

1. The Wood Shot.—With the wood clubs, the player assumes a generally square stance in relation to the intended line of flight. He should feel comfortable and well balanced. The club head is placed on the turf directly back of the ball, with the face at right angles to the flight line. Keeping his eye on the ball, the player starts the club back slowly along the ground until the extended arms naturally lift it. This action continues to the top of the swing, at which point the club shaft is approximately horizontal, with both wrists underneath it. The left arm is fairly straight but not rigid, with just enough elbow bend to permit freedom. The right elbow is kept close to the body. The backswing must be unhurried; a fast jerky backswing will destroy timing.

The downswing is started by a co-ordinated pull of the left hip, shoulder, arm and hand, slowly at first, then accelerated as the ball is neared. Care must be taken not to hit too soon; greatest acceleration should be achieved at the moment of impact with the ball. At impact the left arm and club shaft are in alignment and the club follows through along the line of flight until the arms naturally bring it up and around to the rear. The stroke with a wood club is a sweeping swing rather than the hit which characterizes play with irons.

2. The Iron Shot.—The technique employed in hitting an iron shot is somewhat different from that used with the woods. Iron shots are hit very crisply and downward; the club head comes in contact with the ball and continues down and through, taking some turf called a divot. This aids in control and imparts backspin to the ball so that it rises readily and comes to rest without much roll—a desirable feature, since irons are rarely used for distance but rather for shots of medium to short length. It is easier for the golfer to gauge the travel of a quick-stopping ball. Actually. contact with the ball and the turf must be almost simultaneous, since to hit the turf back of the ball will rob the shot of much of its power, while picking the ball clean mill result in a flat shot and too much roll.

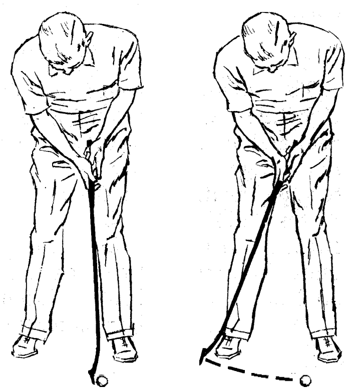


FIG. 8.—PUTTING STANCE AND BACKSTROKE

The stance for long irons is not greatly different from that employed with a wood, with the ball off the left heel, but as the iron selected for a shot becomes progressively shorter (that is, a shorter shaft and a face more laid back) the ball is played more and more toward the right foot. The swing is inclined to be more upright and. especially on the shorter shots, the backswing and follow-through are less full

3. Approaching.—When the player has come within close range of the green, two methods of play are open to him—he may pitch the ball all the way and depend on backspin to stop his ball near the pin, or he may play a chip shot in which the ball flies part way through the air, as to the edge of the close-clipped surface of the green, and then rolls the remaining distance.

4. Shots From Sand.—Even the most expert player will rarely complete his round without having to play his ball from the loose sand in a bunker adjacent to a green. For this purpose he uses his sand wedge. An open stance is used—that is, the left foot is considerably withdrawn from the line to the cup. Care is taken to norm the feet well into the sand to ensure a firm footing through the stroke. The club is carried up more vertically than in other shots and then sent down at a spot behind the ball, following a path that cuts across the line to the hole.

This places a layer of sand between the ball and the club head; the ball thus is blasted from the sand without actually being touched with the club.

When the player's ball is in a bunker at a distance from the green and lies well perched on the sand, it is possible to play an ordinary iron shot and get considerable distance.

5. Putting.— The putt, once the ball is on the green, is the

most delicate shot in golf. The player must hit the ball along a line that allows for very little margin of error, and with enough force to roll the ball to the hole but not too far beyond in case the hole is missed. And since most greens are not level but have numerous minor pitches and slopes great care must be taken to select the proper line, which may be quite far to one side or the other of the hole.

The grip for putting differs from the grip for other clubs. The hands are placed on the shaft so the palms are opposed and parallel to the putter blade. This is for the purpose of relieving all muscular strain in the wrists during the stroke. The player stands quite erect (see fig. 5) with his head directly over the ball and his feet close together and square to the line of putt. The ball is generally played off the left foot, in which case the player's weight is rather more over the left leg than the right, for the sake of balance.

Knees are slightly bent to avoid tenseness. Hands are kept close to the body, with the left elbow moved out to point along the line of putt. Head and body are not allowed to move during the stroke. The putter is soled square across the line of putt, then brought back low along the ground. On the downstroke the putter still maintains its position square in the line of putt, hits the ball crisply in dead centre, then follows through straight toward the hole.

E. Rules of Golf

The rule-making golf organizations are the R.A.G.C. and the U.S.G.A. As a result of a series of conferences in England and Scotland in 1951, the two bodies agreed on a uniform code of rules to govern play all over the world. The only difference is in the specifications for the ball. The minimum size for the United States ball is 1.680 in. in diameter; the minimum size for the British ball is 1.620 in. in diameter. The velocity of the United States ball may not be greater than 250 ft. per second when measured under prescribed conditions on an apparatus maintained by the U.S.G.A. but there is no velocity specification for the British ball.

The two bodies attempt to perpetuate the uniformity in rules by exchanging views on interpretations and on recommendations for revision.

While the basic principle of the rules is simple, the code itself has become complex over the years. The earliest known code, that of the Company of Gentlemen Golfers of Edinburgh, probably drawn up about 1745, contained only 13 rules (see History, above). However, they applied only to match play. As stroke play, foursomes, three-ball and four-ball play came into favour, additional rules had to be drawn. A rule that is fair for two opponents playing against each other might not work at all in stroke play, where each competitor is playing against the entire field. For example, if one ball strikes another on the putting green in singles match play, the owner of the ball struck may replace it or not as he chooses. No one except the two players involved has any interest in the incident. However, the owner of a ball so struck in stroke play must replace it, in fairness to all the other competitors in the field. Also, a rule that is satisfactory in individual play might be completely inadequate when two play as partners in either a match foursome or a four-ball match. There is an additional source of complexity in the fact that golf is played not on uniform fields or courts but on a wide variety of natural expanses.

The number of situations that can develop around a golf ball in play is almost limitless, and the rules makers have attempted over the years to cover as many as possible. Even so, it is impossible to cover all eventualities in rules, and both the U.S.G.A. and the R.A.G.C. issue a series of interpretations each year.

The basic principle of the rules is to require that the ball be played from the teeing ground into the hole by successive strokes with the club. The rules are designed to promote this objective and to prevent the game from becoming one of maneuver by hand. They have been summarized in the statement: "Play the ball as it lies and take the course as you find it." This means that, as a general rule, the ball is to be teed and not touched again with the hands until it is lifted from the hole. The player is expected to employ his own skill with his clubs to avoid rough, hazards and other difficulties and to play his ball without improving its lie in any way.

There are exceptions to this general rule that complicate the code. The rules, for example, provide means of proceeding when a player is physically unable to play his ball as it lies because he has lost it, hit it out of bounds where play is prohibited or into a water hazard where he cannot get at it. The means of proceeding in such cases involve playing another ball in a specified position. If, for example, a player's drive from the tee goes out of bounds, that stroke is counted as one and his next stroke is two. The U.S.G.A. adopted for a trial period of one year effective Jan. 1, 1960, a change in the rules eliminating the penalty stroke for a lost, unplayable or out-of-bounds ball. The rules also permit a player to take relief without penalty when his ball comes to rest in a temporary accumulation of water (as opposed to a permanent water hazard), in ground under repair, against a shed or in a paper bag or near any other artificial structure or substance foreign to the course. Thus the rules contain not only penalties for infractions or inability to proceed in normal fashion but also rights and privileges that a player may exercise in certain situations.

Additionally, of course, the rules define the various areas of the course, such as teeing ground, through the green, hazards and putting green, in each of which rules and procedures may differ. The rules also provide for orderly progress of play.

Golf is played on the honour system. A player is expected to count his own strokes even though he may miss the ball completely, to acknowledge the fact promptly if he violates a rule and incurs a penalty and to avoid interfering in any way with his opponent's or fellow competitors' play. When a referee accompanies players, his primary duty is to settle questions of fact and of golfing law. It is a basic requirement of good sportsmanship in golf to develop a working knowledge of the rules so that one will not through ignorance take advantage of another player, in either a tournament or an informal game. Few players or officials, however, are able to answer all questions that may arise in the differing forms of play, and the experienced ones usually carry rules booklets for reference.

F. Rules of Amateur Status

Golfing rules of amateur status are among the most strict. The U.S.G.A. and the R.A.G.C. both define an amateur as "one who plays the game solely as a non-remunerative or non-profit-making sport."

The rules prohibit an amateur from playing for a money prize, from accepting a prize readily convertible into money or having a retail value exceeding $150 (£30 in Great Britain) and from receiving compensation for giving instruction. The rules also prohibit amateurs from accepting payments in any form, directly or indirectly, toward expenses incurred in connection with a golf competition, with a few specific exceptions under which the British are slightly more liberal. British amateurs may accept payments toward expenses incurred as members of an international, county or club team or similar body. United States amateurs may accept payments toward expenses incurred as members of an international team only. The U.S.G.A. also permits amateurs to accept payments toward expenses incurred as participants in its amateur public links championship and in competitions limited to members of educational institutions, industrial organizations and military services.

Otherwise, amateur golfers are expected to adhere strictly to the classic ideal that amateurs play purely for pleasure and at their own expense.

Additional rules in both codes are designed to deter amateurs from commercializing in any way on their skills or reputations as golfers. However, professionals and amateurs may compete together at will and frequently do. Also, professionals in other sports may play as amateurs in golf provided they conduct themselves in accordance with the rules of amateur status. A golfer who has relinquished his amateur status but has not been a professional for more than five years may regain amateur status by applying to the governing body in his country and serving a probationary period of two years from the date of his last violation of the rules.

V. GLOSSARY

The following terms are used in printed accounts of golf matches and in books of instruction; also included are some vernacular expressions in common usage among players.

Ace.—A hole scored in one stroke.

Addressing the ball.—A player has "addressed the ball" when he has taken his stance by placing his ieet in position ior and preparatory to making a stroke and has also grounded his club (see Ground), except that in a hazard a player has addressed the ball when he has taken his stance preparatory to making a stroke.

All square.—An even score, neither side being a hole up.

Approach.—A stroke or shot to the putting green.

Apron.—The last few yards of iairway in iront oi the green.

Away.—The farthest from the hole.

Backspin.—Backward rotation of the ball, causing it to stop abruptly.

Bent grass.—A species of grass used ior putting greens.

Best ball.—Match in which a single player .competes against the best ball of two or more.

Birdie.—One stroke under par ior a hole.

Bisque.—A handicap stroke or strokes to be taken when desired, with the provision that the player must announce his choice to use a bisque on any hole before teeing off for the next hole.

Blind.—An approach position irom which the green cannot be seen.

Bogey.—Score a moderately good golfer would be expected to make on a hole, allowing two putts.

Borrow.—In putting, to play to either side of the direct line from the ball to the hole to compensate for roll or slant in the green.

Bunker.—An area of bare ground, often a marked depression, usually covered with sand. (See Sand trap; Hazard.)

Bye holes.—Holes remaining aiter a match is finished, that is, after one side is more holes up than remain for play.

Caddie.—Person who carries a player's clubs.

Carry.—Distance irom where a ball is hit to where it first strikes the ground.

Casual water.—Any temporary accumulation of water, as a puddle after rain.

Chip.—Short approach shot, on which the ball flies close to the ground.

Concede.—(*a*) To grant that an opponent will hole out a dead ball (see Dead) in one more stroke. (b) To grant that an opponent has won a hole beiore play has been completed.

Course.—The terrain over which the game is played; the whole area within which play is permitted. (See also Links.)

Cup.—The hole into which the ball is played, $4\frac{1}{4}$ in. in diameter and at least 4 in. deep. (See also Hole.)

Dead.—A ball is said to be dead when so near the hole that putting it in on the next stroke is a "dead" certainty; a ball is said to fall dead when it pitches with little or no run.

Default.—To concede a match to an opponent without playing against him; to fail to appear for a scheduled match.

Divot.—A piece of turf cut out by a club during a stroke, which should always be replaced before the player moves on.

Dog-leg.—A hole that bends sharply to leit or right between tee and green.

Dormie.—A side is dormie when it is as many holes up as remain to be played.

Doton.—In match play, a side is down when it has lost more holes than it has won.

Draw.—Controlled hook (see Hook).

Dub.—An unskilliul player; also, to hit the ball poorly.

Eagle.—Two strokes under par ior a hole.

Face.—(a) Slope of a bunker. (b) Part of the club head that strikes the ball.

Fade.—Controlled slice (see Slice).

Fairway.—The closely cut turf intended for play between tee and green.

Flagstick.—Movable straight indicator, usually a lightweight pole with a numbered flag, placed in the hole to show its location: sometimes referred to as the pin.

Follow-through.—Continuation of the swing of the club after the ball has been struck.

"Fore!"—Warning cry by a player to any person in the way of his ball.

Forecaddie.—A person employed to indicate the position oi balls on the course.

Four-ball match.—A match in which there are two players to a side, each side playing its better ball against the better ball of the other side

Foursome.—A match in which there are two players to a side, each side playing one ball.

Gobble.—A boldly hit putt which finds the hole.

Green.—Putting green around a hole.

Gross.—A player's score beiore deducting any handicap.

Ground.—To sole or rest the club lightly on the ground, preparatory to striking the ball (see Addressing the Ball).

Ground under repair.—Any portion oi the course under repair or maintenance. If a ball should land on ground under repair or if the ground under repair should interfere with the player's stance or swing, the ball may be lifted and dropped, without penalty, as near as possible to where it lay, but not nearer the hole.

Halved.—A hole is halved when each side has taken the same number of strokes.

Handicap.—The number of strokes a player receives to adjust his score to a common level, the generally accepted common level being scratch, or zero-handicap golf.

Hanging.—X hanging ball is one which lies on a downslope.

Hazard.—Any bunker or water hazard.

Heel.—(a) Part of the club head nearest the shait. (b) To hit from this part and send the ball at right angles to the line of play.

Hole.—(a) The hole into which the ball is played (see Cup). (b) One of the 18 units, or holes, on a course, consisting of teeing ground, fairway, rough, hazards and putting green.

Hole-high.—A ball that lies even with the hole (cup) but to one side or the other.

Hole out.—Make the final stroke in playing the ball into the hole.

Honour.—The privilege oi driving off, or playing from the teeing ground, first.

Hook.—To curve the ball widely to the left.

Hosel.—Socket on the club head into which the shait is fitted.

Lateral water *hazard.*—A water hazard running approximately parallel to the line of play and so situated that it is impractical to keep the spot at which a ball crosses the hazard margin between the player and the hole.

Lie.—(a) The inclination of a club when held on the ground in the natural position for striking. (b) The situation of the ball.

Like.—Stroke which makes a player's score equal to his opponent's on a given hole.

Line.—The direction in which a player desires his ball to travel.

Links—A golf course, especially a seaside course.

Loft.—(a) To elevate the ball. (b) Backward slant of the face of the club.

Long game.—The strokes where attaining distance is the more important factor

Loose impediments.—Natural object not fixed or growing, as a stone, leaf or twig.

Marker.—(a) A scorer in stroke play appointed by a tournament committee to record a competitor's score. (b) A marker indicating the iront edge oi a teeing ground or the boundaries of a hole.

Match play.—Reckoning the score by holes won and lost.

Medal play.—Stroke play (see Stroke Play).

Mixed foursome.—Foursome in which a man and a woman play as partners.

Nassau.—A system of scoring under which one point is awarded for winning the first 9 holes, one ior the second 9, and a third ior the full 18.

Net.—Score after deducting handicap.

Observer.—Person appointed by a tournament committee to assist a referee in deciding questions of iact and to report to him any breach of a rule or local rule.

Obstruction.—Anything artificial that has been erected, placed or leit on the course.

Odd.—Stroke that makes a player's score one more than his opponent's on a given hole.

Out of *bounds.*—Ground on which play is prohibited.

Outside agency.—Reieree, observer, marker, forecaddie or other agency not a part of the match or, in stroke play, not a part of a player's side. .

Par.—Theoretically periect play, or the score an expert would be expected to make on a hole, calculated on the number of strokes required to reach the green plus two putts. Par is calculated on the basis oi distance. Women's par for a course is slightly higher than par for men. U.S.G.A. standards ior computing par are:

	Men's par	Women's par
Par 3	Up to 250 yd.	up to 210 yd.
Par 4	251 to 470 yd.	211 to 400 yd.
Par 5	471 and over	401 to 575 yd.
Par 6		576 yd. and over

Penalty stroke.—A stroke added to the score of a side under certain rules.

Pin.—Rod or pole to which flag is attached (see Flagstick).

Pitch.—An approach on which the ball is lofted in a high arc (see Chip).

Pitch-and-run.—An approach on which a part of the desired distance is covered by the roll of the ball after it strikes the ground.

Pivot.—The turn of the body as a stroke is played.

Pull.—To hit the ball so that it will curve to the left.

Putt.—Stroke made on a putting green.

Putting green.—All ground oi the hole being played that is specially prepared for putting or is otherwise defined as such by the committee.

Referee.—Person appointed by the tournament committee to accompany players to decide questions of fact and rules of golf.

Rough.—Long grass bordering the fairway, also at times between tee and fairway; may include bushes, trees, etc.

Rub of the green.—Any deflection or stoppage of a ball by an outside agency; the ball is played as it lies, without penalty.

Run—(a) To run a ball along the ground in an approach, instead of chipping or pitching it. (b) Distance a ball rolls after it lands.

Sand trap.—A bunker having a layer of sand (see Bunker).

Sclaff.—To hit the ground behind the ball, derived from a Scots term meaning "a slight blow."

Scratch player.—One who receives no handicap allowance.

Short game.—Approach shots and putts.

Single.—Match between two players.

Slice.—To curve the ball widely to the right.

Square.—When a match is even.

Stance.—Position of player's feet and body when addressing the ball.

Stroke.—Forward movement of the club with the intention of fairly striking the ball.

Stroke hole.—Hole on which a handicap stroke is given.

Stroke play.—Reckoning the score by total strokes, also known as medal play.

Tee.—An artificial peg or a pinch of sand on which the ball may be placed for the first stroke on each hole.

Teeing ground.—Starting place for the hole to be played, indicated by two marks on the ground; also called the tee.

Three-ball match.—Match in which three play against one another, each playing his own ball.

Threesome—Match in which one player competes against two, who play alternate strokes with the same ball.

Through the green.—The whole area of the course except hazards and the teeing ground and putting green of the hole being played.

Up.—In match play, a side is up when it has won more holes than it has lost.

Water hazard.—Any water (except casual water) or watercourse, regardless of whether it contains water.

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See also the *USGA Journal and Turf Management,* published by the United States Golf Association.

(J. P. EH)

GOLGI, CAMILLO (1843–1926), Italian physician and Nobel laureate noted for basic researches in neurology, was born in Cortona, July 9, 1843 (or, according to some sources, July 7, 1844). After taking his degree at Pavia in 1865 he became physician at the home for incurables in the village of Abbiategrasso. There, despite the primitive means of investigation available, he discovered his silver nitrate method of staining nerve cells and fibres—a method which gave the key to the finer structure of the nervous system. In 1883 he demonstrated in the central nervous system multipolar cells with many branching processes (Golgi cells) that establish connections with other nerve cells. This discovery led to W. von Waldeyer's conception of the neuron as the unit of the nervous system and was fundamental for the development of modern neurology.

Apart from histological researches, Golgi was famous for his observations on malaria. He showed that the parasite of quartan fever differs from that of tertian, that malarial paroxysms are coincident with sporulation of the parasites and that the severity of a malarial attack depends on the number of parasites in the blood. He also made valuable observations on pellagra and on the causation of mental disease.

From 1875 Golgi held in succession the chairs of anatomy and histology and general pathology and histology in the University of Pavia.

In 1906 Golgi, jointly with S. Ramón y Cajal (*q.v.*), was awarded the Nobel prize for physiology or medicine for his work on the structure of the nervous system. He died in Pavia on Jan. 21, 1926.

(W. J. BP.)

GOLGOTHA, a skull, from the Aramaic Golgolta (גֻּלְגָּלְתָּא Targ. Onqelos of Ex. xvi, 16, with the second "l" omitted for euphony to Greek ears). The name of the spot where Christ was crucified (Matt. xxvii, 33; Mark xv, 22; John xix, 17), outside Jerusalem.

The exact location of Golgotha is uncertain. The traditional site may be the correct one. The location depends on the lines along which the walls of Jerusalem ran in Jesus' day. These lines are not now known with certainty.

GOLIAD, an incorporated village of southeast Texas, U.S., on the San Antonio river and the Southern Pacific railway, 85 mi. S.E. of San Antonio; the county seat of Goliad county. Goliad is surrounded by a very rich farming and grazing country.

In nearby Goliad State park are a restored Spanish mission and the well-preserved ruins of a presidio, moved there in 1749. The name Goliad, in use since 1829, is probably an anagram of the name of the Mexican patriot Hidalgo (1757–1811). During the struggle between Mexico and Spain the Mexican leader Bernardo Gutiérrez was besieged there. On the outbreak of the Texan War of Liberation, Goliad was garrisoned by a small force of Mexicans who were soon forced to surrender and, on Dec. 20, 1835, a preliminary "declaration of independence" was published there.

In 1836, when Santa Anna began his advance, Goliad was occupied by 350 American troops under Col. James W. Fannin. In obeying orders to withdraw and join Gen. Sam Houston, they were overtaken on Coletto creek, and after a sharp fight (March 19–20) were obliged to surrender; they were marched back to Goliad and shot down (March 27) by Santa Anna's command.

GOLIARD, a name applied to those wandering students (*vagantes*) and clerks in England, France and Germany, during the 12th and 13th centuries, who were better known for their rioting, gambling and intemperance than for their scholarship. The derivation of the word is uncertain, but it was connected by them with a mythical "Bishop Golias," also called "archipoeta" and "primas"—especially in Germany—in whose name their satirical poems were mostly written. The jocular references to the rules of the "guild" of goliards should not be taken too seriously, though their aping of the "orders" of the church, especially their contrasting them with the mendicants, was denounced by church synods.

Their satires were almost uniformly directed against the church, attacking even the pope. In 1227 the Council of Trèves forbade priests to permit the goliards to take part in chanting the service. In 1229 they played a conspicuous part in the disturbances at the University of Paris in connection with the intrigues of the papal legate.

During the century which followed they formed a subject for the deliberations of several church councils, notably in 1289, when it was ordered that "no clerks shall be jongleurs, goliards or buffoons," and in 1300 (at Cologne) when they were forbidden to preach or engage in the indulgence traffic. This legislation only became effective when the "privileges of clergy" were withdrawn from the goliards.

Along with their satires went many poems in praise of wine and riotous living. A remarkable collection of them, now at Munich, from the monastery at Benedictbeuren in Bavaria, was published by Schmeller (3rd ed., 1895) under the title Carmina

Burana. Many of these, which form the main part of songbooks of German students today, have been delicately translated by John Addington Symonds in a small volume, *Wine, Wonzen and Song* (1884).

The word "goliard" itself outlived these turbulent bands nhich had given it birth, and passed over into French and English literature of the 14th century in the general meaning of jongleur or minstrel, quite apart from any clerical association. It is thus used in *Piers Plowman*, where, however, the *goliard* still rhymes in Latin. and in Chaucer.

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GOLIATH, the name of the giant by slaying whom David achieved renown (I Sam. xvii). The Philistines had come up to make war against Saul, and this warrior came forth day by day to challenge to single combat. Only David ventured to respond, and armed with a sling and pebbles he overcame Goliath. The Philistines, seeing their champion killed, lost heart and were easily put to flight. The giant's arms were placed in the sanctuary, and it was his famous sword which David took with him in his flight from Saul (I Sam. xxi, 1–9). In another passage it is said that Goliath of Gath was slain by a certain Elhanan of Bethlehem in one of David's conflicts with the Philistines (II Sam. xxi, 18–22); the parallel II Chron. xx, 5 avoids the contradiction by reading "Elhanan . . . slew Lahmi the brother of Goliath." But this old popular story has probably preserved the more original tradition. and if Elhanan is the son of Dodo in the list of David's mighty men (II Sam. xxiii, 9, 24) the resemblance between the two names may have led to the transference.

GOLITSYN, BORIS ALEKSEYEVICH (1641–1713), Russian statesman, came of a princely family, claiming descent from Prince Gedymin of Lithuania. Boris became court chamberlain in 1676. He was the young tsar Peter's chief supporter when, in 1689, Peter resisted the usurpations of his sister Sophia, and the head of the loyal council which took refuge in the Troitsa monastery and won over the boyars of the opposite party. In 1690 he was created a boyar and shared with Naryshkin, Peter's uncle, the conduct of home affairs.

After the death of the tsaritsa Natalia, Peter's mother, in 1694, his influence increased further. He accompanied Peter to the White sea (1694–95); took part in the Azov campaign (1695); and was one of the triumvirate who ruled Russia during Peter's first foreign tour (1697–98). The Astrakhan rebellion (1706), which affected all the districts under his government, shook Peter's confidence in him and seriously impaired his position. In 1707 he was superseded in the Volgan provinces by Andrei Matveyev, and in 1713 entered a monastery. He was a typical representative of Russian society of the end of the 17th century in its transition from barbarism to civilization. In many respects he was far in advance of his age. He was highly educated, spoke Latin fluently, frequented the society of scholars and had his children carefully educated. Yet he was a habitual drunkard; it was his drunkenness which ruined him in the estimation of Peter the Great, despite his previous services.

See S. Soloviev, *History* of *Russia* (in Russian), vol. xiv (1858); R. N. Bain, *The First Romanovs* (1905).

GOLITSYN, BORIS BORISOVICH, PRINCE (1862–1916), Russian physicist known for his work on methods of earthquake observations and on the construction of seismographs. Born on Feb. 18 (old style), 1862, in St. Petersburg, he n-as educated in the naval school and naval academy. In 1887 he left the active service for scientific studies and went to Strasbourg. In 1891 he was appointed *Privatdocent* at the University of Moscow and in 1893 professor of physics at Dorpat. The same year he was elected fellow of the Academy of Sciences in St. Petersburg and in 1908 a member of the academy. His early research was in spectroscopy.

His valuable book, *Lectures on Seismometry,* was published in 1912 and translated into German in 1914. He received the degree of doctor of science from the University of Manchester in 1910 and in 1911 he was elected president of the International Seismological association. In 1913 he was appointed director of the Central Physical (later Geophysical) observatory at St. Petersburg and achieved good results in the organization of the meteorological service throughout Russia, especially during World War I. He died on May 4, 1916, in New Peterhof, near St. Petersburg.

(A. FOE.; X.)

GOLITSYN, DMITRY MIKHAILBVICH (1665–1737), Russian statesman, was sent in 1697 to Italy to learn "military affairs"; in 1704 he was appointed to the command of an auxiliary corps in Poland against Charles XII; from 1711 to 1718 he was governor of Belogorod. In 1718 he was appointed president of the newly erected *Kammer Kollegium* and a senator. In May 1723 he was implicated in the disgrace of the vice-chancellor Shafirov and was deprived of all his offices and dignities, which he only recovered through the mediation of the empress Catherine I. Golitsyn remained in the background till the fall of Menshikov, 1727. During the last years of Peter II (1728–30) his high aristocratic theories had full play. On the death of Peter II he conceived the idea of limiting the autocracy by subordinating it to the authority of the supreme privy council, of which he was president. He drew up a form of constitution which the empress Anne was forced to sign at Mittau before leaving for St. Petersburg. Anne lost no time in repudiating this constitution, and never forgave its authors. Golitsyn lived in retirement till 1736, when he was arrested on suspicion of being concerned in the conspiracy of his son-in-law Prince Constantine Cantimir. He was really prosecuted for his antimonarchical sentiments. A court, largely composed of his antagonists, condemned him to death, but the empress commuted the sentence to lifelong imprisonment in Schlusselburg and confiscation of all his estates. He died in prison on April 14, 1737, after three months of confinement.

See R. N. Bain, *The Pupils of Peter the Great* (1897).

GOLITSYN, VASILY VASIEEVICH (1643–1714), Russian statesman, spent his early days at the court of Tsar Alexius where he gradually rose to the rank of boyar. In 1676 he was sent to the Ukraine to keep in order the Crimean Tatars and took part in the Chigirin campaign. The revolution of May 1682 placed Golitsyn at the head of the *Posolsky Prikaz,* or ministry of foreign affairs, and during the regency of Sophia, sister' of Peter the Great, whose lover he became, he was the principal minister of state (1682–89) and "keeper of the great seal."

His foreign policy mas distinguished by the peace with Poland in 1683, whereby Russia recovered Kiev. By the terms of the same treaty, he acceded to the grand league against the Porte, but his two expeditions against the Crimea (1687 and 1689), "the First Crimean War," were unsuccessful and made him extremely unpopular. In the civil war between Sophia and Peter (Aug.–Sept. 1689), Golitsyn halfheartedly supported his mistress, and shared her ruin. He was banished successively to Kargopol, Mezen and Kologora, where he died on April 21, 1714. Golitsyn was unusually well educated. He understood German and Greek. and could express himself fluently in Latin. He was a great friend of foreigners, who generally alluded to him as "the great Golitsyn."

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GOLIUS or **GOHL, JACOBUS** (1596–1667), Dutch orientalist, born at The Hague, studied at the University of Leiden, where in Arabic and other eastern languages he was a pupil of Erpenius. In 1622 he accompanied the Dutch embassy to Morocco, and on his return he was chosen to succeed Erpenius (1624). He then spent five years traveling in Syria and Arabia. The remainder of his life was spent at Leiden where he held the chair of mathematics as well as that of Arabic. He died on Sept. 28, 1667. His most important work is the *Lexicon Arabico-Latinum* (Leiden, 1653), which, based on the *Sihah* of al-Jauhari, was only superseded by the corresponding work of Freytag. In

1656 he published a new edition, with considerable additions, of the *Grammatica Arabica* of Erpenius. After his death, there was found among his papers a *Dictionarium Persico-Latinum* which was published, with additions, by Edmund Castell in his *Lexicon heptaglotton* (1669).

GOLLANCZ, SIR HERMANN (1852–1930), Jewish rabbi, son of the Rev. S. M. Gollancz, studied at University college, London. He became an authority on the Hebrew language and literature, and in 1897 the Chief Rabbis in Galicia conferred on him the highest Rabbinical diplomas, "Hatarath Horaah." He was for 21 years Goldsmid professor of Hebrew at University college, and presented his library to the college at the end of this period (1902–24). From 1892 to 1923 he was predcher at the Bayswater synagogue, and was then appointed emeritus minister for his record service of 51 years. In that year he received a knighthood. He interested himself in many philanthropic works, and founded several synagogues for the working classes. He was a member of the commission on the birth-rate (1913–16), and other Government inquiries.

His publications include many translations from Hebrew and Aramaic and articles contributed to learned reviews.

GOLLANCZ, SIR ISRAEL (1863–1930), British scholar, was born in London July 13, 1863. He was educated at the City of London school and at University college, London and Christ's college, Cambridge. From 1892 to 1895 he was Quain student and lecturer in English at University college, London and in 1896 was appointed university lecturer in English at Cambridge, becoming in 1906 university professor of English language and literature at King's college, London. He became secretary of the British Academy on its foundation in 1903 and was knighted in 1919. He was general editor of the *Temple Classics* and *Kzngs Library* series and of the *Book* of *Homage to Shakespeare* which appeared in 1916. He died June 23, 1930. His published works include *Cynewulf's Christ* (1892); an edition of C. Lamb's *Specimens of Elizabethan Dramatists* (1893); *Exeter Book of Anglo-Saxon Poetry* (1895); *Hamlet in Iceland* (1898); and *The Caedmon Manuscript* of *Anglo-Saxon Biblical Poetry* (192;).

GOLOVIN, FEDOR ALEKSEYEVICH, Count (d. 1706), Russian statesman. During the regency of Sophia, sister of Peter the Great, he was sent to the Amur to defend the new Muscovite fortress of Albazin against the Chinese. In 1689 he concluded with the Celestial empire the Treaty of Nerchinsk. by which the line of the Amur, as far as its tributary the Gorhitsa, was retroceded to China. In Peter's grand embassy to the West in 1697 Golovin occupied the second place fmmediately after Lefort. It was his chief duty to hire foreign sailors and obtain everything necessary for the construction and complete equipment of a fleet. On Lefort's death, in March 1699, he succeeded him as admiral-general. The same year he was created the first Russian count, and was also the first to be decorated with the newly-instituted Russian order of St. Andrew. The conduct of foreign affairs was at the same time entrusted to him, and from 1699 to his death he was "the premier minister of the tsar." Golovin supplemented the Treaty of Carlowitz, by which peace with Turkey had only been secured for three years, by concluding with the Porte a new treaty at Constantinople (June 13, 1700), by which the term of the peace was extended to 30 years and, besides other concessions, the Azov district and a strip of territory extending thence to Kuban were ceded to Russia.

See R. N. Bain, *The First Romanovs* (1905). (R. N. B.)

GOLOVKIN, GAVRIIL IVANOVICH, Count (1660–1734), Russian statesman, was attached (1677), while still a lad, to the court of the tsarevitch Peter, afterwards Peter the Great, with whose mother Natalia he was connected, and vigilantly guarded him during the regency of Sophia. He accompanied the young tsar abroad on his first foreign tour, and worked by his side in the dockyards of Saardam. In 1706 he took over the direction of foreign affairs, and was created the first Russian grand-chancellor on the field of Poltava (1709). Golovkin held this office for 25 years. Under Catherine I. he became a member of the supreme privy council; the empress also entrusted him with her last will whereby she appointed the young Peter II. her successor and Golovkin one of his guardians. On the death of Peter II. in 1730 he declared in favour of Anne, duchess of Courland, in opposition to the aristocratic Dolgorukis and Golitsyns, and his determined support of the autocracy wrecked the proposed constitution, which would have converted Russia into a limited monarchy. Cnder Anne he was a member of the first cabinet formed in Russia. He was one of the wealthiest, and at the same time one of the stingiest, magnates of his day. His ignorance of any language but his own made his intercourse with foreign ministers very inconvenient.

See R. N Bain, *The Pupils* of *Peter the Great* (1897).

GOLOVNIN, VASILI MIKHAILOVICH (1776–1831), Russian naval officer, circumnavigator of the world. was born on April 8 (old style; April 20, new style), 1776, in the province of Ryazan. He received his education at the Kronstadt naval school and from 1801 to 1806 served as a volunteer in the English navy. In 1807 he nas commissioned by the Russian government to survey the coasts of Kamchatka and of Russian America, including also the Kuril Islands.

Golovnin sailed round the Cape of Good Hope, and on Oct. 5, 1809, arrived in Kamchatka. In 1810, while attempting to survey the coast of the island of Kunashiri. he was seized by the Japanese. remaining prisoner until Oct. 13, 1813. Golovnin was presently appointed to the command of a voyage of circumnavigation. He started from St. Petersburg on Sept. 7, 1817, sailed round Cape Horn, and arrived in Kamchatka in the following May He returned to Europe by way of the Cape of Good Hope, landing at St Petersburg on Sept. 1;. 1819.

He died on July 12. 1831. Golovnin's works include: *Journey to Kamchatka* (2 vol., 1819); *Journey Round the World* (2 vol. 1822); and *Narrative of My Captivity in Japan, 1811–1813* (2 vol, 1816). The last was translated into French, German and English (1824).

A complete edition of his works was published at St. Petersburg in five volumes in 1864, with maps and charts, and a biography of the author by N Grech.

GOLTZ, BOGUMIL (1801–1870), German humorist and satirist. uas born at Warsaw on March 20, 1801, and died at Thorn on Nov. 12 1870. Goltz wrote *Buch der Kzndheit* (Frankfort. 1847; 4th ed.. Berlin, 1877), in which he gives a charming and idyllic description of the impressions of his oun childhood Among his other works must be noted *Ein Jugendleben* (1852); *Der Mensch znd dze Leute* (1858); *Zur Charakterzstzk und Naturgeschichte der Frauen* (1859); *Zur Geschichte und Charakferzstik des deutschen Genius* (1864). and *Die Weltklugheit und die Lebensweisheit* (1869).

Goltz was a follower, in some respects, of Rousseau. He desired to see a freer. more natural system of education which should develop a robuster type of manhood.

GOLTZ, COLMAR, Baron von der (1843–1916), Prussian soldier and military writer, was born at Bielkenfeld, East Prussia on Aug. 12, 1843. and entered the Prussian infantry in 1861. In 1864 he entered the Berlin military academy, but was temporarily withdrawn in 1866 to serve in the Austrian war, in which he was wounded at Trautenau.

In 1867 he joined the topographical section of the general staff. and at the beginning of the Franco-German War of 1870–71 u-as attached to the staff of Prince Frederick Charles. In 1871 Goltz was appointed professor at the military school at Potsdam, and the same year was placed in the historical section of the general staff.

In 1878 Goltz became lecturer in military history at the military academy at Berlin, where he remained for five years He published. in 1883. *Rossbach und Jena* (new and rev. ed., *Von Rossbach bis Jena und Auerstadt,* 1906), *Das Volk in Waffen* (Eng. trans., *The Nation in Arms)* both of uhich quickly became military classics. In June 1883 his services were lent to Turkey to reorganize the military establishments of the country. He spent 12 years in this work, the result of which appeared in the Greco-Turkish War of 1897, and he was made a pasha and a *mushir* or field marshal. On his return to Germany in 1896 he became a lieutenant general In 1900 he uas made general of infantry. in

1908 colonel general and in 1911 field marshal. He retired in 1913.

In Aug. 1914 Goltz was appointed governor general of Belgium, then occupied by German forces. In November of the same year he was attached to the Turkish headquarters as aide-de-camp general to the sultan. He was placed in the chief command of the 1st Turkish army in Mesopotamia and succeeded in investing General Townshend's British forces at Kut-el-Amara in Dec. 1915. He died on April 19, 1916, at Baghdad; he was said to have been poisoned by the Young Turks.

Goltz's last work was *Kriegsgeschichte Deutschlands* im *19ten Jahrhundert, 2* vol. (1910–14).

GOLTZ, RUDIGER, COUNT VON DER (1865–1930), German lieutenant general. was born at Ziillichau on June *28, 1864.* He commanded a division of the *Landwehr* at the battle of the Masurian Lakes in Feb. 1915. In the spring of *1918* he led the Baltic division into Finland and was appointed chief in command in the Baltic countries in Nov. 1918. In 1919 he was leading a volunteer army professedly against the Bolshevists, but he was suspected of scheming to use his Baltic volunteers as an instrument for the royalist and reactionary movement and his recall was demanded. Sections of these troops *(Das Baltikum)* actually took part in the military occupation of Berlin which attended the Kapp *coup* in March 1920, and were with difficulty disbanded. He then took part in the youth movement, and in 1924 became president of the United Patriotic associations. Count von der Goltz wrote *Meine Sendung in Finnland und im Baltikum* (1920).

GOLTZIUS, HENDRIK *(1558–1617),* Dutch engraver, was born in *1558* at Mülebrecht. in the duchy of Jiilich. After studying painting on glass for several years under his father, he was taught the use of the burin by Dirk Volkertsz Coornlert, a Dutch engraver. He was employed by Philip Galle to engrave a set of prints of the history of Lucretia. Marriage with a rich widow at 21 enabled him to set up in independent business at Haarlem, where he spent the rest of his life. except for a tour in Germany and Italy in *1*590. He died at Haarlem on Jan. *1, 1617.*

Goltzius' portraits, mostly miniatures, are masterpieces of their kind, both on account of their exquisite finish and as fine studies of individual character. Of his larger heads, the life-size portrait of himself is probably the most striking example. Six scenes from the life of the Virgin are called his "masterpieces," from their being attempts to imitate the style of the old masters. In his command of the burin Goltzius is not surpassed even by Diirer; his eccentricities and extravagances are counterbalanced by the beauty and freedom of his execution. He began painting at the age of *42,* but none of his works in this branch of art displays any special excellences.

GOLUCHOWSKI, the name of an ancient family of Polish aristocracy, two members of which played an important part in Austrian politics. Count AGENOR GOLUCHOWSKI, the elder (1812–75), studied at Lemberg, served in the Galician *Statthalterei* under Stadion, and did excellent work on the Galician agrarian reform of 1847. In Nov. *1848* he became a member of Schwarzenberg's cabinet and was governor of Galicia, 1848–59, 1866–68 and 1871–75. From 1859–61 he was Austrian minister of the interior, during which period he secured for Galicia a degree of autonomy not enjoyed by any other Austrian crownland. while as governor of Galicia he secured the introduction of Polish as official language. He was the principal author of the federalist "October Diploma" of 1860 *(see* AUSTRIA, EMPIRE OF). An excellent administrator, Goluchowski transformed the policy of the Austrian Poles from romantic revolutionism to their eminently successful later policy of co-operation with the Austrian government in return for national concessions in Galicia, and was thus one of the true forerunners of Polish independence.

His son AGENOR GOLUCHOWSKI, the younger (1849–1921) was born on 'larch 25, *1849,* entered the Austro-Hungarian diplomatic service, served in Berlin. Paris and Budapest (1887–93) and became Austro-Hungarian minister of foreign affairs in May *1895.* The appointment caused surprise, but Goluchowski enjoyed Francis Joseph's personal confidence, and his policy was peaceable and practical, and generally conducted with an eye on economic necessities. In particular he showed a conciliatory spirit toward Russia for which he was often blamed by more bellicose spirits. He was author of the Austro-Russian agreement of *1897,* which temporarily ended the two Powers' rivalry in the Balkans and of the Macedonian reform plans of 1902 and 1903 (Mürzsteg program). At the same time, he contrived to pacify Italy's fears by guaranteeing the *status quo (1898)* and stood loyally by the German alliance. It was to Goluchowski that the German emperor William II addressed the famous telegram after Algeciras, saying that he had proved a "brilliant second" and could rely on the Imperial gratitude — a promise redeemed to Goluchowski's more aggressive successor, Aerenthal. in 1908. As a Pole and a Slav, Goluchowski was unpopular with the Magyars who believed him to be inspiring Francis Joseph's opposition to the use of Magyar in the army. He resigned office on Oct. 11, 1906, to ease the crisis in Hungary and did not return to office. He died in Lemberg on March *29, 1921.* (C. A. M.)

GÓMARA, FRANCISCO LÓPEZ DE *(1510–1560),* Spanish historian. author of the *Primera* y *Segunda Parte de la historia general de las Indias . . .* (1552), a panegyric of Hernán Cortés written in a pleasing style by a literary artist.

Gomara was educated at the University of Alcalá, where he took orders. Soon after *1 j40* he entered the household of the famous Cortés who supplied him with most of the material for his *Historia* and also with information which the historian used in his *Crónica de la conquista de Nueva España.* While the novel matter and the attractive style enchanted the Spanish public, the unmeasured laudations of Cortes at the expense of his lieutenants and companions brought about a violent reaction and both works were forbidden on Nov. *17,* 1553.

GOMARUS, FRANCISCUS (original surname GOMMER) *(1563–1641),* Dutch theologian and Calvinist leader, was born at Bruges on Jan. *30, 1563.* He studied at Strasbourg, Neustadt, Oxford and Cambridge, and was pastor of a Reformed Dutch church in Frankfurt am Main from 1587 till 1593, when the congregation was dispersed by persecution.

In *1 j94* he was appointed professor of theology at Leiden. where he became the leader of the opponents of Jacobus Arminius *(q.v.), 1603.* He disputed with Arminius before the assembly of the estates of Holland in *1608,* and was one of the five Gomarists who met five Arminians or Remonstrants in the same assembly of *1609.* On the death of Arminius, Konrad Vorstius. who sympathized with his views, was appointed to succeed him and as a result Gomarus resigned his professorship in *1611.* He became preacher at the Reformed church at Middleburg and taught theology and Hebrew in the newly founded *Illustre Schule.* Later he was professor at Saumur, then at Groningen. He took a leading part in the synod of Dort *(1618)* as an opponent of Arminianism *(q.v.).* He died at Groningen on Jan. 11, *1641.*

Gomarus' works were collected and published in one volume folio. in Amsterdam, in *1645.*

GOMEL (HOMEL), town in Gomel *oblast* of the Belorussian Soviet Socialist Republic, U.S.S.R.; latitude 52° 25' N., longitude 31° 0' E.. on the Sozh river, a tributary of the Dnieper. Pop. *(1959) 166.000.* It is situated on the great north road from Kiev, and is an important railway junction from which five lines radiate, one linking westward with Warsaw. It also has steamer routes to Kiev and Mogilev. Its industries include iron founding, agricultural machinery, sawmilling, the preparation of bristles, brewing and confectionery. It is situated in a forest and marsh-dotted county of the same name, drained by numerous tributaries of the Dnieper.

Its western position gives it a less extreme climate, average January temperatures $-6.j^o$ C., average July temperature 18.5° C. The rivers are frozen for 130 to 140 days.

The town is first mentioned in 1142, when it belonged to the prince of Chernigov. It was alternately in the occupation of Poland and Russia until 1772, when it was finally annexed by Russia. In 1648 it was captured by the Cossack chieftain Bogdan Chmielnicki *(q.v.).*

GOMER, the wife of the prophet Hosea. The first three chapters of the Book of Hosea are concerned with the marriage of Hosea and Gomer, a harlot, and the birth of their three children. *See* HOSEA.

GOMERA, an island in the province of Santa Cruz de Tenerife, part of the Spanish archipelago of the Canary Islands (*q.v.*). Pop. (1950) 29.899. Area 146 sq.mi. It lies 20 mi. W.S.W. of Tenerife and is almost circular, measuring 15¾ mi. from north to south and 13 mi. from east to west. The coasts, especially on the west, are rugged and precipitous and the land rises to the flattish dome of Garajonay (4,879 ft.) in the centre of the island. There is a nearly continuous plant cover consisting, above 1.600 ft., of tree heather scrub with some evergreens, *e.g.*, faya and Canarian holly; and in the lower areas composed mainly of euphorbias and sempervivum with thistles and brambles. Choughs are common and the scrub provides cover for partridges and other birds. The lower levels are semiarid but owing to the plentiful supply of fresh water from springs, the valley bottoms are irrigated and bananas and date palms are grown. In the south vines, figs. cereals and tomatoes arc cultivated. There are no industries other than agriculture and some salting of tunny fish, and the chief products are tomatoes and bananas.

Gomera has no harbour, but San Sebastian. on the east coast. has a sheltered roadstead and is backed by steep hills. It is the chief town, with a population of the municipio in 1950 of 6,664 It was the last stopping place of Christopher Columbus on his first voyage of discovery in 1492 and the house where he stayed and the church he attended are still standing (X)

The Whistled Language of **Gomera.**—Many Gomerans possess the ability to talk hy whistling, an art acquired from the Guanches (*q* a). Whistlers commonly insert tno fingers into the mouth, using the same modifications in position of lips, tongue etc., as in speech. In this manner they are able to produce greatly magnified birdlike sounds. nhich closely imitate the rhythm, tone and other intricacies of spoken Spanish, permitting them to converse across distances that the voice could not bridge. The most expert are found among the goatherds dnelling in the mountains around Chipude.

In the chronicle of the expedition of Jean de Bethencourt (*q.v.*) in 1402, an implausible legend of missing tongues is related, to account for the origin of the whistled language. A more scientific explanation is that it has been of slow development, perfected from necessity after generations of practice.

In 1934 an official test was conducted by the insular government in order to authenticate the fact that conversations phrased in simple words could be carried on. Separated beyond shouting distance. whistlers exchanged 13 unrehearsed messages, composed by a witness and dictated to them. All messages, as sent and as received. were thereupon recorded in writing. Upon subsequent comparison oi notes, 11 messages proved to have been transmitted and understood with exactitude; 2 showed inconsequential discrepancies: the expression "piece of paper" had been substituted for the word "newspaper"; and the command, "pick up two stones," was performed by picking up only one. (A. G. V.)

GOMES, DIOGO (fl. 1440–1482), Portuguese explorer of the Gambia and discoverer of the Cape Verde Islands, mas sent by Prince Henry the Navigator in about 1456 to explore the Guinea coast. Passing beyond the Rio Grande. he was swept back by currents and went far up the Gambia to the town of Cantor. There he made commercial treaties with the Negro chiefs and saw a flourishing trade in gold coming from the south. He had with him an interpreter called Jacob to facilitate communication with Prester John in Abyssinia. In 1460, on the second voyage, he joined with Antonio da Noli and on their return landed in Santiago in the Cape Verde Islands. Their ships later separated and Noli was the first to report the discovery and is credited with it. Portuguese records of exploration from 1448 to 1470 are almost nonexistent, but Gomes dictated accounts of his voyages, and of other earlier exploratory voyages under Prince Henry, to Martin Behaim about 1484. when both lived in the Azores.

Behaim made notes in German, which were translated into Latin by Valentim Fernandes. They were found in a codex in the Royal library at Munich in 1847.

See G. Pereira, "Diogo Gomez" *Bol. Soc. Georgra. Lisbon,* series xvii. *no.* 1. p. 267 ff. (1899) ; G. R. Crone, *The Voyages of Cadamosto,* Hakluyt Society, second series, no. lxxx, p. 91 ff. (1937). (A. Ds.)

GÓMEZ, JUAN VICENTE (c. 1857–1935), Venezuelan dictator, known as "the tyrant of the Andes," was a nearly full-blooded Indian. Of poor birth, he was raised in San Antonio, Táchira state, where he attained wealth and local influence before helping Cipriano Castro shoot his way into the presidency. He served as commander in chief of the army and vice-president and when Castro went to Europe in 1908 for medical treatment: the faithless Gómez seized power and had himself named president. He completely dominated the country until his death in 193j. He silenced the provincial *caudillos* and the Catholic Church and kept the army contented by providing it with modern equipment. Gómez' friendly relations with his neighbours, the U.S., and the nations of western Europe, and large-scale material development, made possible by revenues from the rapidly expanding petroleum industry, served to draw attention away from a brutal dictatorship. Gómez combined an insatiable acquisitiveness for money and power with an abundant capacity for immorality. When he died Dec. 17, 1935, he was the "dean" of all Latin-American tyrants, with 27 years to his credit, still busily adding to his riches, and, as a bachelor, to a long list oi illegitimate children. See VENEZUELA: *History*. (J. J. J.)

GOMEZ, LAUREANO ELEUTERIO (1889–), Colombian politician, was born Feb. 20, 1889 in Bogotá. He obtained an engineering degree in 1909 from the National university, where he entered politics and journalism. Gomez has held numerous high public offices and in 1932 became chief of the Conservative party leading its fight against the Liberal party in congress from 1932 to 1943. He exploited Liberal factionalism to restore Conservative control of government in 1946 and his presidential administration (1950–53) was noted ior economic development and intense rural political violence. Illness forced him to cease active presidential duties on Oct. 31, 1951, which he resumed on June 13, 1953, only to be immediately overthrown by Gen. Gustavo Rojas Pinilla, who seized the presidency.

In exile (1953–57) Gómez concluded agreements with Liberal chief Alberto Lleras Camargo establishing the national front which forced out Rojas on May 10, 1957. See COLOMBIA: *History*. (R. L. GE.)

GÓMEZ DE AVELLANEDA, GERTRUDIS (1814–1873), Spanish lyrical poet and dramatist remembered chiefly for her poems, was horn at Puerto Príncipe (now Camagiiey), Cuba, on March 23. 1814, and moved in 1836 to Spain, where she published her first poems (1841) under the pseudonym of LA PEREGRINA ("The Pilgrim"). Her novels. such as Sub (1841) and *Guatimozín* (1846), are of no great importance. She obtained, however. a series of successes on the stage with *Alfonso Munio* (1844). a tragedy in the new romantic manner; with *Saúl* (1849), *a* biblical drama; and with *Baltasar* (1858). La Avellaneda had a grandiose tragical vision of life, a vigorous eloquence rooted in pietistic pessimism. a dramatic gift eifective in isolated acts or scenes; but she was deficient in constructive power and in intellectual force. Her lyrics, though instinct with melancholy beauty or the tenderness of resigned devotion, too oiten lack human passion and sympathy. She died on Feb. 1, 1873.

See E. B. Williams, *The Life and Dramatic Works of G. Gómez de Avellaneda (1921); E.* Cotarelo y Mori, *La Avellaneda* y *sus obras* (1930).

GÓMEZ FARÍAS, VALENTÍN (1781–1858), Mexican liberal leader, notable for his social reforms of 1833–34 that make him a precursor of Benito Juárez. Born in Guadalajara on Feb. 14, 1781, and trained as a physician, he first became prominent in politics in 1822. In 1833 he was elected vice-president in the administration of Antonio López de Santa Anna (*q.v.*). His energetic support of laws that were designed to prune the temporal powers of the church. reduce the influence of the army and the landowning gentry and reform the university, caused his exile to New Orleans in 1835. A zealous lifelong advocate of federal republican government, his early admiration for the Cnited States changed to distrust by the time of the Mexican War. during which he was again vice-president. Personally devout, his anticlerical attitude has made him a controversial figure in Mexican history. He died in Mexico City on July 5, 1858.

See Vicente Fuentes Diaz, *Gómez Farías, padre de la reforma* (1948).
(C. A. Hn.)

GOMME, SIR GEORGE LAURENCE (1853–1916), knighted 1911, English archaeologist, was born in London on Dec. 17, 1853, and educated at the City of London school. As a boy he entered the service of the metropolitan board of works; but in 1891 he was appointed statistical officer to the London county council, becoming in 1900 clerk to the council. Few men have possessed a more profound knowledge of the past and present history of London, and his book The Making of London (1912) is a classic on the subject. He died at Long Crendon, Buckinghamshire, on Feb. 25, 1916.

GOMPERS, SAMUEL (1850–1924), U.S. labour leader, was born in London, Jan. 27, 1850, emigrated to New York in 1863 where he followed his father's trade of cigar making, and became a naturalized citizen in 1872. For years the leading U.S. labour leader, Gompers had a world-wide reputation for conservatism. He evolved the principles of "voluntarism" when the American community was bitterly hostile to labour organizations. "Voluntarism" stressed that unions should exert coercion by economic actions, *i.e.* strikes and boycotts. In 1886 Gompers led the national organization of cigar makers from the Knights of Labor to form the American Federation of Labor (A.F.L.), of which he was president from 1886 to 1924 (except for one year, 1895). He distrusted the influence of intellectual reformers, fearing any activity which would divert labour's energy from economic goals. To make unionism respectable as a bulwark against radicalism and irresponsible strikes, he encouraged binding written trade agreements and advocated the primacy of national organizations over both local unions and international affiliations.

Gompers kept the A.F.L. politically neutral until pressed by employer tactics, including an open-shop drive, and by federal court injunctions which greatly weakened labour's economic weapons, the strike, picket line and boycott. The Democratic platform of 1908 included an anti-injunction plank; accordingly, Gompers supported Bryan's unsuccessful presidential race. With the victory of Woodrow Wilson in 1912, the Clayton amendments to the Sherman Antitrust act (1914) and the Adamson act (1916) were passed and a cabinet post for labour was created (1913). Gompers hailed the Clayton amendments as "labour's Magna Carta," but the U.S. supreme court interpretation of the act vitiated this hope. He died at San Antonio, Tex., Dec. 13, 1924.

See J. R. Commons *et al.*, History *of Labour in the United States* (1921); Samuel Gompers, *Seventy Years of Life and Labour* (1925).
(R. M. R)

GOMPERZ, THEODOR (1832–1912), German philosopher and classical scholar, was born at Briinn on March 29, 1832. He studied at Briinn and under Herman Bonitz at Vienna. Professor of classical philology at Vienna from 1873 to 1901, he was elected a member of the Academy of Science in 1882. He received the D. Ph. *honoris* causa from Konigsberg and the D. Litt. from Dublin and from Cambridge and became correspondent for several learned societies. He died Aug. 29, 1912, at Baden-bei-Wien, Aus.

Gomperz supervised a translation of J. S. Mill's complete works (12 vol., 1869–80) and wrote a life of Mill (1889). His *Griechische* Denker: eine Geschichte der *antiken* Philosophie (2 vol., 1893–1902; new ed., 3 vol., 1922–24; Eng. trans., 4 vol., 1901–12) is the work for which he is chiefly remembered.

GONADS, DISORDERS OF. The male and female gonads, the testes and ovaries, secrete their respective sex hormones and are the site of maturation and development of spermatozoa and ova (gametogenesis). The sex hormones are responsible for the pubescent growth of the accessory sex organs and tissues and for their maintenance in a state compatible with normal function during adulthood. Pubescent maturation of the gonads and the rate of the secretion of the male and female hormones are controlled by gonadotropic hormones secreted by the anterior pituitary gland. The gonadal endocrine secretions in their turn have a suppressive influence on pituitary gonadotropin secretion. Normal testicular and ovarian functions are maintained in the adult by virtue of this delicately balanced interrelationship between the anterior pituitary gland and the gonads. The central nervous system may interject its modulating influence through the secretion of humoral products by the hypothalamus, that portion of the brain which lies just above the pituitary gland. It can be seen that gonadal disorders may arise from disturbances which affect primarily the hypothalamus, the pituitary or the gonads themselves. (See Endocrinology; Hormones.)

Several clinical syndromes have been explained by disturbances in fetal gonadal development. Although the sex of each embryo is determined genetically, the primordial gonad and the accessory sex apparatus have bisexual potentialities. The embryonic testes secrete a male organizing substance which causes the male accessory sex ducts, etc., to develop and those of the female to atrophy. The ovaries secrete no such organizing substance, but in the absence of the male morphogenetic secretion the female accessory system develops and the male ducts atrophy. Gonadal failure occurring prior to the expected time of sex differentiation of the primordial gonad would thus result in the persistence of the female accessory system.

In Turner's syndrome — in which girls fail to mature sexually, are stunted in growth and may have a variety of other congenital defects such as webbed necks and cardiovascular anomalies — the sexual infantilism is apparently due to such fetal gonadal failure. Microscopic examination of the chromatin in the nuclei of the cells of many of these individuals has revealed a pattern like that seen in normal males. This at first suggested that such individuals were genetic males whose fetal testes failed in early intra-uterine life, thus permitting the accessory sex structures of the female to develop. Recent studies have shown that at least some of these patients possess only 45 instead of the usual complement of 46 chromosomes. Either an X or a Y chromosome has been shown to be missing. Should the gonad on one side develop into a testis and that on the other into an ovary, or if both ovarian and testicular elements should survive in the same gonad, a true hermaphrodite would result. In these hermaphrodites bizarre combinations of male and female external genitalia and internal accessory sex apparatus may be found. Klinefelter's syndrome in men, which is characterized by sclerosis of the spermatogenic elements of the testis, incomplete virilization and prominent breast tissue, may also be ascribable to defective development of the early embryonic gonad. A number of such men have nuclear chromatin patterns like those seen in normal females. In several instances these individuals have been shown to have cells with 47 chromosomes, having two X and one Y sex chromosomes.

Pseudohermaphrodites are persons who have the gonads of one sex associated with a partial or complete sex reversal of the external genitalia. Male pseudohermaphrodites usually appear to be fully feminized both physically and psychologically, with full breasts, female figures and normal or almost normal vulva and vagina. The uterus and tubes are absent or extremely rudimentary. The gonads, which are testes, are usually found in the abdomen or inguinal region. Spermatogenic function is absent or irreparable impaired, and the testes apparently secrete feminizing amounts of estrogen. The sex chromatin pattern of these patients has usually been reported to be that of males.

The female pseudohermaphrodite has ovaries, a uterus with Fallopian tubes and usually a vagina which does not open to the exterior. The clitoris becomes hypertrophied, simulating the hypospadic male phallus. The condition usually is caused by a congenital abnormality of the adrenal cortex, which secretes large amounts of a male hormone before complete development of the normal female external genitalia in early fetal life. The excessive secretion continues throughout life, with some progression of the virilizing process and a suppression of ovaries as a result of the inhibition of pituitary gonadotropic secretions by the excess of androgen (male sex hormone). Treatment with cortisone stops the excessive androgen output. The defects in external genitalia can be corrected by surgery.

(See also Hermaphrodite.)

Hypogonadal states in both sexes may result from a primary defect in the hormone-secreting cells of the gonads or secondarily from any pituitary gonadotropin deficiency. In some patients the disturbance in gonadotropic function is the sole detectable pituitary defect. while in others it is just one aspect of a much broader functional deficiency. These pituitary deficiency states may result from interference in the vascular supply to the gland or from growing tumours in that area. Rarely tumours in the neighbourhood of the hypothalamus may result in deficient gonadal function (Froelich's syndrome). In hypogonadism sperm formation is impaired or absent, and impotence results in males. In females ovulation does not occur. It is possible to treat hypogonadism of both sexes with sex hormones so that sexual desire is normal and competent sexual performance possible; however, it is rare for the gametogenic functions to be restored by hormonal treatment.

Functioning tumours of the adrenal, ovaries and testes may on occasion secrete excessive quantities of either male or female hormones. An excess of male hormone would lead to precocious puberty in boys or to virilization in girls and women. An excess of the female hormone would induce precocious maturation in girls and feminization in men. In either case the gametogenic functions of the gonads would be severely disturbed, presumably in large measure as a result of inhibition of pituitary gonadotropin secretion.

Functional disturbances of the ovaries may occur as a result of a number of organic diseases, including other endocrine disorders, malnutrition and infectious diseases, as well as emotional upsets. The testicles may be damaged by failure to descend into the scrotum (*i.e.,* remain in the abdominal cavity. where the relatively high temperature causes damage), by infections, injuries or X-ray exposure.

A small percentage of men who appear physically and endocrinologically normal have spermatogenic defects which lead to infertility or a subfertile state. Explanations for these cases are wanting, and no treatment is available. *See* also GYNECOLOGY; STERILITY; UROLOGY.

See H. W. Jones, Jr., and W. W. Scott, *Hermaphroditism, Genital Anomalies and Related Endocrine Disorders* (1958). (*R.* L. L.)

GONAGUAS ("borderers"), descendants of a cross between the Hottentots and the Kafirs, before the arrival of the whites in South Africa, and in some districts scarcely distinguishable from other natives except for their broken speech.

GONCALVES CRESPO, ANTÓNIO CÂNDIDO (1846–1883), Portuguese poet who introduced Parnassianism into Portuguese literature. Born in Rio de Janeiro on March 11, 1846, he went to Portugal as a youth and studied at the University of Coimbra. He married the writer Maria Amália Vaz de Carvalho, who introduced him to Lisbon society and the literary *salons* of the capital. He was a member of parliament for a short time, and also editor of the *Jornal do Comércio* and a contributor to literary journals. He was a founder of the review *A Fôlha,* which stimulated Portuguese interest in French Parnassian poetry. Gonçalves Crespo produced only two volumes of verse: *Miniaturas* (1870) and *Nocturnos* (1882), both of which reveal the formal influence of Théophile Gautier, Leconte de Lisle and François Coppée. Though, as their titles suggest, many of his themes are romantic, he displays a greater precision, more careful observation and a finer sensibility than many of the romantics. Though he cannot be considered a great poet and some of his poems are only conventional *salon* art, he was a craftsman in verse who renewed and refreshed the poetic vocabulary of his day.

He died at Lisbon on June 11, 1883.

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GONCALVES DIAS, ANTONIO (1823–1864), Brazilian poet, wrote the nostalgic "Song of Exile," probably the most memorized poem in the Portuguese language. Born near Caxias (Maranhão), Braz., he was educated at the University of Coimbra, Portugal. His collection of poems, *Primeiros Cantos* (1846), was enthusiastically praised by a distinguished Portuguese contemporary. Alexandro Herculano. The poet's immediate popularity was enhanced by *Segundos Cantos* e *Sextilhas de Frei Antão* (1848), and especially *Ultimos Cantos* (1851). which virtually closed the cycle of his lyrics.

In the final decade of his life he held various governmental posts, in which he surveyed the school system of northern Brazil, studied European educational institutions, did research on Brazilian historical sources in European archives and participated in a scientific expedition. The unfinished epic poem on the Indian tribe *Os Tambiras* (1857), an unsuccessful attempt at creating a "Brazilian Iliad," and the *Dicionário da Lingua Tupi* (1858) reflect his preference for indigenous subjects.

He uent to Europe in 1862 and upon his return trip was drowned in a shipwreck within sight of the coast of his native state (Nov. 3, 1864).

Many of his poems were inspired by a series of fleeting romances which consoled, and afflicted, his insatiable heart. In this and other respects, including the excessive vehemence of some of his amorous complaints, he remained a typical romanticist; but he often succeeded in attaining the utmost spontaneity, and a subtlety of expression in perfect consonance with the natural genius of his people.

Modern critics tend to consider him the most representative poet of Brazil.

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GONCHAROV, IVAN ALEXANDROVICH (1812–1891), Russian novelist. was the son of a rich merchant in the town of Simbirsk. At the age of ten he was placed in one of the gymnasiums at Moscow, from which he passed into the Moscow university. He then entered the civil service, being first employed as secretary to the governor of Simbirsk, and afterward in the ministry of finance at St. Petersburg (Leningrad). Absorbed in bureaucratic work, Goncharov paid no attention to the social questions then ardently discussed by his contemporaries, Herzen, Aksakov and Bielinsky.

His first original work was *Obyknovennaya Istoria,* "A Common Story" (1847, Eng. trans. by C. Garnett, 1890, 2nd ed. 1917). In 1856 he sailed to Japan as secretary to Admiral Putiatin, returning by the then tedious land route through Siberia. He published a description of the voyage under the title of "The Frigate *Pallada.*"

In 1857 appeared his masterpiece, *Oblomov* (Eng. trans. by C. J. Hogarth, 1915), which was immediately recognized as a classic. He had been at work on it for ten years. What Prince Mirsky called the "indolent and impotent determinism of the hero" was recognized as of general significance in Russian life, especially in the life of the country gentry. Dobrolubov said of it, "Oblomovka (the country-seat of the Oblomovs) is our fatherland: something of Oblomov is to be found in every one of us." Pisarev, another celebrated critic, declared that "Oblomovism," as Goncharov called the sum total of qualities with which he invested the hero of his story, "is an illness fostered by the nature of the Slavonic character and the life of Russian society."

In 1858 Goncharov was appointed a censor, and in 1868 he published another novel called *Obryv* (Eng. trans., *The Precipice,* 191j), on which he had worked for 20 years. This contains a charming picture of a great Russian household, ruled by a despotic and benevolent grandmother, but aroused great hostility among the intelligentsia by the unsympathetic portrait of the nihilist. Goncharov was convinced that Turgenev borrowed from *The Precipice,* and wrote an account of his wrongs. He died on Sept. 27 (old style Feb. 15), 1891.

A translation of *Oblomov,* by Natalie A. Duddington, appeared in 1929.

GONCOURT, DE, a name famous in French literary history. EDMOND LOUIS ANTOINE HUOT DE GONCOURT was born at Nancy on May 26, 1822, and died at Champrosay on July 16, 1896. JULES ALFRED HUOT DE GONCOURT, his brother, was born in Paris on Dec. 17, 1830, and died in Paris on June 20, 1870.

Writing always in collaboration, until the death of the younger, it was their ambition to be not merely novelists, inventing a new kind of novel, but historians; not merely historians, but the historians of a particular century, and of what was intimate and what is unknown in it; to be also discriminating, indeed innovating, critics of art, but of a certain section of art, the 18th century, in France and Japan; and also to collect pictures and *bibelots,* always of the French and Japanese 18th century. Their histories *(Portraits intimes du XVIII^e^ siècle* [1857], *La Femme au XVIII^e^ siècle* [1862], *La du Barry* [1878], etc.) are made entirely out of documents, autograph letters, scraps of costume, engravings, songs, the unconscious self-revelations of the time; their three volumes on *L'Art du XVIII^e^ siècle* (1859–75) deal with Antoine Watteau and his followers in the same scrupulous, minutely enlightening way, with all the detail of unpublished documents; and when, they came to write novels, it was with a similar attempt to give the inner, undiscovered, minute truths of contemporary existence, the *ine'dit* of life. The same morbidly sensitive noting of the *ine'dit,* of whatever came to them from their own sensations of things and people around them, gives its curious quality to the nine volumes of the *Journal,* 1887–96, which will remain, perhaps, the truest and most poignant chapter of human history written by them.

Their novels, *Soeur Philomène* (1861), *Renke Mauperin* (1864), *Germinie Lacerteux* (186j), *Manette Salomon* (1865), *Madame Gervaisais* (1869), and by Edrnond alone, *La Fille Elisa* (1878), *Les Frdres Zemganno* (1879), *La Faustin* (1882), *Chérie* (1884), are however, the work by which they will live as artists. Learning something from Gustave Flaubert, and teaching a great deal to Émile Zola, they invented a new kind of novel, and their novels are the result of a new vision of the world, in which the very element of sight is decomposed, as in a picture of Claude Monet.

Seen through the nerves, in this conscious abandonment to the tricks of the eyesight, the world becomes a thing of broken patterns, conflicting colours and uneasy movement. A novel of the Goncourts is made up of an infinite number of details, set side by side, every detail equally prominent. While a novel of Flaubert, for all its detail, gives above all things an impression of unity, a novel of the Goncourts deliberately dispenses with unity in order to give the sense of the passing of life, the heat and form of its moments as they pass. It is written in little chapters, sometimes no longer than a page, and each chapter is a separate notation of some significant event, some emotion or sensation which seems to throw sudden light on the picture of a soul. To the Goncourts humanity is as pictorial a thing as the world it moves in; they do not search further than "the physical basis of life," and they find everything that can be known of that unknown force written visibly upon the sudden faces of little incidents, little expressive moments. The soul, to the Goncourts, is a series of moods, which succeed one another, certainly without any of the too arbitrary logic of the novelist who has conceived of character as a solid or consistent thing.

Their novels are hardly stories at all, but picture galleries, hung with pictures of the momentary aspects of the world. French critics have complained that the language of the Goncourts is no longer French, no longer the French of the past; and this is true. It is their distinction — the finest of their inventions — that, in order to render new sensations, a new vision of things, they invented a new language. (A. SY.)

In his will Edmond de Goncourt left his estate for the endowment of an academy, the formation of which was entrusted to Alphonse Daudet and Léon Hennique. The society was to consist of ten members, each of whom was to receive an annuity of 6,000 francs, and a yearly prize of 5,000 francs was to be awarded to the author of some work of fiction. Nine of the members of the new academy were nominated in the will. They were Alphonse Daudet, J. K. Huysmans, Léon Hennique, Octave Mirbeau, the two brothers, "J. H." Rosny, Gustave Geffroy and Paul Margueritte. On Jan. 19, 1903, after much litigation, the academy was constituted, with Elémir Bourges, Lucien Descaves and Léon Daudet as members in addition to those mentioned in de Goncourt's nill, the place of Alphonse Daudet having been left vacant by his death in 1897.

On the brothers de Goncourt *see* the *Journal des Goncourt* already cited; *M.* A. Belloc (afterward Lowndes) and M. L. Shedlock, *Edmond and Jules de Goncourt, with Letters and Leaves from their Journals* (1895); Alidor Delzant, *Les Goncourt* (1889), which contains a valuable bibliography; *Lettres de Jules de Goncourt* (1888), preface *by* H. Céard; R. Doumic, *Portraits d'écrivains* (1892); Paul Bourget, *Nouveaux Essais de psychologie contemporaine* (1886); Emile Zola, *Les Romanciers naturalistes* (1881).

GONDA, a municipal town and district in the Fyzabad division of Uttar Pradesh, India. Pop. of town (1951) 32,566. GONDA DISTRICT has an area of 2,826 sq.mi. It consists of an alluvial plain with very slight undulations, studded with groves of mango trees, and divided into three belts known as the *tarai* or swampy tract, the *uparhar* or uplands and the *tarhar* or wet lowlands, all three being fertile and closely tilled. Several rivers flow through the district, but only two, the Gogra and Rapti, are of any importance. On the outbreak of the mutiny, the rajah of Gonda, after honourably escorting the government treasure to Fyzabad, joined the rebels. His estates, along with those of the rani of Tulsipur, were confiscated and conferred as rewards upon the maharajas of Balrampur and Ajodhya, who had remained loyal. In 1951 the population was 1,877,484.

GONDAL, a town and taluk (subdivision), Madhya Saurashtra district, Bombay state. India. The town (pop., 1951, 37,046) is connected by rail with southeastern Saurashtra and with Rajkot, the state capital. 23 mi. N.

GONDAL TALUK (area 379 sq.mi.; pop., 1951, 92.963) contains part of the former princely state of Gondal (area 1,024 sq.mi.; pop., 1941, 244,514), which was within the Western Kathiawar subagency of the combined Baroda, Western India and Gujarat administration prior to its absorption into Saurashtra on Feb. 1j, 1948. Saurashtra became part of Bombay state on Nov. 1, 1956

The state consisted of two isolated tracts in the centre of the Kathiawar peninsula. The ruler, whose title was thakur, was a Jadeja Rajput.

GONDAR, one of the former capitals of Ethiopia, situated on a basaltic ridge approximately 7,500 ft. above the sea, about 21 mi. N.E. of Lake Tana. Pop. (1951 est.) 13,000. Two streams. the Angreb on the east side and the Gaha or Kaha on the west, flow from the ridge and, meeting below the town, pass onward to the lake. Gondar was a small village when at the beginning of the 16th century it was chosen by the Negus Sysenius (Seged I) as the capital of his kingdom. His son Fasilidas. or A'lem-Seged (1633–1667), was the builder of the castle which bears his name. Later emperors built other castles and palaces. the latest in date being that of the Negus Yasu II, erected about 1736, at which time Gondar appears to have been at the height of its prosperity. Thereafter it suffered greatly from the civil nars which raged in Ethiopia, and was more than once sacked; in 1887 the dervishes under Abu Anga inflicted very great injury, destroying many churches, damaging the castles and carrying off much treasure. The population was estimated by James Bruce in 1770 at 10,000 families. After the pacification of the Sudan by the British (1886–89) there was some revival of trade between Gondar and the regions of the Blue Nile. Among the inhabitants are numbers of Moslems, and a settlement of Falashas was established there.

Cotton, cloth, gold and silver ornaments, copper wares, fancy articles in bone and ivory, excellent saddles and shoes are among the products of the local industry.

Unlike any other buildings in Ethiopia, the castles and palaces of Gondar resemble, with some modifications, the mediaeval fortresses of Europe, the style of architecture being the result of the presence in the country of numbers of Portuguese. Fasilidas's castle was built by Indian workmen, under the superintendence of Ethiopians who had learned something of architecture from the Portuguese adventurers. The castle has two stories, is 90 ft. by 84 ft., has a square tower and circular domed towers at the corners. The most extensive ruins are a group of royal buildings enclosed in a wall. These ruins include the palace of Yasu II, which has several fine chambers. Christian Levantines were employed in its construction and it was decorated in part with Venetian mirrors, etc. In the same enclosure is a small castle attributed to Yasu I. The exterior walls of the castles and palaces named are little damaged and give to Gondar a unique character among African towns. Of the 44 churches, all in the circular Ethiopian style, which are said to have formerly existed in Gondar or its immediate neighbourhood, Maj. P. H. G. Powell-Cotton found only one intact in 1900.

The city fell to British, Sudanese and Ethiopian patriot troops, Nov. 28, 1941, after a siege of several months.

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GONDOKORO. A village in Sudan, on the east bank of the upper Nile in 4° 54' N., 31° 43' E., 1,077 mi. S. of Khartoum by river. was a stopping place for steamers until superseded by Juba just above it on the west bank, beyond which the Nile ceases to be navigable until Nimule (3° 40′ N., 32° 10′ E.).

The site of the village is at the top of a cliff 25 ft. above the river level. Pop. (1956) 500.

Gondokoro was first visited by Europeans in 1841–42, when expeditions sent out by Mohammed Ali, pasha of Egypt, ascended the Nile as far as the foot of the rapids above Gondokoro. It soon became an ivory and slave-trading centre. In 1851 an Austrian Roman Catholic mission was established there, but it was abandoned in 1859. It was at Gondokoro that J. H. Speke and J. A. Grant. descending the Nile after their discovery of its source, met. on Feb. 15, 1863, Samuel Baker and his wife who were journeying up the river. In 1871 Baker, who was at that time governor general of the equatorial provinces of Egypt, established a military post at Gondokoro which he named Ismailia after the then khedive. Baker made this post his headquarters, but Col. (afterward Gen.) C. G. Gordon, who succeeded him in 1874, abandoned the station on account of its unhealthy site, removing to Lado, 11 mi. downstream.

Gondokoro fell into the hands of the mahdists in 1885. After the destruction of the mahdist power in 1898 it was occupied by British troops and formed the northernmost post on the Nile of the Uganda protectorate. In 1914, however, the administration was transferred to the Sudan government, which thereby gained control of the whole stretch of the Nile navigable from Khartoum.

GONDOMAR, DIEGO SARMIENTO DE ACUNA, COUNT OF (1567–1626), Spanish diplomatist, born in Gondomar, Galicia, on Nov. 1, 1567. He inherited wide estates in Galicia and in Old Castile from his father, corregidor of Granada and governor of the Canary Islands. In 1583 Philip II gave him military command of the Portuguese frontier and coast of Galicia. Corregidor of Toro in 1593, he was sent in 1603 to superintend the distribution of the treasure brought from America by two galleons driven to take refuge at Vigo, and on his return was appointed on the board of finance. In 1609 he repelled a naval attack on Galicia made by the Dutch. In the Casa del Sol at Valladolid, where he resided, he collected a library which the marquis of Malpica, his descendant, ceded to Charles III; it is now in the royal library at Madrid.

His reputation, as a diplomatist rests on his two periods of service as ambassador in England (1613–18 and 1619–22). The excellence of his latinity pleased the literary tastes of James I, whose character he judged with remarkable insight. He flattered the king's love of books and of peace, and he made skilful use of his desire for an alliance between the prince of Wales and a Spanish infanta. Sarmiento's aim was to keep James from aiding the Protestant states against Spain and the house of Austria, and to avert English attacks on Spanish possessions in America. His success made him odious to the anti-Spanish and Puritan parties. The active part he took in promoting the execution of Sir Walter Raleigh aroused particular animosity. He was attacked in pamphlets and figured as the principal person in Thomas Middleton's *A Game* at Chess, a political play suppressed by order of the council. Count of Gondomar in 1617, he returned home on leave for his health. through Flanders and France, on a diplomatic mission in 1618. He resumed office in London in 1619; on his retirement in 1622 he was appointed on the royal council and sent on a complimentary mission to Vienna. He died near Haro in the Rioja on Oct. 2, 1626.

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GONDWANA, the historical name for a large tract of hilly country in India which roughly corresponds with the greater part of the present Madhya Pradesh. The name is derived from the aboriginal tribe of Gonds, who ruled the country from the 12th to the beginning of the 18th century in three or four separate kingdoms. They maintained a barbaric civilization and though nominally subject to the Moguls they were not much disturbed, but when the Maratha invaders appeared in the 18th century the Gond kingdoms succumbed and the aboriginal population fled for safety to the hills. Gondwana was included in the dominions of the Bhonsla raja of Nagpur which passed to the British between 1818 and 1853.

FROM RUSSEL, "TRIBES AND CASTES OF CENTRAL INDIA"

MĀRIA GOND IN DANCING COSTUME

The Gonds are an aboriginal hill race of Central India

The Gonds, who call themselves Koitur or "highlanders," are the most numerous tribe of Dravidian stock in India. Their language, akin to the southern languages of India. is unwritten and, except for missionary productions, there is no literature: but it is still the spoken language of 7% of the population of Madhya Pradesh.

The Rajgonds, claiming to have Rajput blood, are on the skirts of Hinduism, but most of the Gonds are animistic in belief.

The term "Gondwana" is also used by geologists as a name for certain rock formations.

See R. V. Russell, "Gonds," in *The Tribes and Castes of the Central Provinces of India,* vol. iii (London, 1916).

GONDWANALAND. This name, derived from Gondwana ("land of the Gonds"), a district of India. was given by Austrian geologist Eduard Suess to the inferred ancient continent that at its greatest extension hypothetically spanned the South Atlantic and Indian oceans. It embraced all (except northwest) Africa, Madagascar, peninsular India, Australia, Tasmania. Antarctica: the Falklands and all South America except the extreme west and northwest. Its unstable margins were, between the Devonian and Jurassic. intermittently and widely transgressed by the oceans; the sea bounding it on the north, wherein deposition went on continuously down to the Tertiary, being called the Tethys.

The distribution of existing plants and animals, and especially of those having disjunctive distribution, *e.g.*, lungfish (Australia, South Africa, South America), marsupials (Australia. South America), sugarbush (Australia, South Africa), arucarian pines (South America, Falklands, Australia. South Pacific), antarctic, or false: beech (*Nothofagus*) (Chile, Tierra del Fuego, New Zealand and Australia-Tasmania) often led to the inference of former transoceanic land connections. P. L. Sclater's Lemuria (Africa, Madagascar, India) and Hermann von Ihering's Arch-hellenis (South America, Africa) are other examples.

Paleontologic data from the Paleozoic and Mesozoic eras have strongly bolstered the theory of Gondwanaland bridges, although the hypotheses of a huge, transverse southern continent is much less widely accepted. Devonian invertebrate, benthonic (bottom-dwelling), marine faunas of Brazil, Uruguay and the Falkland Islands and South Africa have so similar a stamp that John M. Clarke postulated "Flabellitesland" (based on the occurrence of a brachiopod), a continental mass bridging the South Atlantic, across which a shallow Devonian sea transgressed. The flabellites faunal type was recently discovered also in Tasmania. In the later Carboniferous-Permian strata a comparable type of fauna, characterized by the pelecypod (bivalve) *Eurydesma,* is known from Argentina, South Africa and Australia. There was a contemporary and ubiquitous Gondwana coal flora. characterized by the seed ferns *Glossopteris* and *Gangamopteris* (South America, Antarctica, Falklands, South Africa, the subcontinent of India, Australia). *Thinnfeldia,* also a seed fern *(see* PALAEOBOTANY), characterized the flora of Triassic Gondwanaland in the early Mesozoic era. The Permian "White Band" strata in Brazil, South Africa and Madagascar carries *Mesosaurus,* a diminutive aquatic reptile, usually judged to have been of fresh-water ecology. Triassic terrestrial reptiles, especially mammal-like forms, occur in south Brazil and South Africa. The force of their argument is however somewhat reduced by the discovery of related groups in Texas and Russia.

The stratigraphic sequence, and hence physical history, of the existent fragments of the hypothetical Gondwanaland are generally quite similar; between Brazil and South Africa the parallelism is close. Sedimentary analysis of the Gondwana sediments has repeatedly demonstrated sourcelands lying beyond the present strands.

A striking degree of ecologic uniformity appears from stage to stage in the geologic history of the vast continent. Synchronous continental glaciation recurred several times: Cambrian (Brazil, Australia, Africa ?), Siluro-Devonian (Australia. Brazil, Africa ?), Devonian (Brazil, South Africa, Australia), and especially Permo-Carboniferous glaciation in all Gondwana relicts. These cold episodes were apparently circumpolar, and the ice descended to sea level as attested by interlarded marine faunas and glacial beds. Considerable Gondwana coal was also formed interglacially on coastal plains. Glacial scratches and lineation phenomena in the Gondwanaland rocks commonly indicate flowage of the inland ice from areas now oceanic. Erratic elements in the glacial drift are often completely foreign to the lands where they now repose, *e.g.,* Brazilian diamonds.

Essentially the same nonrecorded hiatuses occur throughout Gondwanaland, suggesting synchronous episodes of uplift and erosion. The Late Triassic-Early Jurassic record is of widespread deserts. Local coal swamps and reptile oases occurred. Red beds are almost ubiquitous at this time. In Rhaetic (late Triassic) time widespread tensional faulting occurred and concomitantly the world's greatest episode of intrusion and extrusion of basic igneous rocks from the deep crust. All fragments of Gondwanaland shou this igneous episode. Following this period of diastrophism and vulcanism, virtually all biotic and physical parallelism in the Gondwanaland remnants ceases. Proponents of the Gondwanaland concept postulate that the continent broke up at this time and that vast segments foundered into the oceanic depths.

Paleoclimatologists have found Gondwanaland impossibly large, especially with respect to the Permo-Carboniferous extensive glaciations. Consequently both F. B. Taylor and Alfred Wegener visualized the Gondwanaland disruption as having been a drifting apart of sectors through the viscous basic subcrust. Hence the reassembled blocks would result in a far smaller Gondwanaland.

Neither the oceanic bridges of Suess nor continental drifting have received general geologic support. Oceanography and geophysics have failed to reveal significant areas of continental type rocks on the ocean floors. Basic rocks form the general abyssal floor. Continental drifting has also won few supporters among earth scientists.

Historical geologists argue that similar sequences of strata and physical history can occur in widely separated areas never connected or in close proximity. They suggest that some of the supposedly synchronous events in diverse parts of Gondwanaland may have been heterochronous, thus meeting the paleoclimatological argument for Gondwana of the proponents of the theory of continental drift. Probably the majority of biologists prefer to explain disconnected distributions of floral and faunal forms on the basis of established migrations along transitory isthmian links, island-hopping, swimming, floating and rafting, or of wind transport or carriage by flying organisms; and by parallel (analogous) evolution. These are seemingly generally adequate explanations, especially when considered against the vastness of geologic time, although by no means have all disjunctions been accounted for.

Both Suess's theory of a continent of Gondwanaland and Wegener's hypothesis of continental drift are discussed in some detail in the article CONTINENT. Examples of the application of the concept in explaining geologic phenomena, especially the widespread occurrence of the index fossil, *Glossopteris,* will be found in articles on the geologic systems and periods mentioned, as CARBONIFEROUS SYSTEM AND PERIOD: *Carboniferous of Southern Hemisphere and India;* PERMIAN SYSTEM, etc., and in the geology sections of AFRICA; ASIA; AUSTRALIA, COMMONWEALTH OE; INDIA. Hypotheses tending to disprove the possibility of a Gondwanaland are presented in ISOSTASY and related articles. *See* also FOSSIL; MARSUPIALIA; ZOOGEOGRAPHY.

See C. Schuchert, "Gondwana Land Bridges," in Bulletin *of the Geological Society of* America, vol. *43* (1932). (K. E. C.)

GONFALON, a banner or standard of the middle ages (the late French and Italian form, also found in other Romanic languages, of *gonfanon,* which is derived from the O.H.G. *gundfano, gund,* "war," and *fano,* "flag," *cf.* Mod. Ger. *Fahne,* and English "vane"). It took the form of a rectangular ensign, often slit into streamers at the foot, and swinging from a crossbar attached to a pole. This is the most frequent use of the word. The title of "gonfalonier," the bearer of the gonfalon, was in the middle ages both military and civil. It was borne by the counts of Vexin, as leaders of the men of St. Denis, and when the Vexin was incorporated in the kingdom of France the title. of *Gonfalonier de Saint Denis* passed to the kings of France, who thus became the bearers of the "oriflamme," as the banner of St. Denis was called. Gonfalonier was the title of civic magistrates of various degrees of authority in many of the city republics of Italy, notably of Florence, Siena and Lucca. At Florence the functions of the office varied. At first the gonfaloniers were the leaders of the various military divisions of the inhabitants. In 1293 was created the office of gonfalonier of justice, who carried out the orders of the signiory. By the end of the 14th century the gonfalonier was the chief of the signiory. At Lucca he was the chief magistrate of the republic. At Rome two gonfaloniers must be distinguished, that of the church and that of the Roman people; both offices were conferred by the pope. The first was usually granted to sovereigns, who were bound to defend the church and lead her armies. The second bore a standard with the letters S.P.Q.R. on any enterprise undertaken in the name of the church and the people of Rome, and also at ceremonies, processions, etc. This was granted by the pope to distinguished families.

GÓNGORA Y ARGOTE, LUIS DE (1561–1627), Spanish poet, who brought to perfection the poetic style called, after him, Gongorism, was born on July 11, 1561, at Córdoba, where his father was *corregidor* ("mayor") and owner of a famous library. He studied—not very seriously—at the University of Salamanca and was already known as a poet in 1585, when Cervantes praised him in the *Galatea.* He held a benefice in Córdoba cathedral and undertook important missions for the chapter. In 1612 he settled in Madrid, taking full orders and securing a court chaplaincy in 1617. In 1626 a stroke impaired his faculties and he returned to Córdoba, where he died, May 23, 1627.

Part of Góngora's work was, during his lifetime, the subject of the most furious controversy in Spanish literary history. His light *verse—romances, letrillas,* satires, songs for the guitar—was widely esteemed. but he was considered to have violated the principles of poetry and of language in his long poems *Polifemo* (1612) and *Soledades* (1613–17). In these he elaborated his style (known as *culteranismo)* by the introduction of numerous Latinisms of vocabulary and syntax, and by exceedingly complex imagery and mythological allusions. For three centuries his name was synonymous with obscurity and pedantry, but in the 20th century an astonishing revaluation of Góngora took place; he came to be considered one of Spain's greatest poets, and powerfully influenced contemporary poetry. *Polifemo* and *Soledades* are part pastoral, part epic; they are plotless and devoid of emotional content, but appeal brilliantly to the senses in their descriptions of persons, nature and rustic scenes, and in the music of their lines. Góngora also wrote three unactable plays; an important collection of his letters survives. There are indispensable commentaries on the longer poems.

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GONIOMETER, an instrument for measuring the angles of crystals; there are three kinds—the contact goniometer, the reflecting goniometer and the X-ray goniometer.

The Contact **Goniometer.**—This instrument consists of two metal rules pivoted together at the centre of a graduated semicircle (fig. 1). The instrument is placed with its plane perpendicular to an edge between two faces of the crystal to be measured, and the rules are brought into contact with the faces; this is best

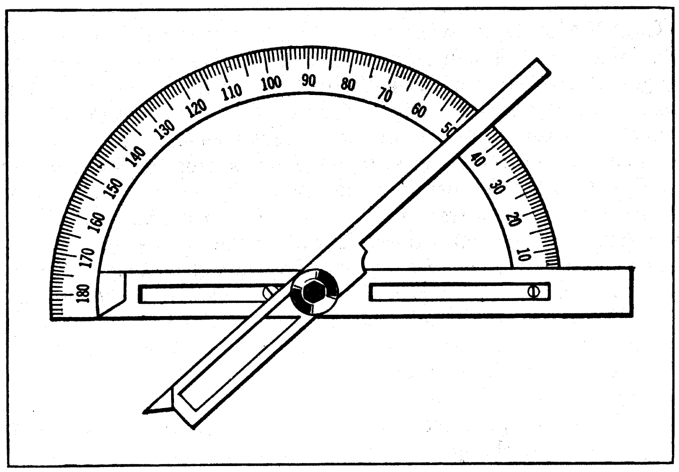

FIG. I.— CONTACT GONIOMETER

done by holding the crystal up against the light with the edge in the line of sight. The angle between the rules, as read on the graduated semicircle, then gives the angle between the two faces. The rules are slotted, so that they may be shortened and their tips applied to a crystal partly embedded in its matrix. The instrument represented in fig. 1 is employed for the approximate measurement of large crystals.

The Reflecting **Goniometer.**—This is an instrument of far greater precision, and is always used for the accurate measurement of the angles when small crystals with smooth faces are available. Such faces reflect sharply defined images of a bright object. By turning the crystal about an axis parallel to the edge between two faces, the image reflected from a second face may be brought into the same position as that formerly occupied by the image reflected from the first face; the angle through which the crystal has been rotated, as determined by a graduated circle to which the crystal is fixed, is the angle between the normals to the two faces.

Several forms of instruments depending on this principle have been devised. The earliest type consisted of a vertical graduated circle reading degrees and minutes, which turned about a horizontal axis. A great improvement was effected by placing the graduated circle in a horizontal position. Many forms of the *horizontal-circle goniometer* have been constructed; they are provided with a telescope and collimator (*q.v.*), and in construction are essentially the same as a spectrometer, with the addition of arrangements for adjusting and centring the crystal. The instrument shown in fig. 2 has four concentric axes, which enable the crystal holder A, together with the adjustment arcs B and centring slides D, to be raised or lowered, or to be rotated independently of the circle H; further, either, the crystal holder or the telescope T may be rotated with the circle, while the other remains fixed. The crystal is

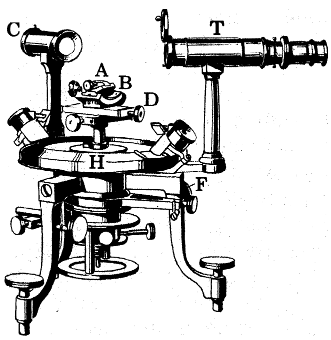

FIG 2 —HORIZONTAL-CIRCLE GONIOMETER

placed on the holder and adjusted so that the edge (zone-axis) between two faces is coincident with the axis of the instrument. Light from any convenient source passes through the slit of the collimator C, and the image of the slit (signal) reflected from the crystal face is then vieued in the telescope. The clamp and the slow-motion screw F enable the image to be brought exactly on the cross wires of the telescope, and the position of the circle with respect to the vernier is read through the lens. The crystal and the circle are then rotated together until the image from a second face is brought on the cross wires of the telescope, and the angle through which they have been turned is the angle between the two face normals.

With a one-circle goniometer, such as is described above, it is necessary to mount and readjust the crystal for the measurement of each zone of faces (*i.e.,* each set of faces intersecting in parallel edges). Further, in certain cases, it is not possible to measure the angles between zones. These difficulties have been overcome by the use of a two-circle goniometer. The crystal is set up and adjusted with the axis of a prominent zone parallel to the axis of either the horizontal or the vertical circle. The positions of the faces are fixed by the simultaneous readings of the two circles.

Some disadvantages are overcome by adding still another graduated circle to the instrument, with its axis perpendicular to the axis of the vertical circle, thus forming a three-circle goniometer. With such an instrument measurements may be made in any zone or between any two faces without readjusting the crystal.

Goniometers have been devised for measuring crystals during their growth in the mother liquid and for cutting section plates and prisms from crystals (precious stones) accurately in any desired direction. An ordinary microscope fitted with cross wires and a rotating graduated stage serves the purpose of a goniometer for measuring the plane angles of a crystal face or section.

The Weissenberg **X-ray Goniometer.**—This is an instrument used in recording X-ray reflections from crystals. The crystal oscillates through about 200° around an edge, as a cylindrical camera is translated back and forth parallel to the crystal rotation axis. In M. J. Buerger's design the angle nhich the rotation axis makes nith the X-ray beam is variable. *See* also Crystallography: *Diffraction by Crystals; Crystal-Structure Analysis.*

(L. J. S.; J. D. H. D.)

GONJA (Gbanya), the northern neighbours of the Ashanti and Bron peoples, living north of the Black Volta river in Ghana and related to the Mossi and Dagomba peoples.

GONORRHEA, a venereal disease initiated by the gonococcus, *Neisseria gonorrhoeae,* occurring nearly always as the result of direct sexual contact and treatable in most cases by penicillin. *See* Venereal Diseases.

GONTAUT, MARIE JOSÉPHINE LOUISE, Duchesse de (1773–1857), was born in Paris on Xug. 3. 1773, daughter of Xugustin François, comte de Montaut-Navailles. who had been governor of Louis XVI. She shared the lessons given by Madame de Genlis to the Orléans family, with whom her mother broke off relations after the outbreak of the Revolution. Mother and daughter emigrated to Coblenz in 1792; thence to Rotterdam, and finally to England, where Joséphine married the marquis Charles Michel de Gontaut-Saint-Blacard (d. 1822). They returned to France at the Restoration and resumed their place at court. Madame de Gontaut became lady in waiting to Caroline, duchess of Berry, and later governess to the princes and princesses of the blood. She remained faithful to the Bourbon cause. In 1827 she was created duchesse de Gontaut. She followed the exiled royal family to Prague, but in 1834 the duc de Blacas thought her comparatively liberal views dangerous and she received a brusque congé from Charles X. Her twin daughters. Joséphine (1796–1844) and Charlotte (1796–1818), married respectively Ferdinand de Chabot, prince de Léon, afterward duc de Rohan, and François, comte de Bourbon-Busset. She died in Paris in 1857.

See her *Memoirs* (Eng. ed., 2 vols., 1894), and *Lettres ine'dites* (1895).

GONVILLE (Gonvile), **EDMUND** (d. 1351), founder of Gonville hall. now Gonville and Caius college, at Cambridge. Eng., is thought to have been the son of William de Gonvile and the brother of Sir Nicholas Gonvile. The foundation of Gcnville hall at Cambridge was effected by a charter granted by Edward III in 1348. It was called, officially, the Hall of the Annunciation of the Blessed Virgin, but was usually known as Gunnel1 or Gonville hall. Its original site was in Free-school lane, where Corpus Christi college now stands. Gonville apparently wished it to be devoted to training for theological study. but after his death the foundation mas completed by William Bateman, bishop of Norwich and founder of Trinity hall, on a different site and with considerably altered statutes.

See also CAIUS, JOHN.

GONZAGA, an Italian princely family named after the town where it probably had its origin. Its known history begins with Luigi I (1267–1360), who, after fierce struggles, supplanted his brother-in-law Rinaldo Bonacolsi as lord of Mantua in 1328, with the title of captain general. and afterwards of vicar general of the empire, adding the designation of count of Mirandola and Concordia, which fief the Gonzagas held from 1328 to 1354. In 1335 his son Guido wrested Reggio from the Scaligeri and held it until 1371. Luigi was succeeded by Guido (d. 1369); the latter's son Luigi II came next in succession (d. 1382), then Giovan Francesco I (d. 1407), then Giovan Francesco II (d. 1444) who received for his military services to the emperor Sigismund the title of marquess of Mantua (1432), an investiture which legitimatized the usurpations of the house of Gonzaga. His grandson, Federigo I (d. 1484), served under various foreign sovereigns, including Bona of Savoy and Lorenzo de' Medici; subsequently he upheld the rights of the house of Este against Pope Sixtus IV and the Venetians, whose claims were a menace to his own dominions of Ferrara and Mantova. His son Giovan Francesco III (d. 1519) commanded the allied Italian forces against Charles VIII at the battle of Fornovo; he afterwards fought in the kingdom of Naples and in Tuscany, until captured by the Venetians in 1509. With the help of his wife, the famous Isabella d'Este, he promoted the fine arts and letters.

He was succeeded by his son Federigo II (d. 1540), captain general of the papal forces. After the peace of Cambrai (1529) his ally and protector, the emperor Charles V, raised his title to that of duke of Mantua in 1530; in 1536 the emperor decided the controversy for the succession of Monferrato between Federigo and the house of Savoy in favour of the former. His son Guglielmo subdued a revolt in Monferrato and was presented with that territory by the emperor Maximilian II. His grandson Vincenzo II (d. 1627) appointed as his successor Charles, the son of Henriette, the heiress of the French family of Nevers-Rethel, who was only able to take possession of the ducal throne after a bloody struggle; his dominions were invaded and he himself reduced to the sorest straits. His great grandson, Ferdinand Charles, acquired Guastalla by marriage in 1678, but lost it soon afterwards; he involved his country in useless warfare, with the result that in 1708 Austria annexed the duchy. On July j, 1708, he died in Venice, and with him the Gonzagas of Mantua came to an end.

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GONZAGA, SAINT ALOYSIUS (1568–1591), one of the most venerated of modern saints and patron of Roman Catholic youth, was born at Castiglione in Lombardy on March 9. 1568, the eldest son of the marquis of Castiglione, cousin of Guglielmo Gonzaga, duke of Mantua. He was educated at the ducal courts of Florence and of Mantua and at the royal court of Madrid, where he was page to the heir of Philip II. In 1585, against the strongest opposition, he resigned his inheritance and entered the Society of Jesus at Rome. One of his spiritual directors was the renowned theologian St. Robert Bellarmine (*q.v.*). Shortly before ordination, while nursing plague victims, he caught the disease and died on June 21, 1591, at the age of 23.

Most characteristic of the virtues of Aloysius Gonzaga was his intense love of chastity. His practices of prayer, austerity, humility and charity were also heroic, while his all-absorbing love for God raised him to high mystical union. Yet his exalted holiness has much of human appeal, especially his strong and constant heroism and his generous enthusiasm for the Christian ideal. Aioysius' reputation suffered from pietistic biographers, but a truer estimation of him as a normal young man has been established by modern scholars, notably Cyril C. Martindale. S.J., and F. Schroeder, S.J. He was canonized in 1726 by Benedict XIII. Pius XI in 1926 renewed his designation as patron of Catholic youth (originally proclaimed in 1729), affirming that many of the newer canonized saints had been inspired to heroic sanctity by the example of St. Aloysius. His feast day is June 21.

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(M. P. H.)

GONZAGA, TOMÁS ANTÓNIO (1744–1810), the finest 18th-century Portuguese writer of love poetry. He was born in Oporto on Aug. 11, 1744, his father being a magistrate of Brazilian origin and his mother the daughter of a British merchant. In 1752 he went to Brazil where his father held juridical appointments, but he returned in 1763 to study law at Coimbra, where he graduated in 1768. In 1782 he returned to Brazil on being appointed judge in Vila Rica. Here he fell in love with the 16-year-old Maria Joaquina Doroteia de Seixas, the *Marília* of his lyrics, but on the eve of marriage to her in 1789 he was arrested on a charge, almost certainly false, of being an accessory to a separatist, anti-Portuguese conspiracy. After three years' imprisonment he was sentenced to exile for life in Mozambique. There in 1793 he married a rich heiress and for the rest of his life held important legal positions in the colony. He died there early in 1810.

His reputation as a poet rests on *Marília* de Dirceu, the first section of which appeared in 1792. This group of lyrics, written before his arrest, expresses the joy of love and the expectation of married happiness, while his second group of poems, which were written in prison and appeared in 1799, express yearning for his beloved and past happiness. Gonzaga borrowed his forms from Anacreon and Theocritus, but the matter, the natural. elegant style and the harmonious versification are his own. *Marília* de **Dirceu** became one of the most frequently reprinted volumes of poetry in the 19th century in Portugal and Brazil.

Gonzaga's complete works were published in 1942. *See* also M. Rodrigues Lapa, *Marília de Dirceu e mais poesias* (1937). (N. J. L.)

GONZÁLEZ DE CLAVIJO, RUY (d. 1412), Spanish diplomat and traveler, was born in Madrid and became chamberlain to King Henry III of Castille and León. On the return of his first embassy from the court of Timur, Henry despatched another which included Gonzblez and a Tatar adviser. They sailed from St. Mary Port, near Cadiz, on May 22, 1403, touched at Gaeta, Rhodes and Constantinople, went by the south coast of the Black sea to Trebizond, and proceeded inland by Erzurum, Tabriz, Tehran and Meshed to Samarkand, where they were favourably received by Timur. They returned successfully after great difficulties and reached Spain on March 1, 1406.

Gonzblez de Clavijo died in Madrid on April 2, 1412. His narrative presents a unique account of Timur's court by a European observer.

BIBLIOGRAPHY.—Two manuscripts of Gonzblez de Clavijo's narrative are preserved in the Biblioteca Nacional, Madrid; his *Embajada a Tamor Lán* was edited by F. Lopez Estrada (1943); English versions of *Embassy to Tamerlane by* Sir Clement Markham (1859) and by G. Le Strange (1928).

(R. A. SN.)

GOOCH, SIR DANIEL, BART. (1816–1889), English mechanical engineer, was born at Bedlington, Northumberland, on Aug. 16, 1816. In 1837 he became the locomotive superintendent of the Great Western railway, and gradually replaced the unsatisfactory locomotives employed by a new and efficient eight-wheeled class. One of these broad gauge locomotives, the "Lord of the Isles" gained a gold medal at the Great Exhibition of 1851, and ran 789,300 miles, with its original boiler, before withdrawal in 1881. Gooch left the railway in 1864, and as a director of the Telegraph Construction company personally superintended the laying of the first two Atlantic cables by the steamship "Great Eastern" in 1865–6. He returned to the Great Western railway as chairman in 1866 and carried out many improvedents before his death at Clewer Park, near Windsor, on Oct. 15, 1889. He was an advocate of the "broad," or 7 ft., gauge for railways, but his death only preceded by three years the complete conversion of the Great Western railway to standard gauge.

GOOCH, GEORGE PEABODY (1873–), English historian, was educated at King's college, London, and Trinity college, Cambridge, and continued his studies in Berlin and Paris. He was Liberal member of parliament for Bath (1906–10), and for Reading (1913). He was joint editor of the Contemporary Review (from 1911); president of the Historical association (1922–25); joint editor of the British Documents on the Origins of the *War, 1898–1914* (from 1926), and president of the National Peace council (1933–36). Gooch made a special study of modem German history, and was one of the first English authorities on the subject.

His many writings include: *Germany and the French Revolution* (1920); *Recent Revelations of European Diplomacy,* 4th ed. (1940); *Studies in Modern History* (1931); *Before the War,* 2 vol. (1936–38); *Courts and Cabinets* (1944); *Studies in German History* (1949).

GOOD, JOHN MASON (1764–1827), English writer on medical, religious and classical subjects, was born on May 25, 1764, at Epping, Essex, the son of a Nonconformist minister. In 1794 he became a member of the British Pharmaceutical society, and in that connection, and especially by the publication of A History *of* Medicine (1795), he effected a greatly needed reform in the profession of the apothecary. In 1820 he took the diploma of M.D. at Marischal college, Aberdeen. He died at Shepperton, Middlesex, on Jan. 2, 1827. Good was acquainted with the principal European languages, and also with Persian, Arabic and Hebrew.

GOODE, GEORGE BROWN (1851–1896), U.S. zoologist, specialized in the study of salt water fish. He was born in New Albany, Ind., on Feb. 13, 1851; graduated from Wesleyan university at Middletown, Conn., and spent a year at Harvard studying natural history under J. L. Agassiz. In 1874 he became chief of the division of fisheries at the National museum, Washington, D.C., and in 1887 assistant secretary of the Smithsonian institution in charge of the National museum, which position he held until his death at Washington, on Sept. 6, 1896. Under his direction the collections at the museum were entirely reorganized and recatalogued in a scientific manner and displayed with an educational aim in view.

His ideas of museum administration and display influenced nearly every important museum of the period. They were also spread by the remarkable Government exhibits prepared by Goode for the Centennial Exhibition of 1876, the World's Columbian Exposition of 1893, exhibitions at Berlin (1880), London (1883) and Madrid (1892–93) and many others. Goode wrote American Fishes (1888) and in 1896 published his most important scientific work, Ocean Ichthyology.

The Annual Report of the U.S. Nat. Museum for 1897 contains a bibliography of Goode's publications together with memoirs by S. P. Langley and others.

GOOD FRIDAY, the English name for the Friday before Easter, kept as the anniversary of the Crucifixion. The term is probably a corruption of "God's Friday." It was called Long Friday by the Anglo-Saxons and Danes, possibly in allusion to the length of the services which marked the day.

The origin of the custom of a yearly commemoration of the Crucifixion is somewhat obscure. It may be regarded as certain that among Jewish Christians it almost imperceptibly grew out of the old habit of annually celebrating the Passover on the 14th of Nisan, and of observing the "days of unleavened bread" from the 15th to the 21st of that month. In the Gentile churches, on the other hand, it seems to be well established that originally no yearly cycle of festivals was known at all. (See EASTER.)

From its earliest observance, the day was marked by a specially rigorous fast, and also, on the whole, by a tendency to greater simplicity in the services of the church. Prior to the 4th century there is no evidence of noncelebration of the eucharist on Good Friday; but after that date the prohibition of communion became common. In Spain, indeed, it became customary to close the churches altogether as a sign of mourning; but this practice was condemned by the council of Toledo (633). In the Roman Catholic Church the Good Friday ritual at present observed is marked by many special features, most of which can be traced back to a date at least prior to the close of the 8th century (see the Ordo Romanus in Muratori's *Liturg.* Rom. Vet.). The altar and the officiating clergy are draped in black and the gospel for the day consists of the history of the Passion as recorded by St. John. This is often sung in plain chant by three priests, one representing the "narrator," the other two the various characters of the story. The singing of this is followed by bidding prayers for the peace and unity of the church, for the pope, the clergy, all ranks and conditions of men, the sovereign, for catechumens, the sick and afflicted, heretics and schismatics, Jews and heathen. Then follows the "adoration of the cross." In the Church of England the history of the Passion from the gospel according to John is also read; the collects for the day are based upon the bidding prayers which are found in the Ordo Romanus. The "three hours" service, borrowed from Roman Catholic usage and consisting of prayers, addresses on the "seven last words from the cross" and intervals for meditation and silent prayer, has become very popular in the Anglican Church, and the observance of the day is more marked than formerly among Nonconformist bodies even in Scotland.

GOODHUE, BERTRAM GROSVENOR (1869–1924), American architect, was born at Pomfret Hill, Conn., April 28, 1869. He studied architecture in New York city with James Renwick, and in 1891 entered the office of R. A. Cram in Boston, Mass., later becoming a partner. In 1903 the firm opened an office in New York city, of which Goodhue took charge. After 1914 he practised alone. He designed churches and cathedrals which were thoroughly modern, yet Gothic in inspiration. At the same time he was one of the most prominent exponents of the skyscraper building.

Among the structures designed by him are St. Thomas's church, the Chapel of the Intercession, and the Church of St. Vincent Ferrer, New York city; the Nebraska State capitol, Lincoln, Neb.; St. Mark's church, Mount Kisco, N.Y.; St. Thomas's college, and the National Academy of Sciences and National Research Council in Washington; University chapel at the University of Chicago; the California Institute of Technology, Pasadena, Calif.; and the Exposition buildings for San Diego, Calif. He was also the architect for the Cathedral of Maryland, Balt. He died in New York city, April 24, 1924.

GOOD-KING-HENRY (*Chenopodium* Bonus-Henricus), a rank-growing perennial herb of the family Chenopodiaceae, found in Great Britain and naturalized in North America. It is a smooth, dark green, little-branched plant, about 2 ft. high, with usually entire arrowhead-shaped leaves. The plant is sometimes cultivated as a pot-herb under the name mercury or all-good. See CHENOPODIUM.

GOODMAN, GODFREY (1583–1656), bishop of Gloucester, was born at Ruthin, Denbighshire, and educated at Westminster and Cambridge. He took orders in 1603, and, after holding various preferments, became bishop of Gloucester in 1625. From this time his tendencies towards Roman Catholicism constantly got him into trouble. In 1633 he secured the see of Hereford by bribery, but Archbishop Laud persuaded the king to refuse his consent. In 1640 he was imprisoned for refusing to sign the new canons denouncing popery and affirming the divine right of kings. He afterwards signed and was released on bail, but next year the bishops who had signed were all imprisoned in the Tower, by order of parliament, on the charge of treason. After 18 weeks' imprisonment Goodman was allowed to return to his diocese. About 1650 he settled in London, where he died a confessed Roman Catholic. His best known book is *The Fall of Man* (1616).

GOODNOW, FRANK JOHNSON (1859–1939), American educationalist, was born in Brooklyn (N.Y.), on Jan. 18, 1859. Educated at Amherst college (Mass.), he graduated in law at Columbia (1882), subsequently proceeding to the École Libre des Sciences Politiques, Paris, and the University of Berlin. He was appointed instructor in history and lecturer in U.S. administrative law at Columbia university in 1883, becoming professor in 1891, and Eaton professor of administrative law and municipal science in 1903. During 1906–7 he was acting dean of political science. He was legal adviser to the Chinese Government, stationed at Peking, during the years 1913 and 1914, and from 1914 to 1928 was president of Johns Hopkins university. Among his published works are *Comparative Administrative Law* (1893); *Municipal Home Rule* (1895) ; *Municipal Problems* (1897) ; *Politics and Administration* (1900); *City Government in the United States* (1904); *The Principles of the Administrative Law of the United States* (1905); *Municipal Government* (1909); *Social Reform and the Constitution* (1911); *Principles of Constitutional Government* (1916); and *China; an Analysis* (1926).

GOODRICH, ANNIE WARBURTON (1866–1954), U.S. nursing educator. was born at New Brunswick. N.J., on Feb. 6, 1866. She was educated at private schools and in 1892 graduated from the New York hospital training school for nurses. She was superintendent of nurses at St. Luke's, New York and Bellevue and allied hospitals and also inspector of nurses' training schools under the New York department of education (1900–14) as well as lecturer at Teachers college. Columbia university (1904–13). In 1914 she became assistant professor of the department of nursing and health at Teachers college. and in 1917 director of nurses. Henry St. settlement. Her services to nursing during World War I led to her appointment in 1918 as dean of the army school of nursing. When Yale university. with aid from the Rockefeller foundation. established its school of nursing in 1923, she accepted the invitation to become dean and held this position together with that of professor of nursing education until 1934 when she retired. She died Dec. 31, 1954, in Cobalt, Conn.

GOODRICH, SAMUEL GRISWOLD (1793–1860), an U.S. publisher and author known under the pseudonym of "Peter Parley," was born at Ridgefield, Conn., Aug. 19, 1793. Largely self-educated, he became a bookseller and publisher at Hartford and later in Boston. There, beginning in 1828, he published for 15 years an illustrated annual, the *Token*, to which he was a frequent contributor both in prose and verse. The *Token* contained some of the earliest work of Nathaniel Hawthorne, N. P. Willis, Henry W. Longfellow and Lydia Maria Child. In 1841 he established *Merry's Museum*, which he continued to edit until 1854. In 1827 he began, under the name of "Peter Parley," his series of books for the young, which embraced geography, biography, history, science and miscellaneous tales. Of these he was the sole composer of comparatively few, but in his *Recollections of a Lifetime* (2 vol., 1856) he wrote that he was "the author and editor of about 170 volumes,". of which about 7,000,000 copies had been sold. and gave a list both of the works of which he was the author or editor and of the spurious works published under his name.

Goodrich was chosen a member of the Massachusetts house of representatives in 1836, and of the state senate in 1837, and in 1851–53 he was consul at Paris, where he remained until 1855.

He died in New York May 9, 1860.

GOODRICH (GOODRICKE), THOMAS (d. 1554), English ecclesiastic, son of Edward Goodrich of East Kirkby, Lincolnshire, was educated at Corpus Christi college, Cambridge, afterward becoming a fellow of Jesus college in 1510. He was consulted about the legality of Henry VIII's marriage with Catherine of Aragon, became royal chaplain about 1530, and bishop of Ely in 1534. He was zealous for the Reformation, helped in 1537 to draw up the *Institution of a Christian Man* (known as the *Bishops' Book*). and translated the Gospel of St. John for the revised New Testament. On the accession of Edward VI in 1547 the bishop was made a privy councillor. He assisted in compiling the First Prayer Book of Edward VI, and he was one of the commissioners for the trial of Bishop Gardiner. In January 1551 he succeeded Rich as chancellor and held this office during the nine days' reign of Lady Jane Grey; but he made his peace with Queen Mary by associating himself with the order commanding the duke of Northumberland to disarm. He conformed to the restored religion, and, though deprived of the chancellorship, kept his bishopric until his death on May 10, 1554.

See the *Dict. Nat. Biog.*, where further authorities are cited.

GOODSIR, JOHN (1814–1867), Scottish anatomist, was born at Anstruther. Fife, on hlarch 20, 1814. He was educated at St. Andrews, and at Edinburgh. Years later he communicated to the British association a paper on the pulps and sacs of the human teeth, and about the same date, on the nomination of Edward Forbes, he was elected to the famous coterie called the "Universal Brotherhood of the Friends of Truth." which comprised artists, scholars, naturalists and others. whose relationship became a potent influence in science. With Forbes he worked at marine zoology: but human anatomy, pathology and morphology formed his chief study.

In 1840 he moved to Edinburgh. where he was appointed conservator of the museum of the College of Surgeons. in succession to William Macgillivray. In his lectures in the theatre of the college in 1842–43 he insisted on the importance of the cell as a centre of nutrition, and pointed out that the organism is subdivided into a number of departments. R. Virchow recognized his indebtedness to these discoveries by dedicating his *Cellular Pathologie* to Goodsir, as "one of the earliest and most acute observers of cell-life." In 1843 Goodsir became curator in the University of Edinburgh. He died at Wardie near Edinburgh, on March 6. 1867.

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GOODWILL. In accounting, goodwill appears as an asset upon the balance sheet at the amount it originally cost, or at such lesser amount as it may have been written down out of profits. No attempt is ever made to re-value the goodwill of a business from year to year for balance sheet purposes. When, however, a change takes place in the owners of a business, the price to be paid for goodwill has necessarily to be agreed upon by the incoming and outgoing parties.

This price is a matter of bargaining. and has nothing to do with the figure that goodwill may appear at in the books of the business changing hands.

Gooduill represents the difference between an established successful business and one that has yet to establish itself and achieve success. The price that a purchaser is willing to pay for goodwill is the price he is prepared to pay for the right to stand in the shoes of his predecessor, and to represent himself as his successor in business. The price that the vendor of a goodwill is content to receive is the compensation that he is content to regard as adequate for his surrender of an income equal to the future profits of the business. The future profits of any business are, in the nature of things. incalculable.

The Result of Fair Dealing. — At one time it used to be thought that the goodwill of a business consisted solely of the goodwill of its customers, and represented the reputation that the business had acquired in their minds as a result of fair dealing over a reasonably extended period of time. Modern thought recognizes that. second only to the esteem of customers, is the esteem of supplying houses and employees.

Writing down Goodwill.--Many persons take the view that goodwill is an unsatisfactory item to appear in a balance sheet.

The earning power of every business fluctuates from year to year; thus, the actual value of goodwill also fluctuates. No attempt would ever be made to record these fluctuations in successive balance sheets, as that would give rise to confusion and serve no useful purpose; but goodwill is very commonly written down year by year when the profits are sufficiently large to make that practice possible. and many persons confuse this with the writing down of such wasting assets as plant and machinery to provide for depreciation. As a matter of fact, the goodwill of a business does not "depreciate" unless the business is a temporary one. Paradoxical as it may seem, goodwill is in practice written down only when in fact its value is increasing.

See L. R. Dicksee and F. Tillyard, *Goodwill and its Treatment in Accounts,* 4th ed. (1920). (L. R. D.)

GOODWIN, JOHN (*c.* 1594–1665), English Nonconformist divine, was born in Norfolk and educated at Queens' college, Cambridge, where he was elected fellow in 1617. He was vicar of St. Stephen's, Coleman street, London, from 1633 to 1645, when he was ejected by parliament for his attacks on Presbyterianism, especially in his *Theommachia* (1644). He established an independent congregation, and put his literary gifts at Oliver Cromwell's service. In 1648 he justified the proceedings of the army against the parliament ("Pride's Purge") in a pamphlet *Might and Right Well Met,* and in 1649 defended the proceedings against Charles I. (to whom he had offered spiritual advice) in *Hubristodikai.* At the Restoration this tract, with some that Milton had written to Monk in favour of a republic, was publicly burnt, and Goodwin was ordered into custody, though finally indemnified. He died in 1665.

Among his other writings are *Anti-Cavalierisme* (1642), a translation of the *Stratagemata Satanae* of Giacomo Aconcio, the Elizabethan advocate of toleration; *Redemption Redeemed, containing a thorough discussion of . . . election, reprobation and the perseverance of the saints* (1651, reprinted 1840). John Wesley published an abridged edition of his *Imputatio fidei.* See *Life by* T. Jackson (1839).

GOODWIN, THOMAS (1600–1680), English Nonconformist divine, was born at Rollesby, Norfolk, on Oct. 5, 1600, and was educated at Christ's college, Cambridge, and became a fellow of Catharine Hall. In 1625 he was licensed a preacher of the university; he became lecturer and then vicar (1632) of Trinity church, Cambridge. Worried by his bishop, who was a zealous adherent of Laud, he resigned all his preferments and left the university in 1634. He lived for some time in London; but in 1639 he withdrew to Holland. Returning to London soon after Laud's impeachment by the Long Parliament, he became minister of an independent congregation in Lime St., East London. In 1643 he was chosen a member of the Westminster Assembly, and at once identified himself with the Congregational party. In 1650 he became president of Magdalen college, Oxford, a post which he held until the Restoration. He was one of Cromwell's intimate advisers, attending him on his death-bed. He was also a commissioner for the inventory of the Westminster Assembly, 1650, and for the approbation of preachers, 1653, and together with John Owen (*q.v.*) drew up an amended Westminster Confession in 1658. From 1660 until his death on Feb. 23, 1680 he lived in London as pastor of the Fetter Lane Independent church.

See his *Works* (5 vols., 1681–1704; reprinted 12 vols., Edin., 1861–66); a memm. prefixed to vol. v. of his *Works;* and a sketch by Addison in No. 494 of the *Spectator.*

GOODWIN, WILLIAM WATSON (1831–1912), U.S. classical scholar, who specialized in Greek grammar and philology, was born in Concord, Mass., on May 9, 1831. He graduated at Harvard in 1851, studied at Bonn, Berlin and Gottingen, receiving his Ph.D. degree from there in 1855; was tutor in Greek at Harvard in 1856–60, and Eliot professor of Greek thereafter until his retirement in 1901. He became an overseer of Harvard in 1903. In 1882–83 he was the first director of the American School of Classical Studies at Athens. Goodwin edited the *Panegyricus* of Isocrates (1864) and Demosthenes' *De Corona* (1901), and assisted in preparing the 7th edition of Liddell and Scott's *Greek-English Lexicon.* He revised an English version by several writers of *Plutarch's Morals* (5 vol.. 1871), and published the Greek text with literal English version of Aeschylus' *Agamemnon* for the Harvard production of that play in June 1906. His most important work was his *Syntax of the Moods and Tenses of the Greek Verb* (1860, enlarged ed. 1890). Besides making accessible to American students the works of J. N. Madvig and P. Kriiger, it presented original matter, including a "radical innovation in the classification of conditional sentences," notably the "distinction between particular and general suppositions." Both this and his *Greek Grammar* (1870) in later editions were largely dependent on the theories of B. L. Gildersleeve for additions and changes. He died in Cambridge, Mass.. on June 16, 1912.

GOODWIN SANDS, a dangerous line of shoals at the entrance to the Strait of Dover from the North sea, about 6 mi. from the Kent coast of England, from which they are separated by and form shelter for, the anchorage of the Downs. The shifting sands, partly exposed at low water, are frequently the scene of wrecks, in spite of lights and bell-buoys. Attempts to erect a lighthouse have failed. Tradition finds in the Goodwins the remnant of an island called Lomea, which belonged to Earl Godwine (11th century) and was afterward submerged. Borings through the sand to the underlying chalk showed this to be highly improbable. Four lightships mark the limits of the sands, and are in communication with the lifeboat stations on the coast.

GOODYEAR, CHARLES (1800–1860), U.S. inventor, was born at New Haven, Conn.. Dec. 29. 1800, the son of Amasa Goodyear, an inventor (especially of farming implements) and a pioneer in the manufacture of hardware in the U.S. In 1821 he entered into a partnership with his father at Naugatuck, which continued till 1830. Already he was interested in an attempt to discover a method of treatment by which India rubber could be made into articles that would stand extremes of heat and cold. To the solution of this problem the next ten years of his life were devoted. For a time he seemed to have succeeded with a treatment of the rubber with aqua fortis. In 1836 he secured a contract for the manufacture by this process of mailbags for the U.S. government, but the rubber fabric was useless at high temperatures. In 1837 he worked with Nathaniel Hayward (1808–65), who had been an employee of a rubber factory in Roxbury and had made experiments with sulphur mixed with rubber. Goodyear bought from Hayward the right to use this imperfect process. In 1839, by dropping on a hot stove some India rubber mixed with sulphur, he discovered accidentally the process for the vulcanization of rubber. In 1844 his first patent was granted. Numerous infringements had to be fought in the courts, the decisive victory coming in 1852. In the same year he went to England, where articles made under his patents had been displayed at the International exhibition of 1851, but he was unable to establish factories there. In France a company for the manufacture of vulcanized rubber by his process failed, and in Dec. 1855 he was arrested and imprisoned for debt in Paris. He died in New York city July 1, 1860. He wrote an account of his discovery entitled *Gum-Elastic and Its Varieties* (2 vol., New Haven, 1853–55).

See also B. K. Peirce, *Trials of an Inventor, Life and Discoveries* of *Charles Goodyear* (New York, 1866); A. C. Regli, *Rubber's Goodyear: the Story of a Man's Perseverance* (New York, 1941).

GOOGE, BARNABE (1540–1594), English poet, son of Robert Googe, recorder of Lincoln, was born at Alvingham, Lincolnshire. He studied at Christ's college, Cambridge, and at New college, Oxford. He was attached to the household of his kinsman, Sir William Cecil, and in 1563 became a gentleman pensioner to Queen Elizabeth. His poems appeared in 1563 as *Eglogs, Epytaphes and Sonettes.* Googe was provost marshal of the court of Connaught, and about 20 letters of his in this capacity are preserved in the record office. He was an ardent Protestant, and his poetry is coloured by his religious and political views.

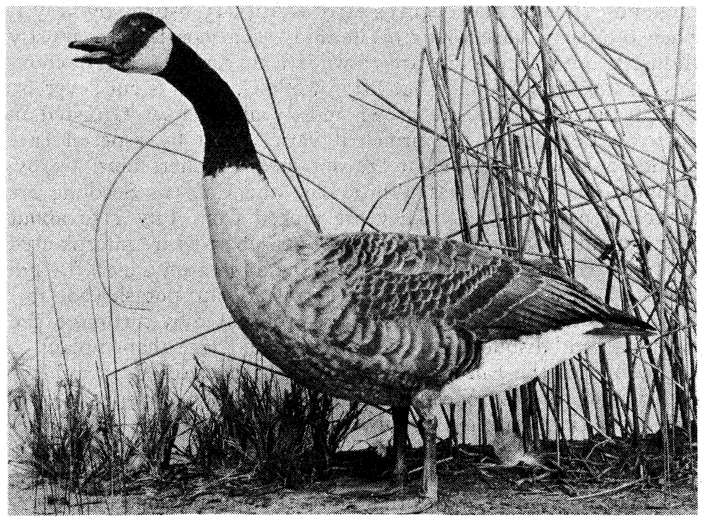
His other works include a translation from Marcellus Palingenius (said to be an anagram for Pietro Angelo Manzolli) of a satirical Latin poem, *Zodiacus vitae* (Venice, 1531?), in 12 books, under the title of *The Zodyake of Life* (1560); *The Popish Kingdome, or Reign of Antichrist* (1570), translated from Thomas Kirchmayer or Naogeorgus; *The Spiritual Husbandrie* from the same author, printed with the last; *Foure Bookes of Husbandrie* (1577), collected by Conradus Heresbachius; and *The Proverbs of . . . Lopes de Mendoza* (1579).

GOOKIN, DANIEL (*c.* 1612–1687), American colonial soldier and magistrate, was born in the British Isles but accompanied his father to Virginia at an early age and remained in the colonies for the greater part of his life. He lived in Virginia, except for a few years in England, until 1643, when he moved to Maryland and thence to Massachusetts because of his sympathy with Puritan teachings. He was a founder of the Roxbury public grammar school, was made captain of the militia in Cambridge, where he next settled, and in 1649 was elected to the Massachusetts house of representatives, becoming speaker of the house in 1651. In 1652 he was elected an assistant, the title given to members of the governor's council in Massachusetts, and held the position uninterruptedly until 1686 except for the year 1676 when he failed to be elected because he had befriended the Indians during King Philip's War. In 1655 Cromwell placed him in charge of the attempt to settle Jamaica, which England had recently acquired, with New Englanders, but the venture was not successful. The following year he was chosen superintendent of all Indians ruled by the Massachusetts government, a post he held, after his re-election in 1661, until his death. His attempts to protect the Indians from mistreatment at the hands of the whites made him widely unpopular with the citizens of Massachusetts. He helped John Eliot found several towns which were to be settled by natives converted to Christianity, the so-called "Praying Indians." He was made major general of Massachusetts in 1681. Gookin was the author of *Historical Collections of the Indians of Massachusetts* (1674); *Historical Account of the Doings and Sufferingsof the Christian Indians in New England;* and a history of New England which he never finished.

GOOLE, a municipal borough (1933), market town and port in the Goole parliamentary division of the West Riding of Yorkshire, Eng., 27 mi. S.W. of Hull and 23 mi. S.E. of York by road. Pop. (1951) 19,234. Area 2 sq.mi. Situated on flat land at the confluence of the Ouse and the Don, which later becomes the Humber, Goole is the terminus of the canal system of the former Aire and Calder navigation, to which it owes its existence. The docks were formally opened in 1826, and by 1956 Goole was the tenth port in the United Kingdom, with extensive coal shipments from the Yorkshire and east Midlands coalfields. Some 47 mi. from the North sea, the port can accommodate vessels of up to 2,000 tons burden, and larger vessels on the spring tides; it has nine interconnected wet docks and a quay length of 3 mi. The principal imports are food and provisions, strawboards, wool and scrap; exports include iron and steel manufactures, coke, pitch and textiles. Regular services operate between Goole and near continental ports and the town is also a railway centre. Other industries are shipbuilding and repairing, engineering, flour milling and the making of fertilizers and clothing, and the town is surrounded by an extensive agricultural area of rich warp land. A special feature is the system of conveying coal on the canal from the collieries by trains of compartment boats ("Tom puddings"), and of hydraulic lifts for discharging them without further handling into the holds of seagoing vessels. The 750,000 gal. water-storage tower is one of the largest in the country. In the town are two public parks, gardens. a market hall and cattle market.

GOOSE, the common name for birds forming the subfamily Anserinae of the Anatidae. Technically "goose" is the female, the male being "gander." Geese differ from ducks in that the sexes are alike in plumage and that the male assists the female in rearing the young. At the close of the breeding season they moult their wing quills and may then be easily approached. When in company, geese usually fly in a V-shaped formation.

The type of the subfamily is the graylag goose *(Anser anser),* from which the domestic goose has been derived. It breeds in suitable localities from Lapland to Spain, and from Scotland to China. The nest is placed in heather or grass and five or six eggs form a clutch. The genus *Anser* constitutes the "gray" geese, and includes, besides the graylag, the bean goose (A. *fabalis),* the pink-footed goose (A. *f. brachyrhynchus)* and the white-fronted goose (A. *albifrons*), all breeding in the northern part of the old world and migrating south in winter. American members of the genus are A. *albifrons* and, in the north, the snow geese, of which



BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

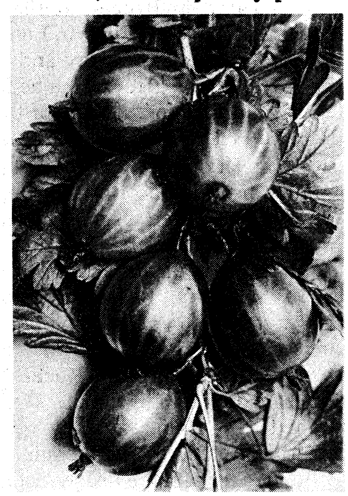
THE CANADA GOOSE (B. CANADENSIS)

the commonest is *Chen hyperborea,* the snow goose proper, white with black primaries, and *Philacte canagica,* the emperor goose of the Aleutian Islands. South America possesses the genus *Chloephaga,* which includes the kelpgoose, *C. hybrida,* and the upland goose, *C. leucoptera.*

The "black" geese include the barnacle goose *(Branta leucopsis),* breeding in Spitsbergen, northeast Greenland and northwest Siberia, supposed of old to be produced from barnacles (Lepadidae), and the brant goose, B. *bernicla,* with a circumpolar breeding range. To this group also belongs the well-known Canada goose (B. *canadensis)* of America. Other species occur in North America, Asia and the Hawaiian archipelago. The largest living goose is the Chinese goose, *Cygnopsis cygnoid,* the origin of the eastern domestic races. *Cnemiorius calcitrans* is a fossil goose from New Zealand, remarkable for its extraordinary patella and its loss of flight. The Egyptian and Orinoco geese *(Alopochen* and *Neochen)* are of doubtful affinities and possess an enlargement of the junction of the bronchial tubes and trachea—a characteristic of the ducks, Anatinae, to which they are now allocated.

GOOSEBERRY, a well-known fruit bush of the northern hemisphere, closely related to the currants, and frequently placed in the same genus, *Ribes,* of which there are about 150 species, mostly natives of western North America. If separated, the currants are *Ribes* and the gooseberries *Grossularia.* They belong to the family Saxifragaceae (*q.v.*). Currants are nonspiny and the flowers are borne in racemes, while gooseberries are spiny and produce their flowers singly or in twos and threes.

The gooseberry is far more important in Great Britain and northern Europe than in North America. In Europe it is made into preserves, and frequently eaten out of hand as berries are in the U.S. In the U.S. most varieties are used as jellies, preserves and in pies. European gooseberries are derived from the species G. *reclinata* (or *Ribes grossularia),* native in northern Africa and from Spain to the Caucasus north to Scandinavia. It was cultivated in English gardens as early as 1600. Hundreds of varieties are known and are classed as early, midseason or maincrop, and dessert kinds. May Duke is the chief early variety; Keepsake is also grown. Both are chiefly raised in the sourh of



J. HORACE MCFARLAND

THE KEEPSAKE GOOSEBERRY (G. RECLINATA)

England. Picking may begin as early as April 15, usually by May 1, when the berries are young. The midseason varieties are mostly Industry and Careless and are grown in Kent and the eastern counties. Industry is thinned but little, while Careless is cut severely. The dessert varieties are grown mostly about East Grinsted in Sussex. Leveller is the principal variety and by especial care berries one ounce in weight are obtained. Shiner, Lord Derby, Gunner, Leader, Careless, White Lion and Cousens Seedling are other dessert varieties. They are picked from July 1 to about Aug. 15 and are marketed ripe. Most gooseberries are interplanted in fruit orchards, the early 3 by 6 ft., the midseason 6 by 6 ft., and the late 4 by 4 ft. Stable manure (1 j tons) plus potash (200 lb.) are used as fertilizer. The bushes are propagated by cuttings taken in the fall and disbudded at the base to form a tree-shaped plant.

In America the European gooseberries are attacked by mildew. Hybridizing the European varieties with American species produced resistant varieties. Poorman and Pixwell are the chief varieties in the United States and Fredonia, Clark, Poorman and Silvia are good in Canada. Pixwell fruit is medium sized, Clark is large. Poorman is large fruited, bright red. Glenndale succeeds as far south as Maryland to Missouri. In Canada thornless varieties have been originated.

Powdery mildew, serious on European varieties, may be controlled with commercial lime-sulphur, $1\frac{1}{2}$ gal. to 50 gal. of water. Anthracnose and leaf spot may defoliate the plants unless controlled by spraying with Bordeaux mixture. The chief insect of red currants and gooseberries, the "imported" currant worm, quickly strips the plants of leaves but is readily controlled by powdered hellebore. The gooseberry, as well as the currant, spreads the blister rust and is prohibited from certain areas where white pine is important. State regulations regarding the planting of gooseberries may be obtained from state authorities. (G. M. D.)

GOOSSENS, a distinguished family of Belgian and English musicians.

1. EUGENE GOOSSENS (1845–1906), Belgian conductor, was born in Bruges, Belg., Feb. 25, 1845. He was admitted to the Brussels conservatory, where he studied the violin, when he was only 14. In 1882, after several years' experience as an operatic conductor in Belgium, France, Italy and England. Goossens was made conductor of the Carl Rosa Opera company, which had been founded in 1875 to travel through England performing operas in English. He died in Liverpool, on Dec. 30, 1906.

2. EUGÈNE GOOSSENS (1867–1958), son of the above, was also a conductor. He was born in Bordeaux, Fr., on Jan. 28, 1867, and was educated in Bruges, at the Brussels conservatory and at the Royal Academy of Music in London. He played the violin with the Carl Rosa Opera company and was a member of the orchestra of the Royal opera, after which he became conductor of the Carl Rosa Opera company in 1899 and of the British National Opera company in 1926. He died in London, Aug. 31, 1958.

3. SIR EUGENE GOOSSENS (1893–1962), English composer and conductor and son of the above, was born in London on May 26, 1893. He received his musical training at Bruges conservatory, the Liverpool College of Music and the Royal College of Music, London. In 1921, after he had for a number of years been associated with Sir Thomas Beecham, he organized an orchestra of his own and gave some concerts of modern chamber music. He was made conductor of the Rochester (N.Y.) Philharmonic orchestra in 1923 and remained in Rochester until 1931, when he became director of the Cincinnati (O.) Symphony orchestra. He remained in Cincinnati until 1946, and during this time he was musical director of the biennial Cincinnati May festivals.

In 1947 he became resident conductor of the Sydney (New South Wales, Australia) Symphony orchestra and director of the New South Wales Conservatorium of Music. He was knighted in 1955. In 1956 he resigned both his Australian positions.

In composition Goossens' output was considerable. Of particular interest is his chamber music which includes: *Suite* for flute, violin and harp (1914); *Five Impressions of a Holiday* for piano, flute or violin, and cello (1914); *Fantasy* for string quartet (1915); *Pastoral and Harlequinade* for flute, oboe and piano (1924); *Fantasy* for wind instruments. He also wrote two operas, *Judith* (produced. 1929) and *Don Juan de Mañara* (1937), both with librettos by the English novelist Arnold Bennett; a ballet, *L'École en crinoline* (1921); two symphonies (1940 and 1942–44); songs and piano, 'cello and violin pieces.

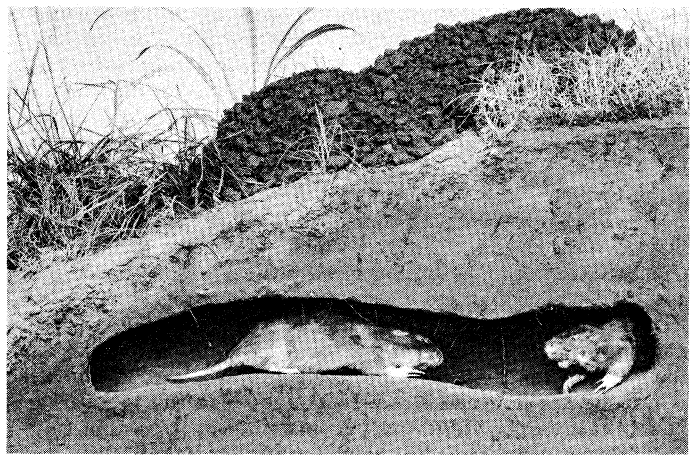
4. LEON GOOSSENS (1897–), English oboist, son of Eugène Goossens (2, above) was born in Liverpool on June 12, 1897. He was the first oboist of the Queen's Hall and Royal Opera House orchestras and of the London Philharmonic orchestra after it was founded in 1932, and made a great reputation as a solo and chamber music performer. His two sisters, Marie (b. 1894) and Sidonie (b. 1899) Goossens, are well known harpists.

GOOTY, a town and hill fortress and tehsil in the Anantapur district of Andhra Pradesh, India, 48 mi. E. of Bellary, with a station on the Southern railway. Pop. (1951) 15,437.

The town is surrounded by a circle of rocky hills, connected by a wall. On the highest hill stands the citadel, 2,100 ft. above sea level. This site was the stronghold of Morari Rao Ghorpade, a famous Maratha warrior and ally of the English, who was ultimately starved into surrender by Hyder Ali in 1775.

GOOTY TEHSIL covers an area of 896 sq.mi. and had a population of 214,851 in 1951.

GOPHER, a name applied in North America to three different groups of animals. The pocket gophers (Geomyidae) are burrowing rodents with large front claws, fur-lined cheek pouches, small ears and small eyes. They occur chiefly in the west and the south. Ground squirrels *(Citellus)* are often called gophers and so is the gopher tortoise *(Gopherus)* native to the southern states. "Gopher" is from an old French word, meaning to tunnel.



BY COURTESY OF CHICAGO NATURAL HISTORY MUSEUM

TYPICAL TUNNEL OF THE POCKET GOPHERS (GEOMYIDAE)

GÖPPINGEN, a town of Germany, in the *Land* of Baden-Wfrttemberg, on the Fils, 22 mi. E.S.E. of Stuttgart on the railway to Friedrichshafen. Pop. (1950) 39,360; (1959 est.) 48,003. Goppingen originally belonged to the Hohenstaufen, and in 1270 came into possession of the counts of Wiirttemberg. It was surrounded by walls in 1129, and was rebuilt after a fire in 1782. It possesses a castle built partly with stones from the ruined castle of Hohenstaufen, which stands 3 mi. N. of the town, by Duke Christopher of Württemberg in the 16th century and now used as public offices. The manufactures include linen and woolen cloth, electric motors, leather, glue, paper and toys. There are machine shops and tanneries in the town. It has a chalybeate spring.

GORAKHPUR, a city, tehsil and division of Uttar Pradesh, India. The city, which had a population in 1951 of 132,436 (including 8,592 persons living in the railway colony), is situated on the left bank of the Rapti river about 100 mi. N. of Varanas. It is believed to have been founded about A.D. 1400. It is the civil headquarters of the district and was an important depot for recruits coming from Nepal to join the Gurkha regiments of the Indian army. It is also the headquarters of the North-Eastem railway and the site of St. Andrew's college and the Maharana

Pratap college, both affiliated with Agra university.

Gorakhpur tehsil covers an area of 655 sq.mi. and had a population in 1951 of 823.644.

GORAKHPUR DISTRICT has an area of 2,439 sq.mi. Pop. (1951) 2,238,588. It lies immediately south of the lower Himalayan slopes, but itself forms a portion of the great alluvial plain. Only a few sand hills break the monotony of its level surface, which is, however, intersected by numerous rivers (Gogra, Gandak, Rapti and others) studded with lakes and marshes. In the north and centre dense forests abound, and the district is not subject to very intense heat, against which it is secured by its vicinity to the hills and the moisture of its soil. For this reason it has usually escaped severe famine.

Gautama Buddha was born, and died, near the boundaries of the district; and near Kasia are remains which were long (but probably erroneously) believed to mark his burial place. From the beginning of the 6th century the country was the scene of a continuous struggle between the Bhars and their Rajput antagonists, the Rathors.

FROM RUSSEL, "TRIBES AND CASTES OF CENTRAL INDIA"

BANJARA WOMAN WITH THE SINGH OR HORN

Toward the end of the 16th century the Mohammedans occupied Gorakhpur town, but they interfered very little with the district, and allowed it to be controlled by the local rajas. In the middle of the 18th century a formidable foe, the Banjaras from the west, so weakened the power of the rajas that they could not resist the fiscal exactions of the Oudh officials, who plundered the country to a great extent. The district formed part of the territory ceded by Oudh to the British under the treaty of 1801.

GORAKHPUR DIVISION comprises the four districts of Gorakhpur, Deoria, Basti and Azamgarh, and has an area of 9,563 sq.mi. The population in 1951 was 8,831,241, giving the very high average density figures of 923 persons per square mile.

GORAL (*Naemorhedus goral*), a small Asiatic goatlike bovine animal having slightly backward curving cylindrical horns and a coarse brownish-gray coat. It is a ruminant (cud chewer) related to the chamois and serow (*qq.v.*), but distinguished from them by peculiarities in skull form, by smaller size, shorter horns and the absence of face glands. Gorals range from the Himalayas to eastern Siberia. See also BOVIDAE. (J. E. HL.; X.)

GORBODUC, a mythical king of Britain. He gave his kingdom away during his lifetime to his sons, Ferrex and Porrex. The two quarrelled and the younger stabbed the elder. Their mother, loving the latter most, avenged his death by murdering the other, and the people, horrified at her act, revolted and slew both her and King Gorboduc.

This legend was the subject of the earliest regular English tragedy written by Thomas Sackville, Lord Buckhurst and Thomas Norton in collaboration. Produced in 1561, it was first published very corruptly in 1565, and in better form as The Tragedy of Ferrex and Porrex in 1570.

GORCHAKOV or GORTCHAKOFF, a noble Russian family, descended from Michael Vsevolodovich, prince of Chernigov, who, in 1246, was assassinated by the Mongols. PRINCE ANDREY IVANOVICH (1768–1855), general in the Russian army, took a conspicuous part in the final campaigns against Napoleon. ALEXANDER IVANOVICH (1769–1825) served with distinction under his relative Suvorov in the Turkish Wars, and took part as a general officer in the Italian and Swiss operations of 1799, and in the war against Napoleon in Poland in 1806–1807 (battle of Heilsberg). PETR DMITRIEVICH (1790–1868) served under Kamenski and Kutusov in the campaign against Turkey, and afterwards against France in 1813–14. In 1820 he suppressed an insurrection in the Caucasus, for which service he was raised to the rank of major-general. In 1828–29 he fought under Wittgenstein against the Turks, won an action at Aidos, and signed the treaty of peace at Adrianople. In 1839 he was made governor of Eastern Siberia, and in 1851 retired into private life. When the Crimean War broke out he offered his services to the emperor Nicholas, by whom he was appointed general of the VI. army corps in the Crimea. He commanded the corps in the battles of Alma and Inkerman. He retired in 1855 and died at Moscow, on March 18, 1868. Other members of the family are separately noted.

GORCHAKOV, PRINCE ALEXANDER MIKHAILOVICH (1798–1883), Russian statesman, cousin of Princes Petr and Mikhail Gorchakov, was born on July 16, 1798, and was educated at the lyceum of Tsarskoye Selo. On leaving the lyceum Gorchakov entered the foreign office under Count Nesselrode. When the German confederation was re-established in 1850 in place of the parliament of Frankfort, Gorchakov was appointed Russian minister to the diet, and formed with Bismarck a friendship which was afterwards renewed at St. Petersburg. Gorchakov was then transferred to Vienna, where he remained through the critical period of the Crimean War. Although he attended the Paris conference of 1856, he abstained from signing the treaty of peace. Alexander II. then appointed him minister of foreign affairs in place of Count Nesselrode. Gorchakov was appointed chancellor, and was, for a time, the most powerful minister in Europe.

When the conflict arose between Austria and Prussia in 1866, Russia remained neutral, and when the Franco-German war of 1870–71 broke out Russia answered for the neutrality of Austria. In 1875 Bismarck was suspected of a design of again attacking France, and Gorchakov let it be known that Russia would oppose any such scheme. Slavophil agitation produced the Russo-Turkish campaign of 1877–78. At the congress of Berlin (June 13 to July 13, 1878) the aged chancellor held nominally the post of first plenipotentiary, but left to Count Shuvalov the odium for the concessions which Russia had to make to Great Britain and Austria. He died at Baden-Baden on March 11, 1883.

See Charles-Roux, Alexandre *II.*, Gorchakov et Napoleon *III.* (1913).

GORCHAKOV, PRINCE MIKHAIL DMITRIEVICH (1793–1861), Russian army officer, served in the campaigns in Persia in 1810 and in 1812–14 against France. During the Russo-Turkish War of 1828–29 he was present at the sieges of Silistria and Shumla. He was appointed a general officer in 1830, served in the campaign in Poland, was wounded at the battle of Grochow and distinguished himself at the taking of Warsaw. In 1846 he became military governor of Warsaw. He was chief of staff of the Russian army serving in Hungary in 1849, and subsequently served as chief of staff of the Russian army and adjutant general to the tsar. In 1853, Gorchakov led the forces which entered Moldavia. When Russia subsequently declared war against Turkey in 1854, he was appointed commander in chief of the troops that occupied Moldavia and Walachia and besieged Silistria. In 1855, at a critical time in the operations, he was appointed commander in chief of the Russian forces in the Crimea, replacing Prince Menshikov. Gorchakov's defense of Sevastopol. the northern part of which he continued to defend until peace was signed in Paris, was conducted with skill. In 1856 he was appointed governor general of Poland to succeed Prince Paskevich, which post he held until his death on May 30, 1861. He was buried, in accordance with his wish, at Sevastopol. (R. L. GF.)

GORDIAN or **GORDIANUS,** the name of three Roman emperors. The first, Marcus Antonius Gordianus Sempronianus Romanus Africanus (A.D. 159–238), an extremely wealthy man, was descended from the Gracchi and Trajan. Alexander Severus made him governor of Africa, and during his proconsulship occurred the usurpation of Maximin. The universal discontent under Maximin ended in a revolt in Africa in 238, and Gordian reluctantly yielded to the popular clamour and assumed the purple. His son, Marcus Antonius Gordianus (192–238), was associated with him. The Senate and most of the provinces supported them. But after a siege of 36 days they fell before Cappellianus, a supporter of Maximin. The Senate continued the revolt against Maximin and elected M. Antonius Gordianus Pius (224–244), grandson of the elder Gordian, joint emperor with two

Senators. The death of Maximin and the murder of Gordian's colleagues by the praetorians left Gordian sole emperor. For some time he was under the control of his mother's eunuchs, till Timesitheus, his father-in-law and praefect of the praetorian guard, persuaded him to assert his independence. When the Persians under Shapur (Sapor) I. (*q.v.*) invaded Mesopotamia, the young emperor opened the temple of Janus for the last time recorded in history, and marched in person to the East. The Persians were driven back over the Euphrates and defeated in the battle of Resaena (243), and only the death of Timesitheus (under suspicious circumstances) prevented an advance into the enemy's territory. Philip the Arabian, who succeeded Timesitheus, stirred up discontent in the army, and Gordian was murdered by the mutinous soldiers in Mesopotamia.

See lives of the Gordians by Capitolinus in the *Scriptores historiae Augustae;* Herodian vii. viii.; Zosimus i. 16, 18; Ammianus Marcellinus xxiii. 5; Eutropius ix. 2; Aurelius Victor, *Caesares,* 27; article SHAPUR (I.); Pauly-Wissowa, *Realencyclopädie,* i. 2619 f. (von Rohden).

GORDIAN KNOT: see GORDIUM.

GORDIUM, an ancient city of Phrygia on the road from Pessinus to Ancyra, and not far from the Sangarius. Its site lies opposite the village Pebi, a little north of the point where the Constantinople-Angora railway crosses the Sangarius.

According to the legend, Gordium was founded by Gordius, a Phrygian peasant who had been called to the throne by his countrymen in obedience to an oracle of Zeus commanding them to select the first person that rode up to the temple of the god in a wagon. The king afterwards dedicated his car to the god, and another oracle declared that whoever succeeded in untying the strangely entwined knot of cornel bark which bound the yoke to the pole should reign over all Asia. Alexander the Great, according to the story, cut the knot by a stroke of his sword. Gordium was captured and destroyed by the Gauls soon after 189 B.C. and disappeared from history. In imperial times only a small village existed on the site.

See *Jahrbuch des Instituts,* Erganzungsheft v (1904).

GORDON, the name of a Scottish family, no fewer than 157 main branches of which are traced by the family historians. A laird of Gorden, in Berwickshire, near the English border, is said to have fallen in the battle of the Standard (1138). The families of the two sons ascribed to him by tradition, Richard Gordon of Gordon and Adam Gordon of Huntly, were united by the marriage of their great-grandchildren Alicia and Sir Adam, whose grandson Sir Adam (killed at Halidon Hill, 1333) at first took the English side in the Scottish struggle for independence, and is the first member of the family definitely to emerge into history. He was justiciar of Scotland in 1310, but after Bannockburn he attached himself to Robert Bruce, who granted him in 1318 the lordship of Strathbogie in Aberdeenshire, to which Gordon gave the name of Huntly from a village on the Gordon estate in Berwickshire. He had two sons, Adam and William. The younger son, laird of Stitchel in Roxburghshire, was the ancestor of William de Gordon of Stitchel and Lochinvar, founder of the Galloway branch of the family represented in the Scottish peerage by the dormant viscounty of Kenmure (*q.v.*), created in 1633; most of the Irish and Virginian Gordons are offshoots of this stock. The elder son, Adam, inherited the Gordon-Huntly estates. He had two grandsons, Sir John (d. 1394) and Sir Adam (slain at Homildon Hill, 1403). Sir John had two illegitimate sons, Jock of Scurdargue, the ancestor of the earls of Aberdeen, and Tam of Ruthven. From these two stocks most of the northern Gordon families are derived Sir Adam's daughter and heiress, Elizabeth, married Sir Alexander Seton, and with her husband was confirmed in 1408 in the possession of the barony of Gordon and Huntly in Berwickshire and of the Gordon lands in Aberdeen. The Seton-Gordons are their descendants. Their son Alexander was created earl of Huntly (see HUNTLY, EARLS AND MARQUESSES OF), probably in 1445; and his heirs became dukes of Gordon, George Gordon (c. 1650–1716), 4th marquess of Huntly, being created duke of Gordon in 1684. His son Alexander, 2nd duke of Gordon (c. 1678–1728), joined the Old Pretender, but gained the royal pardon after the surrender of Gordon

BY COURTESY OF AMERICAN MUSEUM OF NATURAL HISTORY

A PIPER OF THE GORDON HIGHLANDERS, A SCOTTISH REGIMENT ORGANIZED IN 1796

castle in 1716. Of his children by his wife Henrietta Mordaunt, second daughter of Charles Mordaunt, earl of Peterborough, Cosmo George (c. 1720–1752) succeeded as 3rd duke; Lord Lewis Gordon (d. 1754) took an active part in the Jacobite rising of 1745; and General Lord Adam Gordon (c. 1726–1801) became commander of the forces in Scotland in 1782, and governor of Edinburgh Castle in 1786. Lord George Gordon (*q.v.*) was a younger son of the 3rd duke.

The title, with the earldom of Norwich and the barony of Gordon Huntly, became extinct on the death of George, 5th duke (1770–1836), a distinguished soldier who raised the corps now known as the 2nd battalion of the Gordon Highlanders. The marquessate of Huntly passed to his cousin and heir-male, George, 5th earl of Aboyne. Lady Charlotte Gordon, sister of and coheiress with the 5th duke, married Charles Lennox, 4th duke of Richmond, whose son took the name of Gordon-Lennox. The dukedom of Gordon was revived in 1876 in favour of the 6th duke of Richmond, who thenceforward was styled duke of Richmond and Gordon. Adam Gordon of Aboyne (d. 1537) took the courtesy title of earl of Sutherland in right of his wife Elizabeth, countess of Sutherland in her own right, sister of the 9th earl. The lawless and turbulent Gordons of Gight were the maternal ancestors of Lord Byron.

Among the many soldiers of fortune bearing the name of Gordon was Colonel John Gordon, one of the murderers of Wallenstein. Patrick Gordon (1635–99) was born at Auchleuchries in Aberdeenshire, entered the service of Charles X. of Sweden in 1651 and served against the Poles. He changed sides more than once before he found his way to Moscow in 1661 and took service under the tsar Alexis. He became general in 1687; in 1688 he helped to secure Peter the Great's ascendancy; and later he crushed the revolt of the Streltzi. His diary was published in German (3 vols., 1849–53, Moscow and St. Petersburg), and selections from the English original by the Spalding Club (Aberdeen, 1859).

The Gordons fill a considerable place in Scottish legend and ballad. "Captain Car," or "Edom (Adam) of Gordon" describes an incident in the struggle between the Forbeses, and Gordons in Aberdeenshire in 1571; "The Duke of Gordon's Daughter" has apparently no foundation in fact, though "Geordie" of the ballad is sometimes said to have been George, 4th earl of Huntly; "The Fire of Frendraught" goes back to a feud (1630) between James Crichton of Frendraught and William Gordon of Rothiemay; the "Gallant Gordons Gay" figure in "Chevy Chase"; William Gordon of Earlston, the Covenanter, appears in "Bothwell Bridge," etc.

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GORDON, AARON DAVID (1856–1922), theoretician and spiritual mentor of the Zionist co-operative movement, was born at Troyanov in the Ukraine on June 9 or 10, 1856. He distinguished between two sources of knowledge: cognition and experience. Man's unique faculty for self-awareness elevates him above nature (experience) but simultaneously alienates him from the cosmos. Only by working the soil, the particular sphere which the cosmos has entrusted to man, can man once again participate in creation and reintegrate himself into the cosmos. Gordon's Zionism derived from this central idea. Jews, he believed, could overcome their alienation if they returned to the homeland from which they were exiled and work its soil. He was particularly influenced by Nietzsche, Tolstoi and Bergson. The personal example he set by migrating to Israel in 1904 and turning farmer inspired Israel's early pioneers. He helped found Deganiah, Israel's first collective community, where he died on Feb. 22, 1922. His Hebrew works fill five volumes, and his *Selected Essays* were published in English in 1938. (EA. SR.)

GORDON, ADAM LINDSAY (1833–1870), one of the first Australian poets to write in a distinctively Australian idiom, was born at Fayal in the Azores on Oct. 19, 1833, the son of a retired Indian officer who taught Hindustani at Cheltenham college. Gordon was educated in England at Cheltenham and Worcester Royal grammar school.

Gordon's youth was so wild and reckless that in 1853 his father sent him to South Australia, where he joined the mounted police. He then became a horsebreaker, but on his mother's death in 1861 inherited £7,000 and also obtained a seat in the house of assembly. He had the reputation of being the best nonprofessional steeplechase rider in the colony. In 1867 he moved to Victoria, set up a livery stable at Ballarat and published two volumes of poems, *Sea Spray and Smoke Drift* and *Ashtaroth*. In 1869 he settled at New Brighton near Melbourne publishing a third volume of poetry, *Bush Ballads and Galloping Rhymes* (1870). It brought him more praise than money and, discouraged by his failure to make good his claim to property in Scotland and suffering from the effects of a bad fall from a horse, he committed suicide at New Brighton on June 24, 1870.

Gordon's poetry is chiefly English in inspiration but where it is local, it is vividly so. His nature lyrics contain his best poetry. His strong rhythms and simple homespun philosophy make his poetry memorable, and some of his lines have been adopted into the vocabulary of the average Australian.

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GORDON, CHARLES GEORGE (1833–1885), British soldier and administrator, the ninth of the 11 children of Gen. H. W. Gordon (royal artillery)', was born at Woolwich on Jan. 28, 1833. In consequence of his father's military service, he early began that wandering life which was to characterize his adult years. After several years at Corfu, he spent four years at Taunton Grammar school and obtained a cadetship at the Royal Military academy, Woolwich, in 1848. His individuality and high temper asserted themselves during his cadetship, one escapade losing him a term's seniority; but he passed out high enough on the list to obtain a commission in the royal engineers, the more exacting of the two corps for which his training was designed. He showed a marked aptitude for surveying and cartography and in his last year as a cadet won the prize for "fortification." Commissioned as a second lieutenant, he was posted to Chatham, and in Feb. 1854 he was sent to work on the forts then in course of construction at Pembroke dock. There he formed a friendship with a deeply religious brother officer of evangelical views who awakened in him the strong convictions which were henceforth to dominate his life. On the outbreak of the Crimean War he volunteered for service, and he was present at the siege of Sebastopol and took part in the assault on the Redan.

After the war his cartographical skill led to his being appointed to the international commissions set up to demarcate the Russo-Turkish frontiers in Bessarabia and in Armenia, though he appealed in 1857 to be allowed to serve in India against the mutineers. He returned to England in the autumn of 1858, having acquired an interest in eastern peoples which he never lost, was promoted captain and given a staff appointment at Chatham.

In 1860 he volunteered for service with the Anglo-French forces operating against the Chinese in order to secure their acquiescence in the terms of the treaty of Tientsin (July 1858). He was present at the taking of Peking and at the burning of the Summer palace. After peace had been agreed upon, Gordon remained with the British troops left at Tientsin to ensure compliance with its terms and was employed first in constructing quarters for the troops and subsequently, in the winter of 1861–62, in exploring and surveying the country around Tientsin for the British army.

South China, however, had for several years been disturbed by a body of fanatical revolutionaries, whose leader, partly influenced by some ill-digested notions about Christianity, considered himself destined to inaugurate a "reign of peace" and styled himself Tien Wang, or "Heavenly King." Tien Wang had so much success against the Chinese imperial government that in 1862 the greater part of the British forces were moved from Tientsin, to protect the European communities at Shanghai against him. Gordon attracted attention in operations against the rebels and in Sept. 1862 was given an independent command. The Europeans of Shanghai had earlier raised a force for their own defense which went by the not entirely appropriate title of "the Ever-Victorious army" and was commanded by an American, Frederick Townsend Ward (1831–62). British and French forces cleared the area around Shanghai, but Ward was killed, and when the Chinese provincial governor asked the British commander to find a successor to him Gordon was appointed to the command (March 1863).

He at once established a moral supremacy over the "Ever-Victorious" troops, securing the loyalty of most of their American officers—no easy task at the time of the "Alabama" crisis—and winning the devotion of the soldiers by leading them into battle armed with no more than a cane. But for all his successful showmanship his victories owed something to technical military skill: he gave his troops the advantage of careful reconnaissance and planning and heavy gunfire at critical places in the enemy's line. By a skilful use of the waterways with which the country was intersected (particularly for the transport of heavy artillery) he soon established military superiority over an enemy whose strong points were almost always walled towns amid watercourses. His tactics were applied with unvarying success, and great areas were cleared of the rebel forces; on Nov. 29, 1863, his work was crowned by the capture of Suchow. But the fall of Suchow was attended with serious consequences which almost led to a breach between Gordon and his temporary Chinese superiors. He had been in contact with some of the rebel leaders inside the city before its fall and had given them assurances which in his opinion entitled them to expect clemency if they surrendered; but when they gave themselves up, together with the city, the Chinese imperial commander promptly had them beheaded.

This action, quite in accordance with Chinese practice, was utterly repugnant to Gordon, who felt moreover that his personal honour had been seriously slighted. He withdrew his forces from the Chinese army and retired from Suchow to Guinsan, where he kept them inactive until Feb. 1864 when, largely through the intervention of Robert (later Sir Robert) Hart, he once more came to an arrangement with the imperial commander. Nothing further was said of the Suchow affair. It is likely that Gordon was influenced by his sincere desire to see the country finally pacified and by his strong confidence in himself: "I do not apprehend," he wrote, "the rebellion will last six months longer if I take the field. It may take six years if I leave"; and in fact, although he suffered a wound and his first defeats in battle, the rebel stronghold Chanchufu fell in May 1864 and Tien Wang committed suicide in June. Gordon had once more withdrawn his forces and was in process of disbanding them when the capture of Nanking by the imperial army brought the rebellion to a close. Gordon had certainly played the major part in its suppression, and this fact was recognized by the Chinese and the British governments. From the emperor he received the *titu* (the highest Chinese military rank), together with the much-coveted right to wear the yellow jacket, and the offer of a large sum of money which he refused. By the British authorities he was raised to the rank of lieutenant colonel and appointed C.B. He had also achieved popular fame in England, where he was henceforth "Chinese Gordon."

For six years after his return to England from China, Gordon was employed on routine work of a kind little likely to attract attention; he was appointed commanding royal engineer at Gravesend, with the primary duty of supervising the erection of some new forts on the Thames. He consistently shunned the publicity consequent upon his exploits and refused to give any public addresses in connection with them. But at Gravesend he became aware of a further religious experience and as a result began to give his spare time wholly to religious and social work, particularly among boys. Although he was moved in this entirely by his religion, his work was of a practical nature and his concern for the education, clothing and employment of his protégés found recognition, after his death, in the setting up of the Gordon Memorial home for boys.

In Oct. 1871 Gordon was again posted overseas, to Galatz, as British representative on the international Danube commission—an appointment which led indirectly to his long and ultimately fatal connection with Egypt. On a holiday visit to Constantinople in 1872 he met Nubar Pasha, an Armenian subject of the khedive Ismail and in effect the khedive's minister for foreign affairs, who was looking for a successor to Sir Samuel Baker as governor of the Equatorial province (nominally a part of the Egyptian dominions in consequence of their southward expansion since about 1820, in the reign of Mohammed Ali Pasha). Nubar was attracted to Gordon and in 1873 made him an offer of service under the khedive. With the consent of the British government, Gordon accepted and travelled to Egypt early in 1874.

The chief factors which determined the course of Gordon's career in the service of Egypt were his strong sense that he was engaged upon a major civilizing mission and his successful personal relationship (unusual for a European of personal probity) with the khedive Ismail. Ismail is customarily remembered for luxury, periodic indolence and administrative inability; but he saw himself as a benevolent instrument of civilization and justice. Gordon saw and accepted this aspect of the khedive's character and built upon it a close, mutually confident relationship. Common ground between them was a desire, in Gordon's case a determination, to end the trade in Negro slaves; Ismail had made frequent public acts calculated to restrict it, but their effectiveness was much limited by the indifference or corruption of his officials.

Meeting the khedive in Cairo, Gordon insisted that his salary be reduced by £8,000 to £2,000 a year. He then proceeded to Khartoum and thence by river to Gondokoro, the administrative centre of the Equatorial province, where he spent two and one-half years of incessant activity, directed to the pacification of the province, to its exposure to Egyptian influence and commerce and in particular to the suppression of the slave trade. His policy was so far as possible to achieve these results peaceably, being, as he wrote to his sister, "averse to the loss of a single life." His small band of European and American assistants fell before the unhealthful climate and was early reduced to one only—the Italian Romolo Gessi, already a close friend. His first task was to extend his administrative grip southward. In the course of two years he pushed up the Nile until a small steamship (transported in pieces) was launched on Lake Albert. Characteristically he shunned the publicity which must arise from this achievement, moving away to let Gessi command the final dramatic stage. He established friendly relations with the powerful M'tesa, king of Uganda, through negotiations in which his agent was a German doctor, Eduard Schnitzer (soon, as Emin Pasha, to be himself governor of Equatoria). Egyptian authority was established as far as Lake Albert in the west and almost to Lake Victoria in the east. Uninterrupted communications were secured and slavery rigorously controlled. In Dec. 1876 Gordon returned to Cairo.

On reflection Gordon concluded that the great object of his governorship of Equatoria had been only partially accomplished. In his own province he had brought the slave trade to an end, but the traders had found alternative routes through the Sudan. If their activities were to be stamped out, the whole Sudan must be subjected to antislavery administration of equal rigour. When Gordon saw the khedive on Feb. 13, 1877, and stated his case, Ismail immediately appointed him governor general of the Sudan. "I am astonished," he wrote, "at the power he has placed in my hands . . . it will be my fault if slavery does not cease, and if those countries are not opened to the world." It was a task which matched both his ideals and his urgent sense of personal mission. Remembering the toll of sick men in Equatoria he determined to undertake it alone. "I go alone with an infinite Almighty God to direct and guide me" was his comment.

His first task was to restore friendly relations with King John of Abyssinia, but he failed to conclude a full agreement. From Abyssinia he proceeded to his capital, Khartoum, from the south, travelling across the desert on camel back. On his arrival he at once inaugurated a period of administrative reform, abolishing the use of the whip and ruthlessly dismissing corrupt and incompetent officials. But soon his attention was directed westward to the province of Darfur, which stretched away to the central African desert. Here Zobeir, greatest of contemporary slave dealers, had recently expelled the hereditary sultan and come to an agreement with the preceding governor general of the Sudan by which he retained the substance of his conquests under the khedive's nominal sovereignty. But Ismail had summoned Zobeir to Cairo, whence, though loaded with honours, he was not permitted to return, being sent instead, in the summer of 1877, to the Balkans at the head of an Egyptian contingent participating in the Russo-Turkish War. Zobeir's fate was much resented by his son Suleiman, who joined forces with a relative of the original sultan of Darfur with the intention of rejecting the Egyptian connection. Gordon acted swiftly, drove the rebel forces away from the Egyptian posts which they were menacing ("10,000 Egyptian troops had been relieved by Gordon with 300 men") and, riding in full dress as governor general but with no more than 50 men into Suleiman's camp, eventually tamed him by sheer force of character.

After a further unsatisfactory visit to the Abyssinian frontier, he was summoned to Cairo in Jan. 1878 on business of a very different order. The deterioration of Egypt's finances had reached a critical stage. European governments were pressing hard upon the khedive in the interests of the foreign bondholders. Ismail proposed to set up a commission of inquiry into the finances of the country; Gordon, invited to become its president, accepted the task on the understanding that the European debt commissioners were not to be members of it. This condition was rejected by the debt commissioners and led to a heated controversy between Gordon and the British commissioner, Evelyn Baring. The European consuls intervened. and Ismail was obliged to give way and was eventually deposed. Gordon returned to Khartoum, where he found that Suleiman, supplied with smuggled weapons by his father, had again rebelled. He collected a force of 2,000 men and dispatched them against the rebels under the command of his old comrade Gessi, eventually joining him in Feb. 1879 and engaging in an arduous desert campaign which ended in the destruction of the rebel forces and in the execution of Suleiman but reduced Gordon himself to a state approaching total exhaustion. After a further hazardous approach to the Abyssinians as a result of which he was made a prisoner, he returned to Cairo by way of Massawa and handed his resignation to Ismail's successor, the khedive Tewfik.

Gordon left Cairo a deeply disappointed man, for he had learned of the appointment to his place in Khartoum of an Egyptian whom he had previously dismissed for corruption and cruelty, and he foresaw the destruction of all that he had built. He worked closely with the Anti-Slavery society after his return to London (Jan. 1880), and it was his anxiety to combat slavery that led him to accept the suggestion of King Leopold II of Belgium (March 1880) that he should, in due course, succeed H. M. Stanley as administrator of the Congo. In May 1880 he agreed to go to India as private secretary to the new viceroy, the marquess of Ripon, but he resigned a few days after arriving in Bombay after a disagreement with his chief as to the propriety of restoring the deposed amir of Afghanistan, a step which Gordon advocated. From Bombay, at the instance of Sir Robert Hart (by now inspector general of customs for China), he went to Peking where he was successful in dissuading the Chinese from undertaking what, he felt, would be a suicidal war with Russia. On returning to England he exchanged with a brother officer and, in April, went in his place as commanding royal engineer to Mauritius. This post he was obliged to vacate on his promotion as major general in March 1882. Early in 1881 he had telegraphed an offer of mediation to the government of Cape Colony which was at war with the Basutos. This was remembered, and his help was sought more than a year later. At the Cape he saw much of Cecil Rhodes, who agreed with him as to the legitimacy of many of the Basuto grievances. After a discussion with the Cape ministers, he undertook a journey into Basuto territory for direct negotiation with one of the leading chiefs, Masupha, and was placed in considerable danger by an attack against Masupha's territories by another chief—at the instigation, as Gordon believed, of one of the Cape ministers. In consequence of this, he resigned and landed in England in Nov. 1882. From Jan. to Dec. 1883 he lived in Palestine, studying antiquities. Eventually he learned that his post in the Congo was now available—but by that time, he was about to be caught up again in Egyptian and Sudanese affairs.

In Aug. 1881 the peace of the Sudan was broken by the fanatical followers of Mohammed Ahmed (*q.v.*), who in that month proclaimed himself the mahdi; within a year the situation was dangerous. The Egyptian government, preoccupied with the rebellion of Arabi Pasha, did nothing to check the progress of the rebels, and the British government, with whom lay the responsibility for action after the British army had entered Cairo (Sept. 1882), was inhibited by its anxiety to avoid further commitments in the area. It was not until Nov. 1883, when an Egyptian force of 10,000 under William Hicks (Hicks Pasha), a retired British officer, was annihilated by the rebels, that the matter received serious official attention; in Dec. 1883 the British government ordered the abandonment of the Sudan.

Since Sept. 1883 Sir Evelyn Baring (the future Earl Cromer) had been back in Egypt, in effect as viceroy of the country although his title was British agent and consul general, charged among other things with the task of evacuating Egyptian soldiers and administrators from the Sudan. This would clearly be no light task, and it was suggested, by Lord Granville among others, that it was most likely to be successful if undertaken by Gordon. This opinion, canvassed in sections of the press, became widely held in England, where the publication in 1881 of Gordon's central African letters had revived that general enthusiasm for him which his self-effacement had allowed to lapse. The way had been partly prepared for some such step by Sir Evelyn Baring himself, who wrote that "It would be necessary to send an English officer of high authority to Khartoum with full power to withdraw all the garrisons in the Sudan and to make the best arrangements possible for the future government of the country." But neither the Egyptian government nor Sir Evelyn at first favoured the idea of employing Gordon, and the British government, apparently choosing to regard the Sudan as a purely Egyptian affair, temporized. On Jan. 8, 1884. Gordon returned to England and gave an interview to a distinguished journalist, W. T. Stead, in which he emphasized the difficulties of evacuation and the real peril that would face thousands of Egyptians and their families if proper measures were not taken for their protection. The publication of this interview aroused public opinion, and Queen Victoria asked why no reply had been sent to Baring's request for a British officer; but Baring returned a guarded refusal to the suggestion that Gordon should be sent. When Abd el-Kader, the Egyptian minister of war and a former governor general of the Sudan, declined the office, it was again offered to Gordon and accepted by him on Jan. 18, 1884, although in circumstances of such ambiguity as to lead to controversy and recrimination for years to come. The British government proposed to Baring that Gordon should be sent out in an advisory capacity to report on the situation. Meanwhile Baring telegraphed his conclusion that "Gordon would be the best man if he would pledge himself to carry out the policy of withdrawal from the Sudan." These messages crossed in transit, and the two utterly inconsistent proposals were perpetuated by Lord Granville in the form of instructions which ordered Gordon both to report and "to perform such other duties as may be entrusted to him by the Egyptian government through Sir Evelyn Baring." This confusion of ideas existed within the cabinet, some of whose members recognized that Gordon was now needed to supervise the withdrawal, while others (among them Gladstone, the prime minister, who was at Hawarden and received only reports of what took place) believed his mission to be no more than advisory. Gordon left at once, accompanied only by Lieut. Col. J. D. H. Stewart, and reached Cairo on Jan. 24.

Baring at once instructed him to conduct the withdrawal and required the khedive to name Gordon as the governor general of the Sudan. Gordon, with characteristic imaginativeness, sought to establish his former enemy Zobeir Pasha at Khartoum, as being likely, after the evacuation, to preserve some substance of order in the Sudan. But Baring mistrusted Zobeir, and the British government feared the effect on public opinion of such an elevation of a former slave trader. Gordon left Cairo, without Zobeir, on Jan. 26 and, travelling by Korosko and Berber, reached Khartoum on Feb. 18, where his reception was enthusiastic. He at once made approaches for peace with the mahdi and began evacuating Egyptians, of whom 2,000 civilians and 600 soldiers had been sent home when the hostility of the mahdi, whose rejection of peace had become apparent on March 12, made further movement impossible. A revolt in the eastern Sudan placed Egyptians there in jeopardy, and a British force which was sent to Suakin was withdrawn after defeating the mahdists, with the result that the Egyptian garrison at Berber surrendered. Khartoum was isolated by March 18. From that date until Jan. 26 Gordon defended the city against repeated attacks and in the face of a growing shortage of food. He continued to press for Zobeir and a few British or Indian troops (as late as Dec. 14 he wrote: "I ask for no more than 200 men"). But although public opinion grew increasingly vociferous, the cabinet and in particular Gladstone, who because of the initial misunderstanding regarded Gordon as having acted far beyond his instructions, did not decide until August to send a relief expedition; and it was November before this force assembled under Lord Wolseley at Wadi Halfa. In September Gordon had sent four steamers several days' journey down the Nile to await the army; but the British advance column had to fight hard, its leader, Sir Herbert Stewart, was killed, and it did not reach the steamers until Jan. 20. After a further delay of four days, in part because of the fact that the officer appointed to command the final dash was suffering from boils, the steamers set off back to Khartoum carrying British troops. The advance of the British in the face of the fiercest resistance deeply alarmed the mahdists. After a prolonged debate they determined upon a last assault on Khartoum, slipped through the defense lines where a falling Nile had left them unfortified and overcame the starving garrison. Gordon was killed at dawn on Jan. 26. Shortly before, he had written at the end of his last letter to his sister: "we are on our last legs. . . I am quite happy, thank God, and like Lawrence, I have *tried* to do my duty." In his journals he had written: "I altogether decline the imputation that the projected expedition has come to relieve me. It has come to save our national honour in extricating the garrisons."

Gordon's was an unusual, often a tortured and always an individual nature. After his death it became a matter for extravagant eulogy and interested belittlement. Perhaps the most appropriate of the many things said of him after his death came from the Austrian Sir Rudolf Carl von Slatin (Slatin Pasha), then a prisoner in the mahdi's camp, who, shown his head, is reported to have said: "What of it? a brave soldier who fell at his post; happy is he to have fallen; his sufferings are over."

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1933); Shen Lien-chih, *Rôle du Gdnkral Charles-George Gordon dans la répression de l'insurrection des Thai-Phing* (Lyons, 1933); H. E. Wortham, *Gordon: an Intimate Portrait* (London, 1933). (H. S. D.)

GORDON, LORD GEORGE (1751–93), third and youngest son of Cosmo George, duke of Gordon, was born in London on Dec. 26, 1751. He was educated at Eton and entered the navy, rising to the rank of lieutenant in 1772; but Lord Sandwich, then at the head of the admiralty, would not promise him a command, and he resigned his commission shortly before the beginning of the Revolutionary War. In 1774 the pocket borough of Ludgershall was bought for him by Gen. Fraser, whom he was opposing in Inverness-shire, in order to bribe him not to contest the county. He was considered flighty and of little importance. In 1779 he organized, and made himself head of the Protestant associations formed to secure the repeal of the Catholic Relief act of 1778. On June 2, 1780, he headed the mob which marched in procession from St. George's Fields to the houses of parliament in order to present the monster petition against the acts. A terrific riot ensued which continued several days, during which the city was virtually at their mercy. At first, indeed, they dispersed after threatening to make a forcible entry into the house of commons, but reassembled soon afterward and destroyed several Roman Catholic chapels, pillaged the private dwellings of many Roman Catholics, set fire to Newgate and broke open all the other prisons, attacked the Bank of England and several other public buildings, and continued the work of violence and conflagration until the interference of the military, by whom no fewer than 450 persons were killed and wounded, before the riots were quelled. For his share in instigating the riots Lord Gordon was apprehended on a charge of high treason; but, mainly through the skilful and eloquent defense of Lord Erskine, he was acquitted on the ground that he had no treasonable intentions. His life was henceforth full of crackbrained schemes, political and financial. In 1786 he was excommunicated by the archbishop of Canterbury for refusing to bear witness in an ecclesiastical suit; and in 1787 he was convicted of libelling the queen of France, the French ambassador and the administration of justice in England. He was, however, permitted to withdraw from the court without bail, and made his escape to Holland; but on account of representations from the court of Versailles he was commanded to quit that country, and, returning to England, was apprehended, and in Jan. 1788 was sentenced to five years' imprisonment in Newgate, where he lived at his ease, giving dinners and dances. As he could not obtain securities for his good behaviour on the termination of his term of imprisonment, he was not allowed to leave Newgate, and there he died of delirious fever on Nov. 1, 1793. Some time before his apprehension he had become a convert to Judaism, and had undergone the initiatory rite.

A serious defense of most of his eccentricities is undertaken in *The Life of Lord George Gordon, with a Philosophical Review of his Political Conduct*, by Robert Watson, M.D. (1795). The best accounts of Lord George Gordon are to be found in the *Annual Registers* from 1780 to the year of his death.

GORDON, JOHN BROWN, (1832–1904), Confederate army officer and political leader in Georgia during the Reconstruction, was a popular hero in the state. Born Feb. 6, 1832, in Upson county, Georgia, he attended the University of Georgia and later practised law in Atlanta. At the outbreak of the Civil War he joined the Confederate army as captain of volunteers and passed successfully through the grades to lieutenant general. He participated in several major battles and during the course of the war was wounded eight times.

At Appomattox he commanded one wing of Gen. Robert E. Lee's army with the instructions to cut through Gen. U. S. Grant's line. Gordon made the last charge, and was taking the federal breastworks when news of his chief's surrender ended his action.

Following the war he settled in Atlanta, and was a member of the Democratic national conventions of 1868 and 1872. He served in the U.S. senate from 1873 to 1880, when he resigned, and again from 1891 to 1897. Brown was also governor of Georgia (1886–90), and from 1890 commander in chief of the United Confederate Veterans. He wrote *Reminiscences of the Civil War* (1903).

Gordon died in Miami. Fla.. Jan. 9, 1904.

GORDON, SIR JOHN WATSON (*c.* 1788–1864), Scottish portrait painter, who after Sir Henry Raeburn's death in 1823, succeeded to his practice, was born in Edinburgh, where he trained for four years under John Graham at the Trustees' academy. He began to paint historical subjects, but turned to portraiture. He lacked Raeburn's brilliant colour and dramatic modeling, preferring in his later work clear gray tonalities.

Gordon exhibited at the Royal Academy from 1817 on; he became an academician in 1851. A member of the Royal Scottish Academy in 1829, he succeeded to its presidency in 1850 and was knighted. His sitters included Sir Walter Scott (1820), Sir Alexander Hope (1835, Linlithgow) and Thomas De Quincey (1845, National Portrait gallery, London).

He died in Edinburgh on June 1, 1864. (D. L. FR.)

GORDON, LEON (originally JUDAH LOEB BEN ASHER) (1830–1892), Russian-Jewish poet and novelist (Hebrew), was born at Wilna in 1830 and died at St. Petersburg in 1892. He took a leading part in the modern revival of the Hebrew language and culture. His satires did much to rouse the Russian Jews to a new sense of the reality of life, and Gordon was the apostle of enlightenment in the ghettos. His Hebrew style is classical and pure. His poems were collected in four volumes, *Kol Shire Yehuda* (1883–1884); his novels in *Kol Kithbe Yehuda* (1889).

For his works see *Jewish Quarterly Review*, xviii, 437 *et seq.*

GORDON, PATRICK (1635–1699), Russian general, descended from a Scottish family, was brought up in Aberdeenshire, but entered in his 15th year the Jesuit college at Braunsberg, Prussia. In 1655 he enlisted at Hamburg in the Swedish service. In the course of the next five years he served alternately with the Poles and Swedes as he was taken prisoner by either. In 1661 he took service in the Russian army under Alexis I, and in 1665 he was sent on a special mission to England. After his return he fought against the Turks and Tatars in southern Russia. In 1678 he was made major general, in 1679 was appointed to the chief command at Kiev and in 1683 was made lieutenant general. He visited England in 1686, and in 1687 and 1689 took part as quartermaster-general in expeditions against the Crim Tatars in the Crimea. On the outbreak of the revolution in Moscow in 1689, Gordon with the troops he commanded virtually decided events in favour of the tsar Peter I, and against the tsaritsa Sophia. The tsar confided to him the command of his capital during his absence from Russia, employed him in organizing his army according to the European system and raised him to the rank of general in chief. He died on Nov. 29, 1699. The tsar was with him when he died, and with his own hands closed his eyes.

Gordon left a diary of his life in English, the manuscript of which was in the archives of the Russian foreign office. It was translated into German (1849, 1853. 1855). *Passages From the Diary of General Patrick Gordon of Auchleuchries* was printed in 1859.

GORDON-CUMMING, ROUALEYN GEORGE (1820–1866), Scottish traveler and sportsman, known as the "lion hunter," was born on March 15, 1820, the second son of Sir William G. Gordon-Cumming, second baronet of Altyre and Gordonstown. He was educated at Eton, and served in the Madras light cavalry and later in the Cape mounted rifles. At the end of 1843 he sold out, and with a few native followers set out for the interior, hunting in Bechuanaland and the Limpopo valley. In 1848 he returned to England and published his book, *Five Years of a Hunter's Life in the Far Interior of South Africa* (1850; 3rd ed., 1851). His collection of hunting trophies was shown at the Great exhibition of 1851, and afterward exhibited in various parts of the country. He died at Fort Augustus, Scot., on March 24, 1866.

An abridgment of his book, *The Lion Hunter of South Africa* (1856), has been frequently reprinted.

GORE, CATHERINE GRACE FRANCES (1799–1861), English novelist and dramatist, the daughter of Charles Moody, a wine merchant, was born at East Retford, Nottinghamshire. In 1823 she mas married to Capt. Charles Gore, and in the next year she published her first work, *Theresa Marchmont, or the Maid of Honour*. Then followed, among others, the *Lettre* de

Cachet (1827), The Reign of Terror (1827), Hungarian Tales (1829), Manners of the Day (1830), Mothers and Daughters (1831), The Fair of May Fair (1832) and Mrs. Armytage (1836). Every succeeding year saw several volumes from her pen: The Cabinet Minister and The Courtier of the Days of Charles *II*, in 1839; Preferment in 1840. In 1841 Cecil, or the Adventures of a Coxcomb, attracted considerable attention. Greville, or a *Season* in Paris appeared in the same year; then Ormington, or Cecil a Peer, Fascination, The Ambassador's Wife, and in 1843 The Banker's Wife. Mrs. Gore continued to write until her death on Jan. 29, 1861. She also wrote some dramas of which the most successful was the School for Coquettes.

Mrs. Gore's novels nad an immense temporary popularity; they were parodied by Thackeray in Punch, in his "Lords and Liveries by the author of Dukes and *Déjeuners*." Some of them deserve to be revived; her Cecil was reprinted with success in 1927.

GORE, CHARLES (1853–1932), English bishop, was born in 1853, the 3rd son of the Hon. Charles Alexander Gore, brother of the 4th earl of Arran. His mother was a daughter of the 4th earl of Bessborough. He was educated at Harrow and at Balliol college, Oxford, and was elected fellow of Trinity college in 1875. He was vice-principal (1880–83) of the theological college at Cuddesdon, and librarian of Pusey Library (1884–93). Gore exercised a wide influence over undergraduates and the younger clergy, and under his influence the "Oxford Movement" underwent a change which to the survivors of the old school of Tractarians seemed to involve a break with its basic principles. "Puseyism" had based itself on authority and tradition, and repudiated any compromise with the modern critical and liberalizing spirit. Gore, starting from the same basis of faith and authority, set himself the task of reconciling the principle of authority in religion with that of scientific authority by attempting to define their respective spheres of influence. In 1889 he published two works, The *Church* and the Ministry, a vindication of the principle of Apostolic Succession in the episcopate against the Presbyterians and other Protestant bodies; and Roman Catholic Claims, a defence of the Anglican Church and Anglican orders against the Roman Catholics.

So far his published views had been in consonance with those of the older Tractarians. But in 1890 there appeared under his editorship Lux Mundi, a series of essays by different writers, being an attempt "to succour a distressed faith by endeavouring to bring the Christian Creed into its right relation to the modem growth of knowledge, scientific, historic, critical; and to modern problems of politics and ethics." Gore himself contributed an essay on "The Holy Spirit and Inspiration." The book produced a profound effect far beyond the borders of the English Church, and the High Church movement developed thenceforth on "Modernist" rather than Tractarian lines.

In 1891 Gore delivered the Bampton lectures before the university. He chose for his subject the Incarnation, developing the doctrine, the enunciation of which in Lux Mundi had caused so much heart-searching. This is an attempt to explain how it came that Christ, though incarnate God, could be in error, *e.g.*, in his citations from the Old Testament. He interpreted St. Paul's saying (2 Phil. ii, 7) that Christ "emptied himself and took upon him the form of a servant" (*ἑαυτὸν ἐκένωσεν μορφὴν δουλοῦ λαβῶν*) as meaning that Christ, on his incarnation, became subject to all human limitations, and had, so far as his life on earth was concerned, stripped himself of all the attributes of the Godhead, including the Divine omniscience, the Divine nature being, as it were, hidden under the human.[1]

In 1893 Dr. Gore resigned his principalship and became vicar of Radley, a small parish near Oxford. In 1894 he became canon of Westminster. Here he gained commanding influence as a preacher and in 1898 was appointed one of the court chaplains. In 1902 he became bishop of Worcester and in 1905 was installed bishop of Birmingham, a new see, the creation of which had been mainly due to his efforts. While adhering rigidly to his views on the divine institution of episcopacy, Dr. Gore cultivated friendly relations with the ministers of other denominations, and advocated co-operation with them in all matters when agreement was possible. In social questions he became one of the leaders of the group of High Churchmen known, somewhat loosely, as Christian Socialists. He worked actively against the sweating system, pleaded for European intervention in Macedonia, and was a keen supporter of the Licensing Bill of 1908. In 1892 he founded the clerical fraternity known as the Community of the Resurrection. Its members are priests, who are bound by the obligation of celibacy, live under a common rule and with a common purse. Their work is pastoral, evangelistic, literary and educational. In 1898 the House of the Resurrection at Mirfield, near Huddersfield, became the centre of the community; in 1903 a college for training candidates for orders was established there, and in the same year a branch house, for missionary work, was set up in Johannesburg in South Africa.

From 1911 to 1919 Dr. Gore was bishop of Oxford; he then resigned and settled in London. Dr. Gore's works include The *Incarnation* (Bampton Lectures, 1891); The Creed of the Christian (1895); The Body of Christ (1901); The New Theology and the Old Religion (1908); Orders and Unity (1910); The Question of Divorce (1911); The Religion of the Church (1916); Belief in God (1921); The Holy *Spirit* and the Church (1924); Can We Then *Believe?* (1926); and expositions of The Sermon on the Mount (1896), *Ephesians* (1898), Romans (1899) The Epistles of *St.* John (1920). Dr. Gore died Jan. 17, 1932.

GOREE, an island in Senegal, off the west coast of Africa. It lies at the entrance of the large natural harbour formed by the peninsula of Cape Verde. The island, some 900 yd. long by 330 broad, and 3 mi. distant from the nearest point of the mainland, is mostly barren rock. The greater part of its surface is occupied by a town, formerly a thriving commercial entrepôt and a strong military post. With the rise of Dakar (*q.v.*), c. 1860, on the adjacent coast, Goree lost its trade and its inhabitants, mostly Jolofs, had dwindled in 1905 to about 1,500. Its healthy climate, however, makes it useful as a sanatorium. Goree was first occupied by the Dutch, who took possession of it early in the 17th century. It was captured by the English under Commodore Holmes in 1663, but retaken in the following year by de Ruyter. The Dutch were finally expelled in 1677 by the French under Admiral d'Estrées. Goree subsequently fell again into the hands of the English, but was definitively occupied by France in 1817 (see SÉNEGAL: History).

GORELL, JOHN GORELL BARNES, 1ST BARON (1848–1913), English judge, was born at Liverpool on May 16, 1848, the son of Henry Barnes, a shipowner. He was educated at Peterhouse, Cambridge. He began as a solicitor, but was called to the bar in 1876 becoming Q.C. in 1888. He was an expert in Admiralty cases, and in 1892 was made a judge of the Probate, Divorce and Admiralty division, becoming its president in 1905. He was made privy councillor in 1905, and in 1909 raised to the peerage. In 1909 he became chairman of the royal commission on divorce. Lord Gorell, who married in 1881 Mary, daughter of Thomas Mitchell, died at Mentone on April 22, 1913.

See J. E. G. de Montmorency, John *Gorell* Barnes, First Lord *Gorell* (1920).

GORETTI, SAINT MARIA TERESA (1890–1902), a devout Italian girl who was murdered while resisting attempted rape. She was born at Corinaldo on Oct. 16, 1890, the eldest child of farm workers. Her father died shortly after the family had moved to Nettuno in 1900. Wnile her mother worked in the fields, Maria looked aiter the house and younger children. On July 5, 1902, a youth of 20, Alessandro Serenelli, who lived in the same house, mortally wounded her with a stiletto when she resisted his attempt to ravish her. She died, after forgiving him, on July 6, which is kept as her feast day. She was canonized in 1950. After his release from prison, Serenelli received forgiveness from Maria's mother in 1947.

[1]*Cf.* the Lutheran theologian Ernst Sartorius in his Lehre von der *heiligen Liebe* (1844), Lehre vol. ii. pp. 21 et *seq.*: "the Son of God veils his all-seeing eye and descends into human darkness and as child of man opens his eye as the gradually growing light of the world of humanity, until at the right hand of the Father he allows it to shine forth in all its glory."

See J. Carr, *Blessed Maria Goretti* (1949); A. Gits, *A Modern Virgin Martyr* (1956). (H. R. Wn.)

GORGAS, WILLIAM CRAWFORD (1854–1920), U.S. army surgeon, who contributed greatly to the building of the Panama canal by introducing mosquito control to prevent yellow fever and malaria, was born at Mobile, Ala., on Oct. 3, 1854. He was educated at the University of the South, Sewanee, Tenn., and Bellevue hospital medical college, New York city, taking his M.D. in 1879. In 1880 he entered the medical corps of the U.S. army. During the Spanish-American War he served as major in the medical corps, and was sent, after the Santiago expedition, to Havana, where he was in charge of yellow fever patients. From 1898 to 1902 he was in charge of sanitation measures in Havana, and conducted many experiments on the transmission of yellow fever by the mosquito. Because of his success in eliminating yellow fever there he was made assistant surgeon general, U.S. army, with the rank of colonel in 1903.

In 1904 Gorgas was sent as chief sanitary officer to Panamá, where two of the main obstacles to building the canal were yellow fever and malaria (*qq.v.*). In two years he eliminated yellow fever from the canal region. Malaria also was brought under control. In 1907 he was appointed a member of the Isthmian canal commission by Pres. Theodore Roosevelt, and in 1908 was U.S. delegate to the first Pan-American medical congress. He was president of the American Medical association, 1908–09.

In 1913 he was called to the Rand gold mines in South Africa to suggest means for combating the frequent epidemics of influenza. These he found were largely due to crowding the labourers together in barracks.

In 1914 Gorgas was made surgeon general, U.S. army, with the rank of brigadier general, becoming major general in 1915. In 1918 he was retired. He then became the permanent director of the yellow-fever work of the International Health board of the Rockefeller foundation. He went to Central America, and under his direction investigations of yellow fever were made in Guayaquil, Ecuador, and in Guatemala. In 1919 he accepted a contract with Peru to carry out a sanitary program in that country. He died in London, July 3, 1920, and was buried in the Arlington National cemetery, Arlington, Va.

In his honour were established the Gorgas Memorial Institute of Tropical and Preventive Medicine, Inc., Washington, D.C., and the Gorgas Memorial Laboratory of Tropical Research, Panamá.

GORGEI, ARTHUR (1818–1916), Hungarian soldier, was born at Toporcz, in upper Hungary, on Jan. 30, 1818, of a Saxon family. In 1837 he entered the Hungarian bodyguard, transferring in 1842 to the Palatine hussars. In the revolutionary war of 1848, Gorgei offered his sword to the Hungarian government. Entering the Honvéd army with the rank of captain, he was employed in the purchase of arms, and soon became major and commandant of the national guards north of the Theiss (Tisa) river.

After various successes over the Croatian forces, notably at Ozora, where 10,000 prisoners fell into his hands, Gorgei was appointed commander of the army of the Upper Danube, but when Windischgrätz advanced across the Leitha (Dec. 15), he retreated, despite the remonstrances of Kossuth, whom he disliked; and on Jan. 5, 1849 he issued a public manifesto, blaming the Government for Hungary's recent failures. After conducting operations independently and with Klapka, he was appointed Hungarian commander-in-chief after the battle of Kapolna (Feb. 1849) and won a series of brilliant victories. The relief of Komoru (April 22) forced the Austrian troops to evacuate Hungary, and on May 21 Gorgei took Buda.

Meanwhile Kossuth at Debreczen had proclaimed Hungary a republic. Gorgei, who had, strangely enough, a strong dislike of Magyars, refused a field-marshal's baton but consented to become minister of war, while retaining the command of the troops in the field. The Russians had now intervened in the struggle, the allies were advancing into Hungary on all sides, and Görgei was defeated by Haynau at Pered (June 20–21). Kossuth resigned his position as dictator. Gorgei took his place, and finding the military position hopeless, surrendered at Vilagós to the Russian commander (Aug. 13). Alone of the ex-Austrian officers in his force, Gorgei escaped court-martial, at the tsar's personal intervention. He was interned at Klagenfurt till 1867, when he was pardoned and returned to Hungary, but took no part in public life, as his surrender and the personal pardon granted him led the Hungarians to accuse him of treason. After some years work as a railway engineer he retired to Visegrád, where he lived in retreat until his death on May 21, 1916.

Gorgei wrote a justification of his operations (*Mein Leben und Wirken in Ungarn 1848–1859* (Leipzig, 1852), an anonymous paper under the title *Was verdanken wir der Revolution?* (1875), and a reply to Kossuth's charges (signed "Joh. Demár") in *Budapesti Szemle*, 1881, 25–26. *See* also A. G. Horn, *Görgei, Oberkommandant d. ung. Armee* (Leipzig, 1850); Kinety, *Görgei's Life and Work in Hungary* (1853); and Hungary: *History*.

GORGES, SIR FERDINANDO (*c.* 1566–1647), English colonial pioneer in America and the founder of Maine, was born in Somersetshire, England, probably in 1566. From youth both a soldier and a sailor, he was a prisoner in Spain at the age of 21, having been captured by a ship of the Spanish Armada. In 1589 he was in command of a small body of troops fighting for Henry IV. of France, and after distinguishing himself at the siege of Rouen was knighted there in 1591. In 1596 he was commissioned captain and keeper of the castle and fort at Plymouth and captain of St. Nicholas Isle; in 1597 he accompanied Essex on the expedition to the Azores; in 1599 assisted him in the attempt to suppress the Tyrone rebellion in Ireland, and in 1600 was implicated in Essex's own attempt at rebellion in London. In 1603, on the accession of James I., he was suspended from his post at Plymouth, but was restored in the same year and continued to serve as "governor of the forts and island of Plymouth" until 1629, when, his garrison having been without pay for three and a half years, his fort a ruin, and all his applications for aid having been ignored, he resigned. About 1605 he began to be greatly interested in the New World; in 1606 he became a member of the Plymouth Company, and he laboured zealously for the founding of the Popham colony at the mouth of the Sagadahoc (now the Kennebec) river in 1607. For several years following the failure of that enterprise in 1608 he continued to fit out ships for fishing, trading and exploring, with colonization as the chief end in view. He was largely instrumental in procuring the new charter of 1620 for the Plymouth Company, and was at all times of its existence perhaps the most influential member of that body. He was the recipient, either solely or jointly, of several grants of territory from it, for one of which he received in 1639 the royal charter of Maine (*see* Maine). In 1635 he sought to be appointed governor-general of all New England, but the English Civil War—in which he espoused the royal cause—prevented him from ever actually holding that office. A short time before his death at Long Ashton in 1647 he wrote his *Briefe Narration of the Originall Undertakings of the Advancement of Plantations into the Parts of America.* He was an advocate, especially late in life, of the feudal type of colony.

See J. P. Baxter (ed.), *Sir Ferdinando Gorges and his Province of Maine* (Boston, 1890, in the Prince Society Publications), the first volume of which is a memoir of Gorges, and the other volumes contain a reprint of the *Briefe Narration*, Gorges's letters, and other documentary material. Also Henry Sweetser Burrage, *Gorges and the Grant of the Province of Maine*, 1622 (1923); and Raymond Gorges, "Sir Frederick Gorges and His Connection with the Essex Rebellion," *Soc. of Colonial Wars, Publication No. 37* (1926).

GORGET, the name applied after about 1480 to the collar-piece of a suit of armour (O.Fr. *gorgete*, dim. of *gorge*, throat). It was generally formed of small overlapping rings of plate and attached either to the body armour or to the armet. It was worn in the 16th and 17th centuries with the half-armour, with the plain cuirass, and even occasionally without any body armour at all. During these times it gradually became a distinctive badge for officers, and as such it survived in several armies—in the form of a small metal plate affixed to the front of the collar of the uniform coat—until after the Napoleonic wars.

GORGIAS (*c.* 483–376 B.C.), Greek sophist and rhetorician who made important contributions to rhetorical theory and practice, was a native of Leontini in Sicily. In 427 he headed an embassy to ask for Athenian help against the Syracusans. He later came to reside permanently in Greece, where he became a professional teacher of rhetoric. He died at Larissa in Thessaly. Two surviving rhetorical exercises, the *Helen* and the *Palamedes*, are probably genuine, and there are fragments of speeches. In a lost work, *On Nature or on That Which Is Not*, which is summarized by Sextus Empiricus and in the pseudo-Aristotelian treatise *De Melisso, Xenophane, Gorgia*, he argued that there is no being; or that if there is being, it cannot be known; or that if there is being and it can be known, it cannot be communicated to others. He is a central figure in Plato's *Gorgias*, but Plato treats him as a rhetorician rather than as a philosopher.

For fragments and testimonia *see* H Diels and W. Kranz, *Fragmente der Vorsokratzker*, vol. ii, 7th ed. (Berlin, 1954). For his philosophy *see* SOPHISTS; also M. Untersteiner, *The Sophists*, Eng. trans., vol. i, ch. iv–ix (London, New York, 1954) (speculative). For Gorgias as a rhetorician *see* F. Blass, *Die attische Beredsamkeit*, vol. i (Leipzig, 1887). (G. B. KD.)

GORGON, GORGONS, a figure or figures in Greek mythology. Homer speaks of only one Gorgon, whose head is represented in the *Iliad* (v. 741) as fixed in the centre of the aegis of Zeus. In the *Odyssey* (xi. 633) she is a monster of the underworld. Hesiod increases the number of Gorgons to three—Stheno (the mighty), Euryale (the far-springer) and Medusa (the queen), and makes them the daughters of the sea-god Phorcys and of Keto. Their home is on the extreme west; according to later authorities, in Libya (Hesiod, *Theog.* 274; Herodotus II. 91; Pausanias II. 21). The Attic tradition, reproduced in Euripides (*Ion*, 1002), regarded the Gorgon as a monster, produced by Ge to aid her sons the giants against the gods and slain by Athena.

The Gorgons are represented as winged female creatures; their hair consists of snakes; they are round faced, flat nosed, with tongues lolling out and with large projecting teeth. Medusa was the only one of the three who was mortal; hence Perseus was able to kill her by cutting off her head. From the blood that spurted from her neck sprang Chrysaor and Pegasus, her two sons by Poseidon. The head, which had the power of turning all who looked upon it into stone, was given to Athena, or buried in the market-place of Argos. The hideously grotesque original type of the Gorgoneion, as the Gorgon's head was called, was used generally as an amulet, a protection against the evil eye. Heracles is said to have obtained a lock of Medusa's hair from Athena and given it to Sterope, the daughter of Cepheus, as a protection for the town of Tegea against attack (Apollodorus II. 144). Later classical art showed Medusa as coldly beautiful; the realists of Hellenistic times gave her face an agonized expression. Various silly rationalistic accounts are given by late authors. More reasonable is the explanation of anthropologists that Medusa, whose virtue is really in her head, was originally a ritual mask. It also is possible that the staring or pursuing faces, common in nightmares, have a good deal to do with her.

BIBLIOGRAPHY.—N. G. Polites (Ὁ περὶ τῶν Γοργόνων μῦθος παρὰ τῷ Ἑλληνικῷ λαῷ, 1878) gives an account of the Gorgons, and of the various superstitions connected with them, from the modern Greek point of view, which regards them as malevolent spirits of the sea. W. H. Roscher, *Die Gorgonen und Verwandtes* (1870); J. Six, *De Gorgone* (1885), on the types of the Gorgon's head; articles by Roscher and Furtwangler in Roscher's *Lexikon der Mythologie*, by G. Glotz in Daremberg and Saglio's *Dictionnuire des antiquités*; Jane E. Harrison, *Prolegomena to the Study of Greek Religion* (1903).

GORGONZOLA, a town of Lombardy, Italy, province of Milan, from which it is 11 mi. E.N.E. by steam tramway. Pop. (1951) 5,948 (town); 7,444 (commune). It produces the well-known Gorgonzola cheese.

GORI, a town in the Georgian S.S.R. northwest of Tiflis, on the river Kura; altitude, 2,010 ft., lat. 42° 0′ N., long. 44° 7′ E. Population (1933) 13,100. It is the centre of a corn and wine district. The climate is delightfully cool in summer, owing to refreshing mountain breezes, though these are disagreeable in winter. It has timber mills and manufactures railway sleepers, and a jam industry.

Gori was founded (1123) by the Georgian king David II, the Builder, for the Armenians who fled their country on the Seljūk invasion. The earliest remains of the fortress are Byzantine; it was thoroughly restored in 1634–1658, but destroyed by Nadir Shah of Persia in the 18th century. There is a church constructed in the 17th century by Capuchin missionaries from Rome. Five miles east of Gori is the remarkable rock-cut town of Uplis-Tsikhe, which was a fortress in the time of Alexander the Great of Macedon, and an inhabited city in the reign of the Georgian king Bagrat III (975–1014).

GORILLA, the largest of the anthropoid (manlike) apes, inhabiting forest regions of West Africa from the Cameroons to the Congo river and represented by a somewhat different form in mountainous regions of the eastern Belgian Congo. The popular reputation of the giant ape (*Gorilla gorilla*) is largely due to the writings of the explorer Paul B. du Chaillu in 1861 and later. In 1903 a somewhat different type of gorilla was discovered in high mountains of the eastern Belgian Congo, where it thrives at an altitude of 10,000ft. and is protected from the cold by much longer and thicker fur than the western form. This mountain species, or race, is known as *Gorilla beringei*.

Though nearly related to the chimpanzee, the gorilla is a far larger and heavier animal, the males attaining a weight of 450 lb. or more, and a standing height of 5½ feet. The naked skin of the face is black and wrinkled; the hair in general black, commonly with a reddish tinge on the crown and tending to become grey on the back in adult males. The animals inhabit dense forests, commonly in small family groups, feeding on fruits and tender shoots and occasionally raiding plantations. The West African gorillas construct sleeping nests in the branches of trees, which seem to be used chiefly by the females and young. These beds, commonly used only for a single night, are also sometimes constructed on the ground; the American explorer Carl Akeley always found them thus placed by the mountain gorilla. Adult males, owing probably to their great weight, generally remain on the ground. The gorilla is shy and not usually inclined to attack man unless provoked in which case the males are extremely dangerous. A peculiar habit, mentioned by du Chaillu, and observed in all captive gorillas, is a rapid drumming on the chest with both hands. Comparatively few gorillas have been kept in captivity and most of these have survived for only a short time. They seem to react far less favourably to captivity than the chimpanzee, lacking the friendly curiosity, imitativeness and general social adaptability of that animal, and exhibiting in contrast a self-centred repression and lack of interest in their surroundings. A few examples, however, captured when quite young have remained fairly tractable up to the age of five or six years.

The American psychologist R. M. Yerkes, as a result of extensive observations and experiments on the mentality of a young female mountain gorilla, found that this animal showed considerable ability in the solution of problems involving the use of sticks as tools, stacking boxes to secure suspended food, and in experiments involving multiple choice and delayed response. Some insight, memory and anticipation of experience were clearly demonstrated. Though he cautiously avoids generalizing from a single case, Yerkes finds this gorilla, as "compared with chimpanzees and orang-utans of like age . . . remarkably slow in adaptation and limited in initiative, originality and insight." (*See* CHIMPANZEE and PRIMATES.) (J. H. McG.; X.)

GORINCHEM or GORCUM, a town of Holland in the province of south Holland, on the right bank of the Merwede at the confluence of the Linge, 16 mi. by rail E. of Dordrecht. It is connected by the Zederik and Merwede canals with Amsterdam. Pop. (1947) 14,802. Gorinchem possesses several old houses, and overlooking the river are some fortified gateways of the 17th century. It has an old church dedicated to St. Vincent. Gorinchem possesses a good harbour, and a considerable trade in grain, hemp, cheese, potatoes, cattle and fish, the salmon fishery being noted. At three miles distance is the mediaeval castle of Loevestein, where Hugo Grotius was kept a prisoner until he escaped in 1619, hidden in a carton loaded with bboks.

GORING, GEORGE GORING, LORD (1608–1657), English Royalist, soldier, son of George Goring, earl of Norwich, was born on July 14, 1608. He served in the Dutch army, and was lamed at Breda in 1637. Returning in 1639 he became governor of Portsmouth, and won favour with parliament by betraying the "First Army Plot." He then became a Royalist, and obtained Dutch recruits in Dec. 1642. In March 1643 he defeated Fairfax at Seacroft Moor, but was taken prisoner in May. In April 1644 he effected an exchange, and commanded the Royalist left at Marston Moor, being routed by Cromwell. Later, as lieutenant-general of the Royalist horse, his excesses gave the Royalist cause a bad name. In 1645 he went to relieve Oxford, was engaged in the operations round Taunton, and on July 10 was defeated by Fairfax at Langport. He retired in November. Later he commanded some English regiments in the Spanish service.

GORING, HERMANN (1893–1946), German politician, was born on January 12, 1893, and joined the army in 1912. During World War I he transferred to the air arm, in which he won the highest honour "pour le mérite," and commanded the Richthofen squadron in 1918. He became an early associate of Adolph Hitler (*q.v.*), and was wounded in the Munich putsch (Nov. 1923). Goring was one of the first nazi members of the reichstag and in 1932 he became president of that body. When Hitler became chancellor in Jan. 1933, Goring was made reich minister for air and Prussian minister president and minister of the interior. In 1940 Hitler conferred the newly created title of marshal of the reich on him. During World War II he had supreme control over Germany's economic life, and was generally regarded in Germany as second only to Hitler. He was indicted as a war criminal and sentenced to hang by the International Military Tribunal at Nürnberg, Germany, on Oct. 1, 1946, but committed suicide on Oct. 16.

GORIZIA (German *Görz;* Slovene *Gorica*), the capital of a province in Venetia Giulia, Italy, 25 mi. east of Udine by rail. Pop. (1936) 30,265 (town); 46,640 (commune). It lies on the left bank of the Isonzo in a valley almost surrounded by hills. It is the seat of an archbishopric. The richly decorated 17th-century church of St. Ignatius was built by the Jesuits. The old castle, formerly the seat of the counts of Gorizia, dominates the town. Owing to its mild climate, Gorizia was called the Nice of Austria.

Its topographical position made Gorizia the centre of important battles in World War I. On the right bank of the river the village of Podgora, opposite Gorizia, with the hill of the same name dominating, constituted one of the most formidable bulwarks of the Austrian bridgehead, and the Sabotino, farther north, with its vast network of dugouts and caverns, capable of sheltering many regiments, was the other. Repeated attacks on the two hills from June 1915 onward were repulsed with heavy loss, and the attempts to capture the Oslavia saddle between them resulted in desperate engagements at various points which were captured and lost many times. In the general offensive against Gorizia of Aug. 1916, after elaborate preparations conducted by Colonel (later Field Marshal) Badoglio, Hill 188, Oslavia, the Sabotino and Podgora were finally captured with comparatively small loss, and the operations on San Michele having been equally successful, the Italians were able to occupy Gorizia on the 8th. The positions north and east were never completely held, owing to heavy enemy fire, while those to the east remained for the most part in Austrian hands. After Caporetto (Oct. 1917) Gorizia itself had to be evacuated together with all the positions on both banks of the Isonzo. It was reoccupied after Vittorio Veneto (Oct. 1918). The town, which suffered great damage, was almost entirely reconstructed.

GORKY, MAXIM (1868–1936), pen name of the Russian author Alexey Maximovich Peshkov, born at Nizhni-Novgorod. His father, an upholsterer, died when the boy was five; his mother married again, and he grew up in the family of his maternal grandfather, a dyer, whose affairs went from bad to worse. At nine, the boy was made to earn his own bread. In the following 15 years he changed many trades, and covered in search of work all east and south Russia from Nizhni to the Danube and to Georgia. At the same time he contrived to give himself an education, read voraciously and early began to write. While at Tiflis, where he was working in the railway workshops, he succeeded in getting published a story in a local daily, over the signature that has become famous. He now became a provincial journalist, and in 1895 a tale of his (Chelkash, first Eng. trans. 1902) was accepted by a leading St. Petersburg review. Two years later his stories appeared in book form. The success was unprecedented. Gorky found himself placed in public opinion by the side of Tolstoy. Before long his fame crossed the frontier and he became one of the foremost world celebrities. His play The Lower Depths (*Na* Dne, 1903, Eng. trans. 1912) had a run of almost two years at Berlin. His association (from 1899) with the Social Democrats brought on him police persecution, but this only increased his popularity at home. In 1905 he took an active part in revolutionary activities, and in 1906 left Russia for an anti-tsarist campaign abroad. In 1907 he settled in Capri. About the same time he contracted a friendship with Lenin. In 1913 he returned to St. Petersburg and started a review (*Letopis*). During World War I he took a pacifist attitude, and in 1917 he gave his support to the bolsheviks, After their victory he became the official spokesman for culture before the new government, and did much to alleviate the hardships of the intellectual- classes, as well as to preserve cultural treasures. In 1922 his health compelled him to go abroad. After a stay in Germany, he settled at Sorrento. In 1928 he visited the U.S.S.R., where he was given an enthusiastic reception. Gorky's literary work falls into three periods. In the '90s he wrote the short stories that first made him famous. Their subject matter is taken mainly from the lives of tramps and social outcasts, whom he represents with a mixture of outspoken realism and romantic gusto. It was the latter quality that most endeared them to the Russian public. The romantic colouring he gave his tramps and thieves has become somewhat the worse for wear, but the best of these early stories (*My* Fellow-traveller and Twenty-Six Men and a Girl, Eng. trans. 1902) fall little short of being masterpieces. After 1899 Gorky wrote longer and more ambitious novels and plays, which aimed at presenting a broad and comprehensive picture of Russian life and at finding the solution of burning social problems. Most of them lack constructive unity, and are disfigured by interminable conversations on "the meaning of life." The plays especially are hopelessly formless. Toward 1906 Gorky's popularity with the intelligentsia began to decline, but it increased among the working class, who came to regard him as their literary spokesman. His proletarian novel Mother (1907, Eng. trans. 1921, publ. in U.S.A.) which has been turned into a splendid film by the soviet film director Pudovkin, is not, however, by itself a work of great value. Gorky's third period begins with the publication in 1913 of Childhood (Eng. trans. 1915), the first part of an autobiographical trilogy, of which the other parts are In the World (V Lyudyakh, 1915, Eng. trans. 1917) and My Universities (1923, Eng. trans. Reminiscences of my *Youth,* 1924). Together with a volume of Recollections (it includes the famous Recollections of Tolstoy, Eng. trans. 1920, a document of quite exceptional value), and Fragments from my Dzary (1924, Eng. trans. 1924) these works are the best Gorky has written. The penetrating and plastic realism with which he presents a vast gallery of Russian characters is unrivalled. After 1926 Gorky turned to fiction dealing with social problems: The *Artamonov's* Business (trans. Decadence, 1927); The Bystander (trans., B. G. Guerney, 1930). (D. S. M.)

GORKY, region, U.S.S.R.: see NIZHEGOROD.

GORKY, U.S.S.R.: see NIJNI-NOVGOROD.

GÖRLITZ, a town in the Prussian province of Silesia, Germany, on the Neisse, 62 mi. E. from Dresden on the railway to Breslau, and at the junction of lines to Berlin, Zittau and Halle. Pop. (1939) 93,669. Gorlitz is an ancient village which, as Drebenau, received civic rights at the beginning of the 12th century. After a fire in 1131, it was rebuilt and called Zgorzelice. About the end of the 12th century it was strongly fortified, and for a short time it was the capital of a duchy of Gorlitz. It also suffered considerably in the Thirty Years' War and the Seven Years' War. In 1815 the town, with the greater part of Upper Lusatia, came into the possession of Prussia. Gorlitz is wealthy, owing to the extensive municipal forests of 70,000 acres. The fine Gothic church of St. Peter and St. Paul dates from the 15th century; the Frauen Kirche (end 15th cent.) possesses a fine portal and choir in pierced work; the Kloster Kirche, restored in 1868, has handsome choir stalls and a carved altar dating from 1383. The old bastion, named Kaisertrutz, has been used as a guardhouse and armoury. Near the town is the chapel of the Holy Cross, where there is a model of the Holy Sepulchre at Jerusalem made during the 15th century. In the public park there is a bust of Schiller and a monument to Alexander von Humboldt, also a statue of the mystic Jakob Böhme (1575–1624). There is a large library and a rich collection of antiquities, coins and articles of *virtu*. Görlitz, next to Breslau, is the largest and most flourishing commercial town of Silesia, and is classic for study of German Renaissance architecture. Cloth is manufactured, also various linen and woollen wares, machines, railway wagons, glass, sago, tobacco, leather, chemicals and tiles.

GÖRRES, JOSEPH VON (1776–1848), German writer, was born on Jan. 25, 1776, at Coblenz, and educated at a Latin college under clerical direction. Young Görres sympathized with the French Revolution, harangued the revolutionary clubs in the Rhineland, and insisted on the unity of interests which should ally all civilized States. He then began a Republican journal called *Das rote Blatt* (afterwards *Rübezahl*), in which he eloquently defended French principles.

After the peace of Campo Formio (1797) there was some hope that the Rhenish provinces would be constituted into an independent Republic. In 1799 the provinces sent to Paris an embassy of which Görres was a member; it arrived two days after Napoleon had assumed the supreme direction of affairs. After much delay he received the embassy; but the only answer they obtained was "that they might rely on perfect justice, and that the French Government would never lose sight of their wants." Görres on his return published a tract called *Resultate meiner Sendung nach Paris,* in which he reviewed the history of the French Revolution. He was thoroughly disillusioned. During the 13 years of Napoleon's dominion Görres lived a retired life. In 1801 he married Catherine de Lasaulx; from 1806 to 1808 he lectured at Heidelberg. With K. Brentano and L. von Arnim he edited the famous *Zeitung für Einsiedler* (subsequently re-named *Tröst-Einsamkeit*), and in 1807 he published *Die deutschen Volksbücher.*

He loved the German folk-tale, not as a vehicle for romantic ideas, but in its stark realism. His versions have none of the fanciful adornments given to the folk-tale by Novalis and Tieck, but are more akin to those of the brothers Grimm. He returned to Coblenz in 1808. He now studied Persian, and published a *Mythengeschichte der asiatischen Welt* (2 vols., 1810) and *Das Heldenbuch von Iran* (1816), a translation of part of the *Shahnama,* the epic of Firdousi. In 1813 he was drawn into the movement for national independence and in 1814 founded the *Rheinische Merkur.* The intense earnestness of the paper, its hostility to Napoleon, and its fiery eloquence secured for it a position unique in the history of German newspapers. Napoleon himself called it *la cinquième puissance.* It advocated a united Germany, with representative government, but under an emperor after the fashion of other days—for Görres now abandoned his early revolutionary ideas. He inveighed most bitterly against the second peace of Paris (1815), declaring that the territory comprising Alsace and Lorraine should have been demanded back from France.

Stein was glad enough to make use of the *Merkur* at the time of the meeting of the congress of Vienna, but Hardenberg in May 1815 warned Görres to remember that he was not to attack France but only Bonaparte. The *Merkur* evinced an antipathy to Prussia, a desire for an Austrian emperor, and also a tendency to pronounced liberalism—which made it most distasteful to Hardenberg and Frederick William III. Görres disregarded the warnings of censorship, and accordingly his paper was suppressed early in 1816 at the instance of the Prussian Government; soon afterwards Görres was dismissed from his post as teacher at Coblenz. In the wild excitement which followed Kotzebue's assassination the reactionary decrees of Carlsbad were framed, and these were attacked by Görres in his pamphlet *Deutschland und die Revolution* (1820). He reviewed the circumstances which had led to the murder of Kotzebue, and, while expressing horror at the deed itself, he urged the danger of repressing the free utterance of public opinion by reactionary measures. The pamphlet was suppressed by the Prussian Government, and orders were immediately issued for the arrest of Görres and the seizure of his papers. He escaped to Strasbourg, and thence went to Switzerland. Görres later became a vehement Ultramontane. King Ludwig of Bavaria gave him the chair of history at Munich. His *Christliche Mystik* (1836–42) was an exposition of Roman Catholic mysticism. Görres died on Jan. 29, 1848.

Görres's *Gesammelte Schriften* (only his political writings) appeared in six volumes (1854–60), to which three volumes of *Gesammelte Briefe* were subsequently added (1858–74). *See* J. Galland, *Joseph von Görres* (1876, 2nd ed. 1877); J. N. Sepp, *Görres und seine Zeitgenossen* (1877) and by the same author, *Görres,* in the series *Geisteshelden* (1896); J. G. Uhlmann, *Joseph Görres und die deutsche Einheits und Verfassungsfrage* (1912); M. Berger, *Görres als politischer Publizist* (1921). A *Görres-Gesellschaft* was founded in 1876 to encourage the Catholic aspect in culture.

GORRIE, JOHN (1802?–1855), U.S. physician and inventor. His parentage and place and date of birth are uncertain, but there is reason to believe that he was born on the island of Nevis in the West Indies and was taken to Charleston, S.C. by his parents in Oct. 1803. He was educated in the schools of Charleston and was graduated from the Western College of Physicians and Surgeons at Fairfield, N.Y. in 1829. After four years in Abbeville, S.C., he set up practice at Apalachicola, Fla. in 1833, soon becoming one of the town's leading citizens. He was elected mayor in 1836 or 1837, but retired to give more time to his profession. Much of his time was taken with the treatment of malaria and other fevers. He foresaw that if sleeping rooms could be cooled, much could be done to prevent or relieve fevers, and thus was led to the invention of the first cool-air machine on record. He received little recognition for this work during his lifetime, but in 1914 he was designated as one of Florida's representatives in Statuary Hall. Dr. Gorrie died June 16 (or June 29), 1855.

GORSAS, ANTOINE JOSEPH (1752–1793), French publicist and politician, son of a shoemaker, was born at Limoges (Haute-Vienne) on March 24, 1752. He set up an army school at Versailles. In 1781 he was imprisoned in the Bicêtre on an accusation of corrupting the morals of his pupils, his real offence being the writing of satirical verse. On Sept. 10, 1792 he was elected to the Convention (Seine-et-Oise). He sat at first with the Mountain, but his agreement with the Girondists became gradually more pronounced; during the trial of Louis XVI. he voted for the king's detention during the war and subsequent banishment. An attack on Marat in the *Courrier* led to a raid on his printing establishment on March 9, 1793, but he escaped to Normandy to join Buzot, and after the defeat of the Girondists at Pacy-sur-Eure he found shelter in Brittany. The Convention passed a resolution forbidding representatives to engage in journalism. On June 2 he was ordered by the Convention to hold himself under arrest. He was imprudent enough to return to Paris in the autumn, where he was arrested on Oct. 6, and guillotined the next day.

See the *Moniteur,* No. 268 (1792), Nos. 20, 70 new series 18 (1793); M. Tourneux, *Bibl. de l'hist. de Paris,* 10,291 *seq.* (1894).

GORSE: *see* Furze, Gorse or Whin.

GORST, SIR JOHN ELDON (1835–1916), English statesman, was born at Preston, the son of Edward Chaddock Gorst, who took the name of Lowndes on succeeding to the family estate in 1853. He graduated third wrangler from St. John's College, Cambridge, in 1857, and was admitted to a fellowship. After beginning to read for the bar in London, he sailed for New Zealand, where he married in 1860 Mary Elizabeth Moore. The Maoris had at that time set up a king of their own in the Waikato district and Gorst, who had made friends with the chief Tamihana (William Thomson), acted as an intermediary between the Maoris and the Government. Sir George Grey made him inspector of schools, then resident magistrate, and eventually civil commissioner in Upper Waikato. Tamihana's influence secured his safety in the Maori outbreak of 1863. In 1908 he published a volume of recollections, under the title of *New Zealand Revisited: Recollections of the Days of my Youth.* He returned to England and was called to the bar at the Inner Temple in 1865, becoming Q.C. in 1875. He sat in parliament for Cambridge from 1865 to 1868. After the Conservative defeat of that year he was entrusted by Disraeli with the reorganization of the party machinery, and in five years of hard work he paved the way for the Conservative success at the general election of 1874. At a bye-election in 1875 he re-entered parliament as member for Chatham, which he continued to represent until 1892. He joined Henry Drummond-Wolff, Randolph Churchill and Arthur Balfour in the "Fourth Party," and he became solicitor-general in the administration of 1885–86 and was knighted. On the formation of the second Salisbury administration (1886) he became under-secretary for India and in 1891 financial secretary to the Treasury. At the general election of 1892 he became member for Cambridge university. He was deputy chairman of committees in the House of Commons from 1888 to 1891, and on the formation of the third Salisbury administration in 1895 he became vice-president of the committee of the council on education (until 1902). Sir John Gorst adhered to the principles of Tory democracy which he had advocated in the days of the fourth party, and took an active interest in the housing of the poor, the education and care of their children, and in social questions generally, both in parliament and in the press. But he was always "independent" in his political action. He objected to Chamberlain's proposals for tariff reform, and lost his seat at Cambridge at the general election of 1906 to a tariff reformer. He then withdrew from the vice-chancellorship of the Primrose League, of which he had been one of the founders, on the ground that it no longer represented the policy of Lord Beaconsfield. In 1910 he contested Preston as a Liberal, but failed to secure election. He died in London on April 4, 1916.

His elder son, Sir J. Eldon Gorst (1861–1911), was financial adviser to the Egyptian government from 1898 to 1904, when he became assistant under-secretary of state for foreign affairs. In 1907 he succeeded Lord Cromer as British agent and consul-general in Egypt. He died at Castle Combe, Wiltshire, on July 12, 1911.

An account of Sir John Gorst's connection with Lord Randolph Churchill will be found in the *Fourth Party* (1906), by his younger son, Harold E. Gorst.

GORTER, HERMAN (1864–1927), Dutch poet, was born on Nov. 26, 1864, at Wormerveer. He taught for some time in the gymnasium at Amersfoort, and then settled at Bussum. His strong impressionistic tendencies colour his three chief publications—Mei, *een Gedichte* (1893), *De School der Poëzie* (1897) and *Pan, een Gedichte* (1912). His translation of Spinoza's *Ethics* appeared in 1895.

See Hauser, *Die niederländische Lyrik von 1875–1900* (1901).

GORTON, SAMUEL (1592–1677), colonial fighter for religious and civil liberty, was born in Gorton, England, in 1592. For a time a clothier in London, he sailed for Boston, Mass., "to enjoy liberty of conscience." Failing to find it there and being involved in religious, political and property disputes at Plymouth, Aquidneck, Providence and Shawomet successively, he went to England, where he published in 1646 *Simplicities Defence against Seven Headed Policie* (reprinted in the R. I. Hist. Soc. *Collections*, vol. ii), giving an account of his grievances against the Massachusetts government.

He returned to Shawomet in 1648 with a letter from the earl of Warwick, after whom he renamed the settlement, and lived there in peace and honour until his death on or before Dec. 10, 1677. He left several religious treatises, both in print and manuscript, some of them surprisingly modern in concept in spite of their quaint phraseology.

Estimates of him have shifted from his contemporaries' denunciations as "a most prodigious minter of exorbitant novelties" and "a man whose spirit was stark drunk with blasphemies and insolences," to his later biographers' tributes as "a forgotten founder of our liberties," "the premature John the Baptist of New England Transcendentalism."

Edward Winslow's attack on Gorton, *Hypocrisie Unmasked* (1646), was issued by the Club for Colonial Reprints (Providence, 1916). Among his biographers are J. M. Mackie in J. Sparks, *Library of American Biography*, 2nd ser., vol. v (184;) ; L. G. Janes (1896), and Adelos Gorton (1907).

GORTYNA or Gortyn, an important ancient city of Crete on the small Lethaeus (Mitropolipotamo) river. It was about three hours distant from the south coast with which it communicated by means of two harbours, Metallum and Lebena. Near the town was the spring, overhung by an evergreen plane tree, which in popular belief marked the scene of the amours of Zeus and Europa.

Gortyna was, next to Cnossus, the largest and most powerful city of Crete, but neither played a conspicuous part in the history of Greece. Under the Romans Gortyna became the metropolis of the island.

Extensive ruins remained in existence at the village of Hagii Deka, including the great inscription containing many of the ancient laws. The ruinous church of St. Titus dates from about the 4th century.

See also Crete, and for a full account of the laws *see* Greek Law.

(J. L. My.)

GÖRTZ, GEORG HEINRICH VON, Baron von Schlitz (1668–1719), Swedish statesman, entered the Holstein-Gottorp service, and after the death of the duchess Hedwig Sophia. Charles XII.'s sister, became influential during the minority of her son, Duke Charles Frederick. His earlier policy aimed at strengthening Holstein-Gottorp at the expense of Denmark. With this object, during Charles XII.'s stay at Altranstädt (1706–07), he tried to divert the king's attention to the Holstein question, and six years later, when the Swedish commander, Magnus Stenbock, crossed the Elbe, Gortz surrendered the fortress of Tonning to the Swedes.

He next attempted to undermine the grand alliance against Sweden by negotiating with Russia, Prussia and Saxony for the purpose of isolating Denmark, or even of turning the arms of the allies against it. The plan foundered on the refusal'of Charles XII to save the rest of his German domains by ceding Stettin to Prussia.

Another simultaneous plan of procuring the Swedish crown for Duke Charles Frederick failed. Gortz first suggested the marriage between the duke of Holstein and the tsarevna Anne of Russia.

On the arrival of Charles XII. from Turkey at Stralsund, Görtz was the first to visit him, and emerged from his presence virtually chief minister. Gortz owed his extraordinary influence to the fact that he was the only one of Charles's advisers who believed, or pretended to believe, that Sweden was still far from exhaustion, or at any rate had a sufficient reserve of power to give support to an energetic diplomacy. Ostensibly, Gortz was only the Holstein minister at Charles's court, in reality he was everything in Sweden except a Swedish subject—finance minister, plenipotentiary to foreign Powers, factotum, and responsible to the king alone, though he had not a line of instructions. His chief financial expedient was to debase, or rather ruin, the currency by issuing copper tokens redeemable in better times; but it was no fault of his that Charles XII., during his absence, flung upon the market too enormous an amount of this copper money for Gortz to deal with. By the end of 1718 the hatred of the Swedes towards him was so intense and universal that they blamed him for Charles XII.'s tyranny as well as for his own.

Gortz hoped to conclude peace with at least some of Sweden's numerous enemies before the crash came and then, by means of fresh combinations, to restore Sweden to her rank as a great power. In pursuance of his "system," Görtz displayed a genius for diplomacy which would have done honour to a Metternich or a Talleyrand. He desired peace with Russia first of all, and at the congress of Aland even obtained relatively favourable terms, only to have them rejected by his obstinately optimistic master. Simultaneously, Görtz was negotiating with Cardinal Alberoni and with the whigs in England. On the sudden death of Charles XII. the whole fury of the Swedish nation fell upon Görtz. After a trial before a special commission which was a parody of justice —the accused was not permitted to have any legal assistance or the use of writing materials—he was condemned to be beheaded, and promptly executed. His death was certainly a judicial murder, and some historians even regard him as a political martyr.

See R. N. Bain, *Charles XII* (1895), *Scandinavia,* ch. 12 (1905); B. von Beskow, *Freiherre Georg Heinrich von Görtz* (1868).

GORZ: *see* GORIZIA.

GOSCHEN, GEORGE JOACHIM GOSCHEN, 1ST VISCOUNT (1831–1907), British economist and administrator. did useful work under both Liberal and Conservative governments in the last part of the 19th century. The son of William Henry Goeschen, a London banker of German origin. he was born in London on Aug. 10, 1831. He was educated in Saxony. at Rugby and at Oriel college. Oxford. where he was president of the union and took a first class in classics in 1853. He became prominent in the banking world early and was made a director of the Bank of England at 27. His *Theory of the Foreign Exchanges* (1861) was long famous. Goschen entered parliament in 1863 as Liberal member for the City of London, a seat he held till 1880, when he was elected for Ripon. He made his mark at once in the house of commons. became a junior minister in Nov. 1865 and sat in the cabinet as chancellor of the duchy of Lancaster for the first half of 1866. In Gladstone's great cabinet of 1868 Goschen was at first president of the poor law board. where he projected useful reforms, and then, from March 1871 to Feb. 1874, first lord of the admiralty. He and the French negotiated (1876) with the khedive in Cairo the decree that established the dual Anglo-French control of Egyptian bonds.

Goschen stoutly opposed Disraeli's policy in the eastern crisis in 1876–78. He did not join Gladstone's government in 1880 because he disapproved of the impending extension of the franchise. but he did accept the post of special ambassador to Constantinople and helped to settle various Balkan frontier questions in 1880–81. He refused Gladstone's successive offers of the viceroyalty of India. a secretaryship of state or the speakership. He found himself more and more at variance with extreme Liberals, and carried East Edinburgh in 1885 against a radical. When Gladstone declared for Irish Home Rule. Goschen opposed him vigorously. But he lost his Edinburgh seat in the election of July 1886 and only returned to the house of commons in Feb. 1887 for St. George's, Hanover square. When Lord Randolph Churchill resigned in Dec. 1886. Goschen took his place as chancellor of the exchequer ("I forgot Goschen." said Churchill) and operated a successful conversion of the national debt in 1888. He was in opposition from 1892 to 1895. and returned to the admiralty as first lord in Salisbury's coalition cabinet (1895–1902) where he supervised large expansions of the fleet. He retired with a viscountcy in 1900. but kept up an interest in politics and economics: he was one of the weightiest free-trade Unionists in the tariff controversy of 1903–06. He became chancellor of Oxford university in 1903. He died at his home in Sussex on Feb. 7, 1907.

One of his brothers, SIR (WILLIAM) EDWARD GOSCHEN (1847–1924), was British ambassador in Berlin on the outbreak of war in 1914. His elder son, GEORGE JOACHIM (1866–1952), who succeeded him as 2nd viscount; was Conservative member of parliament for East Grinstead from 1895 to 1906 and governor of Madras. 1924–29.

See A. R. D. Elliot, *Life of Lord Goschen,* 2 vol. (1911).

(M. R. D. F.)

GOSFORTH, an urban district of Northumberland, Eng.. adjoins Newcastle upon Tyne on its northern side. Pop (1961) 27,072. The Great North road approximately halves the district and provides its main shopping street. Gosforth is a modern and almost entirely residential town for industrial and commercial Tyneside. St. Nicholas parish church was rebuilt on the present site in 1799. In the district. wholly or partly. are two golf courses, three rugby football fields and one cricket field. The Woolsington airport is about 4 mi. to the northwest. Gosforth house, built by James Paine in 1755–64, was restored in 1921 after being burned by suffragettes in 1914. It lies behind the Newcastle race course. (C. S. PE.)

GOSHAWK, *i.e.,* goose hawk (*Accipiter gentilis),* the largest short-winged hawk used in falconry. The genus *Accipiter* may be distinguished from *Falco* by the smooth edges of its beak. its short wings and its long legs and toes. The sexes differ greatly in size.

The goshawk feeds on small mammals. especially squirrels, and birds of all kinds, including game birds and domestic pigeons and poultry. It ranges across central and northern parts of Europe and Asia. south to Corsica. Sardinia Albania and northwest Iran, a dozen races being recognized: the eastern goshawk *(A. g. atricapillus)*, from northwestern Alaska to Michigan and Maine, south in the mountains to Pennsylvania, and the western goshawk *(A. g striatulus)*, from Alaska to California and New Mexico, are well known in America. About 20 other species are found throughout Africa, southern Asia, the Malays and nearby islands and Australia.

GOSHEN, an Old Testament place name of unknown meaning.

1. The region in Egypt in which Jacob and his sons were settled as shepherds (Gen. xlv, 10; xlvii, 1, etc), praised as "the best of the land' (Gen. xlvii. 6). called also. anachronistically, "the land of Rameses" (Gen xlvii, 11). It was spared by the plagues (Ex. viii. 22, in Hebrew text verse 18; ix. 26). Apparently Goshen was situated on the eastern edge of the Nile delta, close to the desert. but. since no certain mention of Goshen (Gesem in the Septuagint) has been found in the Egyptian documents. the exact location is disputed, as is its extent (Judith i, 9, 10 being hyperbolic).

2 One of the districts of southern Palestine conquered by Joshua (Josh. x, 41: xi. 16), probably so called after its main town Goshen (Gosom in the Septuagint), not yet identified, but according to its position in the list of Josh xv. 51 to be found southaest of Hebron. (L. H. GR.)

GOSLAR, a toun in Lower Saxony. Federal Republic of Germany, on the Gose. at the north foot of the Harz. 24 mi. S.E. of Hildesheim and 31 mi. S.S.W. of Brunswick. Pop (1950) 40.689; (1959 est) 40.666.

Goslar, probably founded under Henry the Fowler (920). became important under Otto the Great nhen minerals were discovered there. It nas often the meeting place of Gerinan diets and about 1350 it joined the Hanseatic league. In the middle of the 14th century the famous Goslar statutes, a code of laws, adopted by many other towns, was published. Fires in 1632, 1728 and 1780 damaged the town's prosperity. In 1802 Goslar came into the possession of Prussia, in 1807 it was joined to Westphalia and in 1866 it was, along with Hanover, reunited nith Prussia.

Goslar is surrounded by walls. Among the noteworthy buildings are the "Zwinger," a tower with walls 23 ft. thick. and the market church, in Romanesque style, restored after its partial destruction by fire in 1844, containing a library in which are some of Luther's manuscripts. The old town hall (Rathaus) has interesting antiquities and the Kaiserhaus is the oldest secular building in Germany, built by the emperor Henry III before 1050. A small chapel is all that remained after 1820 of the cathedral of St. Simon and St Jude founded by Henry III about 1040; it contains an old altar supposed to be that of the idol Krodo which formerly stood on the Burgberg near Neustadt-Harzburg. The church of the former Benedictine monastery of St. Mary, or Neuwerk, is Romanesque of the 12th century The house of the bakers' guild is a hotel. Other buildings include the birthplace of Marshal Saxe; a natural science museum. containing a collection of Harz minerals; and a museum of antiquities. Sulfur, copper, silver and other mines are important. The tom, long noted for beer, possesses small manufactures and trades in fruit.

GOSLICKI, WAWRZYNIEC (1533?–1607), Polish bishop, better known under his Latinized name of Laurentius Grimalius Goslicius, nas born about 1533. After having studied at Cracow and Padua, he entered the church, and was successively appointed bishop of Kaininietz and of Posen. It was chiefly through Goslicki's influence that the Jesuits were prevented from establishing their schools at Cracow. He died on Oct. 31, 1607.

Goslicki's principal work is *De optimo senatore,* etc. (1568). Two English translations were published respectively under the titles *A Commonwealth* of *Good Counsaile,* etc. (1607), and *The Accomplished Senator,* translated into English by William Oldisworth (1733).

GOSNOLD, BARTHOLOMEW (d. 1607), English navigator. In 1602, in command of the "Concord." chartered by Sir Walter Raleigh and others, he crossed the Atlantic. coasted from what is now Maine to Martha's Vineyard, landing at and naming Cape Cod and Elizabeth Island (now Cuttyhunk) and giving the name Martha's Vineyard to the island now called No Man's Land, and returned to England with a cargo of furs, sassafras and other cominodities obtained in trade with the Indians about Buzzard's bay. In London he actively promoted the colonization of the regions he had visited and, by arousing the interest of Sir Ferdinando Gorges and other influential persons, contributed toward securing the grants of the charters to the London and Plymouth companies in 1606. In 1606–07 he was associated with Christopher Newport in command of the three vessels by which the first Jamestown colonists were carried to Virginia. As a member of the council he took an active share in the affairs of the colony, seconding the efforts of John Smith to introduce order, industry and system in the colony. He died from swamp fever on Aug. 22, 1607.

See *The Works of John Snzith,* Arber's edition (1884); and J. M. Brereton, *Brief and True Relation of the North Part of Virginia* (reprinted by B. F. Stevens, 1901). an account of Gosnold's voyage of 1602.

GOSPELS, derived from the Anglo-Saxon *godspell,* "good tidings," which translates the Latin *evangelium* (from Greek euaggelion) It is commonly assumed that the term gospel denotes primarily a written account of Jesus' life. In fact. homever. as the German poet-philosopher Johann Gottfried Herder remarked. Christianity did not start with the writing of gospels but with preaching, and Peter's first sermon at Pentecost was already the complete Christian gospel. Indeed. the word was used by the early Christian church in a quite distinct sense long before any written account of Jesus' life existed.

Earliest Christian Use of the Word.—It is quite certain that the term "evangel" (as well as the verb "to evangelize") was first employed in the Greek-speaking church rather than by Jesus and the Aramaic-speaking Christians of Palestine. In the Greek world, this term was widely used for "news" or "message" of any kind—profane or sacred, political or private. A pre-Christian occurrence of the word in connection with the emperor cult is found in the Priene inscription in praise of Augustus (9 B.C.): "The birthday of the God was the beginning of the evangels due to him." In the Greek version of the Old Testament, the Septuagint, the noun is used three times, twice meaning "reward for good news." The verb occurs more frequently, but neither it nor its Hebrew equivalent is used in a technical sense. Only in a few passages (mainly from Deutero-Isaiah) does the word seem to have a special religious meaning, but the influence of these on the early Christian use of the word cannot be proved. Thus it seems to have been a profane word adopted by the Christians to denote the act of proclaiming the message as well as the message itself.

No emphasis can be placed on the etymological meaning "good" news. In certain New Testament passages (Luke iii, 18; Acts xiv, 15; Rev. x. 7 and xiv. 6) it does not mean good news at all but simply nens, and it is elsewhere used as synonymous with other words denoting preaching, proclamation and word. It was used for the oral preaching of the early Christian missionaries (not for written documents), and this meaning continued in use through the 2nd century A.D. Already in the Pauline Epistles (excluding the Pastorals). the term gospel is used frequently (56 times), often in a technical Christian sense. without reference to any content. Whether or not this is an originally Pauline contribution (the noun and verb never occur in this sense in the Johannine literature, James. Jude or II Peter), it is certainly an inner Christian development, without any pagan or Jewish antecedents. The consciousness that there was only *one* saving message, the gospel, is uniquely Christian.

Gospel as a **Name** for Writings.— Paul also provides the first indication of how the term gospel developed into the designation for a written document. I Cor. xv, 1 ff. and Rom. i, 1 ff. speak of the gospel as an orally transmitted formula which describes the Christ-event, Jesus' death and resurrection. A more developed creedal formula is called gospel by Ignatius of Antioch (early 2nd century A.D.). Since our Gospels basically are expanded creedal formulations, gradually extended backward to include the narratives of Jesus' life, it is easy to see why such written accounts later were called Gospels. In the Gospel of Mark, however— apparently the first of these written accounts— the "gospel" is not yet identified with the written book but denotes the history of that revelation which is identical with Jesus' life, death and resurrection.

Nevertheless. Mark's work is the potential beginning of a new use of the term, by which not only the oral preaching of the Christ-event but also its written account could be called gospel. Such use mas transferred to other writings, Matthew and Luke. which include the "remembered words of the Lord," as originally distinct from the oral gospel (cf. I Clem. xiii. 1–2; Acts xx, 35), within the Marcan framework. The earliest witness to this new use of the term is the heretic Marcion (early 2nd century A.D.), who described Luke's Gospel as "the Gospel" in contradistinction to "the Apostolicon" (a collection of Pauline epistles). A few years later Justin Martyr speaks of the "Memoirs of the Apostles" —a term derived from the "remembrance of the words of the Lord"—and in a few instances adds "which are called gospels." This is the first witness to the use of the plural. Since then the word gospel has come to be used for a great number of other unrelated accounts of Jesus' life and collections of his words. such as John's Gospel and numerous noncanonical writings.

The present article deals only with the four Gospels received by the church in general. and mith the history of the tradition which led to their composition. For further information see BIBLE: Canon of the *New* Testament; MATTHEW. GOSPEL ACCORDING TO SAINT; MARK, GOSPEL ACCORDING TO SAINT; LCKE, GOSPEL ACCORDING TO SAINT; and JOHN. GOSPEL OF SAINT.

Formation of the Gospel Tradition.— Between Jesus' crucifixion and the first composition of a written gospel at least one generation elapsed. Older criticism tried to bridge this gap either by reference to the oral testimony of disciples and eyewitnesses, who were said to have written at least one or two of the Gospels (Matthew and John); or by the hypothetical reconstruction of primitive written sources of the canonical Gospels. Later New Testament criticism has attempted to discover the tradition behind the written accounts. So-called form criticism (M. Dibelius. R. Bultmann. V. Taylor, F. C. Grant and others) has opened up the possibility of reconstructing the history of the material incorporated in the Gospels. This is a history of transmitted oral traditions, which were primarily small. independent units (such as single stories or short sayings). and not of extended accounts. oral or written. By isolating these small units or forms, determining their original "life situation," evaluating the motives of alterations and recognizing editorial techniques used when such tradition became written gospel, it is possible to describe the preliterary history of the gospel formation.

The earliest church conceived of Jesus' words and works not as biography or objective history. From the very beginning the "life situation" of all the tradition about Jesus was the preaching and teaching of the church, in the course of which the transmitted stories and sayings served as a guide for the new life of the Christian people. The need of instructing new believers and of defending the faith, the expression of church life in worship and liturgy and the development of theology as a matter concerned mith the saving event in the man Jesus of Nazareth were moving factors in the formation of the tradition. In this sense it was the church that created the gospel tradition.

The traditional material incorporated in the Gospels is basically of two kinds. each with numerous subclassifications: (1) narratives, including legends about the person of Jesus (birth legends, baptism, passion and resurrection), miracle stories (healings and wonders) and tales (such as the Emmaus road incident); and (2) sayings—prophetic and apocalyptic, proverbial, legal, ecclesiastical, Christological and parable. Often also single sayings were transmitted as the central features of little anecdotes, which Dibelius calls paradigms. With regard to form, almost all the above categories have parallels in Hellenistic oral folklore and late Jenish oral traditions. Thus, stories of Greek heroes and Hellenistic wondermen provided a pattern for the legends about

Jesus, and the form of the sayings is clearly patterned after Old Testament prophecy, Jewish apocalyptic and wisdom speculation and rabbinic law. A peculiarly Christian "form" is found only in the narratives centred around the passion of Jesus and in the sayings about the theological significance of Jesus as "the one nho has come." Just as this unique form is integral to the core of the gospel proclamation, so the literary form "gospel" is unique to Christianity. without precedent or parallel. To compare the Gospels with the Greek writing of history or biography would precisely miss their uniqueness. which is rooted in the fact that here the church preached the coming of the divine in a particular historical person—Jesus Christ.

The "Synoptic Problem."--The first three Gospels, Matthew, Mark and Luke, are known as Synoptic Gospels because they have such an agreement in structure, content and wording that they can easily be arranged in parallel columns so as to provide a synoptic view of their content (from Gr. synopsis; *syn,* "along with." *opsis,* "view"). By such an arrangement. the question of the kind of literary relationship that exists among these three Gospels is necessarily forced upon the observer. This question, called the Synoptic problem, has been elaborately studied in modern times.

The traditional solution explains the striking similarities on the basis of the priority of Matthew or of a supposed primitive Matthew in a Semitic language; this is sometimes identified with the so-called Gospel According to the Hebrews (see APOCRYPHA, NEW TESTAMENT). Mark is consequently seen as dependent on Matthew Luke on both Matthew and Mark (and John on all three Synoptic Gospels). This view remains the prevailing Roman Catholic explanation, even if elaborately modified.

Theologians of the rationalistic period were the first to challenge this long-accepted hypothesis. (1) J. J Griesbach (in 1774–75) held that Mark used not only Matthew but also Luke (hypothesis of usage). (2) G. E Lessing (in 1776 and 1778) and J G. Eichhorn (in 1794) argued that all three Synoptics utilize a lost Aramaic gospel (primitive Gospel hypothesis). (3) J G. Herder (in 1796–97) and J C L Gieseler (in 1818) thought this primitive Gospel was transmitted orally (tradition hypothesis). (4) F. Schleiermacher (in 1832) assumed the existence of small written collections or fragments out of which the Evangelists composed their writings (fragments hypothesis).

All these attempted explanations have survived in one form or another, and though all of them certainly contain some truth, most Protestant and some Roman Catholic scholars hold that only one hypothesis explains the Synoptic problem satisfactorily the so-called two-source hypothesis. The evidence given by K. Lachmann (in 1835), that Mark as the earliest Gospel must have been the source for both Matthew and Luke, was supplemented by the philosopher C. H Weisse (1838). who suggested a second source besides Mark which Matthew and Luke also used. Through the work of H. J Holtzmann (1863), B. H. Streeter (1925) and many others, the two-source hypothesis has taken the following form, in which it is widely accepted among Protestant scholars:

1. Matthew and Luke used the Gospel of Mark, from which they drew most of their narrative material as well as the basic outline of the life of Jesus.
2. Matthew and Luke used a second source (Q), no longer extant. which contained for the most part only sayings.
3. Matthew and Luke each had one or more other sources for the material peculiar to their respective Gospels.

Mark.—The hypothesis may be stated as follows: Mark, either in its present form or in a slightly different earlier Greek form, was the first written Gospel and was a source for Matthew and Luke.

Of the 661 verses contained in the authentic text of Mark, more than 600 are reproduced or represented in Matthew and about 350 in Luke. Only 31 verses in Mark are wholly unrepresented in either Matthew or Luke. Furthermore. in the material common to all three Gospels. there is very seldom verbatim agreement of Matthew and Luke against Mark. although such agreement is common between Mark and Matthew or Mark and Luke or all three. Where Matthew and Luke agree against Mark, several explanations are possible: (1) secondary harmonization of the texts of Matthew and Luke; (2) Matthew and Luke in particular instances preferred a parallel tradition rather than Mark's wording; (3) possibly the present Mark is slightly different from the recension used by Matthew and Luke.

The following sections in Mark are represented in both Matthew and Luke according to the Marcan sequence. although Matthew and Luke often insert other material into this framework: Mark i, 1–15. 39; ii, 1–iii. 12; iv, 1–12; vi, 14–16, 30–44; viii, 29–ix, 8, 14–37; x. 13–30, 32–34. 46–52; xi, 1–11, 15–19. 27–33; xii. 1–27, 35–40; xiii. 1–20. 24–32; xiv–xv (almost completely) Many Marcan passages not contained in this list are entirely missing in Luke but are still to be found in Matthew, often in the Marcan order; thus. Matt xiv, 1–xxviii, 10 completely follows Mark's order (Mark vi, 14–xvi, 8) throughout without any changes of position. On the other hand the first part of Mark (i, 40–iii, 12 and iv. 1–v. 23) is almost entirely taken over in Luke (v, 12–vi, 19 and viii, 4–56), whereas Matthew often deviates here. These findings cannot be explained except on the supposition that the Greek Gospel of Mark mas the direct source for Matthew and Luke.

It must be emphasized that since Matthew and Luke used the Greek Mark. they cannot be considered as translations from Aramaic prototypes, though, of course, non-Marcan materials in Matthew and Luke may well have a more direct Semitic background.

Q—The postulation of a second common source of Matthew and Luke, the "Saying-Source," conventionally designated Q (from German *Quelle,* "source") constitutes a more complicated problem The sayings found in both Matthew and Luke but absent from Mark are the chief reason for this postulation. Many of these saying parallels show a great verbatim agreement; moreover, they are sometimes given in the same sequence, though usually this is not true on a large scale. Furthermore a number of sayings are "doublets": i e., they are given twice in Matthew or Luke or both, once in a setting from the Marcan context and a second time according to Q. Examples of such doublets are: (1) Matt xiii, 12 (=Luke viii, 18) taken from Mark iv, 25; the same saying in Matt xxv, 29 (=Luke xix, 26) without Marcan parallel (*i.e.,* from Q). (2) Matt. xvi, 24 ff. (=Luke ix. 23 ff.) taken over within the Marcan context from Mark viii, 34 ff ; the same sayings in Matt. x. 38 ff. (=Luke xiv. 27; xvii, 33) from Q

These and other phenomena seem to justify the hypothesis that Q was one written document available to Matthew and Luke alike. But other observations make such a conclusion less certain: within the Q material, Matthew and Luke show less agreement than they do in their reproduction of Mark Especially the sequence and order of the Q material lacks consistency. For this reason attempts to reconstruct Q, though numerous. have remained entirely speculative, at least as far as the original order of sayings in Q is concerned. In addition, the extent of the Q-recension used by Matthew seems to have been different from that used by Luke. Thus. Q certainly was not such a clearly defined written document as was Mark Nevertheless. some statements about Q can be made with relative confidence: (1) it was available to Matthew and Luke as a written source; (2) the language was certainly Greek, although most of the Q material contains distinct "translation Greek" with a strong Semitic flavour. Often such linguistic peculiarities are found in the Q material of both Matthew and Luke in parallel passages, thus indicating that these Q traditions must go back to one and the same translation of an Aramaic original, which might have already existed in a written form.

Attempts have been made to refer to this Aramaic Q a statement about Matthew made by Papias and quoted in Eusebius: "Matthew compiled the sayings in the Hebrew language. and every man translated them as he was able." Papias himself meant to speak of the Gospel of Matthew but his statement in no way fits our Matthew, which is not a collection of sayings and which never existed in an original Aramaic form. Possibly Papias mistook a tradition about an Aramaic Q for a staternent about Matthew But even if Papias thus witnesses to a written Aramaic Q, it could not have contained all the present Q material. In many instances Matthew and Luke do contain parallel sayings that originated from different translations of the same Aramaic saying; on the other hand, a few Q sayings are Greek formulations without Semitic background.

Thus it may be concluded that Q represents the still flexible but at least partly written sayings tradition of the Greek-speaking church, which rested largely on similar Palestinian collections in Aramaic. Though Q reflects certain theological tendencies, mainly those of the first decades of the church in Palestine, it could not be called the work of an "author," and thus is not literature and certainly not a Gospel. Q may have taken written form before the middle of the 1st century and was translated into Greek probably before A.D. 70. The early Greek church, of course, as well as Paul himself, knew sayings of the Lord in the Greek language. But all attempts to prove a direct use of the Saying-Source Q in any other apostolic, postapostolic or 2nd-century literature have failed. After Matthew and Luke used it, Q apparently proved to be no longer of any value and quickly disappeared.

Other Sources.—The authors of Matthew and Luke also clearly depend upon other sources for most of the material peculiar to each of them. Most probably this is the case with the material in the great Lucan digression, or "travel narrative" (Luke ix, 51–xviii, 14), for which a special written source (containing among other traditions the most valuable "great parables") apparently was available to Luke. The infancy stories of Luke, and of Matthew as well, also go back to special traditions, whether written or oral. Finally, the resurrection narrative in Luke is not from Mark but has a tradition of its own. Scholars have tried to reconstruct a "proto-Lucan Gospel," but none of the suggestions is conclusive, although the existence of special literary sources available to Luke cannot be doubted. The character of the material peculiar to Matthew forbids even more the reconstruction of a special proto-Matthew. This material is largely nonliterary, having its origin and life situation mainly in the liturgy and the regulations of the church's life. All attempts to exploit the peculiarities of Matthew and Luke to establish a new hypothesis about the origin of and relationship among the Gospels have not shaken the two-source hypothesis but rather have served to supplement and confirm it.

The Fourth Gospel.—The Gospel According to St. John stands apart. Developments in higher criticism do not even favour dependence of John upon the Synoptic Gospels. Nevertheless, this Gospel is in some ways related to the Synoptic tradition. Its account of Jesus' passion and resurrection is parallel to and evidently more primitive than the source used by Mark. It employs a written narrative containing signs and miracles of Jesus, which again is very close to the tradition recorded in Mark but at the same time shows some rather primitive features. The Johannine tradition about the Baptist also goes back to the same root as the parallel Synoptic accounts and has preserved much valuable information now lost in the Synoptics. On the other hand, John's Gospel always presents the material with its own peculiar interpretation, adding discourses from traditions that have no parallels in the Synoptic Gospels, a feature that gives the Fourth Gospel an entirely different character. In appearance it is more theological, sometimes called more spiritual, yet John's Gospel was written with even more emphasis upon the historicity of the revelation than were the Synoptic Gospels. Thus John presents a mature interpretation of the gospel of revelation in the historic person Jesus of Nazareth, as seen consciously from the distance of a third-generation Christianity in the last decades of the 1st century.

Character of the Gospels.—The oral gospel was not preached in order to give historical or even biographical information; neither did the Gospel literature, as the final fruit of early-Christian preaching, come into existence in the interests of history in the modern scientific (objective) sense of that word. The tradition behind the Gospels was sustained at every stage for the sake of preaching and edification, with apologetic and theological motivation. The Gospels and the tradition behind them must be described as tendentious and slanted. Nonetheless, there is some material of historical value in them. Not only do they attest the fact that Jesus was truly a historic person, but also they include several historical "blocks" that are not entirely dissolved by theological interpretation—the passion narrative, for example, and many of the sayings and parables (especially those that show Jesus' unique eschatological consciousness). Thus the venture of writing a "life of Jesus" remains a legitimate task for the historian.

But for understanding of the character of the Gospels it is important to recognize that even such historical data were handed down only as they served theological purposes and not for their own sake. This does not suggest that the essence of the Gospels is spiritual information or "eternal truth" as opposed to "history." Rather it is the announcement that revelation has come as the Jesus of history. The Gospels present this historical revelation in its true meaning; *i.e.*, history in its real, theological dimension. History and theology, historical Jesus and risen Lord, are thus inseparably bound together in one story. See JESUS CHRIST; see also references under "Gospels" in the Index volume.

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GOSPORT, a municipal borough (1922) in the Gosport and Fareham parliamentary division of Southampton, Eng., on a peninsula between the west side of Portsmouth harbour and the Solent, 18 mi. S.E. of Southampton. Pop. (1961) 62,436. Area 9.7 sq.mi. Gosport, originally part of the manor of Alverstoke held by the bishops of Winchester, prospered during the 16th and 17th centuries because of the rising importance of the Royal Navy. Primarily a victualing station, it flourished during the Napoleonic Wars. Later it shared in the navy's development of Portsmouth harbour, and is now the site of many important naval establishments. Gosport was one of the main embarkation areas for the Allied invasion of France on June 6, 1944. The town suffered considerable damage during World War II, and redevelopment schemes were undertaken, chiefly the virtual clearance of parts of the old town and their replacement with industrial and residential developments respectively. Holy Trinity church contains the organ, originally belonging to the duke of Chandos, on which Handel is said to have played. Industries connected with the sea are well established in Gosport, particularly shipbuilding and sailmaking. The other principal industries include the making of wallpaper and paint, radios and radar, tools, air components, pens, clothing and general and light engineering.

GOSS, SIR JOHN (1800–1880), English composer, was born at Fareham on Dec. 27, 1800. His church music includes the anthems "O Taste and See," "O Saviour of the World," and others;

and in the history of the glee he has also an honoured place. He died in London on May 10, 1880.

GOSSAERT, JAN: *see* MABUSE, JAN.

GOSSE, SIR EDMUND (1849–1928), English man of letters, eminent for his valuable work in bringing foreign literature home to English readers, was born in London, Sept. 21, 1849, son of the religious zoologist P. H. Gosse. His early life, recounted in the best and most enduring of his many books, *Father and Son* (1907), followed a pattern common in his generation: a love-hate relationship with a puritan father, followed by escape into the exhilarating world of belles-lettres. Gosse, however, never became an aesthete or a bohemian; he kept to decorous beaten tracks: the British museum, the board of trade (where he was "translator" for nearly 30 years) and the house of lords (librarian: 1904–14).

Gosse was a prolific versifier, translator, literary historian, critic and journalist, and in his own time he was very influential. He had the misfortune, however, to be working just before the modern revolution in standards of scholarship and criticism, so that much of his output now appears amateurish. Moreover, most of his best books, such as his translations of Ibsen (*Hedda Gabler,* 1891; with W. Archer, *The Master-Builder,* 1893), his literary lives and editions (*e.g., Thomas Gray,* 1884; *Donne,* 1899; *Sir T. Browne,* 1905), his literary histories (*18th Century Literature,* 1889; *Modern English Literature,* 1897) and his critical essays (*e.g., Critical Kit-Kats,* 1896; *French Profiles,* 1905), though written with charm and gusto, have been outclassed by subsequent work in these fields. Nevertheless he deserves credit as a pioneer, particularly in the study of Scandinavian and French literature, and English literature of the 17th and 18th centuries. And his evident relish for literature, as a thing to be savoured and enjoyed, is something that modern critics too often lack. In *Father and Son* all Gosse's finest gifts—grace, irony, wit and tolerance—combine to form a minor classic of autobiography. Gosse was knighted in 1925 and died in London, May 16, 1928. (B. WY.)

GOSSE, PHILIP HENRY (1810–1888), British naturalist and popularizer of zoological subjects, was born at Worcester on April 6, 1810. In 1827 he became a clerk in a seal-fishery office at Carbonear, Nfd., where he beguiled the tedium of his life by investigations into natural history. After an unsuccessful interlude of farming in Canada he traveled in the United States, taught for some time in Alabama and returned to England in 1839.

A visit to Jamaica in 1844 led to accounts of the birds of that island and to his *A Naturalist's Sojourn in Jamaica* (1851). For the rest of his life he devoted himself to the description of the animal life, mainly the invertebrates, of the British seas and fresh waters. The nature of the numerous successive popular or semi-popular volumes is shown by specimen titles, such as *A Naturalist's Rambles on the Devonshire Coast* (1853); *Evenings at the Microscope* (1859); and *A Year at the Shore* (1865). His books were illustrated with his own meticulously drawn and coloured figures. Technical accounts of the British sea anemones and corals, and a larger work on the minute rotifers (with C. T. Hudson) retain usefulness for reference.

Gosse's membership in the Plymouth Brethren involved him in the complete rejection of all ideas of evolution. Two years before the appearance of *On the Origin of Species* he expressed the non-evolutionpry position in a unique book, *Omphalos* (1857). Gosse was elected fellow of the Royal society in 1856. He died at St. Marychurch, Devon, on Aug. 23, 1888.

See Peter Stageman *et* al., *Bibliography of the First Editions* of *Philip Henry Gosse, F. R. S.* (1955). (K. P. S.)

GOSSEC, FRANÇOIS JOSEPH (1734–1829), French musical composer, son of a small farmer, was born at the village of Vergnies, in Belgian Hainaut, and became a choirboy at Antwerp. He went to Paris in 1751 and was introduced by Rameau to La Popelinière, a wealthy amateur who made him conductor of his private hand. His first symphony was performed in 1754, and as conductor to the prince de Condé's orchestra he produced several operas and some 30 symphonies. Gossec gave enormous stimulus to the development of orchestral and chamber music in France.

Gossec died at Passy on Feb. 16, 1829.

GOSSON, STEPHEN (1554–1624), English writer, notable for his attacks on the theatre, was baptized at Canterbury, Kent, on April 17, 1554. Educated at Corpus Christi college, Oxford, he became a playwright and actor but later attacked the stage, poetry, music and other pastimes in *The Schoole of Abuse* (1579), probably commissioned by the city authorities. In *The Ephemerides of Phialo* (1579), an imitation of John Lyly's *Euphues,* Gosson parried the first retaliations of the players, mentioning in the appended *Apologie of the Schoole of Abuse* that they had "got one in London to write certaine *Honest excuses."* This spokesman for the players was Thomas Lodge. *Playes confuted in five Actions* (1582) closed Gossun's career as a controversialist. Between 1579 and 1583 he was a tutor. In April 1584 he entered the English college at Rome but later took Anglican orders. His preferment was rapid and in 1600 he was appointed rector of St. Botolph's, Bishopsgate, London, where he died on Feb. 13, 1624. A sermon, a few early occasional poems and the titles of three plays complete his acknowledged work. According to Francis Meres, he also wrote pastoral poetry. The theatre controversy sheds more light on the academic training of the disputants than on the drama. Its literary interest is slight except insofar as Gosson's dedication of *The Schoole of Abuse* to Sir Philip Sidney, for which he was "scorned," may have prompted Sidney to write his *Defence of Poesie* (1595).

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GÖTA, a river of Sweden, draining Lake Vener. The name is also applied to the canal which leads from Goteborg to Stockholm The river flows out of the southern extremity of the lake almost due south to the Cattegat, which it enters by two arms enclosing the island of Hisingen, the eastern forming the harbour of the port of Goteborg. The Gota river is 58 mi. long and is navigable for large vessels, a series of locks surmounting the falls of Trollhattan (*q.v.*). Passing the wooded Halleberg and Hunneberg Lake Vener is reached. From Sjotorp, midway on the eastern shore, the western Gota canal leads southeast to Karlsborg. Locks raise it from the Vener level (144 ft.) to 300 ft., and lower it to Lake Vetter (289 ft), which the route crosses to Motala. The eastern canal then descends to Lake Boren, after uhich the canal crosses a rich plain. Lake Rox with its ruined castle of Stjernarp is next traversed. At Norsholm a branch canal connects Lake Glan to the north, giving access to Norrköping. Passing Lake Asplången, the canal follows a cutting, and then resumes an elevated course to Soderkoping, after which the Baltic is reached at Mem. The whole distance from Goteborg to Stockholm is about 360 mi. The length of artificial work on the Gota canal proper is 47 mi.

The idea of a canal dates from 1516, but the construction was organized by Baron von Platten and engineered by Thomas Telford in 1810–32.

GOTARZES or GOTERZES, king of Parthia (c. A.D. 38–51). When the troublesome reign of Artabanus II ended in A.D. 39, he was succeeded by Vardanes, probably his son; but against him rose Gotarzes, who also belonged to the king's family. He soon made himself detested by his cruelty—among many other murders he even slew his brother Artabanus and his whole family—and Vardanes regained the throne in 42; Gotarzes fled to Hyrcania and gathered an army from the Dahan nomads, but the war ended by treaty, as both kings were afraid of their nobles. When Vardanes was assassinated in 47, Gotarzes was acknowledged in the whole empire. He then placed on his coins the usual Parthian titles, "king of kings Arsaces the benefactor, the just, the illustrious (*Epiphanes*), the friend of the Greeks *(Pkilhellen)*," without mentioning his proper name. The hostile party brought from Rome an Arsacid prince, Meherdates (Mithradates), who lived there as hostage, but he was taken prisoner by Gotarzes, who died soon after. According to Tacitus, Gotarzes died of illness; Josephus says he was murdered.

An earlier "Arsakes with the name Gotarzes" appears to have reigned in Babylonia *c.* 87 B.C.

GÖTEBORG (GOTHENBURG), the second city of Sweden and its largest seaport, situated in the valley and on the heights of the Gota alv (Gota river) estuary, the centre being 5 mi. above the river mouth in the Kattegat.

Pop. (1960) 404,349.

Goteborg was founded in 1619 by Gustavus Adolphus II (charter dated June 4, 1621), but earlier urban settlements had already existed on the site. A settlement of the same name had been founded on the island of Hisingen, to the north, by Charles IX, but it had been destroyed by the Danes. A considerable number of the earliest inhabitants of the present town were foreigners. mainly Dutchmen, but also Englishmen, Scots, Belgians and Germans. As a result of the Dutch settlement. Goteborg took on a certain Dutch quality. Evidence of this is still provided by the canals, built in the Dutch style, and by the planning of the city centre.

The city's prosperity was laid in the early 18th century by the founding of the Swedish East India company, and during Napoleon's continental blockade it became Europe's chief market for British goods. A second period of wealth started with the opening of the Gota canal (1832) and the setting up of a transoceanic service. The town was strongly fortified until 1807, and around the main wall a moat was dug, which still encircles the old part of the city. The forts called Skansen Lejonet ("the Lion") and Skansen Kronan ("the Crown") are other relics of the old iortifications. Part of the canal system has been filled in, and in its place are two important streets, Östra Hamngatan and Vastra Hamngatan. Two other principal streets of the old town are Norra Hamngatan and Sodra Hamngatan, one on each side of the Great Harbour canal. Gustav Adolfs Torg (market place), including the town hall (1750), the exchange (meeting place of the city council and the town's administrative centre; 1849), and the law courts (1672, restored 1732, 1817) with an annex (an interesting example of modern Swedish architecture; 1935–37) is also in the old town. In Norra Hamngatan, west of the Kristine church (1648, rebuilt 1780), stand the former office and warehouse buildings of the Swedish East India company (1750–62) and the house of its manager, Nicholas Sahlgren (1753); the company's premises house the Cultural History museum, and the house is occupied by the city finance department. In this part of the town also is the cathedral (1633, rebuilt 1815–25, restored 1956–57). Southward, Ostra Hamngatan continues as Kungsportsavenyen, familiarly called "the Avenue," leading to Gotaplatsen, round which stand the city theatre (1934), the art gallery (1923) and the concert hall (1935).

Outside the old moat and alongside it lies a continuous park area more than a mile long traversed by Nya Allén. At the junction of the Avenue with Nya Allén stands the city's opera house, Stora Teatern (1859). The city contains a university, a technical college, a commercial college, a school of social studies and a navigation school. Museums include the Maritime museum and aquarium, the Natural History museum, and the Rohss Museum of Art and Craits. Among the larger parks are Slottsskogen, with a zoological section and bird lakes, the botanical gardens and the Trädgårdsföreningen (the Garden society). Principal exports are paper, cardboard, timber, paper pulp; imports are mineral oils, fruit and iron. The shipbuilding yards on Hisingen island are the largest in Sweden. Other big industries are the manufacture of ball bearings, cars, textiles and food. (Lo. S.)

GOTHA, a town of Germany, in the district of Erfurt, alternately with Coburg the former residence of the dukes of Saxe-Coburg-Gotha, on the Leine canal, 6 mi. N. of the slope of the Thiiringenian forest. Pop. (1959 est.) 56,470.

Gotha (in old chronicles called *Gotegewe* and later *Gotaha)* existed as a village in the time of Charlemagne. In 930 its lord, the abbot of Hersfeld, surrounded it with walls. It was a town as early as 1200, when it came into the possession of the landgraves of Thiiringen. On the extinction of that line it fell to the electors of Saxony, and later to the Ernestine line of dukes. After the battle of Miihlberg in 1547 the castle of Grimmenstein was partly destroyed, but it was again restored in 1554. At the end of the 16th century it came into the possession of Ernest the Pious. In 1825 it was united to the dukedom of Coburg. The old inner town is encircled by suburbs, and is dominated by the castle of Friedenstein, begun in 1643, lying on the Schlossberg.

The new museum, south of the castle, contains the picture gallery, cabinet of engravings, natural history museum, Chinese museum and a collection of antiquities. The church of St. Margaret has a beautiful portal and a lofty tower (12th century), twice burned down, and rebuilt in its present form in 1652; the church of the Augustinian convent has an altarpiece by the painter Simon Jacobs; and the old town hall dates from the 11th century. The schools include a gymnasium founded in 1524.

Gotha makes sausages, porcelain, tobacco, rubber, machinery, mechanical instruments, musical instruments, shoes, furniture and toys.

The book trade is represented, including the firm of the great geographical house of Justus Perthes, founded in 1785.

GOTHAM, WISE MEN OF, the early name given to the people of the village of Gotham, Nottingham, in allusion to their reputed simplicity. But if tradition is to be believed the Gothamites were not so very simple. The story is that King John intended to live in the neighbourhood, but that the villagers, foreseeing ruin as the cost of supporting the court, feigned imbecility when the royal messengers arrived. John, on this report, determined to have his hunting lodge elsewhere, and the "wise men" boasted, "We ween there are more fools pass through Gotham than remain in it." The "foles of Gotham" are mentioned as early as the 15th century in the *Towneley Mysteries;* and a collection of their "jests" was published in the 16th century under the title *Merrie Tales of the Mad Men of Gotham, gathered together by A.B., of Phisicke Doctour*. As typical of the Gothamite folly is usually quoted the story of the villagers joining hands round a thornbush to shut in a cuckoo so that it would sing all the year.

GOTHIC ARCHITECTURE is a term used generally to signify the style of architecture that developed from Romanesque during the 12th century and became general in Europe by the middle of the 13th century. For a discussion of the structural principles involved in the development of Gothic, *see* ARCH AND VAULT; BUTTRESS; ARCHITECTURE; ARCHITECTURAL ENGINEERING. The architecture of the periods preceding Gothic is traced in BYZANTINE ARCHITECTURE and ROMANESQUE ARCHITECTURE; the period following Gothic is traced in RENAISSANCE ARCHITECTURE. The development of specific types of buildings during the Gothic period will be found in RELIGIOUS ARCHITECTURE; MONASTERY; GOVERNMENTAL ARCHITECTCRE.

The article is divided into these sections:

I. INTRODUCTION

The Word Gothic. — The interest of the early humanists (Petrarch, Boccaccio, etc.) in classical culture inspired Italian artists to employ classical forms. In 1419 Filippo Brunelleschi introduced the classical orders in Florence. According to his biographer, Manetti, 'Brunelleschi revived the good architecture of the Romans, which the Vandals, Goths, Lombards and Huns destroyed and replaced with their own inferior architecture. Filarete held that the barbarians in general, and the French and Germans in particular, were responsible for the bad architecture that thereafter was usually called *maniera tedesca* ("German style"). The so-called Pseudo-Raphael, in 1510, attributed the discovery of the pointed arch to the Germans, who, having no hatchets, bent together the branches of trees to form a roof. Later Giorgio Vasari in 1550 narrowed down the list of culprits to the Goths who had sacked Rome in 410. The architecture then termed Gothic spanned the period from 410 to 1419 and its characteristic member was said to be the pointed arch. Christopher Wren (1632–1723), knowing that Moslems used pointed arches, evolved the theory that Gothic was of Saracenic origin.

In the 18th century the Byzantine and Carolingian styles were distinguished and historians found it useful to divide the long period that remained. François Blondel the Younger in 1771 divided the entire medieval development into two periods: *architecture gothique ancienne,* from the 6th to the 11th century; and *architecture gothique moderne* up to Francis I (1515). The term Romanesque was first applied to 11th- and 12th-century architecture by W. Gunn and C. de Gerville in 1819, and thereafter the word Gothic was confined to its present meaning. The style was praised with certain reservations by J. G. Soufflot in 1743 and M. A. Laugier in 1755 and 1765 in France. Goethe praised it without reservations in his dithyramb on the façade of the Strasbourg cathedral (1773), and enthusiastic comments, somewhat better substantiated, by romanticists followed. The 19th century saw the beginning of the serious study of the topography and history of the style. Scholars were aware that Gothic had nothing to do with the Goths. Some of them introduced new terms, *e.g.,* stile ogival, *Germanischer Stil,* but the abusive name Gothic had become a name of honour. Ultimately it came to signify a neutral concept.

The Definition of Gothic **Architecture.**—The term came to be applied to buildings of such different forms that a clarification of the concept became desirable. In the 18th century, writers attempting to determine the essence of Gothic associated it with the picturesque (William Gilpin, 1768), but found in it also an aspiration toward the sublime and infinite. Although this theorizing was of great importance, the pointed arch continued to be regarded as the specific feature. What was required was a descriptive analysis such as was used. for example, in zoology. This was furnished by the apothecary Thomas Rickman in 1817. He described the parts in succession: portals., windows, arches, piers, capitals, buttresses, etc., and even indicated the transformations which took place in the phases of English Gothic. After this model many books were written, better and more nearly complete, and this method of classification is still in use. The first attempt to give a real definition of Gothic.was made by the architect Johannes Wetter. In a footnote to his guide to the cathedral of Mainz (1835) he emphasized four architectural members of Gothic churches, placing each one in functional relation to an element of the style. The first member was the pier and it was related to the stylistic element of attenuation of all members; second, the buttressing system was related to the dissolution of the walls; third, the pointed arch was related to verticalism; fourth, the ribbed vault was related to structural character. Prior to Wetter, Rickman and others had listed Gothic forms without connecting them, but Wetter offered a clear system. But since it was derived from High Gothic buildings, it became the task of later historians to investigate the origin of those characteristics and their transformations to the end of Late Gothic. Gothic style represents a historical process which requires a dynamic, not a static, definition.

II. THE ORIGINS OF GOTHIC ARCHITECTURE AND THE TRANSITIONAL STYLE

English scholars believed that the Gothic style originated in England; German scholars were convinced that the *maniera* tedesca came from Germany. G. D. Whittington, a young English theologian, established the fact in 1809 that St. Denis near Paris (1137–44) preceded all Gothic edifices in other countries. Forgotten for a time, this fact was rediscovered by Franz Mertens in 1843 and now is universally accepted. But since the construction of the ribbed vault in the St. Denis choir showed a mastery of the technique, historians searched for more primitive examples. John Bilson in 1899 demonstrated that in the middle ages ribs were first connected with groin vaults in the choir of Durham cathedral (1093). During the two generations prior to the building of the St. Denis choir (1140), the geometric construction, the technique of scaffolding and the statics were improved in France.

The Introduction of the **Rib.**—A lengthy controversy arose concerning the reason for the introduction of ribs. It was useless to investigate ribs (*i.e.,* transverse arches) in barrel vaults, ribs in domes or arches supporting flat ceilings (Syria) because the point to be determined was why ribs mere combined with Romanesque groin vaults, transforming them into Gothic ribbed vaults. Ribs composed of bricks had been employed in Roman architecture to serve as scaffolds and to reinforce the finished vaults. These ribs, however, being covered with plaster and small slabs, were invisible; they became visible much later when the buildings fell into ruin. It is unlikely that the master of Durham was acquainted with such ruins. Actually, the ribs represented the final step in the formation of scaffolds. Originally scaffolds consisted of wooden barrel vaults crossing one another. In oblong bays, which mere usually preferred, the resulting groins were doubly curved, three-dimensional lines, in many cases distorted by the great weight of the stones supported by the scaffold. After various experiments which can still be traced, the method was radically changed. First wooden arches were constructed for the diagonal groins, then from these arches the boards were laid for the severies (*i.e.,* compartments of the vault). This ensured precise lines for the groins. To avoid distortions the wooden diagonal arches were replaced by arches of stone, called ogives by Villard de Honnecourt, ribs by the English and cintres permanents by Viollet-le-Duc. While the attempt to solve certain problems of geometric construction, technique and statics was important in the development of the rib, its real function was aesthetic: to furnish precise lines. The diagonal rib was not a continuation of a structural member of the wall; since these members were frontal their continuations could only be frontal transverse arches. Diagonal ribs, on the contrary, required diagonal supporting shafts. The statement that Gothic developed from the top down is valid. but it must be emphasized that the structural character of the ribs conformed to Norman stylistic use of strong articulation.

The Principle of **Division.**—The rib was an aesthetic improvement suited to the structural character of a Romanesque building, such as Durham cathedral. However, its diagonality opposed the frontality of the capitals and plinths of the piers and, still more, it disturbed the spatial character of the architecture. All compartments of Romanesque churches were built as separate units combined according to the principle of addition. The space of a Romanesque groin vault looks like a single unit resting horizontally upon the space below. The rib, however, divides the space of the vault into interdependent parts. Each arch involves the imagination of the plane in which it lies. As a result the vault and the space beneath it become a unit divided by the planes of the diagonal ribs. This led the architects to turn the shafts in a diagonal direction. The chief reason for the transformation from the Romanesque into a new style was the principle of division and fusion of the bays. which governed the building in all its aspects. Thus, a building resulted which seemed to be a whole differentiated into parts, like an organism, while in Romanesque buildings one form was added to another, producing a whole by addition, as in the formation of crystals. The process of transformation continued through more than four centuries. It can be studied first as a process immanent in the history of architecture. The equally important question of its relation to the culture of the time may be considered later.

Transitional Style.—At Durham the segmental form of the diagonal ribs was chosen in order to bring the crowns of all three pairs of arches (diagonal ribs. transverse and wall arches) to the same level. (See fig. 2.) In Lessay (c. 1100) the diagonal rib was given the more satisfying form of a half circle, but it started at a level below the transverse and longitudinal arches, nhich resulted in irregularity. In Trinité in Caen the ribs were originally segmental arches combined with the Romanesque diaphragm system. This may have led the other master. who at the same time vaulted St. Étienne in Caen (c. 1120). to create the sexpartite ribbed vaults to fit the alternating forms of the Romanesque piers. In the porch of St. Pierre in Moissac (c. 1125) an architect tried for the first time to bring the crowns of all three pairs of arches to the same level by using pointed arches, but the diagonal ribs began at an angle of less than 90°. forming a segmental pointed arch. In the aisles of St. Étienne in- Beauvais (c. 1130) the diagonal ribs are semicircular, as are the transverse and longitudinal arches of the bays. but they are stilted and very heavy with broad rectangular profiles. However, there for the first time the shafts for the diagonal ribs are turned in the diagonal direction. In the transepts the progressive master made the transverse arches pointed and gave them a riblike profile, thus making the whole lighter and the bays less strongly separated. This treatment was repeated in the transverse arches in St. Germer near Beauvais (after 1132), but the gallery openings and the windows had round arches. In the choir of St. Germer the boss of the ribbed vault was decorated with sculpture for the first time. Other innovations of the early 12th century were the substitution of a ribbed vault for the quarter-sphere vault in an apse in the little chapter house in Jumieges (1109), an important step, as the form of a dome points to the interior, the severies of a ribbed vault to the exterior. The ribbed vault was introduced into the narrow ambulatory of Morienval about 1125. The ribs received spurs at their extrados so that the severies could lean on them and the vaulting be executed freehand. At the time of all these advances the first experiments were made in adding ribs to the crowns. The first ridge ribs were constructed in Airaines (c. 1140) and Montivilliers near Le Havre (c. 1150).

The adaptation of the building to the rib and the improvement of the geometric construction of the ribbed vault itself have been rightly called the active transition; the passive transition occurred where details were copied and freely combined with Late Romanesque forms. In Germany ribbed vaults were introduced after about 1120 (Petersberg near Erfurt); in Burgundy about 1135 in the porch of Cluny; in Anjou in 1145 (in the cathedral in Angers); in Italy not before 1150. The Italians did not create the ribbed vault by themselves; *e.g.,* early dates given by Kingsley Porter for the ribbed vaults in St. Ambrogio in Milan are erroneous.

III. EARLY GOTHIC

St. **Denis and Sens.**—Abbot Suger began the reconstruction of

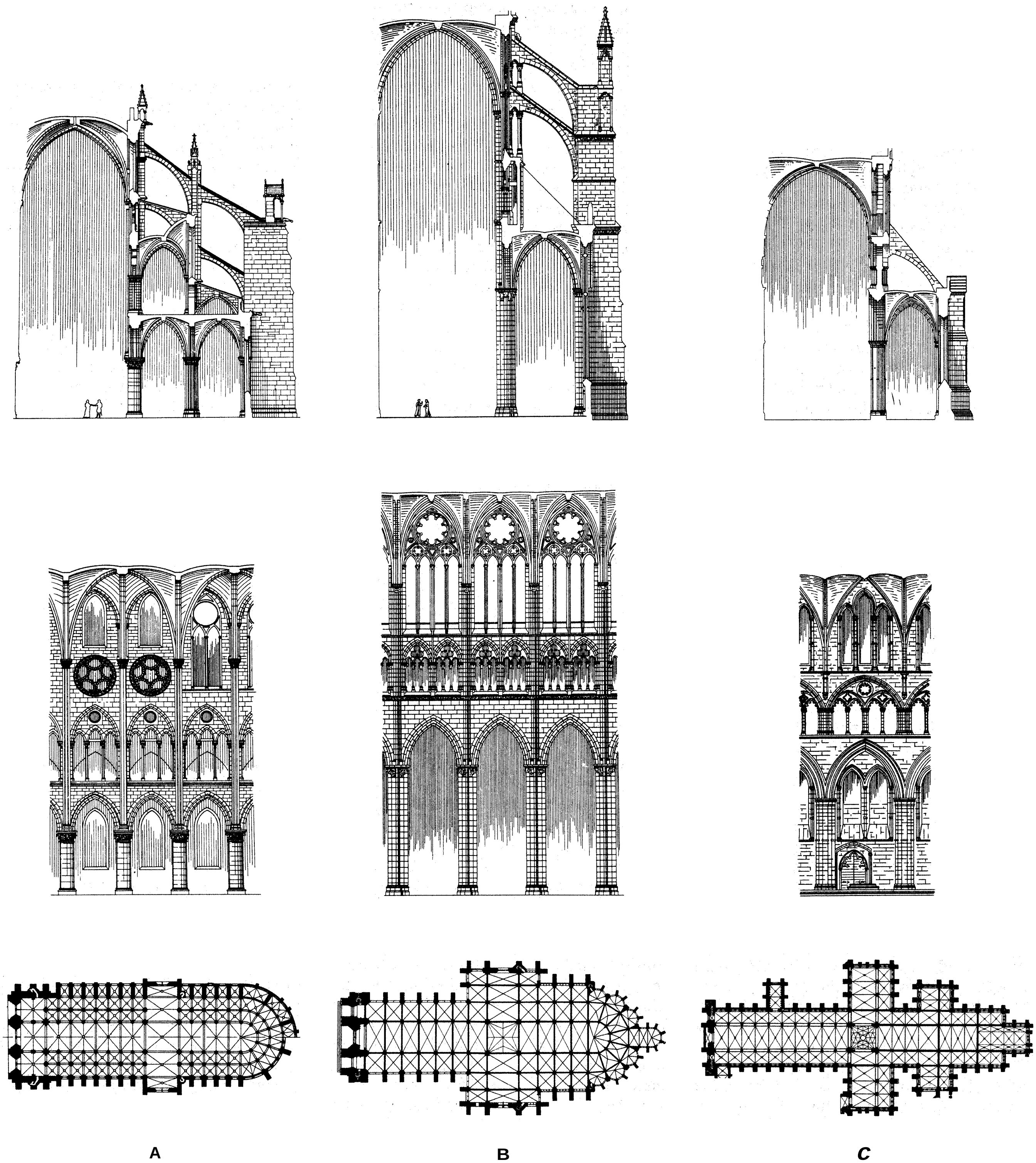
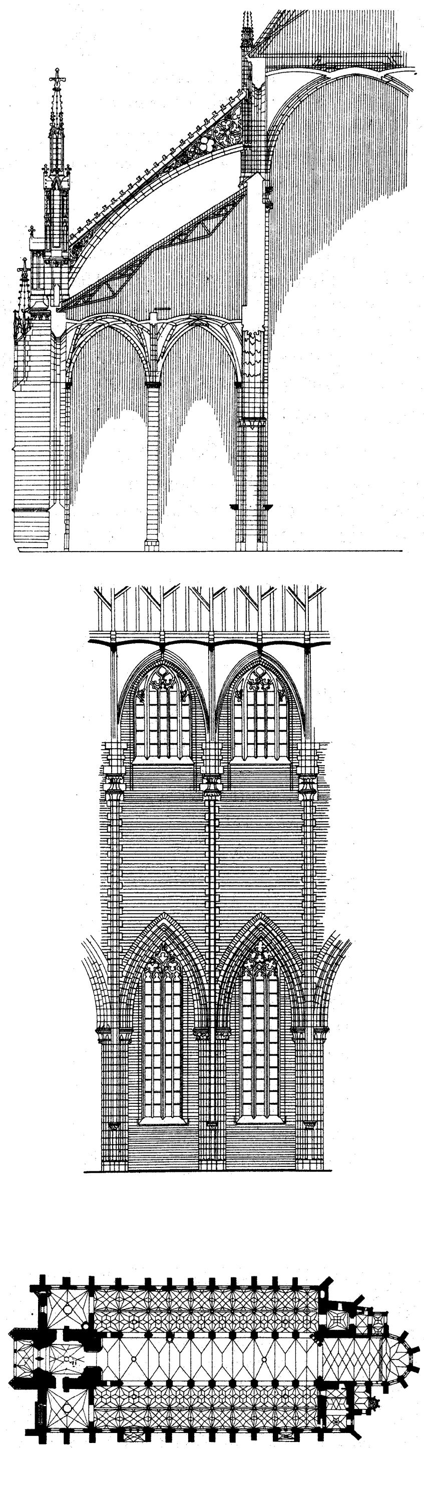


FIG. 1.— EXAMPLES OF GOTHIC CATHEDRALS. SHOWING HOW THE GROUND PLAN
(A) Notre Dame cathedral, Paris, 1163; (B) Amiens cathedral, 1220: (C) Salisbury cathedral, 1220;

his church, St. Denis (c. 1137), by building t o bays at the west of the old Carolingian nave and erecting the west facade. The architect was not yet able to solve all the problems presented by ribbed vaults. He set the springers of the ribs, even within the same bay, at different levels. but his design of the facade became the model for succeeding Gothic facades. The three portals, adorned with columns and statues, form a continuous zone; the oculus window in the centre above the window of the upper story, although still small, concentrates the whole composition; the towers, originally two, continue with their buttresses those of the lower parts. The choir was built from 1140 to 1144 by a second master. Its central part had to be replaced in 1231, but the ambulatory and the second ambulatory. a continuous row of chapels, are still intact. There all difficulties in the construction of ribbed vaults were overcome by using pointed arches. The diagonal ribs are half circles, but light and with round profiles. The capitals of the thin columns which separate and at the same time fuse the two ambulatories are chalice shaped, at least in the lower parts, so that the force seems to rise through them without interruption. (The advanced crocket capitals of the columns toward the chancel date from a restoration of about 1200.) Suger was proud of his church and especially of the stained glass in the chapels, which, he wrote, created a continuous light. Contemporary with this first truly Gothic architecture was the choir of Sens. Its interior elevation (arcade, triforium and clerestory) perhaps like the lost central part of St. Denis, except that Sens had alternating piers with sexpartite vaults. This vault form was repeated in Senlis and other churches.



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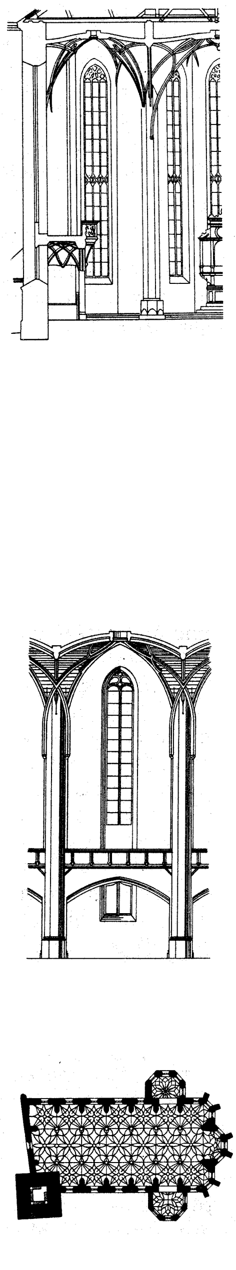
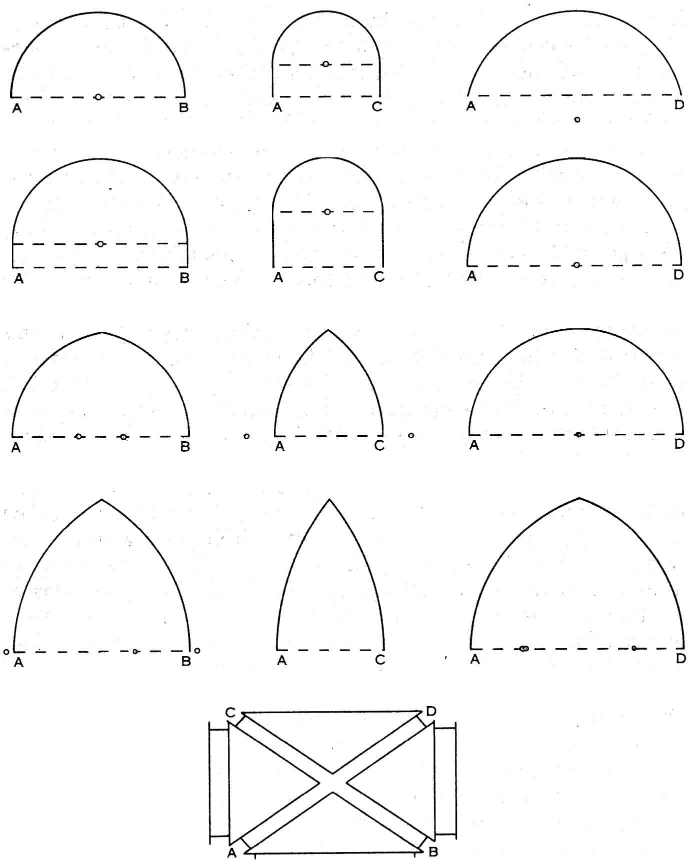


E

CORRESPONDS TO THE CROSS SECTION AND ELEVATION
(D) Ulm minster, 1377; (E) Annaberg parish church, 1499

Paris, **Laon** and **Noyon.**—The next main Early Gothic cathedrals of France were Noyon (after c. 1150), Laon (after *c.* 1160) and Paris (1163) Though all used alternating piers with the sexpartite vault, each has individual features. Noyon has transept arms with semicircular endings like apses. At Laon the arms of the transept have strong extensions and flat endings. Notre Dame at Paris (fig. 1A) has double aisles, the flat endings of its transept having been flush with the outer aisles before they were extended (*c.* 1250). A major problem at this time was how to form piers. In the main apse of Noyon the clustered shafts rise above the abaci of the column capitals; there, equal supports were required. In the nave the use, originally, of the sexpartite vault required the alternation of piers and columns. As seen from the west this variety gives the effect of richness, but lacks uniformity. The master of Laon, therefore, repeated in his choir and transepts the form of the supports used in the apse at Noyon. A second master continued it in the nave, after experimenting with thin, free columns around the main thick round piers at the uneven places. It was logical to raise five shafts above the abaci at the uneven places and three at the even places, corresponding to the number of ribs springing from each in sexpartite vaults. This, however, was not consistent with the uniform row of columns in the arcades. Therefore the master of Notre Dame at Paris mounted groups of three shafts above all round piers. In this he was progressive, but he retained the round form of the main apse, while the master of Laon, a few years before, had already introduced the polygonal apse (in its original stage). The straight sides of the polygon were better suited to the straight stained glass, the severies and the basic diagonality of the style. The diagonal principle also effected the development of crocket capitals. Romanesque capitals were designed to have the four sides seen separately and frontally. In early capitals each side had flat palmettes pressed between parallel surfaces; later the ornament was freed of this constraint and the leaves curled forward. Finally emphasis was placed on the diagonal leaf and, after about 1180, the crocket capital became a characteristic feature of the style. Relief also developed as a consequence of the rib. As the ribs protruded from the surface of the severies, so all members seem to protrude. Geometrically, it is equally correct to say that the shaft protrudes or that the wall recedes, but aesthetically it depends on whether there are enough points on the foremost plane to give an impression of a continuity from which the other forms recede, or whether these points are too few to maintain this continuity, in which case they seem to advance individually from the rear. From Noyon on the change of relief is notable. In the Romanesque style, relief emphasizes the distance between the object and the beholder; in the Gothic style the relief draws us to it.

Early Gothic produced a system for the church interior and slowly altered stylistically the exterior as well. This occurred automatically when windows and portals received pointed arches. Round arches lead the eye from one springing point over the crown to the other, emphasizing the horizontal diameter. Pointed arches, on the contrary, lead the eye from both sides at the same time up to the crown, emphasizing the vertical axis. The Gothic profiles



PARTLY AFTER JOHN BILSON

FIG. 2—SCHEMATIC SURVEY (IN FOUR STAGES) OF THE DEVELOPMENT OF RIB VAULTS

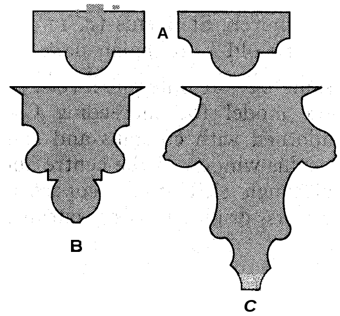
Letters on each stage correspond to the plan below. Small circles indicate the radius point of the arc

of windows and portals made the walls look thin.

The exterior also has the effect of attracting rather than repelling the beholder, especially at the portals. This effect was greatly enhanced by the introduction of flying buttresses at the choirs and naves, in France first at Notre Dame in Paris. The aesthetic impression given by these quarter-circle arches is that they counteract, in an upward direction, the thrust of the vault and roof. In reality they lead the thrust down to the buttresses at the walls of the aisles; but their chief stylistic function is to surround the clerestory with space which belongs to the building and to the limitless space beyond. The limits of the cathedral become fluid.

In the west façade of Laon (c. 1190) a monumental example of Gothic relief was created by placing the main part of the façade with its wheel window in such a way that it stood out from the plane of the towers, and the three portals in turn stood out from the main wall. The arches of the three entrances are crowned with Gothic gables, thrust down so that they touch the arches and both spaces penetrate each other. Pinnacles rise between the gables, and simpler ones rise above the dwarf gallery of the second floor. The towers end in octagons with diagonally advancing tabernacles. In Laon appear the first Gothic gargoyles. The master of Notre Dame at Paris (c. 1208) sought a harmonious balance between vertical and horizontal, but he also used Gothic relief. Characteristically, the socle of each portal jamb is fused into a single unit diagonal in direction.

Canterbury, Lincoln, **Wells.**—Although ribbed vaults were built in England after Durham (Winchester, 1107; the crypt of Gloucester cathedral, 1120), Early Gothic was not really introduced until 1174, when William of Sens rebuilt the choir of Canterbury cathedral using forms borrowed from the French. Even the introduction of a second transept was modeled after the French Romanesque abbey of Cluny, and the coloured columns are supposed to have been patterned after a church at Valenciennes no longer extant. Flying buttresses may have been used for the first time at Canterbury (now hidden). A specifically English form of Gothic began with Hugh's choir in Lincoln (1192). In England this phase is called Early English, but if the Gothic style is regarded as European, the general term Earlv Gothic should be used for both England and France, despite the national differences. As early as about 1180, when the cathedral at Wells was begun, the English horizontal fusion of the bays was used instead of the French vertical fusion. The architect of Lincoln invented a new pattern of ribbed vault with two bosses in each ridge rib and with extra ribs rising from the springing point to these bosses. These ribs were called tiercerons and lay on the surface of the severies. These vaults collapsed when the central tower fell in 1239 and were rebuilt in their original form. They were the forerunners of the star vaults in the nave of the same building. See EARLY ENGLISH PERIOD.



AFTER DEHIO AND BEZOLD

FIG. 3.—MAIN TYPES OF RIB PROFILES

(A) Early Gothic; (B) High Gothic Amiens cathedral; (C) Late Gothic, St. Severins, Paris

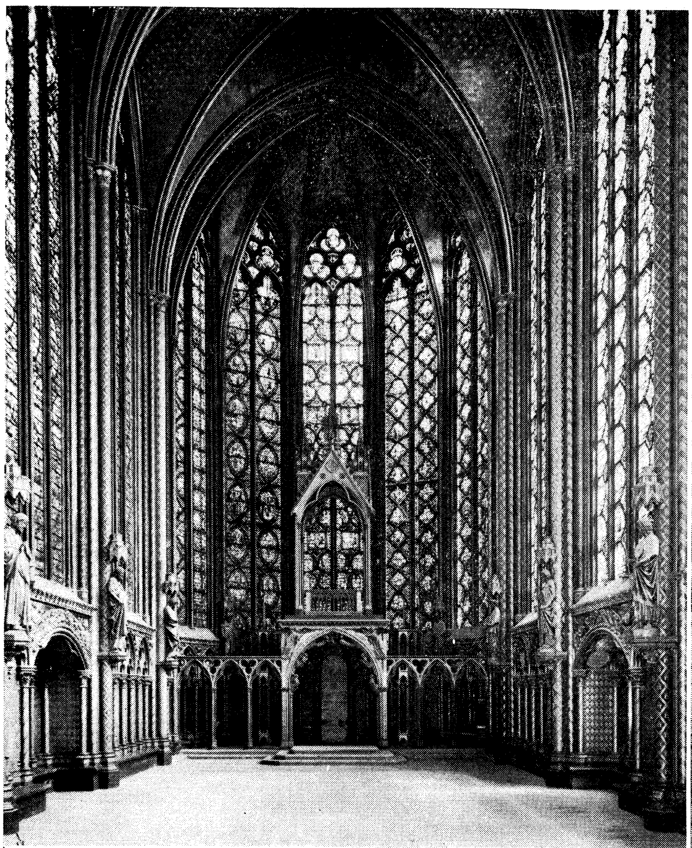
IV. HIGH GOTHIC

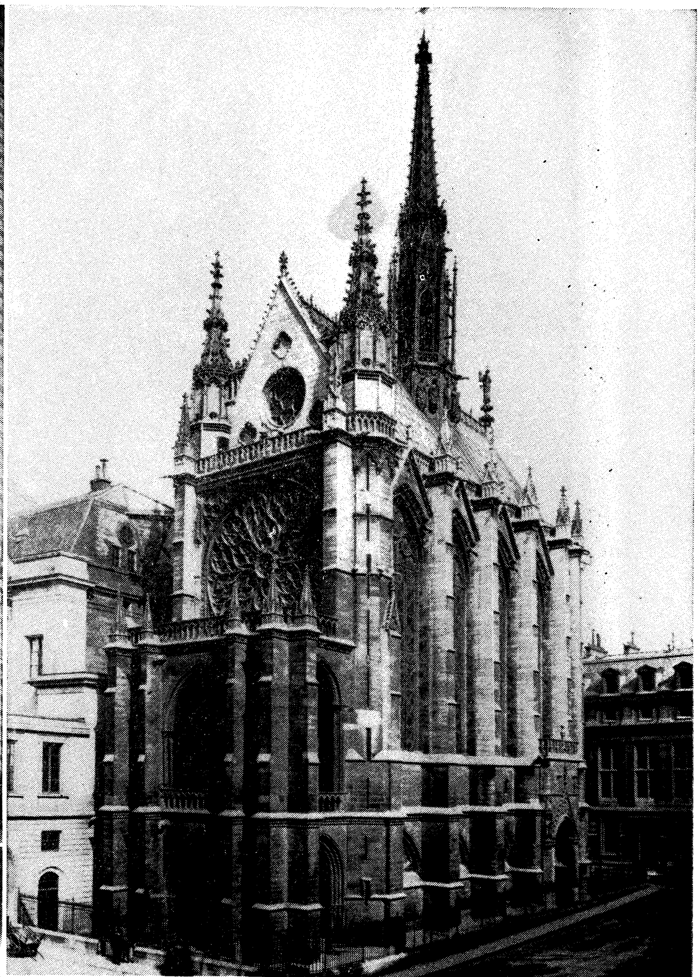
A. THE DEVELOPMENT OF THE INTERIOR

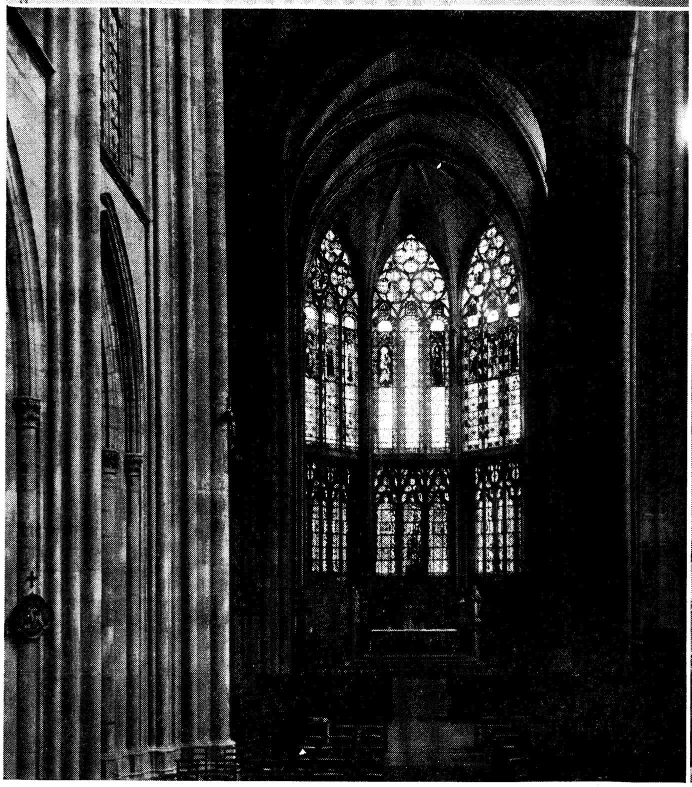
Chartres.—The system of flying buttresses used in Canterbury and Notre Dame in Paris made the already existing galleries seem superfluous, at least from the standpoint of statics. The master who built the cathedral of Chartres after the fire in 1194 omitted the galleries, heightened the aisles and lengthened the upper windows downward, returning to a three-story elevation like that at Sens. The flying buttresses also made it possible to broaden the windows of the clerestory and, as they were to be filled in with stained glass, it was found practical to design pairs of lancet windows, each of nearly the same breadth as those in the aisles. Each pair was surmounted by an oculus or circular window which harmonized with the round wall arches of the quadripartite ribbed vaults. The alternating system of piers used with sexpartite vaults therefore became unnecessary. It was retained, however, and round and octagonal piers alternate. They have shafts on each of four sides: and the shaft facing the nave supports five colonnettes (*i.e.*, small columns) rising to the transverse arches, the diagonal ribs and the wall arches. The triforium, which is at the same level as the roof of the aisles, is treated as a wall passage with rows of small arcades. This elevation improves on those of Laon and Paris; the entire building is simpler and more unified. The criticism that from the interior it is impossible to see that the flying buttresses maintain equilibrium, and that from the exterior it is impossible to understand why they are there, is not valid. Anyone acquainted with interior and exterior will recognize their organic unity. In Chartres most of the original stained glass has been preserved; more than a thousand representations of legends, parables, saints and donors are depicted in its warm colours and mystic light. Many subtle irregularities in the edifice are not immediately apparent, but are felt. They contribute to the exceptional impression of a living. sacred space. The unknown master opened the way for High Gothic. See CHARTRES.

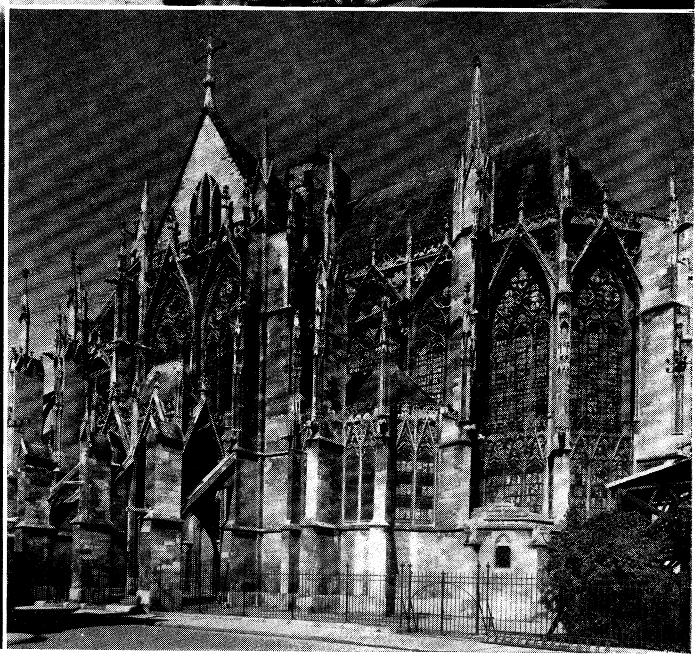
Bourges.—The cathedral of Bourges, built about 1200. has equal round piers. The vaults are sexpartite, like those at Notre Dame in Paris, but higher and differently proportioned. The cross section with double aisles was also copied from Paris. The transept is omitted; flying buttresses bridge both pairs of aisles in the upper part. Special flying buttresses for the lower aisles are evidence of this generation's enthusiasm for this specifically Gothic member.

Rouen.—In the cathedral of Rouen. begun after the fire in 1200. the shafts supporting the quadripartite vaults rise up to the vault with only a slight interruption at the springing line of the









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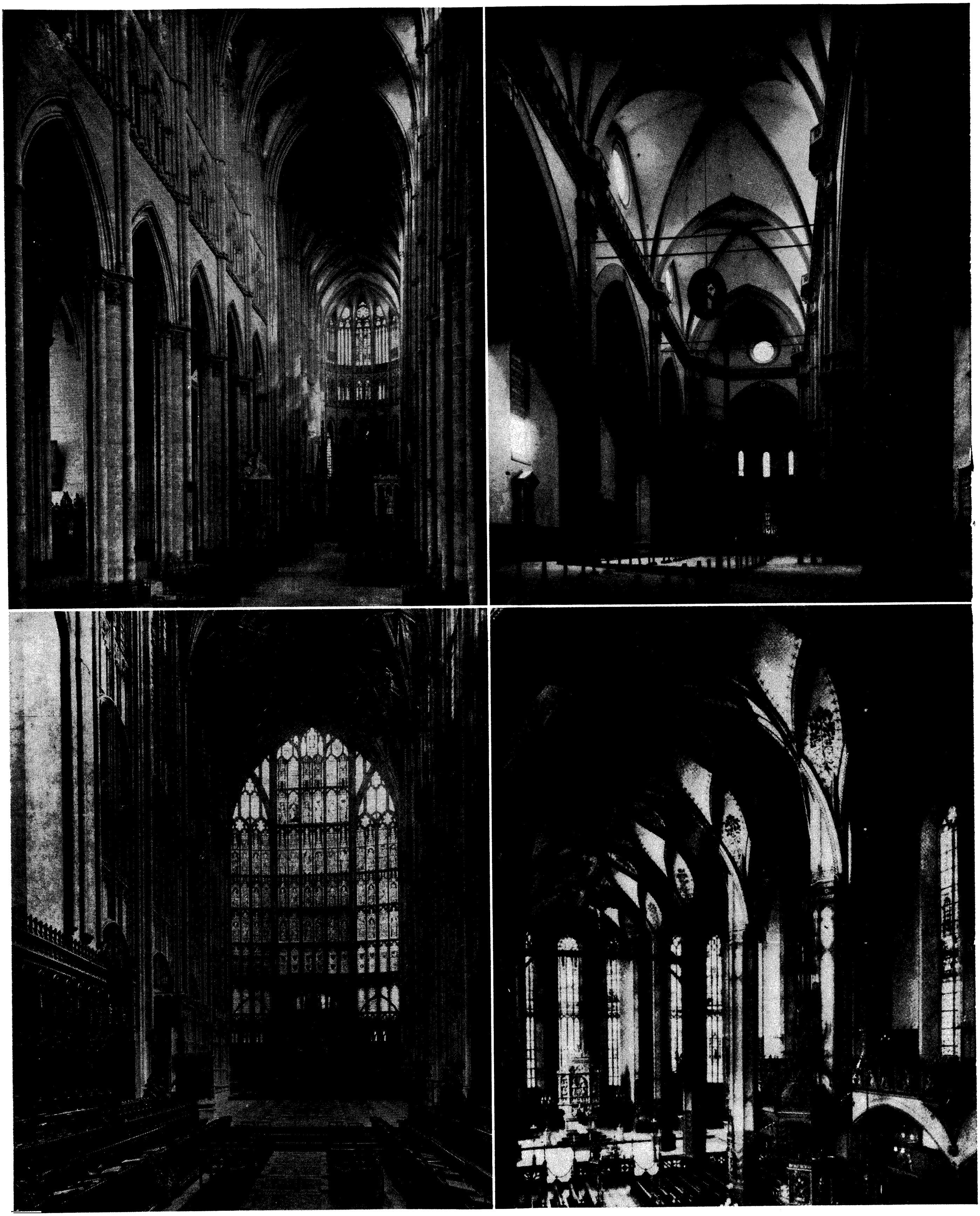
HIGH GOTHIC CHURCHES IN FRANCE

Top left: Interior of Ste. Chapelle, Paris, 1243–48. Architect unknown. A perfect High Gothic skeleton structure: structural members with tracery and stained glass windows have supplanted walls

Top right: Exterior of Ste. Chapelle showing the first Gothic gables overlapping windows and pinnacles overlapping the eaves. The tracery in the large circular window is Flamboyant style, c. 1485; the tower above the roof, 19th century

Bottom left: Interior of St. Urbain, Troyes, 1262. Architect probably Jean Langlois. Advanced High Gothic style with anticipation of Late Gothic in the ogee arches in the tracery

Bottom right: Exterior of St. Urbain



PHOTOGRAPHS (TOP LEFT) W. F. MANSELL, (TOP RIGHT) A. F. KERSTING, (BOTTOM RIGHT) A MEICHE, ANNABERG, GER.

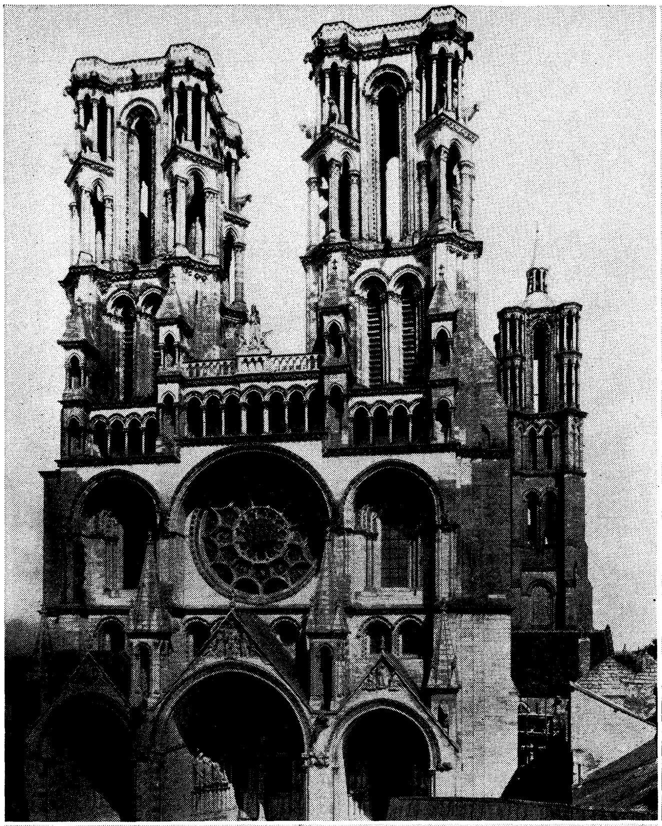
FRENCH, ITALIAN, ENGLISH AND GERMAN GOTHIC

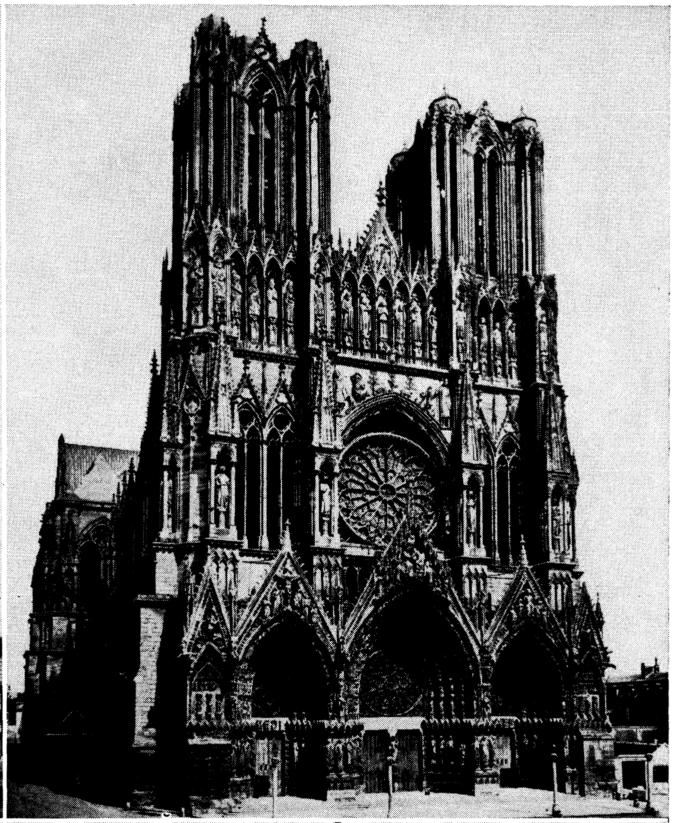
Top left: Interior of Amiens cathedral, France. High Gothic: nave 1220-36 by Robert de Luzarches; choir by Thomas and Renaud de Cormont. Regarded as the classic Gothic cathedral for its monumentality, verticalism and structural logic

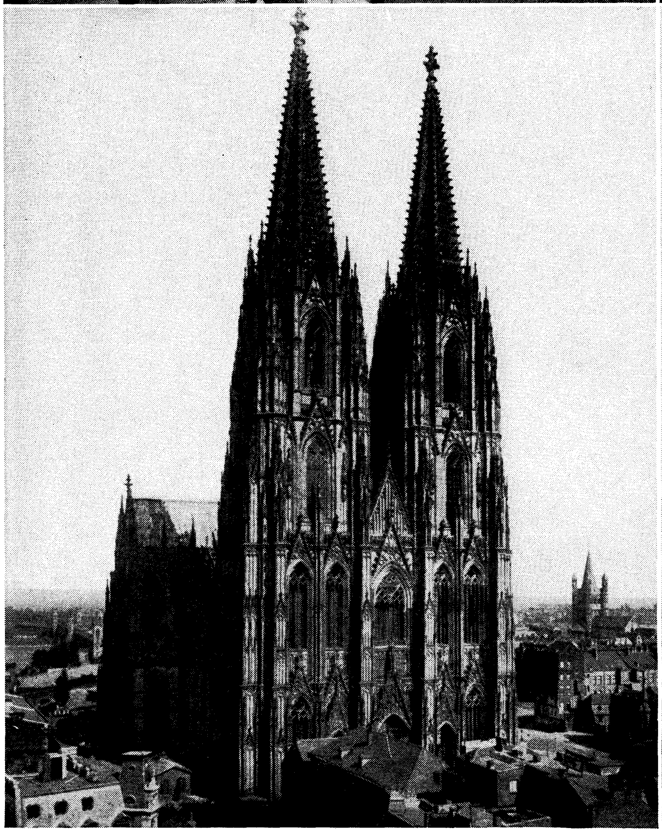
Top right: Interior of the cathedral of Florence, Italy. Italian version of Gothic style; built by Arnoifo di Cambio in 1294; continued by Francesco Talenti in 1355; cupola by Fiiippo Brunelleschi, 1420. The structure shows earthbound proportions and horizontalism stressed by the springing line

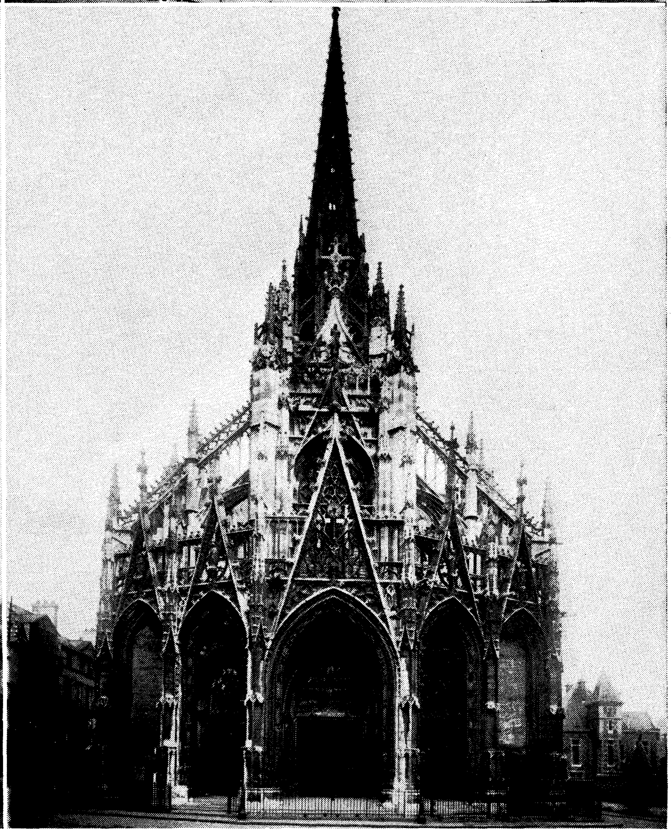
Bottom left: Chancel of Gloucester cathedral, England. Rebuilt after 1337, the beginning of the Rectilinear (or Perpendicular) style, one of the two English forms of Late Gothic

Bottom right: Interior of St. Anna, Annaberg, Saxony, Germany. Built in 1499. This hail-church, representing a final stage of German Late Gothic, shows a tendency toward the fusion of space and architectural members









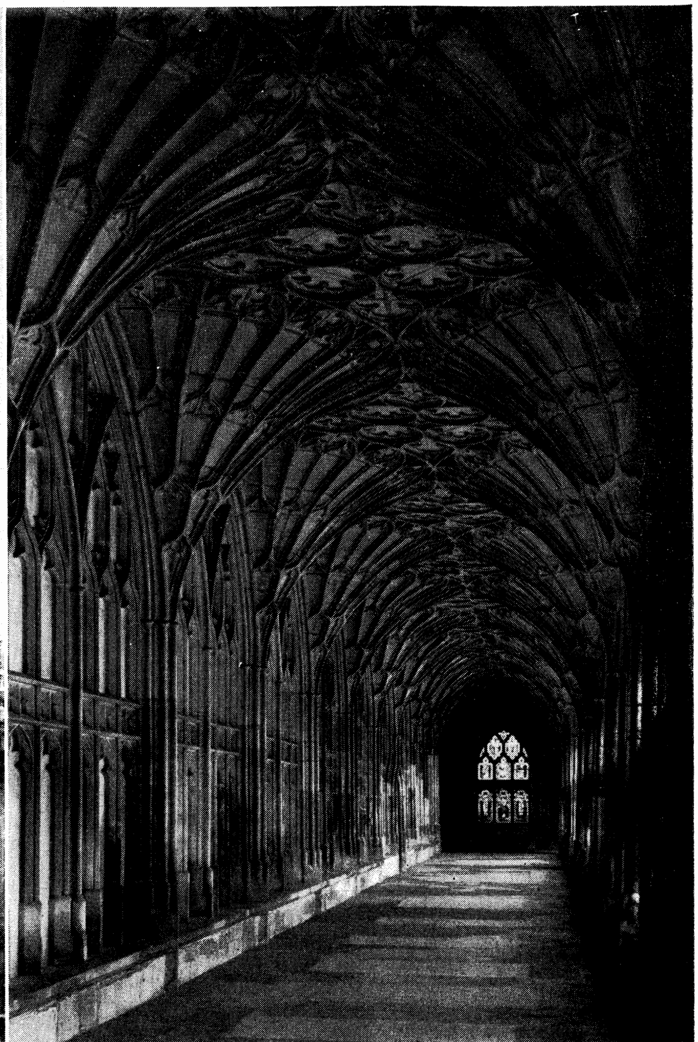
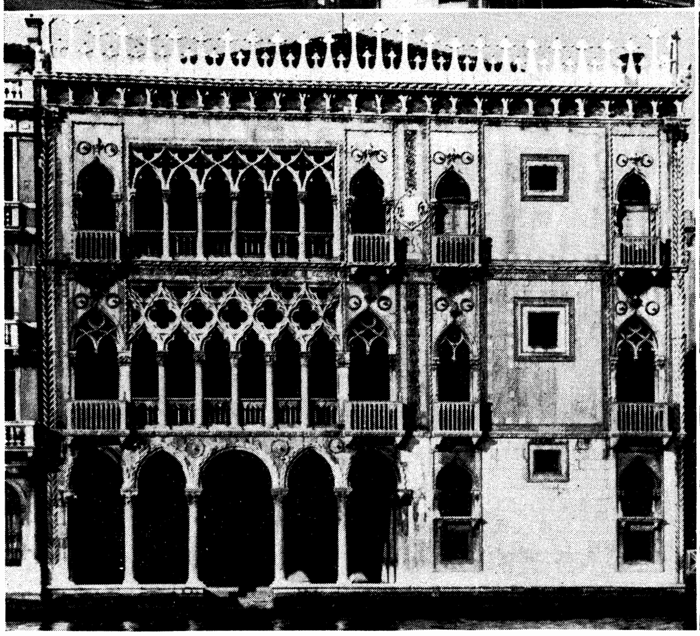
PHOTOGRAPHS, (TOP LEFT, BOTTOM RIGHT) ARCHIVES PHOTOGRAPHIQUES, PARIS, (TOP RIGHT, BOTTOM LEFT) EWING GALLOWAY

Top left: Laon cathedral, France, west front, c. 1190. Dissolution of the plane, actually three planes one before the other, all strongly perforated, creates contrasts of light and shadow. Gothic gables and pinnacles. Diagonally turned tabernacles on the towers. Early Gothic

Top right: Reirns cathedral, France, west front, c. 1240. Skeleton structure, tracery in the oculus as in the windows. Richly decorated with architectural members and High Gothic sculpture. High Gothic

Bottom left: Cologne cathedral, Germany, west front, begun c. 1300. The towers finished according to the original design 1842–80. Repetition of the form of tracery windows with Gothic gables as first introduced in the Ste.-Chapelle, Paris. The spires are dissolved into tracery. High Gothic

Bottom right: St. Maclou, Rouen. France, 1434; west fapade c. 1500. The five gables copied from Reims but translated into Late Gothic Flamboyant style protruding into space in the form of a polygon. The flying buttresses become part of the fapade. Late Gothic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GOTHIC ARCHITECTURE OF THE 14TH AND 15TH CENTURIES

Top left: Town hall, Louvain, Belgium, 1448. Late Gothic. Gothic proportions combined with emphasis on horizontal lines. Profusely decorated with statues between the windows and on the turrets

Top right: One wing of the cloister of Gloucester cathedral, England, 1351. English Late Gothic. The first use of fan-vaults to fuse the bays. All ribs are of the same curve and profile; curvilinear tracery is spread between all ribs

Bottom left: Ca d'Oro, Venice, Italy, 1421, by Giovanni and Bartolomec Buon. Asymmetrical, employing a combination of different forms of arches and tracery. Emphasis on texture instead of structure is characteristic of Late Gothic

Bottom right: Wladislav hall, Hradčany castle. Prague, Czech., 1493–1502, by Benedict Ried. The hall has doubly curved ribs similar to those of St. Anna, Annaberg, Germany arcade. Galleries were planned, but omitted. However, their openings were kept and in the aisles a group of thin colonnettes was arranged on the level of the omitted vaults, a unique and extremely attractive invention, but by no means classic.

Reims.—The cathedral of Reims (1210) continued the tradition of Chartres. The master of Reims, probably Jean d'Orbais, clarified the form of the piers. They are all round with single shafts in the four main directions. The abaci of the shafts join the abacus of the main column and give the impression that the entire pier is turned 45°, corresponding to the ribs. The ribs are pointed; the round arch was thereby finally driven from its last stronghold. The most important new detail was Gothic tracery. Each clerestory window at Chartres was a group of three separate units, one juxtaposed with the other. The master of Reims transformed them into a single unit, designing first the outer contour as a pointed arch, then dividing the whole by a central colonnette supporting two pointed arches and an oculus between them. Not only did the principle of division replace that of addition, but the profiles were fused at the points where the arches and oculus touched. This form was to be the germ of countless variations (fig. 4). Reims, the church of the coronation of the French kings, is majestic in all its parts. All members are strong; the ornaments are naturalistic but stylized foliage, and the exterior is adorned with exquisite sculpture.

Amiens and St. Denis.—The master of the nave of Amiens cathedral, 1220, excelled the design of Reims. All members seem to have attained an ultimate correctness: the piers, in their relation to the arcades and the shafts of the vault; the tracery in the triforium; and, by means of the common shafts, the fusion of the triforium with the clerestory. Again the diagonal rib has the form of a half circle, perhaps in order not to exaggerate the enormous height. The nave of Amiens, 1220–36, has been praised as the culmination of Gothic style (fig. 1B).

There are scholars who claim that the decadence had already begun with the choir of Amiens, but this is a misconception. Later architects thought of themselves as continuing the stylistic trend that led to the nave of Amiens. Pierre de Montereau, rebuilding the nave of St. Denis (in 1231), continued the trend of Amiens by more closely combining the triforium with the clerestory and by flattening the roof of the aisles, so that the triforium could be lightened with stained glass. This reduced the elevation of the nave to only two stories, as had been done before, though in another way, in the festive choir of Le Mans (1218).

Salisbury.—Contemporaneous with Amiens was the cathedral of Salisbury (begun 1220), representative of classic English horizontalism. The shafts of the vaults begin between the arches of the triforium. The flow of space is strengthened by the specifically English round form of all abaci (without decoration). There is no French tracery, nor flying buttress. (See fig. 1C.)

Sainte **Chapelle.**—The Sainte Chapelle (1243–48), in Paris, rising above an undercroft. has, like all chapels of the great cathedrals, only one story. The windows dissolve the walls completely. The building consists of structural groups of shafts, and the grill formed by the tracery and of the light passing through the stained glass. This chapel, built to house the crown of thorns and other relics of Christ's martyrdom and to serve as the private room for religious contemplation of Louis IX (St. Louis), is as classically Gothic as the nave of Amiens. On the exterior, Gothic gables. which before were combined only with portals, crown the tracery windows. They overlap the eaves of the high roof and, together with the accompanying pinnacles. weaken the horizontal line. This combination of tracery, Gothic relief of the jambs and vertical radiation into the air became a pattern usable anywhere for openings as well as for blind forms.

Troyes.—The most progressive work of its generation was a church of comparatively small size, St. Urbain in Troyes (1262). The choir has no ambulatory and a single chapel on each side parallel to the chancel. A triforium was not required because the roofs of the chapels are saddle roofs, but the apse received a pseudo triforium as continuation of the chapel windows, uhich have different tracery patterns inside and out, both being visible together. These complexities make the most of forms developed earlier. The structural members are so reduced in breadth as almost to suggest metalwork. The capitals are omitted partly to produce a continuous upward flow, an innovation that appeared in the southern portal of Notre Dame in Paris shortly before.

Rouen.—The French High Gothic style was perfectly realized in monumental form in that portion of St. Ouen at Rouen that followed the first design of 1318. There we feel that all problems were solved and that all forms are self-evident from the standpoint of Gothic style. The perfection of style represented in this masterpiece has been called doctrinaire, which, however, is a misinterpretation.

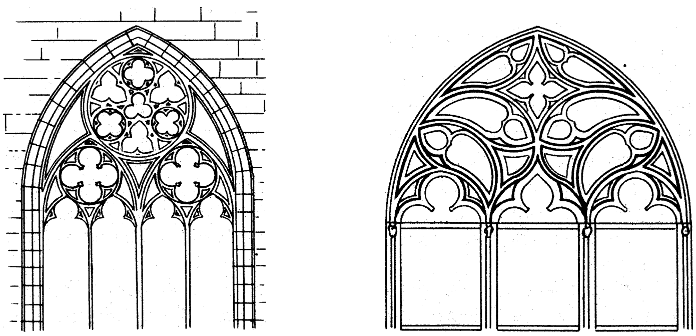
Other European Cathedrals.—The nave of Strasbourg minster (begun c. 1245) was based on that of St. Denis. U'estminster abbey (1245), in London, was influenced by common features of French Gothic rather than a single model. Strasbourg and Cologne were works of Germans, Westminster abbey the work of an Englishman, all of them able to continue the French tradition with deep understanding. Even the angel choir of Lincoln cathedral (1255) has a big French tracery window at the straight east end, although otherwise the elevation of the chancel follows pure English tradition and the vaults with ridge ribs and tiercerons emphasize the horizontal unity of the space. Churches of French High Gothic style elsewhere are: in Germany, Our Lady's church at Trier (1227), St. Elizabeth at Marburg (1235) and the cathedral at Halberstadt (1239); in Spain, the cathedral of Toledo (*c.* 1225); in Belgium, St. Gudula at Brussels (c. 1225); and in the Netherlands, the cathedral of Utrecht (1254).

B. The Development of the Exterior

In the faqade of Reims cathedral (c. 1240), elements of the façade of Laon were translated in a highly imaginative fashion into High Gothic. The entire structure is a transparent skeleton of gables, pinnacles and tracery. The tracery in the big oculus window transformed the wheel into the rose, as was first done in the transepts of St. Denis (1231). It was repeated with further refinements in the rose windows of the transept of Notre Dame (after c. 1250) and in St. Nazaire at Carcassonne (c. 1320).

The design of the west faqade of Strasbourg cathedral (1277), by Master Erwin, shows the autonomy of tracery, as does the splendid composition of the *portail* des libraires, the entrance of the north transept of Rouen cathedral (c. 1280). In both cases the gable of the portal is perforated and grows up freely before the parapet, the row of tracery and the tight pattern of the rose. In Strasbourg the tracery is, continuous, forming a grill before the faqade. Although it seems unreasonable to perforate the roof of a tower with tracery, this did occur in the stylistic development. It is to be seen in Freiburg im Breisgau (1310), and again later in the design for the towers of Cologne (executed in 1848 after the original .plans drawn during the Gothic period). The preponderance of tracery led also to such richly decorated works as the southern side of St. Catherine in Oppenheim (1317).

Tracery is one of the most striking details with which to evaluate the various phases of the Gothic style. The first form of tracery (*i.e.,* two pointed arches and a circle between them at the top) was followed by the forms of three and more lights with



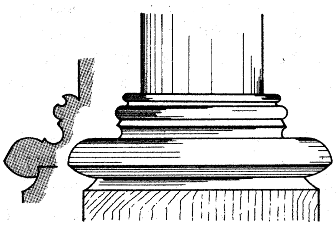
A B

AFTER DEHIO-BEZOLD AND AFTER L BEHLING

FIG. 4.— TRACERIES

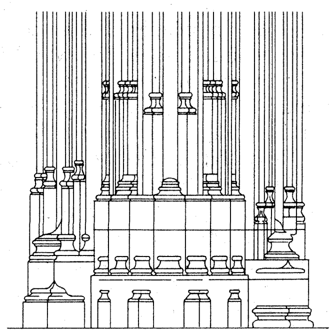
(A) High Gothic, Herford, Germany, and (B) Late Gothic, Strasbourg, France three and more circles (fig. 4). In St. Nicaise in Reims (begun 1231; sold as building material, 1798) cusps were introduced; these were small, pointed members growing out of the profiles of the pointed arches. The transfer of tracery to the big round windows led Frenchmen to call their phase of High Gothic the Rayonnant style (*q.v.*). In the second half of the 13th century the circles were replaced by spherical triangles, quadrangles, etc. These were polygons consisting of three or more curved sides. This form appears for the first time in the small triangular windows of the undercroft in Sainte Chapelle and soon thereafter in Westminster abbey and elsewhere. Later it supplanted all circles in the traceries. It has rightly been interpreted as an attempt to destroy the circles as the last vestige of the Romanesque. The spherical polygon is a continuous series of pointed arches around a centre. In England big rose windows are exceptions (Durham, eastern transept, 1235), and rectangular windows with pointed arches or groups of lancet windows are the rule. In Germany, too, long windows were sometimes preferred; for example, in the faqade of St. Elizabeth in Marburg (c. 1275). In France the big oculus remained an almost indispensable means of achieving aesthetic balance in the composition. Yet it was in France that the slenderness of proportions became exaggerated. The limit was reached in the choir of Beauvais cathedral (1247), which collapsed in 1284. (See TRACERY; ORNAMENT, ARCHITECTURAL.)

Originating in the midst of the development of this style, the Gothic gable is a grandchild, so to speak, of the ribbed vault. This gable can make any building Gothic, even one with a flat ceiling or an open timber roof. It is to be seen in abundance in the choir at Amiens cathedral (1256–69) and in Cologne cathedral (1248), which was designed by a master who knew the plans for Amiens before the choir was continued. (See GABLE; SPIRE.)



AFTER DEHIO AND BEZOLD

FIG. 5.— PLINTHOF HIGH GOTHIC Cross section is shown at left



AFTER DEHIO AND BEZOLD

FIG. 6.—LATE GOTHIC PLINTH OF A PILLAR. TOLEDO CATHEDRAL, SPAIN

Meanwhile the style spread through Europe. The Cistercians, often said to have brought Gothic to all countries, were slow to accept the style. Its rich detail was antipathetic to their asceticism. They replaced the triforium with closed walls. although the windows, with their Gothic relief, created the impression of thinness and gave the walls qualities of Gothic lightness and tension.

Italy was hesitant in adopting Gothic forms. There, wall surfaces were used extensively for frescoes as in Assisi (1228) and in Sta. Croce in Florence (1295). The latter even had an open timber roof like many other churches of the mendicant orders.

V. LATE GOTHIC

In Arniens ribs received a sharp edge to emphasize their middle line. Later architects developed pear-shaped profiles for ribs, shafts and mullions of tracery. Those lines consisting of a convex part continued by a concave one were then used as ogee arches in traceries at places where the pointed arches of the lights continued directly into adjoining circles. They appeared first, perhaps, in St. Urbain in Troyes, 1262, and not much later in Heiligenkreuz in Austria.

England. — In England the ogee arches isolated from tracery were used in the Eleanor crosses after 1292. They became the prevailing form of the Curvilinear style. The upper part of the ogee arch was bent forward to form the nodding arches. The most splendid example of this three-dimensionality is the row of niches in the Lady chapel in Ely (after 1321). In traceries the concave-convex line could be substituted for all concave figures of the High Gothic style. Such tracery is fully developed in the reredos of Beverley minster (1334). In the big western window of York cathedral (1338) it suggests growing leaves.

In the Curvilinear style, soft "textile" lines replaced the rigid structural curves of the earlier style, and in tracery the emphasis was upon the creation of complete continuity. These modifications also affected the vaults. In the chancel of Exeter cathedral (c. 1300) the diagonal ribs, together with the ridge rib and the tiercerons, although still suggesting structure, formed a continuous pattern without emphasis upon the transverse arches marking the limits of the bays. There, however, the basic form was still the quadripartite vault; the cone of the fan vault had not yet appeared. An approach to the latter was the vault in the chapter house in Wells (c. 1300), where ribs of different function have the same profile and the central portion looks like a complete fan vault, except that it rests on the central pier and is continued by severies to the walls. The vaults in the choir of Wells (c. 1329), Tewkesbury (c. 1335) and Gloucester (after 1337) have the basic form of barrel vaults. Fragmentary ribs (liernes), rising like branches from diagonal ribs or from tiercerons, counteract the feeling of structure to give the impression of textile nets.

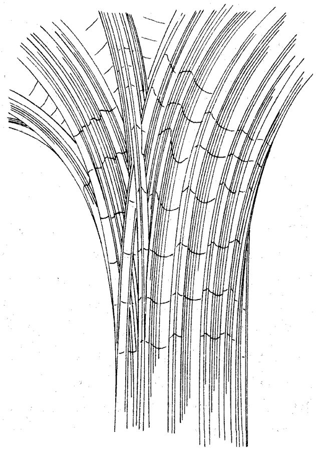
In London the so-called court school, in building St. Stephen (1292, burned 1834), created the Rectilinear (Perpendicular) style which, with its rigid vertical and horizontal lines, was the opposite of the Curvilinear (Decorated). Yet these grill-like patterns also were applied in such a way as to create continuity and the feeling of infinite expansibility. The rows of vertical mullions climbing up the extrados of the pointed arch were not static anymore. The spandrels filled with these fragmentary forms were seemingly cut by the arch. The most impressive work in this style was the choir of Gloucester cathedral, where the Late Gothic decorative grill stands in front of the original Romanesque structure. In the transept the vertical lines are crossed by the oblique lines of enormous buttresses. In Gloucester true fan vaults were used in the cloister for the first time (1351). They consist of concave, inverted cones. Halves of these cones rise on each side of the gallery. All the ribs are equal; the space between them is filled with Curvilinear tracery. The separation of bays is practically eliminated, and there is a continuous flow of space.

See DECORATED PERIOD; PERPENDICULAR PERIOD.

Germany. — In Germany the Rectilinear form was little used, although a parallel can be seen in the west faqade of Strasbourg (1277). In High Gothic times hall churches were preferred and there almost exclusively used after 1330. The tendency toward spatial continuity altered the form of the piers; *e.g.*, in the Wiesenkirche in Soest (1331). The shafts mere combined with the pier so that its core was scarcely recognizable; capitals were omitted; and the ribs continued the shafts with the same profile. The leading architect of Germany was Peter Parler who, at the age of 23, was called to Prague, the capital of the empire at the time of Charles IV, to continue the cathedral. He built complicated vaults with hanging bosses and ribs rising free through the space. A hanging boss is, of course, the opposite of structural, and ribs that do not bear severies are a denial of High Gothic ideals. The doctrine that High Gothic represents the apogee of Gothic and Late Gothic its decadent phase should be rejected. Late Gothic is actually a quite consistent culmination of the entire development of Gothic style. Parler seems to have been influenced by English Late Gothic, as free ribs were used in the screen in Southwell (c. 1325). The vault in Prague was the first real net vault on the continent. Parler was also the first to use an even number of sides for the polygon of a choir in Kuttenberg (1360). This meant that there was no longer a wall frontal to the axis, and that diagonality prevailed.

Later architects transferred the form of the hall to the choirs. The ambulatory and the chapels were then drawn into the unified flow of the entire space. An early work of this kind was the choir of Schwabisch Gmiind (1351); a late one was that of St. Lorenz in Nuremberg (1445); and a still later one was Our Lady's church in Munich (1468). Many of these churches, built on the one-story system, had extraordinarily elongated windows which also dominated the exterior, together with the enormous roofs covering both nave and aisles. In German territories the translation of High into Late Gothic was also accomplished in the tower designs. Outstanding works were the towers of St. Stephen in Vienna (after 1359) and of Strasbourg minster (its octagon. 1400; its spire finished in 1439). The tower in Vienna rises with continuously diminishing extension; the stories are not sharply separated and are pushed upward like the parts of a telescope. The tower of Strasbourg has a spire dissolved in wreaths of small tabernacles containing staircases leading up to the highest point.

France. — In France the development was retarded by the Hundred Years' War. The English Curvilinear was adopted in Amiens in the chapel of Bishop La Grange (1373). The traditional verticalism applied to the tracery of the Curvilinear transformed its character into upward flaming forms, hence the name Flamboyant style (q.v.). It changed the rose windows into explosive patterns such as that of Lyons cathedral (1392) or of the Sainte Chapelle, Paris (148j). One of the most impressive works in this style is the upper part of the facade of Rouen cathedral (c. 1490).



AFTER DEHIO AND BEZOLD

FIG 7 — LATE GOTHIC RIBS WITH INTERPENETRATIONS. ST.

National Variations.—While in High Gothic times French rationality and English imagination created two leading variants of Gothic, in Late Gothic times other nations created their own versions. Materialists emphasizedthe inheritedand supposedly permanent qualities;idealists emphasized the spiritual tradition of acquired qualities. Of course both work together, but it is easier to prove the consistency of the tradition from master to pupil. Some regional variations of Gothic are obviously dependent also on the material available. Regions which had no stone suitable for building used bricks and adapted Gothic forms to this material; e.g., in northeastern Germany. Bavaria, southern France and Holland. Specifically national talents are clearly evident in the Late Gothic churches of Spain and Portugal. The cathedral of Gerona (1417), with its vault 73 ft. in width, is the widest in Gothic architecture. Many Spanish churches are notable for their extraordinary dimensions. Seville, 1412, is the largest. Yet Spanish architecture is also individual in its decorative detail, based in part on Moorish ornamentation. In Portugal the church of Belém (c. 1500) is unique by reason of the west-east extension of the transept and its extremely rich cloister.

As Late Gothic in Spain shows the influence of Islamic architecture, so Italian Gothic is influenced by classical models. That the proportions of Roman buildings were retained is best shown by comparing the cathedral of Florence (1296) with that of Amiens. Florence, however, should not be criticized on this basis. The way from the majestic nave to the crossing with its cupola must rather be seen as a symbol of the way to salvation through endeavour. The totally diiferent cathedral of Milan, 1387, must also be judged on its own merits.

Common Features. — Obvious as are the national differences, it must be recognized that there mas a trend common to all countries. Rotating foliage on capitals appeared in the nave of Wells cathedral (c. 1250) and in the chapter house in Southwell (before 1300). It was followed by rotating patterns in tracery. by spiral columns and by vaults with ribs in the form of three-dimensional double curves. These forms were found in Spain, Germany and even in Italy. Vasari criticized spiral columns because they cannot carry any weight. We understand today that all these forms were based on the desire to produce endless movement, continuity, multiplicity of views, recession and, insofar as possible, the substitution of texture for structure

Culminating features of the style were found in many countries: the Laurentius portal of Strasbourg cathedral (1495); the church of Xnnaberg in Saxony (1499), where complicated, curved ribs and piers with concave sides pushed through the vault (fig. 1 E); Palencia cathedral in Spain (after 1500); the totally perforated Flamboyant porch of St. Maclou in Rouen (c. 1500); the Henry VII chapel in Westminster (1500), with hanging fan vaults. In all these cases the aim was not to display skill and ingenuity. but to carry to its extreme the principle of division, introduced by the first ribs. Strangely enough, this led to those double curved lines, as at Annaberg. that the architect of Durham choir was trying to avoid. By the time the Gothic style was superseded by the Renaissance style its possibilities had been practically exhausted by the various nations.

Ultimately the form of the whole and the detail was determined by the individual masters who were influenced not only by their patrons and national traditions, but also by the ideas of their colleagues. More than a thousand names of masons have come down to us but, apart from their work, we know little about them. We know more about the organization of the guilds.

VI. SECULAR ARCHITECTURE OF THE GOTHIC PERIOD

The same masters who built the cathedrals also made the designs for their cloisters like Gloucester and for monasteries like Mont St. Michel (q v.) Insofar as the ribbed vault in all its stages, tracery. Gothic profiles, etc.. was used in secular buildings, such buildings may be included in a survey of the history of Gothic style. But whether the monasteries, castles, town halls and private houses themselves may be called Gothic is another question. The same question may be raised in regard to the fortifications of cities and to the many types of parish churches in every country. Gothic is essentially ecclesiastical, and we would do better to speak of secular architecture of the Gothic period rather than of secular Gothic architecture. Yet the palace of the archbishop in Sens (1240) has big High Gothic windows. with tracery and buttresses adorned nith tabernacles and crowned by pinnacles. In the facade of the Palazzo Vecchio in Florence (1299), on the other hand, although it too has Gothic windows, the heaviness of the closed malls prevails. The ducal palace in Venice shows in its two lower stories the Gothic dissolution of the wall by the arrangement of open galleries combined with Late Gothic tracery in the second floor, but the wall rising above is flat and adorned with a definitely "textile" pattern. This facade was built about 1300–1424. From this mixture of principles of structure and texture the composition of the palace Ca d'Oro in Venice (1421) is derived. The palace of the popes in Avignon, 1334, shows closed walls and contains occasional Gothic details. Late Gothic style is felt strongly in the Flamboyant decoration of the *salle des pas perdus* in the palace of the dukes in Poitiers (1393); in the picturesque private house of Jacques Coeur in Bourges (c. 1430); and the richly decorated exterior of the council house in Löwen (1447). The last phase may be represented by the Albrechtsburg in Meissen (1471), with its many varieties of Late Gothic vaults and its picturesque irregularity, the Wladislav hall in the castle in Prague, 1493; and the Palais de Justice in Rouen. aith its big rectangular windows which are nearly Renaissance in character, but with free tracery rising before the dormer windows (c. 1500).

See also CASTLE; HALL; HALF-TIMBER WORK.

VII. THE CONCEPT OF GOTHIC

The sculpture and painting. including stained glass (q.v.), of the Gothic period may properly be called Gothic. It must not be overlooked that Gothic style was already at its height when the fine arts began to be assimilated into the building ahich they were to adorn. The concept of Gothic has been so enlarged that today one speaks of Gothic music. Gothic liturgy, Gothic metaphysics and even of the Gothic man. Since the middle of the 19th century scholars have debated the question of whether the Gothic spirit manifested itself in all fields; one art historian demanded derisively to be shown the transmission belts between them. Yet there is no need to look for transmission belts if one understands that all art is form as symbol of the Zeitgeist. We saw that the first ribs disturbed the formal unity of Romanesque style because they introduced the principle of division. But they were accepted and their possibilities were exploited up to the latest Gothic because the culture tended to accept the belief that the individual is only a part of a transcendent whole, a fragment of the universe and of infinity. The unity of form and meaning resulted primarily from the profound desire of men to be united in themselves, to have style themselves. In this sense one might use the term "Gothic man."

VIII. THE SURVIVAL AND REVIVAL OF GOTHIC ARCHITECTURE

It is understandable why the Italian "Renaissance man" rejected Gothic; why in the north traditional Gothic was mixed with Renaissance; *e.g.,* in St. Pierre in Caen (1518) and St. Eustache in Paris (1532). The so-called German Renaissance may be seen as an expression of the desire to bridge the irreconcilable differences of Reformation and Counter Reformation. Gothic remained a specific Catholic style and lost its original meaning until romanticism began to revive Gothic forms. An early revival occurred in England at Strawberry Hill (begun 1750), where Horace Walpole built a "Gothic castle." Gothic revival works were built quickly with cheap materials. A. W. N. Pugin (*q.v.*) became a Catholic, believing this to be the prerequisite for the revival of Gothic. With Charles Barry he built the Houses of Parliament in London (1836). K. F. Schinkel had built the neo-Gothic Werder Kirche in Berlin (1821) without espousing Catholicism. The spiritual background had changed. Viollet-le-Duc (*q.v.*) restored French Gothic buildings and wrote theoretical and historical treatises. The 19th century revived all styles in succession. Heinrich von Ferstel in Vienna built the Votive church (1856) in French High Gothic and the university (1873) in Renaissance. The occasional use of Gothic was a manifestation of generations imbued with the idea of historism. The 20th century created a new style based on the exploitation of concrete, steel and glass, expressing the fundamentally different modern view of society and existence. There is still a demand for the Gothic style for churches and colleges which feel themselves rooted in the medieval tradition. In 1928 Princeton university finished a Gothic chapel and in 1948 adorned its most modern library with details derived from Gothic models. The Gothic spirit is remote from contemporary life. To love and appreciate Gothic in its original masterpieces the history of the forms must be understood to be symbolic of the endeavour to create sacred places for the worship of God. See MODERN ARCHITECTURE.

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GOTHIC ART is the climactic medieval style of western Europe an art that followed Romanesque art and preceded Renaissance art (*qq.v.*). The Gothic synthesis was first achieved in the fle de France (an area roughly within a roo-mi. radius of Paris), then spread outward to England, Germany, Italy and Spain. Originating about the middle of the 12th century, the style ran a course from an early linear, straightforward and sinuous stage, during which the major architectural and aesthetic problems were solved, to a Rayonnant style (*q.v.*) in the 13th and 14th centuries, and finally to a later flamboyant style (*q.v.*) in the 15th and 16th centuries, full of complicated tracery, lavish detail and elaborate filigree designs. While continental and American historians usually refer to these aspects as early, high and late Gothic, their British counterparts generally distinguish three periods: the Early English period, the Geometric and Curvilinear phases of the Decorated period (*q.v.*), and the Perpendicular period (*q.v.*).

Renaissance classicism never completely supplanted the Gothic in northern Europe, and the style received a new impetus from the romantic movement beginning about the middle of the 18th century. This Gothic revival (though it is also partially a survival) continues with diminishing intensity to the present day where it is still encountered in churches, university buildings and occasionally in skyscrapers.

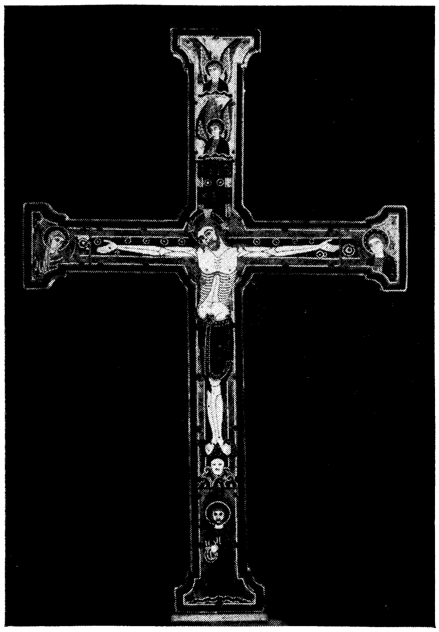
The great century of Gothic art, however, was the 13th when its focal centre was in northern France. The prototype of the style has been recognized in the Abbey church of St. Denis, near Paris, begun in 1140 by that trusted councilor of French kings, Abbot Suger. The significance of St. Denis is not so much in its originality as in its creative combination of such successful features of the late Romanesque as the pointed arch for raising the crowns of the vaulting, ribbed groin vaults resting on slender clustered columns, and the use of spur and flying buttresses at points of particular stress. Thereafter, Laon, Paris, Chartres, Rheims, Amiens, Rouen, Beauvais and Bourges became French cathedral towns. Surviving examples of Gothic secular architecture are found in such castles as Carcassonne, France, and Eltz, Ger.; town halls as the Palais de Justice (Rouen), Westminster hall (London), Doge's palace (Venice), the Palazzo Publico (Siena), the Bargello and Palazzo Vecchio (Florence); college and university buildings as in Italy, France and England; civil and commercial structures in city squares as those of Brussels and Niirnberg; guild halls as the Cloth Hall at Ypres; domestic houses of stone and wood construction as those of Jacques Coeur at Bourges, Diane de Poitiers at Rouen, numerous houses with half-timber work (*q.v.*) in England, and the steep-gabled, multistoried houses of the Hanseatic League cities. (See also GOTHIC ARCHITECTURE; ARCH AND VAULT.)

Gothic sculpture existed in close relationship to the buildings it was intended to embellish and was consequently incorporated directly into the architectural design. There was less emphasis than there had been during the Romanesque on carved capitals of interior columns, because the greater height placed them beyond the range where specific representations could be seen, and because the clustered piers were less conducive to unity. Hence a generalized type of foliated capital evolved, while more specific representations were transferred to the stained glass windows and the sculpture of the exterior. Otherwise interiors included: baptismal fonts, choir screens, sarcophagi with effigies of the deceased, and altars, all of stone; carved wooden choir stalls and small statues of carved or polychromed wood; metalwork of beaten gold, silver and copper gilt; enamel on metal, and cloisonné work in such forms as chalices, monstrances, reliquaries and crucifixes.

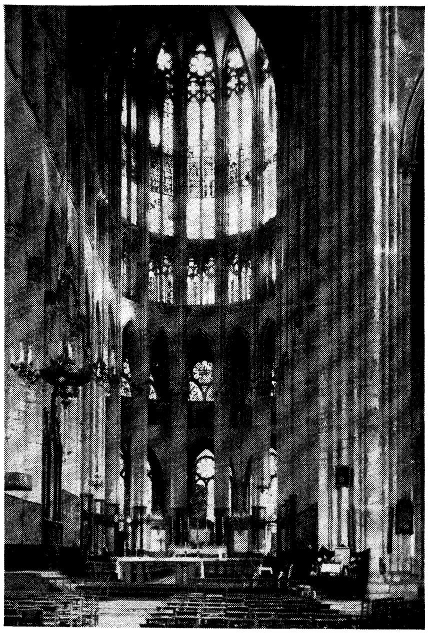
Exterior sculpture was found in profusion in niches along wall surfaces, and especially in the monumental compositions of the portals of façades and transepts where the columns enframing the portals, the doorjambs, lintels, tympana, voussoirs and archivolts, all provided surfaces for sculptural representation. The exterior orientation, furthermore, focused the sculptor's attention on problems of light and shade, and carving in depth became important. (See also SCULPTURE: *Romanesque* and Gothic.)

The more monumental pictorial compositions of the Gothic are found in the luminous, translucent window panels of stained glass and in wall hangings such as embroideries and tapestries, rather than in mosaics and fresco murals as in previous periods. (See STAINED GLASS; TAPESTRY.) Miniature painting (*q.v.*) was far more important than its diminutive size would indicate. The art of the book, at this time, achieved a peak of craftsmanship that has never been surpassed. The pages of these missals, psalters, books of hours and lectionaries contain all the elements of the Gothic style in miniature form. In such outstanding examples as the Duc de Berry's *Très* Riches Heures, the pages are designed as frameworks for such details as the initial letters, text and illuminations. In the margins the minutiae of nature are portrayed with the greatest skill and delicacy. (See ILLUMINATED MANUSCRIPTS.) Such sacred books as well as their secular counterparts in the epics

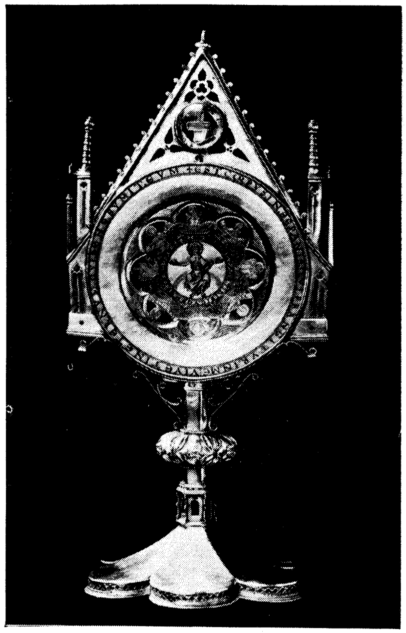
GOTHIC ART



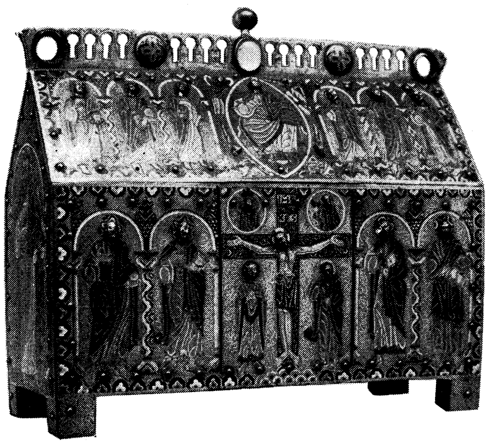
Limoges cross, champlevé enamel on copper; French, late 12th or early 13th century. In the Cleveland Museum of Art



The cathedral choir at Beauvais, France; 13th century. The vaults rise to a height of 157 ft.



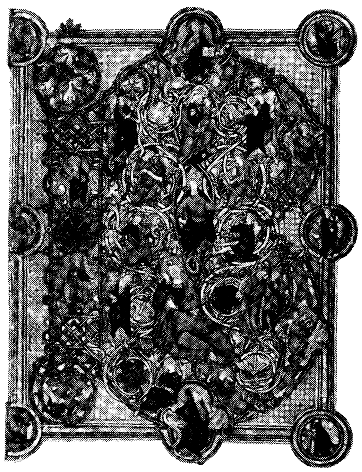
Silver gilt and niello monstrance with paten of St. Bernward. Monstrance from Lower Saxony (Brunswick), late 14th century; paten from Hildesheim, 12th century. In the Cleveland Museum of Art



Limoges chasse or reliquary of champlevé enamel on copper; French, late 12th or early 13th century. In the Metropolitan Museum of Art, New York

"Virgin and Child," painted limestone; French, early 14th century. In the Metropolitan Museum of Art, New York

Wheelwrights and barrelmakers, stained glass detail from St. Juiian window of Chartres cathedral; French, 13th century



Initial "B," with tree of Jesse; illumination from the *Windmill Psalter;* English, c. 1290. In the Pierpont Morgan library, New York

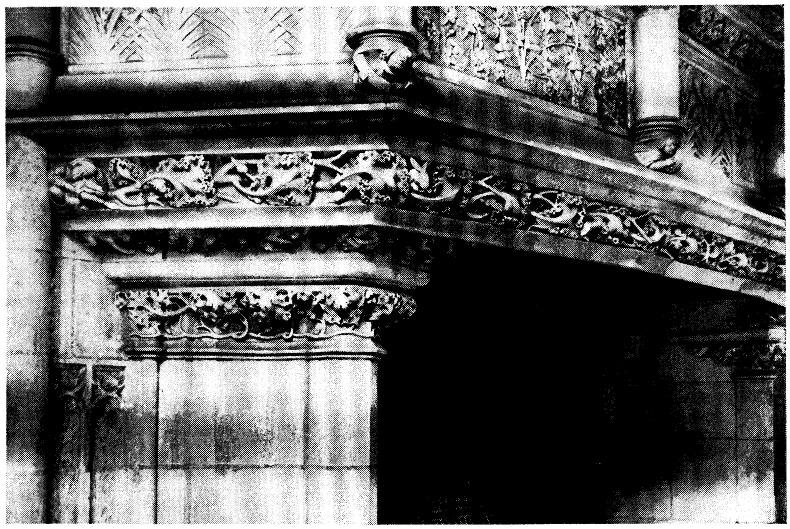
GOTHIC ARCHITECTURE AND MINOR ARTS

BY COURTESY OF (TOP LEFT) THE CLEVELAND MUSEUM OF ART J H WADE COLLECTION (TOP RIGHT) THE CLEVELAND MUSEUM OF ART J H WADE COLLECTION AND GIFT OF MRS R HENRY NORWEB (CENTRE LEFT) THE METROPOLITAN MUSEUM OF ART GIFT OF J. PIERPONT MORGAN 1917, (BOTTOM CENTRE) THE PIERPONT MORGAN LIBRARY (BOTTOM RIGHT) THE METROPOLITAN MUSEUM OF ART THE CLOISTERS COLLECTION PURCHASE, 1937; PHOTOGRAPH, (TOP CENTRE) A. BARETTE

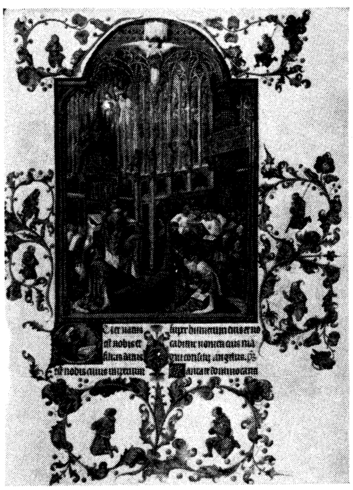
GOTHIC ART

"Virgin and Child;" French, 14th century. In the Louvre, Paris

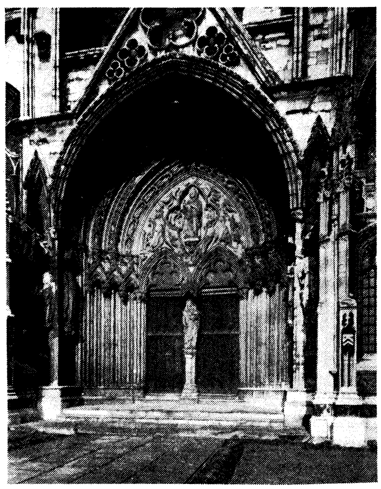
Statues of St. Vincent, St. Denis and St. Piat from the south portal (*c.* 1210–1250) of Charrres cathedral, France



Detail of the fireplace in the house of Jacques Coeur (*c.* 1450) at Bouryes, France



"Celebration of the Mass in Sainte Chapelle." miniature from ***Les Trds riches Heures du duc de Berry*** attributed to the Limburg brothers; Flemish, 15th century. In the Musée Condé, Chantilly, France



Judgment porch (*c.* 1270) south doorway of Angel choir, Lincoln cathedral, England

"St. Matthew," stone relief from a choir screen; French, 13th century. In the Louvre, Paris

EXAMPLES OF GOTHIC SCULPTURE, PAINTING AND ARCHITECTURE

BY COURTESY OF (TOP RIGHT) FRENCH GOVERNMENT TOURIST OFFICE, PHOTOGRAPHS, (TOP LEFT, BOTTOM RIGHT) ALINARI (CENTRE RIGHT) WAYNE ANDREWS (BOTTOM LEFT) PHOTOGRAPHIE GIRAUDON, (BOTTOM CENTRE) A. F. KERSTING

and courtly romances often had covers of carved ivory and richly jeweled hammered gold work. While these art forms and representations have primarily an aesthetic appeal for the modern eye, in Gothic times they had practical, didactic, instructional and inspirational objectives.

The various functions of the cathedral as religious centre, shrine for pilgrimages, university building, choir school, and theatre for liturgical and nonliturgical drama account for its comprehensive iconography. The veneration of the Virgin Mary and the chivalric ideal of womanhood were the sacred and secular sides of the Gothic coin. The numerous dedications of cathedrals to Notre Dame (*e.g.,* Paris, Chartres, Rheims, Rouen, Amiens), the inclusion of Lady chapels on the main axis of church plans, and the histories of the Virgin in sculpture and glass testify to the importance of Marian worship. Aristocratic preoccupation with genealogy is reflected in the tree of Jesse designs, uhich traced the 'kingly ancestors of Christ. A farming community's concern with the calendar is seen in such representations as the signs of the zodiac and labours of the month.

Number symbolism played a major role in such iconographic plans and arrangements. The tympanum space above portals was divided into bands or zones in strict hierarchical fashion. Elsewhere trefoil and quatrefoil forms were employed as geometrical frames for serial representations in stone and glass. The number three, reflected in the many tripartite divisions of space, alluded to the Trinity, and four to such quaternities as the elements of fire, earth, air and water. Their sum added up to seven as the symbol for man, whose nature was both spiritual and physical. Their product indicated such series as the twelve Apostles, tribes of Israel, signs of the zodiac, labours of the month and the like. Such glass and stone representations have often been characterized as the Bible of the poor and the books of the illiterate. But since they also included compendiums of human knowledge as vast in range as any of the treatises or encyclopaedias compiled by the scholastic philosophers, they were addressed to literate minds as well.

The Gothic cathedral, as a dramatic spatial composition, thus became a kind of visual *summa* that embraced the entire life and art of the period. Here architecture, sculpture, glass painting, and a host of minor arts combined to create a sublime theatre for the Gothic liturgy. By the meeting and merging of technical and aesthetic factors, these material means succeeded in achieving the desired immaterial and spiritual ends. The masses of masonry, which had remained essentially static with the Romanesque, were activated with the Gothic so as to quicken the pulse of spatial motion. The accent on aspiring pinnacle forms, the rhythmic repetitions of vertically ascending lines, and the soaring perpendicular perspectives carried the eye irresistibly upward. Gazing at the interior alone, a sense of mystery is created because the slender supporting piers seem inadequate to carry the superstructure to such breath-taking heights. The high vaulting and labyrinthine interior space, moreover, provided a resonant acoustical chamber for the choral chant; the exterior walls were brought to life through the myriad of eloquent sculptural forms; and the incorporation of the flow of light through the medium of stained glass added the dimension of kaleidoscopic colour to etherealize the interior space still further. And just as St. Thomas Aquinas' *Summa theologiae,* by its logical divisions and subdivisions of premises and propositions, brought together all the tenets of Christian thought, just as the trivium, quadrivium and expanded Gothic university curriculum provided for the imparting of all human knowledge, so also did the Gothic cathedral, with its systematic divisions and subdivisions of space, encompass an encyclopaedic scope of subject matter in its sculptural and glass representations that made it a veritable mirror of the Gothic mind.

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GOTHS, a Teutonic people who in the 1st century A.D. appear to have inhabited the middle part of the basin of the Vistula. They were probably the easternmost of the Teutonic peoples. According to their own traditions they had come originally from the island Scandza, *i.e.* Skåne or Sweden and landed first in a region called Gothiscandza. Thence they invaded the territories of the Ulmerugi (the Holmryge of Anglo-Saxon tradition), which were probably in the neighbourhood of Riigenwalde in eastern Pomerania, and conquered both them and the neighbouring Vandals.

Early History.—Under their sixth king Filimer they migrated into Scythia and settled in a district which they called Oium. The rest of their early history, as it is given by their historian Jordanes, is due to an erroneous identification of the Goths with the Getae, an ancient Thracian people. The credibility of the story of the migration from Sweden has been much discussed by modern authors. The legend was not peculiar to the Goths, similar traditions being current among the Langobardi, the Burgundians and apparently several other Teutonic nations. Although so many populous nations can hardly have sprung from the Scandinavian peninsula the existence of these traditions certainly requires some explanation. In part, at least, they are probably due to a Scandinavian element in the royal families of the various nations which participated in them. It is also probable that a portion of the Gothic nation came from the island of Gotland in the Baltic, for it is clear from archaeological evidence that this island had an extensive trade with the coasts about the mouth of the Vistula.

The first certain references to the Goths in ancient literature go back to the first years of the Christian era, when they seem to have been subject to the Marcomannic king Maroboduus. They do not enter into Roman history until the 3rd century, when their frontier seems to have been advanced considerably farther south, and the whole country as far as the lower Danube was frequently ravaged by them. The emperor Gordian is called "victor Gothorum" by Capitolinus, and further conflicts are recorded with his successors, one of whom, Decius, was slain by the Goths in Moesia. The emperor Gallus was forced to pay tribute to them, and during the next twenty years they frequently ravaged the maritime regions of Asia Minor and Greece. Aurelian is said to have won a victory over them, but the province of Dacia had to be given up. In the time of Constantine the Great, Thrace and Moesia were again plundered by the Goths, A.D. 321. Constantine drove them back and then concluded peace with their king Ariaric.

Though by this time the Goths had extended their territories far to the south and east, it must not be assumed that they had evacuated their old lands on the Vistula. Jordanes records several traditions of their conflicts with other Teutonic tribes, in particular a victory won by Ostrogotha over Fastida, king of the Gepidae, and another by Geberic over Visimar, king of the Vandals, about the end of Constantine's reign, in consequence of which the Vandals sought and obtained permission to settle in Pannonia. Geberic was succeeded by the most famous of the Gothic kings, Hermanaric (Eormenric, Iormunrekr), one of the greatest figures of Germanic saga, whose deeds are recorded in the traditions of all Teutonic nations. According to Jordanes he conquered the Heruli, the Aestii, the Venedi and a number of other tribes who seem to have been settled in the southern part of Russia. From Anglo-Saxon sources it seems probable that his supremacy reached westwards as far as Holstein. To his time belong a number of other heroes whose exploits are recorded in English and Northern tradition, amongst whom we may mention Wudga (Vidigoia), Hama and several others, who in *Widsith* are represented as defending their country against the Huns in the forest of the Vistula. Hermanaric committed suicide in his distress because of an invasion of the Huns about A.D. 370, and the portion of the nation called Ostrogoths then came under Hunnish supremacy. (F. G. M. B.)

Later History.—From about this time the history of the East and West Goths parts asunder. The East Goths do not at first enter into the history of the Empire. In 376 a great part of the West Gothic people, under their chief, Frithigern, crossed the Danube into the Roman province of Moesia with the approval of the imperial government. Disputes between the new settlers and the Roman officials soon led to a war, marked by the great Gothic victory at Adrianople in 378, when the emperor Valens was killed. His successor Theodosius the Great made terms with the Goths in 381 and the mass of the Gothic warriors entered the Roman service as *foederati*. Athanaric, the Gothic leader, came to Constantinople in 381; he was received with high honours, and had a solemn funeral when he died.

The death of Theodosius in 395 broke up the union between the West Goths and the Empire. The Goths threw off their allegiance, and chose Alaric as their king. Under him, the Goths are an independent people under a national king; their independence is in no way interfered with if the Gothic king, in a moment of peace, accepts the office and titles of a Roman general. But under Alaric the Goths make no lasting settlement. Cessions of territory are offered to them, provinces are occupied by them, but as yet they do not take root anywhere; no Western land becomes *Gothia*.

Greece was the scene of Alaric's first great campaign, in 395–6. His Italian campaigns fall into two great divisions, that of 402–3, when he was driven back by Stilicho, and that of 408–10, after Stilicho's death. In this second war he thrice besieged Rome (408, 409, 410). The second time it suited a momentary policy to set up a puppet emperor of his own, and even to accept a military commission from him. The third time he sacked the city. The intricate political and military details of these campaigns are of less importance in the history of the Gothic nation than the stage which Alaric's reign marks in the history of that nation. It stands between two periods of settlement within the Empire and of service under the Empire. Under Alaric there is no settlement, and service is quite secondary and precarious; after his death in 410 the two begin again in new shapes.

Under Ataulf, the brother-in-law and successor of Alaric, another era opens, the beginning of enterprises which did in the end lead to the establishment of a settled Gothic monarchy in the West. His position is well marked by the speech put into his mouth by the Roman historian Orosius. He had at one time dreamed of destroying the Roman power, of turning *Romania* into *Gothia*, and putting himself in the place of Augustus; but he had learned that the world could be governed only by the laws of Rome and he determined to use the Gothic arms for the support of the Roman power. In many shiftings of allegiance, Ataulf seems never to have wholly given up the position of an ally of the Empire. His marriage with Placidia, the daughter of the great Theodosius, was taken as the seal of the union between Goth and Roman, and, had their son Theodosius lived, a dynasty might have arisen uniting both claims. But the career of Ataulf was cut short by his murder at Barcelona in 415. Under Wallia, who became king in that year, a more settled state of things was established. The Empire received again, as the prize of Gothic victories, the Tarraconensis in Spain, and Novempopulana and the Narbonensis in Gaul. The Roman "Aquitania Secunda" became the West Gothic kingdom of Toulouse. The dominion of the Goths was strictly Gaulish; their lasting Spanish dominion had not begun.

Under Wallia's successor Theodoric I. (419–451) Goths and Romans became for a time united against their common enemy Attila King of the Huns. But they met Gothic warriors in his army. By the terms of their subjection to the Huns, the East Goths came to fight for Attila against Christendom at Châlons, just as the Serbs came to fight for Bajazet against Christendom at Nicopolis. Theodoric fell in the battle (451). After this momentary meeting, the history of the East and West Goths again separates for a while. The West Gothic kingdom of Toulouse grew within Gaul at the expense of the Empire, and in Spain at the expense of the Suevi. Under Euric (466–485) the West Gothic power again became largely a Spanish power. The kingdom of Toulouse took in nearly all Gaul south of the Loire and west of the Rhone, with all Spain, except the north-west corner, which was still held by the Suevi. Provence alone remained to the Empire. The West Gothic kings largely adopted Roman manners and culture; but, as they still kept to their original Arian creed, their rule never became thoroughly accep able to their Catholic subjects. They stood, therefore, at a great disadvantage when a new and aggressive Catholic power appeared in Gaul through the conversion of the Frank Clovis. In 507 the West Gothic king Alaric II. fell before the Frankish arms at Campus Vogladensis, near Poitiers, and his kingdom, as a great power north of the Alps, fell with him. That Spain and a fragment of Gaul still remained to form a West Gothic kingdom was owing to the intervention of the East Goths under the rule of the greatest man in Gothic history.

When the Hunnish power broke in pieces on the death of Attila, the East Goths recovered their full independence. Even before this time, in 406, a large body of Goths, apparently belonging to the eastern branch of their race, had invaded Italy under their king Radagais. Later in the century, the East Goths entered into relations with the Empire and obtained a settlement in Pannonia. Subsequently, they play in south-eastern Europe nearly the same part which the West Goths played in the century before. Towards the close of the jth century their royal house produced a great figure, famous alike in history and in romance, in the person of Theodoric, son of Theodemir. Theodoric the Great is sometimes the friend, sometimes the enemy, of the Empire, but in all cases alike he remains the national East Gothic king. It was both as Gothic leader and as ally of the Empire that he set out in 488, by commission from the emperor Zeno, to recover Italy from Odoacer. By 493 the East Gothic power was fully established over Italy, Sicily, Dalmatia and the lands to the north of Italy. Under Theodoric the history of the East and West Goths converges again, through the marriage of a daughter of Theodoric to the Visigothic king Alaric II. After Alaric's fall in 507 his heir was protected by Theodoric, in whose later years the kingdoms of the East and West Goths were in effect united.

The East Gothic dominion was now again as great in extent and far more splendid than it could have been in the time of Hermanaric. But it was now of a wholly different character. The dominion of Theodoric was not a barbarian but a civilized power. His twofold position ran through everything. He was at once national king of the Goths, and successor, though without any imperial titles, of the Roman emperors of the West. The two nations, differing in manners, language and religion, lived side by side on the soil of Italy; each was ruled according to its own law, by the prince who was, in his two separate characters, the common sovereign of both. The Goths seem to have been thick on the ground in northern Italy; in the south they formed little more than garrisons. In Theodoric's theory the Goth was the armed protector of the peaceful Roman; the Gothic king had the toil of government, while the Roman consul had the honour. All the forms of the Roman administration went on, and the Roman polity and culture had great influence on the Goths themselves.

Such a system as that which Theodoric established needed a Theodoric to carry it on. On his death (526) the East and West Goths were again separated. Amalaric, son of Alaric II., succeeded to the West Gothic kingdom in Spain and Septimania. Provence was added to the dominion of the new East Gothic king Athalaric, the grandson of Theodoric through his daughter Amalaswintha. But the essential weakness of the East Gothic position in Italy now showed itself. The long wars of Justinian's reign (535–555) recovered Italy for the Empire, and the Gothic name died out.

The West Gothic kingdom lasted much longer, and came much nearer to establishing itself as a national power in the lands which it took in. But its history was long influenced by the difference of race and faith between the Arian Goths and the Catholic Romans of Gaul and Spain. The Arian Goths ruled over Catholic subjects, and were surrounded by Catholic neighbours. The Catholics everywhere preferred either Roman, Suevian or Frankish rule to that of the heretical Goths; even the unconquerable mountaineers of Cantabria seem for a while to have received a Frankish governor. In some other mountain districts the Roman inhabitants long maintained their independence, and in 534 a large part of the south of Spain, including the great cities of Cadiz, Cordova, Seville and New Carthage, was, with the good will of its Roman inhabitants, reunited to the Empire, which kept some points on the coast as late as 624. That is to say, the same work which the Empire was carrying on in Italy against the East Goths was at the same moment carried on in Spain against the West Goths. But in Italy the whole land was for a while won back, and the Gothic power passed away for ever. In Spain the Gothic power outlived the Roman power, but it outlived it only by itself becoming in some measure Roman. The greatest period of the Gothic power as such was in the reign of Leovigild (568–586). He reunited the Gaulish and Spanish parts of the kingdom which had been parted for a moment; he united the Suevian dominion to his own; he overcame some of the independent districts, and won back part of the recovered Roman province in southern Spain. He further established the power of the crown over the Gothic nobles, who were beginning to grow into territorial lords. The next reign, that of his son Reccared (586–601), was marked by a change which took away the great hindrance which had thus far stood in the way of any national union between Goths and Romans. The king and the greater part of the Gothic people embraced the Catholic faith. A vast degree of influence now fell into the hands of the Catholic bishops; the two nations began to unite; the Goths were gradually romanized and the Gothic language began to go out of use. In short, the Romance nation and the Romance speech of Spain began to be formed. The kingdom, however, still remained a Gothic kingdom. "Gothic," not "Roman" or "Spanish," is its formal title; only a single late instance of the use of the formula "regnum Hispaniae" is known. In the first half of the 7th century that name became for the first time geographically applicable by the conquest of the still Roman coast of southern Spain. The Empire was then engaged in the great struggle with the Avars and Persians, and, now that the Gothic kings were Catholic, the great objection to their rule on the part of the Roman inhabitants was taken away. The modern Spanish nation is the growth of the long struggle with the Mussulmans, which followed the overthrow of the Visigothic kingdom in 711. Nevertheless, the Goths hold altogether a different place in Spanish memory from that which they hold in Italian memory. In Italy the Goth was but a momentary invader and ruler. In Spain the Goth supplies an important element in the modern nation. And that element has been neither forgotten nor despised. Part of the unconquered region of northern Spain, the land of Asturia, kept for a while the name of Gothia, as did the Gothic possessions in Gaul and in the Crimea. The name of the people who played so great a part in all southern Europe, and who actually ruled over so large a part of it has now wholly passed away; but it is in Spain that its historical impress is to be looked for.

Among the West Goths written laws had already been put forth by Euric. Alaric II. (484–507) put forth a *Breviarium* of Roman law for his Roman subjects; but the great collection of West Gothic laws dates from the later days of the monarchy, being issued by King Recceswinth about 654. Of special Gothic histories, besides that of Jordanes, already so often quoted, there is the Gothic history of Isidore, archbishop of Seville, a special source of the history of the West Gothic kings down to Svinthala (621–631). Not for special facts, but for a general estimate, no writer is more instructive than Salvian of Marseilles in the 5th century, whose work *De Gubernatione Dei* is full of passages contrasting the vices of the Romans with the virtues of the barbarians, especially of the Goths. In all such pictures we must allow a good deal for exaggeration both ways, but, there must be a ground-work of truth. The chief virtues which the Catholic presbyter praises in the Arian Goths are their chastity, their piety according to their own creed, their tolerance towards the Catholics under their rule, and their general good treatment of their Roman subjects. He even ventures to hope that such good people may be saved, notwithstanding their heresy. For the Gothic language see below. (E. A. F.)

There is now an extensive literature on the Goths, and among the principal works may be mentioned: T. Hodgkin, *Italy and her Invaders* (Oxford, 1880–99); F. Dahn, *Die Konige der Germanen* (1861–99); E. von Wietersheim, *Geschichte der Völkerwanderung* (1880–81); R. Pallmann, *Die Geschichte der Völkerwanderung* (Gotha, 1863–64); B. Rappaport, *Die Einfälle der Goten in das romische Reich* (Leipzig, 1899), and K. Zeuss, *Die Deutschen und die Nachbarstämme* (Munich, 1837). Other works which may be consulted are: E. Gibbon, *Decline and Fall of the Roman Empire*, edited by J. B. Bury (1896–1900); J. B. Bury, *History of the Later Roman Empire* (1889); P. Villari, *Le Invasioni barbariche in Italia* (Milan, 1901); and F. Martroye, *L'Occident a l'époque byzantine: Goths et Vandales* (Paris, 1903). There is a popular history of the Goths by H. Bradley in the "Story of the Nations" series (London, 1888). For the laws *see* the *Leges* in Band I. of the *Monumenta Germaniae historica, Leges* (1902); A. Helfferich, *Entstehung und Geschichte des Westgotenrechts* (Berlin, 1858); F. Bluhme, *Zur Textkritik des Westgotenrechts* (1872); F. Dahn, *Lex Visigothorum. Westgotische Studien* (Würzburg, 1874); C. Rinaudo, *Leggi dei Visigote, studio* (Turin, 1878); and K. Zeumer, "Geschichte der westgotischen Gesetzgebung" in the *Neues Archiv der Gesellschaft fur ältere deutsche Geschichtskunde*. *See* also THEODORIC.

Gothic Language.—Our knowledge of the Gothic language is derived almost entirely from the fragments of a translation of the Bible which is believed to have been made by the Arian bishop Wulfila or Ulfilas (d. 383) for the Goths who dwelt on the lower Danube. The mss. which have come down to us and which date from the period of Ostrogothic rule in Italy (489–555) contain the Second Epistle to the Corinthians complete, together with more or less considerable fragments of the four Gospels and of all the other Pauline Epistles. The only remains of the Old Testament are three short fragments of Ezra and Nehemiah. There is also an incomplete commentary on St. John's Gospel, a fragment of a calendar, and two charters (from Naples and Arezzo, the latter now lost) which contain some Gothic sentences. All these texts are written in a special character, which is said to have been invented by Wulfila. It is based chiefly on the uncial Greek alphabet, from which indeed most of the letters are obviously derived, and several orthographical peculiarities, *e.g.*, the use of *ai* for e and *ei* for ī reflect the Greek pronunciation of the period. Other letters, however, have been taken over from the Runic and Latin alphabets. Apart from the texts mentioned above, the only remains of the Gothic language are the proper names and occasional words which occur in Greek and Latin writings, together with some notes, including the Gothic alphabet, in a Salzburg ms. of the 10th century, and two short inscriptions on a torque and a spear-head, discovered at Buzeo (Walachia) and Kovel (Volhynia) respectively. The language itself, as might be expected from the date of Wulfila's translation, is of a much more archaic type than that of any other Teutonic writings which we possess, except a few of the earliest Northern inscriptions. This may be seen, *e.g.*, in the better preservation of final and unaccented syllables and in the retention of the dual and the middle (passive) voice in verbs. It would be quite erroneous, however, to regard the Gothic fragments as representing a type of language common to all Teutonic nations in the 4th century. Indeed the distinctive characteristics of the language are very marked, and there is good reason for believing that it differed considerably from the various northern and western languages, whereas the differences among the latter at this time were probably comparatively slight (see TEUTONIC LANGUAGES). On the other hand, it must not be supposed that the language of the Goths stood quite isolated. Procopius (*Vand.* i. 2) states distinctly that the Gothic language was spoken not only by the Ostrogoths and Visigoths but also by the Vandals and the Gepidae; and in the former case there is sufficient evidence, chiefly from proper names, to prove that his statement is not far from the truth. With regard to the Gepidae we have less information; but since the Goths, according to Jordanes (cap. 17), believed them to have been originally a branch of their own nation, it is highly probable that the two languages were at least closely related. Procopius elsewhere (*Vand.* i. 3; *Goth.* i. 1, iii. 2) speaks of the Rugii, Sciri and Alani as Gothic nations. The fact that the two former were sprung from the north-east of Germany renders it probable that they had Gothic affinities, while the Alani, though non-Teutonic in origin, may have become gothicized in the course of the migration period.

In the 4th and 5th centuries the Gothic language—using the term in its widest sense—must have spread over the greater part of Europe together with the north coast of Africa. It disappeared, however, with surprising rapidity. There is no evidence for its survival in Italy or Africa after the fall of the Ostrogothic and Vandal kingdoms, while in Spain it is doubtful whether the Visigoths retained their language until the Arabic conquest. In central Europe it may have lingered somewhat longer in view of the evidence of the Salzburg ms. mentioned above. Possibly the information there given was derived from southern Hungary or Transylvania where remains of the Gepidae were to be found shortly before the Magyar invasion (889). According to Walafridus Strabo (de Reb. Eccles. cap. 7) also, Gothic was still used in his time (the 9th century) in some churches in the region of the lower Danube. Thenceforth the language seems to have survived only among the Goths (*Goti* Tetraxitae) of the Crimea, who are mentioned for the last time by Ogier Ghislain de Busbecq, an imperial envoy at Constantinople about the middle of the 16th century. He collected a number of words and phrases in use among them which show clearly that their language was still essentially a form of Gothic. (H. M. C.)

The more important phonetic changes are:—

(1) e became *i* always; e.g., wigs (road). But *i* later became e (written *ai* in Ulfilas' orthography) before r, h; e.g., *hairdeis* (herdsman).

(2) *u* became o (written au) before *r*, h; e.g., *baurgs*. (In Ulfilas' orthography the letters transcribed e, o are used for long vowels only.)

(3) *ai, au* became *ē, ō;* but the digraphs were still written.

(4) short vowels (except u) in final syllables were lost; e.g., *dags, gasts: dagaz*, -gastiz.

(5) final nasals and explosives were lost; e.g., *sunu* (Acc. sing.): Skr. *sūnum.*

(6) final long vowels (including those which had become final through the last change) were (in general) shortened (*ī>i, ō>a, ē>a*); e.g., waurhta (1 sing. pret.): (N. inscr.) *worahtō; liuba* (N. sing. fem.): (N. inscr.) *liubu.*

(7) voiced spirants when final (also before s) became voiceless; e.g., bap (3 sing. pret. of bidjan).

All these changes which occurred before or during the 4th century rendered the Gothic language hardly intelligible to a person who spoke a northern or western language. At a later date Gothic underwent further changes which do not appear in Ulfilas' version (c. 370 A.D.), or only to a slight extent.

(1) *i* became a close e- sound; e.g., *Venethae* (Jordanes), for *Winid-*.

(2) *u* became a close *o* sound: *e.g.*, Ῥόγοι (Procopius) : *Rugii;* later o became a in unaccented syllables, e g., *ūraz* (for -us).

(3) *ē* became i; e.g., *leikeis* for *lekeis* (not infrequently in the MSS.).

(4) *ō* became *ū;* e.g., *sunjus* for *sunjos.*

The Gothic and Scandinavian (*q.v.*), languages have one or two characteristics in common, the most important of which is the treatment of intervocalic j and w in a number of words. In the former case we find Goth. *-ddj-* and O.N. *-ggi-*, whereas in German a diphthong developed; e g., Goth. twaddje (Gen. of *twai,* "two"). In the latter case both Goth. and Scand. had *ggw* while a diphthong appears both in English and German, *e.g.,* Goth. *triggws* ("true"), Anglo-Saxon getriowe, getriewe, Old High German *gitriuwi.* Gothic and Scandinavian preserved the ending *-t* in the 2 singular of the strong Preterite, while English and German had a different form with the stem of the plural. By the 4th or 5th century the Scandinavian languages had far more resemblance to English and German than to Gothic.

See H. C. von der Gabelentz and J. Joebe, *Ulfilas* (Altenburg and Leipzig, 1836–46); E. Bernhardt, *Vulfila* oder die gotische *Bibel* (Halle, 1875). For other works on the Gothic languages see J. Wright, *A* Primer of the Gothic Language (Oxford, 1892), p. 143 f. To the references there given should be added: C. C. Uhlenbeck, *Etymologisches* Worterbuch d. got. Sprache (Amsterdam, 2nd ed., 1901); F. Kluge, "Geschichte d. got. Sprache" in H. Paul's Grundriss d. germ. Philologie (2nd ed., vol. i, Strassburg, 1897); W. Streitberg, Gotisches Elementarbuch (Heidelberg, 1897); Th. von Grienberger, *Beiträge zur* Geschichte d. deutschen Sprache u. Literatur, xxi 185 ff.; L. F. A. Wimmer, Die *Runenscrift* (Berlin, 1887), p. 61 ff.; G. Stephens, Handbook to the Runic Monuments (London, 1884), p. 203; F. Wrede, *Über* die Sprache der *Wandalen* (Strassburg, 1886). For further references see K. Zeuss, Die Deutschen, p. 432 f. (where earlier references to the Crimean Goths are also given); F. Kluge, op. *cit.*, p. 515 ff.; O. Bremer, ib. vol. iii, p. 822; and W. Streitberg, *Gotisches* Elementarbuch, 1920.

GOTLAND, an island in the Baltic sea belonging to Sweden, lying between 57° and 58° N., and having a length from S.S.W. to N.N.E. of 75 mi., a breadth not exceeding 30 mi. and an area of 1,220 sq.mi. The nearest point on the mainland is 50 mi. from the westernmost point of the island. With the island Fårö, off the northern extremity, the Karlsoe, off the west coast, and Gotska Sando, 25 mi. N. by E., Gotland forms the administrative district (lan) of Gotland. The island is a level plateau of Silurian limestone, rising gently eastward, with a few low isolated hills inland, and with steep coasts fringed with free-standing columns of limestone (raukar). The climate is temperate, and the soil, although in parts dry and sterile, is mostly fertile. Rye, wheat and oats are grown, and especially barley, which is exported to the breweries on the mainland. The sugar beet is also produced and exported, and there are beet-sugar works on the island. Sheep and cattle are kept; there is a government sheep farm at Roma, and the cattle may be noted as belonging principally to an old native breed, yellow and horned. Some lime-burning, cement-making and sea-fishing are carried on. The capital of the island is Visby, on the west coast. The shrunken walled town of Visby was one of the richest commercial centres of the Baltic from the 11th to the 14th century, and its prosperity was shared by the whole island. It retains ten churches besides the cathedral. Tht massive towers of the village churches are often detached, and doubtless served purposes of defense. The churches of Roma, Hemse, with remarkable mural paintings, Othen and Larbo may be specially noted. Some contain fine stained glass, as at Dalhem near Visby. The natives of Gotland speak a dialect distinguished from that of any part of the Swedish mainland. Pop. of *län* (est. 1940) 58,444. Density per sq.mi. 48.

HISTORY

Gotland has a remarkable history, the most important part of which goes back to mediaeval times. Already in the early period of the Stone Age the island was a centre of trade and shipping in the Baltic, and its commercial importance increased during the Bronze and Iron Ages. Out of the 7,000 Roman coins dating from the two first centuries after Christ which have been found in Scandinavia more than 5,000 have come from Gotland, while most of the Byzantine solidi and of those from the Western empire were dug up on the islands of Gotland, Öland and Bornholm. About 30,000 Arabic coins have been found in Scandinavia, more than half of them in Gotland. Hence it is deduced that the island was a commercial centre for Sweden, Denmark, Germany and eastern Europe with connections extending far beyond this region After the Scandinavian countries had been converted to Christianity, pilgrims from Norway and Sweden often travelled to the Holy Land by way of Gotland.

During the 9th century Gotland ranked as part of Sweden although in administration and government it was largely autonomous. The peasants of the island were also traders and their wealth was famous far and wide. Nearly 100 churches were built or restored during the island's great days. A town came into existence at Visby and German merchants took up their abode there. The peasant-traders found their competition injurious and open strife broke out between the townsfolk and the countryfolk. About A.D. 1280 the Swedish king, Magnus Ladulås, bound the island closer to Sweden and levied taxes as a punishment for these disturbances. During the 14th century Visby continued to be talked about as the richest city in Scandinavia. Covetous neighbours were tempted by this and the Danish king, Valdemar Atterdag, invaded the island in the year 1361 and defeated an army of peasants outside Visby, which became his prey. Visby was a member at this period of the Hanseatic league which now united with Sweden and Norway against Denmark, but owing to dissensions among the allies the Danish king went unscathed. During the later portion of the middle ages Visby and the whole island of Gotland were a resort for pirates and for foreign invaders such as the *Vitelianerna* (from Mecklenburg), the Teutonic knights, the Danes, and Erik of Pomerania who from the vantage point of the newly-built castle of Visborg spread terror over this part of the Baltic during the years 1437–49. The Danish country nobles, the brothers Tott, exercised the lofty calling of Sea-rovers from the island during the years 1449–87. The island belonged de facto to Denmark and was formally transferred to the Danish throne by Sweden by the Peace of Stettin in 1570. Through the Peace of Bromsebro, in 1645, Sweden regained the island, which has since continued to belong to her except during the years 1676–79, when the Danes occupied it and for some weeks in 1808.

During the middle ages the special laws of Gotland were kept on the island. The importance of Visby in the sea-trade of the world is conclusively attested by the famous code of maritime law which bears its name. This "sea law which the merchants and seamen have made at Visby" *("Waterrecht dat de Kooplude en de Schippers gemakt hebben to Visby")* was based upon the Liibeck code and was first printed in Low German in 1505 but probably dated back to about 1240 (*see* MARITIME LAW).

Visby boasts a number of fine ruins of churches and a large portion of its walls dates from mediaeval times. It has become in consequence one of Sweden's principal tourist resorts.

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GOTŌ-RETTŌ, Japanese archipelago (literally, five-island chain) lying off the western coast of Kyushu, administered by Nagasaki prefecture. There are more than 100 islands (34 are inhabited) with a total area of 266 sq.mi. stretching about 62 mi. from northeast to southwest.

The five largest and most densely settled islands are Fukue, Hisaka, Naru, Wakamatsu and Nakadōri, in south-north sequence. Largely created by volcanic activity, the islands have mountainous interiors. Intensive dry-field farming is practised on terraces and slopes, with irrigated rice restricted to a few slender coastal plains. Fishing is the main economic activity for large ports like Fukue (Fukue Island), Narao (Nakadōri Island) and many smaller ports. In the northern half of the archipelago, fishing leads agriculture in importance and the islands' economy focuses on Sasebo. However. fishing is secondary to agriculture in the southern half and regular ferry service ties the regional economy to Nagasaki. (J. D. EE.)

GOTTER, FRIEDRICH WILHEEM (1746–1797). German poet and dramatist, the chief exponent of French classicism in the German literary life of his time. Born on Sept. 3, 1746, at Gotha, he studied at Gottingen, and, after a minor diplomatic appointment at Wetzlar, returned in 1768 to Gotha as tutor to two young nobles. There with Heinrich Christian Boie (*q.v.*) he founded the famous *Gottinger Musenalmanach* (1768), in which much of the poetry of the *Göttinger Bund* was published. In 1770 he was once more in Wetzlar, where he held a diplomatic secretarial post, and became associated with Goethe's circle. He settled in Gotha in 1774 and died there. March 18, 1797.

Gotter's poetry is elegant and polished but lacks imaginative depth. Most of his plays were based on French originals.

See Gotter's collected *Gedichte,* 3 vol. (1787–1802); R. Schlosser, F. *W. Gotter. sein Leben und seine Werke* (1894). (A. Gs.)

GOTTFRIED VON STRASSBURG (*fl.* 1210), one of the greatest medieval German poets. The dates of his birth and death are unknown, as are the circumstances of his life. and the only information about him consists of references to him in the work of other poets and inferences from his own work. The breadth of learning displayed in his epic *Tristan und Isolde* reveals that he must have enjoyed the fullest education offered by the cathedral and monastery schools of the middle ages, and this, together with the authoritative tone of his writing, indicates that. although not himself of noble birth, he spent his life in the society of the well-born. *Tristan* was probably written about 1210. Gottfried is thus a literary contemporary of Hartmann von Aue, Walther von der Vogelweide and Wolfram von Eschenbach.

The Celtic legend of Tristan (*q.v.*) and Iseult (Ger., Isolde) reached Germany through French sources. The first German version is that of Eilhart von Oberge (*c.* 1180), but Gottfried, although he probably knew Eilhart's poem, based his own work on the Anglo-Norman version of Thomas of Brittany (1160–70). The story centres in Tristan's journey to Ireland on behalf of his uncle, King Mark of Cornwall. to bring back Isolde as the king's bride. On the return voyage, Tristan and Isolde unwittingly drink a magic potion which makes them fall in love with each other. They seek to outwit Mark. but are eventually discovered, and Tristan flees to Brittany, where he marries another Isolde, "Isolde of the white hands." Here Gottfried's poem breaks off and the story is completed by Gottfried's continuators, Ulrich von Turheim and Heinrich von Freiberg. In the course of further adventures Tristan receives a wound from a poisoned spear, and only the first Isolde, who has since become Mark's wife, can heal him. She is summoned from Cornnall. Word is to be brought to the sick Tristan when the vessel returns: it is to mount a white sail if she is on board. a black sail if she is not. The ship is sighted, flying a white sail. Tristan's jealous wife, however, tells him that the sail is black. and when Isolde arrives, she finds Tristan dead. Overcome with grief. she joins her lover in death.

Gottfried's moral purpose, as he states it in the prologue to his poem, is to present to courtiers of fine feeling (edeliu *herzen,* literally "noble hearts") an ideal of the love relationship. The core of this ideal. which derives from the romantic cult of woman in medieval courtly society, is that love (*minne*) ennobles through the suffering with which it is inseparably linked. This Gottfried enshrines in a story in which actions are motivated and justified, not by a standard ethic, but according to the fictional "rules of love" affected by court circles. Thus the love potion, from being the direct cause of the tragedy. has become (as already in Thomas's version) the mere outward symbol of a situation brought about by the inner nature of the relationship between the lovers—an adulterous relationship, yet approved by the "courts of love" by reason of its spontaneity, its exclusiveness and its completeness.

Although unfinished, Gottfried's is the finest of the medieval versions of the Tristan legend and one of the most perfect creations of the medieval courtly spirit, distinguished alike by the refinement and elevated tone of its content and by the elaborate skill of its poetic technique.

Apart from *Tristan* Gottfried is known also to have written lyric poems, but only two *Sprüche* have survived which can with reasonable certainty be ascribed to him.

BIBLIOGRAPHY.—Gottfried's *Tristan* has been edited many times, notably by R. Bechstein, 4th ed. (1923). There is an Eng. trans. by A. T. Hatto (1960). *See* also Gottfried Weber, *Gottfrieds von Strassburg Tristan und die Krise des nochnzittelalterlichen Weltbildes um 1200* (1953); G. Ehrismann, *Geschichte der deutschen Literatur bis zum Ausgang des Mittelalters* ii, 2, 1, pp. 297-336 (1954), both containing full bibliographies. (RD. J. T.)

GOTTHELF, JEREMIAS: *see* BITZIUS, ALBERT.

GOTTINGEN, a town in the *Land* of Lower Saxony, Germany, at the west foot of the Hainberg, in the valley of the Leine. 67 mi. S. of Hanover. Pop. (1959 est.) 77,696. A village of Goding or Gutingi is named in documents of about A.D. 950. The place received municipal rights from the German king Otto IV about 1210, and during the 14th century it held a high place in the Hanseatic League. In 1531 it joined the Reformation movement. and in the following century it suffered considerably in the Thirty Years' War. After a century of decay, it was anew brought into importance by the establishment of its university; and a marked increase in its industrial and commercial prosperity has again taken place in recent years. Toward the end of the 18th century Gottingen was the centre of a society of young poets of the *Sturm und Drang* period of German literature, known as the *Gottinger Dichterbund* or *Hainbund* (*see* GERMAN LITERATURE).

The town is traversed by the Leine canal, which separates the Altstadt from the Neustadt and from Masch, and is surrounded by ramparts. The old streets are crooked and narrow. Gottingen possesses a mediaeval town hall, built in the 14th century and restored in 1880. Industries include branches of the publishing trade, manufacture of cloth and woollens and of scientific instruments. The university, founded by George II in 1734 and opened in 1737, rapidly attained fame. Political disturbances, in which both professors and students were implicated, and the expulsion in 1837 of seven professors—Die *Gottinger Sieben*—for protesting against the revocation by King Ernest Augustus of Hanover of the liberal constitution of 1833, reduced the prosperity of the university. The events of 1848. on the other hand, told somewhat in its favour; and, after the annexation of Hanover in 1866, it was carefully fostered by the Prussian government. The main university building lies on the Wilhelmsplatz, and, adjoining, is the library with the richest collection of modern literature in Germany. There are zoological, ethnographical and mineralogical collections, the most remarkable being Blumenbach's collection of skulls. The Society of Sciences *(Sozietat der Wissenschaften)* is well known and publishes the *Göttingische gelehrte Anzeigen.*

GOTTSCHALK [GODESCALUS, GOTTESCALE] (*c.* 808–867?), German theologian, was born near Mainz, the son of a Saxon noble who obliged him to enter the Benedictine monastery of Fulda, then under the abbot Hrabanus Maurus. In 829, at the synod of Mainz, on the pretext that he had been unduly constrained by his abbot, he obtained his liberty, withdrew first to Corbie and then to Orbais where his study of St. Augustine led him to support the doctrine of absolute predestination and the denial of liberty and responsibility. Between 835 and 840 Gottschalk was ordained priest, and went to Italy. Driven out through the influence of Hrabanus Maurus, now archbishop of Mainz, he travelled through Dalmatia, Pannonia and Norica, preaching and writing. In 848 he presented to the synod at Mainz a profession of faith and a refutation of the accusations by Hrabanus Maurus. He was convicted of heresy however, obliged to swear that he would never enter the territory of Louis the German, and handed over to Hincmar, archbishop of Reims.

The next year at a provincial council at Quierzy, presided over by Charles the Bald, Gottschalk attempted to justify his ideas, but was again condemned, was degraded from the priesthood, and shut up in the monastery of Hautvilliers. There Hincmar tried again to induce him to retract, but he continued to defend his doctrine, and a great controversy resulted. Prudentius, bishop of Troyes, Wenilo of Sens, Ratramnus of Corbie, Loup of Ferrières and Florus of Lyons wrote in his favour. Hincmar wrote *De praedestinatione* and *De una non trina deitate* against his views, and called in Erigena. The question was discussed at the councils of Kiersy (853), of Valence (855) and of Savonnihres (859). Finally Pope Nicolas I. took up the case, and summoned Hincmar to the council of Metz (863). Hincmar declared that Gottschalk might defend himself before the pope. Nothing came of this, and Gottschalk died without recanting. Of his many works we have only the two professions of faith *(cf.* Migne, *Patrol. Lat.,* cxxi.), and some poems, ed. L. Traube in *Mon. Germ. hist.: Poetae Latini aevi Carolini* (t. iii., 1896). Fragments of his theological treatises have been preserved in the writings of Hincmar, Erigena, Ratramnus and Loup of Ferrières.

From the 17th century, when the Jansenists exalted Gottschalk, much has been written on him. Mention may be made of F. Picavet's "Les Discussions sur la liberté au temps de Gottschalk, de Raban Maur, d'Hincmar, et de Jean Scot," in *Comptes rendus de l'acad. des sciences morales et politiques* (1896); and A. Freystedt's "Studien zu Gottschalks Leben und Lehre," in *Zeitschrift* fur *Kirchengeschichte* (1897). Further bibliography in Uberweg's *Gesch. der Philosophie.*

GOTTSCHALL, RUDOLF VON (1823–1909), German man of letters, was born at Breslau on Sept. 30, 1823, the son of a Prussian artillery officer. He studied law at Konigsberg, but was expelled on account of his Liberalism. Breslau and Leipzig proved equally intolerant, and he completed his studies in Berlin. During this period he wrote *Lieder der Gegenwart* (1842) and *Zensurflüchtlinge* (1843) — the poetical fruits of his political enthusiasm. In 1852 he married Marie, baroness von Seherr-Thoss, and for the next few years lived in Silesia. In 1864 he settled in Leipzig, Down to 1887 Gottschall edited the *Brockhaus'sche Blatter fur litterarische Unterhaltung* and the monthly periodical *Unsere Zeit.*

Among Gottschall's volumes of lyric poetry are *Sebastopol* (1856), *Janus* (1873), *Bunte Blüten* (1891); among his epics, *Carlo Zeno* (1854), *Maja* (1864), dealing with an episode in the Indian Mutiny, and *Merlins Wanderungen* (1887). *Pitt und Fox* (1854) was his best comedy. The tragedies, *Mazeppa, Catharine Howard, Amy Robsart* and *Der Gotze von Venedig,* were written in imitation of Schiller. His historical novels, *Im Banne des schwarzen Adlers* (1875; 4th ed., 1884), *Die Erbschaft des Blutes* (1881), *Die Tochter Rübezahls* (1889), and *Verkiimmerte Existenzen* (1892), enjoyed great popularity. His critical work includes *Die deutsche Nationalliteratur des 19. Jahrhunderts* (1855; 7th ed., 1901–02), and *Poetik* (1858; 6th ed., 1903). *See* his autobiography, *Aus meiner Jugend* (1898).

GOTTSCHED, JOHANN CHRISTOPH (1700–1766), German literary theorist and critic who introduced French 18th-century classical standards of taste into German literature, especially drama, was born on Feb. 2, 1700, at Judithenkirch near Konigsberg. He studied at Konigsberg. In 1730 he was appointed professor of poetry at the University of Leipzig, and in 1734 became professor of logic and metaphysics there. His lectures, writings, editorship of several literary journals and work for dramatic reform, in which he collaborated with the actress Karoline Neuber (*q.v.*), led to the establishment of a so-called "Leipzig school" of acting and criticism. He died at Leipzig, Dec. 12, 1766.

Gottsched's most influential work was his *Versuch einer kritischen Dichtkunst fur die Deutschen* (1730), the first German treatise on the art of poetry to apply the French classical standards of reason and good taste advocated by Nicolas Boileau. His aims to purify German as a literary language and to develop a classical German style were advanced by his *Ausführliche Redekunst* (1728) and *Grundlegung einer deutschen Sprachkunst* (1748). He wrote several plays on classical principles, of which *Der sterbende Cato* (1732), an adaptation of Joseph Addison's tragedy, is the most notable. His *Deutsche Schaubühne* (6 vol., 1740–45), containing mainly translations from the French, provided the German stage with a classical repertory, to replace the improvisations and melodramas previously popular. He also prepared a bibliography of German drama, *Nötiger Vorrat zur Geschichte der deutschen dramatischen Dichtkunst* (1757–65). His influence decreased after 1740 when he came into conflict with the Swiss writers, J. J. Bodmer and J. J. Breitinger (*qq.v.*), who demanded that poetic imagination should not be hampered by artificial rules.

Gottsched's wife, LUISE ADELGUNDE VIKTORIE, née KULMUS (1713–1762), helped her husband in his work of dramatic reform, and was the author of several popular comedies. She also translated French classical dramas, Addison's *Spectator* (9 vol., 1739–43), Pope's *Rape of the Lock* (1744) and other French and English works.

BIBLIOGRAPHY.—Gottsched's *Gesammelte Schriften* were ed. by E. Reichel (1902–06). *See* also E. Wolff, *Gottscheds Stellung im deutschen Bildungsleben,* 2 vol. (1895–97); H. Lachmann, *Gottscheds Bedeutung für die Geschichte der deutschen Philologie* (1931); G. Schimansky, *Gottscheds deutsche Bildungsziele* (1939). Frau Gottsched, *Lustspiele,* R. Buchwald and A. Koster (eds.), 2 vol. (1908). *See* P. Schlenther, *Frau Gottsched und die bürgerliche Komodie* (1886). (A. Gs.)

GÖTZ, JOHANN NIKOLAUS (1721–1781), German poet, was born at Worms on July 9, 1721. He studied theology at Halle (1739–42), where he became intimate with the poets J. W. L. Gleim and J. P. Uz, acted for some years as military chaplain, and afterward filled various other ecclesiastical offices. He died at Winterburg on Nov. 4, 1781. Gotz wrote short lyrics and several translations, of which the best is a rendering of Anacreon. The best known of his poems is the elegy, *Die Mädcheninsel.*

GOUACHE, a type of opaque water colour, and, by extension, a picture painted in this medium. Water colour (French and German *aquarelle)* is the specific term for the transparent method *(see* WATER-COLOUR PAINTING); gouache is applied opaquely. Whites and pale tints are produced by the addition of white pigment, ordinarily zinc white (Chinese white). Gouache colours contain the same ingredients as water colours but are compounded with more vehicle and inert pigment. Artists sometimes combine gouache, water colour and pastel in the same picture. Water colour is like a stain in the paper, and the tiny pigment particles become enmeshed in its fibres; gouache colour lies on the surface, forming a continuous layer or coating. Tinted papers and smooth papers can be used instead of the special rough-finish, handmade papers which are indispensable in creating the sparkling, transparent water colour. Gouache paintings are characterized by a directly reflecting brilliance, different from that of water colour. The medium has its own kind of freshness, lightness and spontaneity of free brushstrokes. When applied with bristle brushes it exhibits a slight but effective impasto quality; gouache paint is also capable of being worked out to smooth, fla less colour fields with sable brushes. (RH. M.)

GOUDA, a town of the Netherlands, in the province of South

Holland, on the Gouwe at its confluence with the Ysel, and a junction station 12½ mi. by rail N.E. of Rotterdam. Pop. (1957 est.) 42,181 mun. Tramways connect it uith Bodegraven on the old Rhine and Oudewater on the Ysel; there is a regular steamboat service along canals in various directions. The Groote Markt is the largest market-square in Holland. Among the numerous churches belonging to various denominations. the first place must be given to the Groote Kerk of St John. It was founded in 1485, but rebuilt after a fire in 1552, and is remarkable for a celebrated organ, and a series of 40 stained-glass windows, mostly from the hand of Crabeth. Other buildings are the Gothic town hall, founded in 1449 and rebuilt in 1690, and the weigh-house, built in the 17th century and adorned with a fine relief.

In the time of the counts Gouda was busy with brewing and cloth-weaving; but at a later date the making of clay tobacco pipes became the staple trade. and, although this industry somewhat declined, the churchwarden pipes of Gouda are well known. It also manufactures candles. The transit and shipping trade is considerable, and as one of the principal markets of South Holland, the round, white Gouda cheeses are known throughout Europe Boskoop, 5 mi. N. by W. of Gouda on the Gouwe, is famous for its nursery gardens; and the little town of Oudewater, as the birthplace of the famous theologian Arminius in 1560. In World War II Gouda was occupied by Germany.

GOUDIMEL, CLAUDE (c. 1510–1572), musical composer of the 16th century, born about 1510. Both French and Belgians claim him as their countryman. In all probability he was born at Besançon, for in his edition of the songs of Arcadelt, as well as in the mass of 1554, he calls himself "natif de Besançon" and "Claudius Godimellus Vescontinus." The excellent Latin in which his letters were written proves that, in addition to his musical knowledge, he had a good classical training. In 1555 he published, with Nicolas Duchemin, a musical setting, now lost, some odes of Horace, and in 1557 and 1558 a Magnificat and two Masses. He was living in Metz in 1557, and at about this time, probably, joined the Huguenots. For them he composed a setting of the celebrated French version (1565) of the Psalms by Marot and Beza. The French version of the Psalms was at first used by Catholics as well as Protestants, until their use was forbidden in Catholic churches. Goudimel moved to Lyons, where he perished during the St. Bartholomew massacres of August 27–28, 1572.

Among modern books containing examples of Goudimel's work see especially O. Douen, *Clément Marot et le psautier huguenot* (2 vols., 1878), and *Choix de Psaumes* (1879); H. Expert, *Le Psautier huguenof du XVI^e^ siècle* (1902); J. Tiersot, *Ronsard et la musique de son temps* (Leipzig, 1903); and T. Gerold, *Clément Marot, Psaumes avec les mélodies* (Bibliotheca Romanica, Strasbourg, 1919).

GOUGE, a tool of the chisel type with a curved blade, used for scooping a groove or channel in wood, stone, etc. (*see* TOOL). *A* similar instrument is used in surgery for operations involving the excision of portions of bone. "Gouge" is also used as the name of a bookbinder's tool, for impressing a curved line on the leather, and for the line so impressed. In mining, a "gouge" is the layer of soft rock or earth sometimes found in each side of a vein of coal or ore, which the miner can scoop out with his pick, and thus attack the vein more easily from the side.

GOUGH, SIR HUBERT DE LA POER (1870–), British soldier, was born on Aug. 12, 1870, a son of Gen. Sir C. Gough, V.C., and joined the 16th Lancers in 1889. In 1911 he became brigadier-general commanding the III. Cavalry Brigade at the Curragh, where his attitude with regard to Ulster and the use of the troops in 1914 caused a grave political crisis (*see* ENGLISH HISTORY). He took his brigade to France in August of that year, and after successive promotions, was given command of the newly constituted V. Army; with this he played an important part in the battle of the Somme. In 1917 he was for some time in charge of the Ypres offensive, where his conduct of the operations received considerable criticism. The brunt of the great German offensive of March 1918 fell on his troops, who were unable to withstand the pressure and fell back with heavy loss in personnel and material. Gough's dispositions under circumstances of the utmost difficulty were appropriate, but he was deprived of his command. In 1919 he was head of the British Mission to the Baltic States. He retired in 1922, nith the rank of general. He then became a director of Siemens Bros. Gough received K.C.B (1916), K C V.O (1917), and G.C B. (1937).

GOUGH, HUGH GOUGH, VISCOUNT (1779–1869), Irish field marshal, a descendant of Francis Gough who was made bishop of Limerick in 1626, was born at Woodsdown, Limerick, on Nov 3, 1779. Having entered the army in Aug. 1794, he served with the 78th Highlanders at the Cape of Good Hope, taking part in the capture of Capetown and of the Dutch fleet in Saldanha bay in 1796. His next service was in the West Indies, where, with the 87th (Royal Irish Fusiliers), he shared in the attack on Porto Rico, the capture of Surinam, and the brigand mar in St. Lucia. In 1809 joining the army in Portugal under Wellington, he commanded his regiment as major in the operations before Oporto, by which the town was taken from the French. At Talavera he was severely wounded, and had his horse shot under him. For his conduct on this occasion he was afternard promoted lieutenant-colonel, his commission, on the recommendation of Wellington, being antedated from the day of the duke's dispatch. He was thus the first officer who ever received brevet rank for services performed in the field at the head of a regiment. He was next engaged at the battle of Barrosa, at which his regiment captured a French eagle. At the defense of Tarifa the post of danger was assigned to him, and he compelled the enemy to raise the siege. At Vittoria, where Gough again distinguished himself, his regiment captured the baton of Marshal Jean Baptiste Jourdan. He was again severely wounded at the battle of Nivelle, and was soon after created a knight of St. Charles by the king of Spain.

After a short respite from active service he served in southern Ireland In 1837 he took command in Mysore, whence he was sent to China during the first Chinese War (1841–42). After the conclusion of the treaty of Nanking in Aug. 1842 the British forces were withdrawn. Gough was created a baronet. In Aug. 1843 he was appointed commander in chief of the British forces in India, and in December he took the command in person against the Mahrattas and defeated them at Maharajpur, capturing more than 50 guns. In 1845 occurred the rupture with the Sikhs, who crossed the Sutlej in large numbers. Gough conducted the operations. Successes in the hard-fought battles of Mudki and Ferozeshah were succeeded by the victory of Sobraon, and shortly afterwards the Sikhs sued for peace at Lahore. Gough was then raised to the peerage as Baron Gough (April 1846). The war broke out again in 1848, and again Lord Gough took the field; but the result of the battle of Chillianwalla being equivocal, he was superseded by the home authorities in favour of Sir Charles Napier; before the news of the supersession arrived Gough had finally crushed the Sikhs in the battle of Gujrat (Feb. 1849). His tactics during the Sikh wars were the subject of an embittered controversy (*see* SIKH WARS). Lord Gough then returned to England and was raised to a viscountcy. A pension of £2,000 per annum was granted to him by parliament, and an equal pension by the East India company.

In Nov. 1862, he was made field marshal. He died on March 2, 1869.

See R. S. Rait, *Life and Campaigns of Viscount Gough*, 2 vol. (1903); W. Lee-Warner, *Life of the Marquis of Dalhousie*, 2 vol. (1904).

GOUIN, SIR LOMER (1861–1929), Canadian politician, was born at Grondines, Que.. on March 19, 1861. Educated at Laval and McGill universities, he was called to the bar in 1884 and became Q.C. in 1900. In 1897 he was elected to the Quebec legislature and from 1905 to 1920 was prime minister and attorney general of the province. He declined to join Sir Robert Borden's coalition ministry, subsequently declaring his allegiance to the Liberal opposition. Gouin was included in the King cabinet of 1921 as minister of justice. He was a Canadian representative at the fourth assembly of the League of Nations at Geneva. In 1924 he attended the imperial and economic councils in London as one of Canada's representatives. He died at Quebec on March 28, 1929.

GOUJON, JEAN (c. 1510?–1568?), the greatest French sculptor of the mid-16th century. The first record of him documents his activity in 1540 as an architectural sculptor in Rouen. His earliest mature masterpiece was the superb relief decoration made in 1544–45 for the rood screen of the church of St. Germain l'Auxerrois, Paris, now in the Louvre, which also marked the beginning of his collaboration with the architect Pierre Lescot. The especially beautiful relief of the Pietà illustrates all of the characteristics of Goujon's personal variation of mid-16th-century mannerism, in which the highly subjective and rarefied ideals of beauty created by the artist's imagination were not compromised by reference to what was thought "imperfect Nature." These attenuated and hypersensitive human forms were skillfully coerced onto a plane in poses which are audaciously unliteral and suggest aesthetic movements as unreal as those of the ballet; the whole was then exquisitely embroidered with a linear play of nervous, finely divided draperies.

GIRAUDON

APOSTLE JOHN BY JEAN GOUJON, FORMERLY IN ST GERMAIN L AUXERROIS, NOW IN THE LOUVRE, PARIS

Goujon's masterpiece was the famous relief ornamentation of the later altered Fontaine des Innocents in Paris (1547–49), where the six extraordinarily narrow spaces between the pilasters are filled with elegantly elongated figures of nymphs. At about the same time Goujon must have made the less fine reliefs on the Hôtel Carnavalet, which were executed largely by assistants. Goujon's brilliant reliefs on the court façade of the Old Louvre (*c.* 1549–53) were irresponsibly recut by 19th-century restorers. The later ones in the attic above show how his late work was bolder in relief and freer from his early architectural restraint. The great hall inside contains Goujon's most ambitious sculpture, especially the famous gallery with caryatids carved in the round, but these too were falsified by restoration. Recent scholarship has refuted many traditional attributions to Goujon. His career after 1562 remains largely a mystery; some have thought that as a Protestant he fled Paris.

See Pierre du Colombier, *Jean Goujon* (1949); Anthony Blunt, *Art and Architecture in France, 1500–1700* (1953). (J. HM.)

GOUJON, JEAN MARIE CLAUDE ALEXANDRE (1766–1795), French publicist and statesman, was born at Bourg on April 13, 1766. After a number of years at sea, he became *procureur-général-syndic* of the *département* of Seine-et-Oise (1792), and subsequently took his seat with the Mountain in the Convention.

After the revolution of 9 Thermidor (July 27, 1794) he denounced the Jacobin club, and on 1 Prairial (May 20, 1795) supported the demands of the populace who invaded the legislature. The failure of the insurrection brought about his arrest, and he committed suicide after his trial.

GOULBURN, HENRY (1784–1856), English statesman associated with Sir Robert Peel and his policies, was born in London on March 19, 1784, and educated at Trinity college, Cambridge. Member for Horsham in 1808, he sat in the unreformed parliament for a series of small constituencies before being elected for Cambridge university, which he represented from 1831 until his death near Dorking, Surrey, on Jan. 12, 1856. Undersecretary at the home office from 1810 to 1812 under Spencer Perceval, and for war and the colonies under Lord Liverpool from 1812 to 1821, Goulburn was chief secretary for Ireland from 1821 until his resignation when George Canning became prime minister in 1827. Holding this office during a difficult period, he proved efficient and conciliatory, although frequently denounced as an Orangeman; and he became the close associate of his predecessor, Sir Robert Peel, whose views he shared on most questions, notably Ireland and Catholic emancipation. Chancellor of the exchequer under the duke of Wellington from 1828 to 1830, Goulburn successfully continued and extended the fiscal and financial policies initiated by William Huskisson and Viscount Goderich. In 1834–35 he was home secretary in the first ministry of Peel, under whom he returned to the exchequer in 1841, retaining his position until the defeat of the government five years later. The prime minister, as first lord of the treasury, himself introduced the important budgets of 1842 and 1845, the Bank Charter act and the provisions for the repeal of the Corn laws. Consequently, Goulburn's role has often been regarded as that of a chief clerk, with little responsibility for directing policy. Nevertheless, as a trusted adviser, and an administrator capable of implementing great changes, he was invaluable to Peel. In the last phase of their association, Goulburn came to differ from his leader, though never publicly. In 1845 he agreed to repeal of the Corn laws with the greatest reluctance; and after 1846, when he ceased to play any prominent part in politics, he was a persistent if private advocate of that Conservative reunion to which Peel remained opposed.

Goulburn was a generally respected figure of the second rank who sat in parliament for 48 years, during 25 of which he held office. In addition, he was narrowly defeated for the speakership in 1839. Deeply Conservative in outlook, he was much influenced by "liberal Toryism," particularly in economic matters. Throughout his career, but especially as a member of Peel's inner circle, Goulburn was a prime example of the "man of business" in politics, concerned to preserve the existing order through efficient administration and judicious attention to "proved abuses." (A. F. T.)

GOULBURN, a city of Argyle county, N.S.W., Austr., 134 mi. S.W. of Sydney by the Great Southern railway. Pop. (1954) 19,183. The municipality was created in 1859 and became a city in 1864. It lies in a productive agricultural and pastoral district at an altitude of 2,129 ft., and is a thriving commercial centre. There are Anglican and Roman Catholic cathedrals.

Goulburn is a railway centre. There the railway to Canberra, Cooma and Bombala branches to the south, and to Crookwell and Taralga to the north.

GOULD, AUGUSTUS ADDISON (1805–1866), U.S. conchologist, author of a systematic study of Pacific mollusks and shells and expert on Massachusetts invertebrates, was born in New Ipswich, N.H., April 23, 1805, and graduated at Harvard in medicine in 1830. His reputation was world-wide; his writings fill many pages of the publications of the Boston Society of Natural History. He published with Louis Agassiz (*q.v.*) the *Principles of Zoology* (2nd ed., 1851); he edited the *Terrestrial and Air-breathing Mollusks* (1851–55) of Amos Binney (1803–47). The two most important monuments to his scientific work are *Mollusca and Shells* (vol. xii, 1852) of the U.S. Pacific ocean exploring expedition (1838–42) under Lieut. Charles Wilkes, published by the government, and the *Report on the Invertebrata of Massachusetts* (1841). He died in Boston Sept. 15, 1866.

His other works include *The Study of Botany in Connection with Medicine* (1835); *Description of Shells* (1848); *The Naturalists' Library* (1849); *Animal Life in the Ocean at Great Depths* (1862); *Otia Conchologica* (1863); *Search Out the Secrets of Nature* (1885).

See National Academy of Science, *Biographical Memoirs,* vol. v, pp. 91–113, and *Bibliography,* pp. 106–113 (1905).

GOULD, BENJAMIN APTHORP (1824–1896), U.S. astronomer, best known for his work in connection with longitude determinations, was born at Boston, Mass., Sept. 27, 1824. He graduated from Harvard college in 1844, studied mathematics and astronomy under C. F. Gauss at Göttingen, and returned to the U.S. in 1848. He was in charge of the longitude department of the U.S. coast survey (1852–67); he developed and organized the service, was one of the first to determine longitudes by telegraphic means and employed the Atlantic cable in 1866 to establish longitude relations between Europe and America. The *Astronomical Journal* was founded by Gould in 1849; and its publication, suspended in 1861, was resumed by him in 1885. From 1855 to 1859 he was director of the Dudley observatory at Albany, N.Y.; and in 1859 published a discussion of the places and proper motions of circumpolar stars to be used as standards by the U.S.

coast survey.

He undertook (1868), on behalf of the Argentine republic, to organize a national observatory at Córdoba; began to observe there with four assistants in 1870; and completed in 1874 his *Uranometria Argentina* (published 1879). He then made a zone catalogue of 73,160 stars (1884), and a general catalogue (1885) compiled from meridian observations of 32,448 stars. He died in Cambridge, Mass., Nov. 26, 1896.

GOULD, JAY (1836–1892), American financier, was born in Roxbury, Delaware county (N.Y.), on May 27, 1836. Though he left school in his 16th year, he devoted himself assiduously thereafter to private study, chiefly of mathematics and surveying. In 1852–56 he worked as a surveyor in preparing maps of Ulster, Albany and Delaware counties in New York, of Lake and Geauga counties in Ohio, and of Oakland county in Michigan, and of a projected railway line between Newburgh and Syracuse, in New York state. In 1863 he was appointed manager of the Rensselaer and Saratoga railway. He bought and reorganized the Rutland and Washington railway.

In 1859 he removed to New York city, where he became a broker in railway stocks, and in 1868 he was elected president of the Erie railway, of which he and James Fisk, Jr., (*q.v.*), had gained control. The management of the road under his control, and especially the sale of $5,000,000 of fraudulent stock in 1868–70, led to litigation, and Gould was forced out of the company in March 1872 and compelled to make restitution. It was during his control of the Erie that he and Fisk admitted Tweed to the directorate of the Erie, and Tweed in turn arranged favourable legislation for them at Albany. With Fisk in Aug. 1869 he began to buy gold, his hope being that, with the advance in price of gold, wheat would advance to such a price that western farmers would sell, and there would be a consequent great movement of bread-stuffs from west to east, which would result in increased freight business for the Erie road. His speculations in gold culminated in the panic of "Black Friday," on Sept. 24, 1869, when the price of gold fell from 162 to 135.

Gould gained control of the Union Pacific, from which in 1883 he withdrew after realizing a large profit. Buying up the stock of the Missouri Pacific, he built up the "Gould System" of railways in the South-western States. In 1880 he was in virtual control of 10,000m. of railway. He obtained a controlling interest in the Western Union Telegraph Company, and after 1881, in the elevated railways in New York city. He died on Dec. 2, 1892.

His eldest son, GEORGE JAY GOULD (born 1864), was prominent also as an owner and manager of railways, and became president of the Little Rock and Fort Smith railway (1888), the St. Louis, Iron Mountain and Southern railway (1893), the International and Great Northern railway (1893), the Missouri Pacific railway (1893), The Texas and Pacific railway (1893), and the Manhattan Railway Company (1892); he was also vice president and director of the Western Union Telegraph Company. It was under his control that the Wabash system became transcontinental.

The eldest daughter, HELEN MILLER GOULD SHEPARD (1868–1938), became widely known as a philanthropist, and for her gifts to American Army hospitals in the war with Spain.

GOUNOD, CHARLES FRANÇOIS (1818–1893), French composer, was born in Paris on June 17th, 1818, the son of F. L. Gounod, a talented painter. He studied at the Paris Conservatoire under Reicha, Halévy and Lesueur, and won the "Grand Prix de Rome" in 1839. In Rome he devoted much of his time to the study of the works of Palestrina and Bach. In 1843 he went to Vienna, where a "requiem" of his composition was performed. On his return to Paris he tried in vain to find a publisher for some songs which he had written in Rome. He became organist to the chapel of the "Missions Étrangères," and seems to have contemplated entering holy orders. Through the intervention however of Madame Viardot, the celebrated singer, he was commissioned (1851) to compose an opera on *Sapho*, a text by Émile Augier, for the Académie Nationale de Musique. Its success was not very great but it brought its composer's name to the fore, though for a time not to any great purpose, since neither his second dramatic attempt consisting of some choruses written for *Ulysse*, a tragedy by Ponsard, played at the Théâtre Français in 1852, conducted by Offenbach, nor his third *La Nonne sanglante*, given at the Paris Opéra in 1854, advanced his reputation.

Goethe's *Faust* had for years exercised a strong fascination over Gounod, and he at last determined to turn it to operatic account. The performance at a Paris theatre of a drama on the same subject delayed the production of his opera for a time. In the meanwhile he prepared a pleasing operatic version of Molière's comedy, *Le Médecin malgré lui* (Théâtre Lyrique, 1858). The first performance of *Faust* took place at the Théâtre Lyrique on March 19, 1859. The subject had already inspired in various ways Spohr, Schumann, Berlioz, Liszt and Wagner among others. *Faust* was given in London in 1863, when its success at first doubtful, became enormous, so that it was heard concurrently at Covent Garden and Her Majesty's theatres.

Gounod's next opera was *Philémon et Baucis a* charming setting of the mythological tale (Théâtre Lyrique, 1860) in which the composer followed the traditions of the Opéra Comique, employing spoken dialogue, though without abandoning the individuality of his own style. *La Reine de Saba* (Grand Opéra, Feb. 28, 1862) a four-act opera, was a more ambitious work, but had little success, although the score contains some of the composer's happiest inspirations. *La Reine de Saba* was adapted for the English stage under the name of *Irene*. *Mireille*, which followed (Théâtre Lyrique, March 19, 1864), founded upon the *Mireio* of the Provençal poet Mistral, contains much charming and characteristic music, but again the public was unresponsive; nor did *La Colombe*, heard at Baden in 1860, and at the Opéra Comique, succeed.

Gounod next sought inspiration in Shakespeare, and in the result *Rome'o et Juliette* (Théâtre Lyrique, April 27, 1867) had a success second only to that of *Faust*. Some have even preferred it to the latter. Gounod expressed his own opinion of the relative value of the two operas enigmatically by saying, "*Faust* is the oldest, but I was younger; *Rome'o* is the youngest, but I was older." The success of *Rome'o et Juliette in* Paris was great from the outset. In London it was not until the part of Romeo was sung by Jean de Reszke that the work was fully recognized.

Corneille's *Polyeucte* provided the subject of Gounod's next opera, but its production was delayed by the Franco-German war, during which Gounod visited London. There he composed the "biblical elegy" *Gallia* for the inauguration of the Royal Albert Hall, and a number of songs to English words, many of which have attained an enduring popularity, such as "Maid of Athens," "There is a green hill far away." On his return to Paris he hurriedly set to music an operatic version of Alfred de Vigny's *Cinq-Mars* (Opéra Comique, April 5, 1877), which found little favour. *Polyeucte*, which appeared at the Grand Opéra on Oct. 7, 1878 was no better received; nor was *Le Tribut de Zamora* (1881).

But Gounod had other strings to his bow besides the theatre. As Saint-Saens put it in his *Portraits et Souvenirs:*

> Gounod did not cease all his life to write for the church, to accumulate masses and motets; but it was at the commencement of his career, in the *Messe de Sainte Cécile*, and at the end, in the oratorios *The Redemption* and *Mors et vita*, that he rose highest.

Saint-Saens held that the three works mentioned will survive all the master's operas and however this may be they certainly contain many beautiful pages which have won them warm admirers along with the *Messe du Sacré Coeur* (1876) and the *Messe à la mémoire de Jeanne d'Arc* (1887). *The Redemption*, a "sacred triology," dedicated to Queen Victoria, and produced at the Birmingham Festival of 1882 bears the unmistakable imprint of the composer's hand, but the work in its entirety is not exempt from monotony. *Mors et vita*, dedicated to Pope Leo XIII., was first produced in Birmingham, at the Festival of 1885.

Gounod was a great worker. Besides the works already mentioned may be named two symphonies which were played during the 1850s, but have long since fallen into neglect. He also attempted to set Molière's comedy, *Georges Dandin*, to music, keeping to the original prose, but this work was never performed. Gounod died at St. Cloud on Oct. 18, 1893.

See his own posthumous *Mémoires d'un artiste (1896)*; C. Saint-Saens, *Charles Gounod et le Don Juan de Mozart* (1893) and *Le Livret* *de Faust (Monde Musicale,* 1914–19). *See* also P. L Hillemacher (1906); C. Bellaigue (1910), and Prod'homme and Daudelot (1911).

GOURAMI *(Osphronemus goramy).* a large. fresh-water food fish native to Asia, where it is widely cultured in ponds. Being omnivorous and tenacious of life, it often attains a length of 2 ft. and a weight of 12 to 14 lb. or more. It possesses an accessory respiratory organ above the gills, enabling it to live in warm, stagnant water and even for some time out of water. The flat oblong giant gourami is the largest member of the family Osphromenidae, to which belong also many small aquarium fish called gourami—pearl gourami *(Trichogaster),* kissing gourami *(Helostoma),* etc. *See* also AQUARIUM; FISHES.

GOURAUD, HENRI JOSEPH ÉTIENNE (1867–1946), French general, was born at Paris on Nov. 17, 1867. He entered St. Cyr in 1888, and was commissioned to the infantry in 1890. In 1894 he was seconded for duty under the colonial administration; and thereafter he served in the French Sudan for two years. He was serving in Morocco at the outbreak of World War I.

On Sept. 17, 1914, Gouraud was promoted temporary general of division, and the following January was appointed commander of the colonial army corps. On Feb. 15, 1915, he was made a substantive general of division. In May he replaced D'Amade as commander of the force in Gallipoli, where he was so badly wounded that his right arm had to be amputated. He was awarded the *médaille militaire* on July 10, 1915. On recovering from his wound he went to Italy in charge of a mission, and then in Dec. 1915 he was appointed to command the 4th army. A year later he was sent temporarily, as commissioner general, to Morocco; but he again took command of the 4th army in June 1917. From 1915 to the summer of 1918 the sector of the 4th army was relatively quiet, save for one moment in the spring of 1917 in which it was drawn into the ambit of Nivelle's offensive on the Aisne, and at that time Gouraud was in Morocco. Thus, when on July 1j, 1918, the Germans launched their last offensive on the Champagne front, Pétain had difficulty in winning him to the necessity of a "coil spring" defense. But when the time came Gouraud carried out its principles admirably, and brought the Germans' last effort to a standstill in his battle zone. In Oct. 1919 he became high commissioner in Syria and commander in chief in the Levant. He was appointed military governor of Paris in 1924. He died at Paris on Sept. 16, 1946.

GOURD, a name commonly used to designate the hard-shelled, ornamental fruits of two very different species, *Cucurbita pepo* var. *ovifera* and *Lagenaria siceraria.* These species are members of the gourd family, Cucurbitaceae (*q.v.*). Technically, botanists have broadened the term to include fruits of the wax gourd—*Benincasa hispida;* teasel *gourd—Cucumis dipsaceous;* sponge gourd—*Luffa cylindrica;* and snake *gourd— Trichosanthesanguina.*

Cucurbita pepo var. *ovifera,* the yellow-flowered gourd, includes the small ornamental gourds used for decorative purposes. The nest egg gourd, pear-shaped gourd, bicolour gourd, spoon gourd, and ladle gourd are common forms of this species. *Lagenaria siceraria,* the white-flowered gourd, has extremely large fruits. Some may attain a length of three feet or more, and fruits with diameters of one and one-half feet are not uncommon. Typical varieties are the bottle gourd, kettle gourd, Hercules club, dipper gourd and sugar-trough gourd.

Both species have a long history of association with man, and neither has ever been found in the truly wild state. *C. pepo* var. *ovifera* is native to northern Mexico and the eastern United States. L. *siceraria* probably comes from tropical Africa but evidence on this point is not decisive. Archaeological specimens of this species have been recovered in both hemispheres. Specimens found in an Egyptian tomb are dated at the time of the 5th Dynasty (3500–3300 B.C.), while in Peru seeds, shells and some intact fruits have been recovered from a large midden at Huaca Prieta in strata dated at about 3000 B.C. For primitive peoples without either metalware or pottery, the *Lagenaria* gourds served many purposes. They were used for cutlery, utensils, scoops, ladles, containers of all sorts, fish-net floats, whistles and rattles. In modern times the immature fruits have been used to a limited extent for food, but their chief use is for ornamental purposes. They are frequently painted bright colours, then used to decorate gardens, patios and even living rooms. Many of the smaller gourds of *C. pepo* var. *ovifera* are naturally banded, striped or mottled in various shades of green and yellow, while the solid white ones may be painted to suit the decorator's taste. Others are warted, and some are prized for their bizarre shapes.

These plants are vigorous, trailing annuals. C. *pepo* var. *ovifera* has comparatively large triangular-shaped leaves that are often deeply lobed. Stems and leaves are covered with short bristles that give them a harsh touch. The flowers are large, showy, and orange-yellow in colour. They are of two kinds, male and female, both produced on the same plant. Usually the male flowers appear a week or more in advance of the female flowers and are located toward the extremities of the runners. *Lagenaria* has musky-scented, large, heart-shaped leaves, of soft, velvety texture. The beautiful snow-white flowers open in the evening and close late the following morning. Like *C. pepo,* each plant bears male and female flowers.

Identical methods of culture can be followed with both the yellow-flowered and white-flowered gourds. The seeds should be planted in the spring immediately after danger from frost has passed. They require a long growing season to mature a crop of fruits and are killed with the first autumn frost. Well-drained mellow soils of good fertility are preferred. A warm, sunny location is best for maximum growth. A trellis built for the purpose, a fence or wall for the vines to crawl over are excellent for obtaining clean, well-shaped fruits, of maximum colour, without blemishes or ground spots. (T. W. W.)

GOURGAUD, GASPAR, BARON (1783–1852), French soldier, was born at Versailles on Sept. 14, 1783. He served in the campaigns of 1803–5, at Saragossa, and in the Danubian campaign of 1809. He acted as ordnance officer to Napoleon throughout the Russian campaign of 1812, served in the campaign in Saxony, and saved the emperor's life at Brienne. Though one of the royal guards of Louis XVIII. in 1814, he joined Napoleon in the Hundred Days (1815), was named general and aide-de-camp, and fought at Waterloo. He shared Napoleon's exile at St. Helena, but tired of the life at Longwood and the friction with Montholon, and went to England, where he published his *Campagne de 1815.* He returned to the army in 1830, became a deputy to the Legislative Assembly in 1849, and died in Paris in 1852.

Gourgaud's works include: La *Campagne de 1815* (1818); *Napoléon et la Grande Armée en Russie: examen critique de l'ouvrage de* M. *le comte P. de Ségur* (1824); *Réfutation de la vie de Napoléon par Sir Walter Scott* (1827); *Mémoires pour servir a l'histoire de France sous Napoldon,* with Montholon (1822–23); and *Bourrienne et ses erreurs,* with Belliard *et al.,* 2 vol. (1830). His most important work is the *Journal inkdit de Ste.-Hélène,* 2 vol. (1899).

See B. Jackson, *Notes and Reminiscences of a Staff Officer* (1904), and the bibliography to the article LOWE, SIR HUDSON.

GOURKO, JOSEPH VLADIMIROVICH, COUNT (1828–1901), Russian general, of Lithuanian extraction, was born on Nov. 15, 1828. He entered the imperial bodyguard, rose rapidly in the service, and at the outbreak of the Russo-Turkish war of 1877 he was placed in command of the van of the Russian invasion. He took Tmovo on July 7, crossed the Balkans by the Hain Bogaz pass, debouching near Hainkioi, and, notwithstanding considerable resistance, captured Uflani, Maglish and Kazanlyk; on July 18 he attacked Shipka, which was evacuated by the Turks on the following day. Thus within sixteen days of crossing the Danube Gourko had secured three Balkan passes and created a panic at Constantinople. He then made a series of successful reconnaissances of the Tunja valley, cut the railway in two places, occupied Stara Zagora (Turkish, Eski Zagra) and Nova Zagora (Yeni Zagra), checked the advance of Suleiman's army, and returned again over the Balkans. In October he was appointed commander of the allied cavalry, and attacked the Plevna line of communication to Orkhanie with a large mixed force, captured Gorni-Dubnik, Telische and Vratza, and, in the middle of November, Orkhsnie itself. Plevna was isolated, and after its fall in December Gourko crossed the Balkans, totally defeated Suleiman, and occupied Sophia, Philippopolis and Adrianople, the armistice at the end of January 1878 stopping further operations *(see* RUSSO-TURKISH WARS). Gourko was made a count, and decorated with the 2nd class of St. George and other orders. In 1879–1880 he was governor of St. Petersburg, and from 1883 to 1894 governor-general of Poland. He died on Jan. 29, 1901.

GOURMANCHE, an agricultural, cattle-raising people closely related to the Mossi, whom they resemble in social characteristics, in the Gourma province of the Upper Volta, Africa. They are organized in territorial groups under a paramount chief descended from the conqueror of the Mossi. *(See* Delafosse, ***Haut Sénégal*** Niger [1912]).

GOURMONT, REMY DE (1858–1915), French critic, essayist and novelist, was born on April 4, 1858, at the Château de la Motte, Bazoches-en-Houlme (Orne). He went to Paris in 1883, after having studied at Caen, and entered the Bibliothèque Nationale, where he remained for eight years; he was obliged to leave in 1891 in consequence of having published an article which was considered antipatriotic. In 1890 he founded, with several friends—including J. Renard and others—the *Mercure de France,* of which he was one of the chief collaborators for about 20 years. In his critical works, a distinction must be made between (1) notes on contemporary life published in the *Mercure* under the title of *Epilogues* (1903–13); (2) the series of *Promenades litte'raires* and *Promenades philosophiques* (1904–13), which are sometimes comparable with the *Causeries du Lundi* of Sainte-Beuve; (3) the series of studies dealing with pure literature, style and versification *(Le Latin mystique,* 1892; *L'Esthétique de la langue française,* 1899; *La Culture des idées,* 1900; *Le Chemin de velours,* 1902; *Le Problème du style,* 1907). As a critic, he had the great merit of drawing attention to the intellectual importance of Villiers de l'Isle Adam, Huysmans, Mallarmé, Nietzsche, etc., when the work of these authors was still little known.

He also had an original and precise conception of style. He was always on the alert to break up ideas or images associated by tradition or custom and to analyze them separately in order to set up new associations which, in their turn, might eventually be broken. From the philosophical point of view. Remy de Gourmont agreed, in principle, with the symbolists, in admitting that there exist other realities than those of the mind; but this idealism tended in his case to be sceptical and, at times, even cynical.

Like Schopenhauer and Nietzsche, with whose works he was so fully conversant, he owed much to the French moralists of the 18th century and to Montaigne. This quality of cynicism is clearly apparent in his *Physique de l'amour* (1903), in which he attempts to eliminate from the philosophy of love all mystical and romantic elements and to bring it into line with biology.

Remy de Gourmont was also the author of plays and symbolist poems which are no longer interesting except to the student, and of various novels, of which the most important are *Sixtine,* a *roman de la vie cérébrale* (1890); *Les Chevaux de Diomède* (1897); *Le Songe d'une femme* (1899); *line Nuit au Luxembourg* (1906); and *Un Coeur virginal* (1907). His gift for creating living characters is lacking in these books, but those of his works inspired by the philosophical romances of the 18th century, especially Diderot, are noteworthy for their lucidity and are marked by a fantastic and alert individuality. Remy de Gourmont wrote on many subjects, and with Anatole France was one of the last representatives of the *grande culture générale* in France.

JEAN DE GOURMONT (1877–1928), brother of the above, also contributed largely to the *Mercure de France.* He wrote some poems and a novel, *Le Toison d'or* (1908).

GOUROCK, a small burgh and seaside town of Renfrewshire, Scot., on the south bank of the Clyde, $25\frac{1}{2}$ mi. W.N.W. of Glasgow by road. Pop. (1951) 9,107. Gourock pier is the railhead for most of the Clyde passenger steamers, and Cardwell bay, at the eastern end of the town, is extensively used by Clyde yachtsmen. Tower hill (480 ft.) rises behind the town and divides it into three parts: Kempock (east), Ashton (west) and Midton (centre). A relic of pagan times is the tall gray stone. locally known as "Granny Kempock." formerly regarded as a talisman. Gourock's industries include yacht building and repairing and marine engineering.

GOURVILLE, JEAN HERAULD (1625–1703), French adventurer, was born at La Rochefoucauld, and in 1646 became secretary to François de la Rochefoucauld, author of the *Maximes,* whom he served during the Fronde, in his intrigues with the parliament, the court and the princes. In these negotiations he came into contact with Condé, Mazarin and Nicolas Fouquet. In 1658 he farmed the *taille* in Guienne. He bought depreciated *rentes* and had them raised to their nominal value by the treasury; he extorted gifts from the financiers for his protection, being Fouquet's confidant in many operations of which he shared the profits. In three years he accumulated an enormous fortune, still further increased by his unfailing good luck at cards, playing even with the king. He was involved in the trial of Fouquet and in April 1663 was condemned to death for peculation and embezzlement of public funds; but, escaping, was executed in effigy. He sent a valet one night to take the effigy down from the gallows in the court of the Palais de Justice and then fled the country. He remained abroad for five years, being excepted from the amnesty accorded by Louis XIV to the condemned financiers. Having returned secretly to France, he entered the service of Condé who, unable to meet his creditors, had need of a clever manager to put his affairs in order. In this way he was able to reappear at court, to assist at the campaigns of the war with Holland and to offer himself for all the delicate negotiations for his master or the king. He received diplomatic missions in Germany, in Holland and especially in Spain, though it was only in 1694 that he was freed from the condemnation pronounced against him by the chamber of justice. From 1696 he fell ill and withdrew to his estate where he dictated his *Mémoires,* an important source for the history of his time. In spite of several errors, introduced purposely, they give a clear idea of the life and morals of a financier of the age of Fouquet and throw light on certain points of the diplomatic history.

See his *Mémoires* (1724), of which there is a modern edition, with notes, an introduction and appendix, by L. Lecestre, 2 vol. (1894–95).

GOUT is a disease associated with an inborn error of metabolism, manifest by acute attacks of distress in one or more of the joints of the extremities. It is one of the oldest diseases described in medical literature. Colchicine, the drug most useful in treatment, is one of the oldest in therapeutics *(see* COLCHICUM). Gout is not rare; the incidence is at least 5% of all significant problems in the field of systemic arthritis. There is a hereditary element in the causation, incidence in some families being very high. The male-female ratio is 20:1.

Some patients develop gout secondary to a chronic blood disease. It may appear initially in any decade of life, and between attacks the patient experiences no articular symptoms. Kidney stone, albumin in the urine and elevation of blood pressure are related phenomena.

Acute symptoms of gout develop suddenly and persist for days or weeks if proper treatment is not followed. Heat, redness, tenderness and pain of the affected joints are observed. The body temperature may rise several degrees. The concentration of uric acid in the blood is elevated. A number of factors—including acute infection, emotional upset, surgical operation, direct injury, overindulgence in food or alcohol or administration of certain drugs—may precipitate an acute attack. Precipitation of microscopic amounts of uric acid in the cartilage precedes the first attack.

Appearance of uric acid deposits in the ear or under the skin about the joints appears many years later and only in a minority of patients.

Significant progress in the management of gout was a product of the mid-20th century. This resulted in a form of therapy more satisfactory than any available for other major types of joint disease. Full amounts of colchicine are used in the treatment of the acute attack. Following regression of acute symptoms, prophylaxis requires daily ingestion of colchicine as well as of an agent for eliminating uric acid from the body, the preferred drug in this group being probenecid. The prophylactic regimen should be maintained for several years, depending upon the severity of the affliction.

A high intake of water aids in the elimination of uric acid from the body. A normal balanced diet is recommended save for the avoidance of high purine foods; *i.e*, liver, kidney and sweetbreads. Alcohol in moderation is permitted. A patient who adheres to the prophylactic regimen should lead a normal life. pursue normal activities and should suffer little or no distress from acute attacks.

A few patients die prematurely because of kidney disease, but longevity in gout is normal. Chronic deforming changes are not common (J. H. T.)

GOUTHIÈRE, PIERRE (1732–*c* 1813), French metalworker, perhaps the most celebrated of his time, was baptized at Bar-sur-Aube on Jan 19, 1732, the son of a saddler. He obtained his diploma as a master gilder at the same time as he married the widow of his former employer, Ceriset (1758). He executed a great quantity of metalwork, the best of which was superior to that of any of his rivals in that great period of French craftsmanship. He collaborated with the most eminent cabinetmakers and interior designers of his day. The severity of his design was felicitously counterbalanced by the grace and suppleness of the molding. He invented the process of dull gilding.

His personal reputation began in 1769 with the magnificent jewel chest for Dauphiness Marie Antoinette. From then onward he did work at Fontainebleau, supplied the duc d'Aumont in Paris, Madame du Barry at Louveciennes and the cornte d'Artois at Bagatelle. Nevertheless he ran into financial difficulties and became bankrupt in 1788. The Revolution completed his downfall. He died in Paris in 1813 or 1814.

Gouthière's immense prestige is partly explained by the famous public sale in Paris in 1782 of the collection of the duc d'Aumont, in the course of which Louis XVI and Marie Antoinette acquired many columns and vases in porphyry or marble mounted by the famous metalworker. Pieces from the sale include a splendid red jasper bowl in the Wallace collection, London, and pieces at the Louvre. Paris.

See Jacques Robiquet, *Vie et oeuvre de Pierre Gouthière* (1921). (S GR)

GOUVION-SAINT-CYR, LAURENT DE (1764–1830), French marshal, mas born at Toul on April 13, 1764 At the age of 18 he nent to Rome with the view of prosecuting the study of painting, but although he continued his artistic studies after his return to Paris in 1784 he never definitely adopted the profession of a painter.

In 1792 he was chosen a captain in a volunteer battalion, and served on the staff of Gen. Adam de Custine. Promotion followed rapidly, and in the course of two years he had become a general of division. In 1796 he commanded the centre division of Jean Victor Moreau's army in the campaign of the Rhine, and by coolness and sagacity greatly aided him in the celebrated retreat from Bavaria to the Rhine. In 1798 he succeeded André Masséna in the command of the army of Italy. In the following year he commanded the left wing of Jean Baptiste Jourdan's army in Germany, but when Jourdan was succeeded by Masséna, St.-Cyr joined the army of Moreau in Italy, where he distinguished himself in face of the great difficulties that followed the defeat of Novi. When Moreau. in 1800, was appointed to the command of the army of the Rhine, Gouvion-St.-Cyr was named his principal lieutenant, and on May 9 gained a victory over Gen. Paul Kray von Krajova at Biberach. He was not, however, on good terms with his commander and retired to France after the first operations of the campaign.

In 1801 he was sent to Spain to command the army intended for the invasion of Portugal, and was named grand officer of the Legion of Honour. When a treaty of peace was shortly afterward concluded with Portugal, he succeeded Lucien Bonaparte as ambassador at Madrid. In 1803 he was appointed to the command of an army corps in Italy, in 1805 he served with distinction under Masséna and in 1806 was engaged in the campaign in southern Italy. He took part in the Prussian and Polish campaigns of 1807 and in 1808, in which year he was made a count, he commanded an army corps in Catalonia; but, not wishing to comply aith certain orders he received from Paris (for which *see* Sir Charles Oman. *A Hzstory of the Peninsular War*, vol. iii, 1807–14), he resigned his command and remained in disgrace until 1811. He was still a general of division. having been excluded from the first list of marshals because of his action in refusing to influence the troops in favour of the establishment of the empire. On the opening of the Russian campaign he received command of an army corps, and on Aug. 18. 1812, obtained a victory over the Russians at Polotsk. in recognition of which he was created a marshal of France He received a severe wound in one of the actions during the general retreat. St.-Cyr distinguished himself at the battle of Dresden (Aug. 26–27, 1813), and in the defense of that place against the allies after the battle of Leipzig, capitulating only on Nov. 11, when Napoleon had retreated to the Rhine. On the restoration of the Bourbons he was created a peer of France and in July 1815 was appointed war minister, but resigned his office in the following November. In June 1817 he was appointed minister of marine, and in the following September again resumed the duties of war minister, which he continued to discharge until Nov. 1819. During this time he effected many reforms, particularly in respect to measures tending to make the army a national rather than a dynastic force. He exerted himself also to safeguard the rights of the old soldiers of the empire, organized the general staff and revised the code of military law and the pension regulations He was made a marquess in 1817. He died at Hyères (Var) on March 17, 1830.

Gouvion-St.-Cyr would doubtless have obtained better opportunities of acquiring distinction had he shown himself more blindly devoted to the interests of Napoleon, but Napoleon paid him a high compliment by referring to his "military genius," and entrusted him with independent commands in secondary theatres of war. It is doubtful, however. if he possessed energy commensurate with his skill, and in Napoleon's modern conception of war, as three parts moral to one technical, there was more need for the services of a bold leader of troops whose doctrine predisposed him to self-sacrificing and vigorous action, than for a savant in the art of war of the type of St.-Cyr. Contemporary opinion, as reflected by Jean de Marbot, did justice to his "commanding-talents," but remarked the indolence which was the outward sign of the vague complexity of a mind that had passed beyond the simplicity of mediocrity without attaining the simplicity of genius.

He was the author of the following valuable works: *Journal des opkrations de l'armke de Catalogne en 1808 et 1809* (1821); *Mémoires sur les campagnes des armkes de Rhin et de Rlzin-et-Moselle de 1794 à 1797* (1829); and *Mkmoires pour servir à l'histoire militaire sous le Directoire, le Consulat et l'Empire* (1831).

See Gay de Vernon, *Vie de Gouvion Saint-Cyr* (1857).

GOVERNMENT is concerned specifically with that side of social life which is focused upon consent, control, power and authority. Wherever men attempt to work together through organization, government arises, for no organization can function without some pattern of rule nhich determines who is in ultimate charge. Government as a field of study is, therefore. inseparable from the study of man and society in all times and places.

The rich materials which modern critical history and anthropology have made available, if properly implemented by what psychology. sociology, economics, jurisprudence and the other social studies have to contribute to the analysis of the process of governing men. provide an unprecedented opportunity for developing a science of government.

DEFINITION AND CLASSIFICATION

Government, State and Nation.—Government has been defined in many different ways by a long list of philosophers and social scientists from Plato and Confucius to those of the present day. These definitions have frequently been cast in terms of the purpose of government.

The most commonly acknowledged end or purpose of government has been either justice or the public good. But there have always been conflicting views which, while admitting that justice or the public good ought to be the end of government, have insisted that it has rarely, if ever, actually achieved any such ideal. Conceiving of themselves as realists, such writers and students of government have alleged that the actual end of government appears to be some sort of self-satisfaction of those who do the governing, be this the acquisition of additional power, or glory, or riches or any combination of these and other desires of the human heart.

Looking back over the last 2.500 years of this debate, the detached observer is obliged to conclude that none of these views represents the whole truth, and that all of them contain some truth. As a result, there has been a tendency since the 19th century to discard ends as a key to defining government and a predisposition to concentrate on the process of government—how government works. This is known as the functional view. It might be summed up in the definition that a government is a group of human beings. large or small, who control the operations and the changes of an organization. The "revolution of nihilism," however, has taught the perils of ignoring the ends of government.

While it is usual to think of a nation or other large group when speaking of a government, and employing the expression the government, it is obvious that all other groups as well have some kind of government, whether they be families, business enterprises, trade unions, churches, universities or anything else. But in modern times, these group governments are typically subordinated to the government; they operate within the framework of a legal system which owes its authority, if not its existence, to the government and is enforced by the government. This fact of being on top of all the other governments, which characterizes the government of a modern nation, is by no means as self-evident as one is inclined to assume. In other times and places other groups, such as churches, have had independent and sometimes superior authority. If the world community ever gets to the point of developing fully its own government, that government probably will be superior to the governments of nations.

When viewed as independent and legally self-sufficient organizations, modern nations are spoken of as states. The word state arose in Europe during the 16th and 17th centuries in the course of the very development which made the nation the focal point of power and authority. In fact, the concepts of state and nation are so intimately linked that the expression national state is really a pleonasm. It is important to distinguish the much broader phenomenon of government (defined above) from the concept of the state, although many writers, especially in Europe, continually confuse the two and speak of the theory of the state when they really mean the theory of government.

The concept of the state crystallized in the period of determined struggle of secular rulers against the medieval notions of independent power. These rulers needed a concept which might effectively challenge the church by investing the nation with a halo comparable to that possessed by the mystic body of the believers. Medieval writers had laboured to develop the idea of the visible and the invisible church. State and nation came to occupy a comparable position in the social philosophy of secular writers. It is no accident that the founders of the modern theory of the state—Niccolo Machiavelli, Jean Bodin, Thomas Hobbes—were all violently antiecclesiastical. The portions of their works in which they denounce the ecclesiastical authorities as "the kingdom of darknesse" (Hobbes) and the like are now rarely read, but they show that the concept of the state arose in the fight against the church. At the same time, it is interesting that Richard Hooker's great treatise on government is entitled The Laws of Ecclesiastical Polity; in defending the Elizabethan settlement, the judicious Hooker had to face the transfer of authority from church to state.

Classification of Governments.— Since the days of Plato and Aristotle, governments have been classified in a great many different ways. The Greek philosophers adopted a scheme of classification which was compounded of a strictly numerical criterion and a very general value judgment.

In doing this, they undoubtedly built upon an older tradition of which some evidence survives, such as the famous discussion of the Persian king Darius, reported by Herodotus, and the work of the sophist Hippodamus of Miletus. Plato saw the several forms of politeia, or political order, as corruptions of the ideal order which he delineated in the Republic. It has often been overlooked that he addressed himself to the order in the polis (city) only; his classification is not supposed to cover the political systems of the barbarians, though broadly speaking he inclines, as most Greeks, to see these despots as analogues to the tyrant in the polis. Tyrannos was, of all the politeias, the worst and most corrupt. with the tyrant himself the most unhappy of men. It is the rule of one who is completely lacking in virtue. Its opposite is, relatively speaking, the best, the rule of one who is a man of virtue. The same distinction holds for the other four possible political orders: if a few virtuous men rule, the result is aristocracy; if a few unvirtuous ones, oligarchy; if many possessing some virtue, timocracy; if many without virtue, democracy. This classification which turns upon virtue (arete) in the rulers was eventually qualified by Plato in two directions. On the one hand, he recognized that for the virtue of rulers may be substituted a law of comprehensive scope, and on the other hand he came to feel that a mixture of the three numerical schemes (one, the few, the many) might be best. These ideas found comprehensive expression in his late works, especially The Laws.

Aristotle built upon this foundation, while introducing some significant changes. The discussion is not cast in terms of an ideal, but rather in those of a standard or model. This model is conceived in relation to the end (telos) of the polis: the happiness of its citizens. Happiness itself is comprehensively conceived, embracing as it does the largely contemplative life of the few philosophers, as well as the more mundane concerns of wealth, friends and family. Aristotle's model he calls politeia or political order as such. In Aristotle's terms there was a good and a bad rule of one, of a few and of many. These he called monarchy and tyranny, aristocracy and oligarchy, polity and democracy. His concept of the polity corresponds to the idea of a constitutional democracy in the United States, whereas he uses the term democracy to denote. a constitutionally unrestrained rule of the majority. Without retaining their precise Aristotelian meaning, these terms have become a part of the general political vocabulary of modern man. Yet other writers and thinkers have added many a differentiating concept to this group of six. Thus, the rule of the rich has been called a plutocracy, the rule of the priests theocracy, the rule of officials bureaucracy (*q.v.*). The last term is of modern origin. In the 16th and 17th centuries it was customary to divide governments into monarchical and republican, a usage which finds expression in the U.S. constitution when it provides that each state shall have a "republican form of government." The mid-20th century brought to the fore a classification into democratic and dictatorial or totalitarian governments, while other ideas such as socialism, liberalism and conservatism have also served as a basis of classification.

Perhaps the classification of most universal significance is that which is determined by the key aspect of the pattern of control: whether power is concentrated or divided. All more stable power is based on organization and the control of organization. Without common objectives there can be neither organization nor power. Power, therefore. always presupposes several human beings who are joined together in pursuing a common objective. "All human associations are established for some purpose," is the opening phrase of Aristotle's Politics. That would seem to preclude a genuine division of power. Yet actually objectives may be common because: (1) they are spontaneously shared; (2) they are mutually supplementary; or (3) though conflicting, they are outweighed by other considerations. If organization results in the third case, it is because those who want it get the others to cooperate by constraining or coercing them, and thus making them prefer the avoidance of the threatened penalty to whatever induced them to object.

In order to avoid a situation in which conflicting objectives predominate, power may be divided; different groups in the community may be entrusted with different tasks and charged with restraining other groups.

This theory of constitutionalism, which has been stated in many different forms (*see* CONSTITUTION AND CONSTITUTIONAL LAW), affords a basis for classifying governments according to whether they are constitutional or not, or more exactly according to the extent to which they are constitutionalized. Force or constraint and consent are the two intertwined bases of power and control, with complete constraint and complete consent the unreal extremes between which most human organizations and their governments can be ranged. All power situations contain both force and consent, although in crude, everyday speech we often talk as if there were some governments which are completely based on consent and others completely on force. Actually, governments may be classified according to the degree of either force or consent involved in their operation.

Finally. there is found a species of informal classification which characterizes the government by naming the class or group which is in control. Plutocracy and theocracy are really part of this classification. But we often speak of undertakings such as military government, colonial government and feudal government. It is obvious that such a scheme of classification is indeterminate as long as it does not comprise all conceivable groups which might control. But sociologists using these terms have often failed to analyze adequately what they assumed; namely. that the particular group actually governed. On the whole, it is fair to state that too much has been made of the problem of mere classification.

In opposition to all such schemes of classification, there have been from time to time students of government who have set out to discover the common features of all schemes of government. The phrase "invisible government" has been coined to suggest that no matter what the outward form there always is an invisible government of the few, and that all governments are merely formal disguises for the rule of an elite or special class. Perhaps the most ambitious attempt along this line was made by the Italian Gaetano Mosca, who in his The *Ruling* Class maintained this view with much show of historical learning. Although further refined and generalized by Vilfredo Pareto in his general sociology with its theory of the elite, it is not a tenable view; the task of governing cannot be divorced from the wielding of legitimate authority. and the informal participation of diverse individuals does not constitute these as a class in the sense of Mosca, or an elite in Pareto's understanding.

COMPARATIVE GOVERNMENT

The comparative study of governments is an uncompleted task. Modern governments have been effectively compared and an overall theory based on experience has been presented by such writers as James Bryce, G. D. H. Cole, Herman Finer and Carl J. Friedrich. But these undertakings have been strictly limited to contemporary governments of western European origin. The much more extensive task of systematic comparison and evaluation of the process of government covering all cultures and groups remains to be done. It will be well, however, to present some of this knowledge in general survey form in the following sections. We may conveniently use a historical plan and discuss the following major fields of experience: (1) primitive government. (2) large-scale (Asian) despotism, (3) Greco-Roman republicanism, (4) medieval (European) government, (5) modern western government.

HISTORICAL SURVEY

Primitive Government. — The government of so-called primitive peoples displays a great variety of forms. Anthropologists have shown conclusively that all these people do possess governments, be they ever so rudimentary. Many of them combine religious and governmental functions, so that high priests are often kings and vice versa. Frequently kings are deified in that they are supposed to be endowed with supernatural powers and are regarded with awe. These views are reflected in a number of institutions of the Greek city-state, as well as of Rome. They are also recognizable in the institutions of imperial Japan, China and elsewhere. Rut it would be a mistake to assume that these primitive forms of government are necessarily despotic in their practical workings. As a matter of fact, few of them are. Even in warlike tribes where the king is often the military leader some species of consent pattern is worked. The characteristic feature which differentiates primitive government from the later forms is the lack of any kind of regularized or institutionalized administration. If writing is used at all, it is primitive, and the frequent lack of any considerable employment of currency prevents the development of accounting practices. Primitive government, in its most general connotation, may be described as a government incidental to tribal life and informally linked to its general patterns of behaviour and belief.

Asian Despotism. — Throughout Asia there arose, in conjunction with the development of literacy, the general increase in culture and the forward march of technology, especially in warfare, a species of government which is passing only in modern times. These governments are usually spoken of as despotic, although this term is something of a misnomer, because they were quite limited in scope and, while extending over large land masses, they often included the greatest variety of governmental practice in local jurisdictions. These great systems seem really to have been slow extensions of primitive tribal governments, usually were based upon an underlying homogeneous group growing out of the conquering tribe, and on the whole showed a remarkable viability. They were invariably monarchical in structure, and the monarch was usually invested with divine attributes, if he was not actually deified. They were, it has been held by some, in no sense states, as the west has understood this term, and the trials and tribulations which China encountered in its efforts to grow into a modern state are in part attributed to the fact that the preceding pattern of government had not yet developed any such close-knit system of administration or of legislation as had been established by the monarchies of the west when they were overthrown by their several revolutions (see below). It was contended by others that these oriental despotisms were "states" in a particularly virulent sense. Karl Wittfogel, for instance. argued that these despotisms, especially Chinese despotism, represent a power system which embodies total power in the sense of totalitarian dictatorship. He believed that this kind of government arose in response to the technical requirements of an agriculture which depended wholly upon irrigation. Hence he called these societies "hydraulic." The central piece of this form of government would then be a bureaucracy, described as monopolistic and characterized by "total terror, total submission and total loneliness." This elaborately argued contention has met with sharp criticism.

Whatever may be the eventual conclusion regarding the nature and value of this type of government. there can be little doubt that while it is ill-adapted to the modern world and a machine technology, it served the people reasonably well as long as they lived under a system of handicraft production, whether in industry or agriculture. As the remarkable state of culture in all its forms (literature, arts, music and religion) attests, these systems were fairly tolerant of, if not positively interested in, human creativity. An occasional outburst of violence such as that which occurred in China under Shih Huang Ti (246–210 B.C.) merely shows that this system of government is habitually ill-adapted to extreme governmental control. Its worst feature, in the long run, was unquestionably its tendency to fall to pieces when the court circles grew corrupt. lazy and indifferent. At such times these systems often plunged into anarchy and became exposed to sudden invasions by outsiders, especially barbarians of bellicose disposition. But these despotic systems lasted longer than any other known form of government to date, and were swept away only by the onrush of modern industrial civilization with its multiplicity of governmental tasks.

Greco-Roman Republicanism. — When the city-states of the so-called classical world are considered, one is on more familiar ground. Not only have the great writers of antiquity, such as Aristotle, Thucydides and Polybius, left an explicit record of the government of these remarkable communities, but a vast amount of the most searching learning has gone into the critical examination of these records. a learning associated with names such as Numa D. Fustel de Coulanges and Theodor Mommsen, which combined a deep grasp of the problems of government with thorough historical scholarship.

The remarkable cultural flowering that occurred in Greece at the height of the power of the city of Athens cast a golden glow over these city-states. As later ages marveled at the Periclean age, they inclined toward idealizing its political institutions. Yet, from a modern viewpoint, it is all-important to remember that even the most democratic of these republics, such as Athens, rested upon a broad basis of slavery. The citizenry was in other words, an upper class whose privileged position permitted it to participate in public affairs. The defense of slavery by both Plato and Aristotle, though often treated as a deplorable aberration. is really of central importance to their political philosophy. They believed in a superior race, and not in the "common man everywhere."

Upon the substratum of this slave population, the size of which has been variously estimated, the city-states were originally organized as monarchies under tribal kings. These were gradually superseded by military aristocracies, which in turn gave way to an aristocracy of wealth and to an ever-widening body of citizens. The divergent rate of progress in different cities toward this kind of democracy eventually led to a situation in which most Greek cities were split into a democratic and an aristocratic faction, each epitomized by one leading city—Athens or Sparta. The conflict between the two types of government culminated in the disastrous and long-drawn-out struggle known as the Peloponnesian War (*q.v.;* 431–404 B C.). While frequently represented as a fight between two ideologies, it was in fact as much a war between rival imperialisms, and it prepared the way for the final subjugation of all Greek cities by the kingdom of Macedon and later by Rome. The Greeks experimented extensively with federation as a solution to their problem of combining unity with independence of the cities, but the federations proved no match for enemies whose government rested upon the more solid basis of territorial control. (See GREECE. History.)

The Roman republic, which eventually achieved the overlordship of all Greek cities. in Sicily, in Asia Minor and in Greece proper, followed the tradition of the Greek cities at first, but soon grew beyond it by developing a solid territorial foundation. This foundation was provided by the conquest of the Italic cities and the subsequent settlement of Romans on the land, conferral of Roman citizenship upon the inhabitants, or both. Furthermore, Rome evolved a complex constitutional structure in which monarchical, aristocratic and democratic elements were skillfully blended. Perhaps the most extraordinary feature of this government was its dual executive, welding the imperium. or power to command. After a time, tno consuls replaced the monarch as the chief executives; they had practically identical functions, and could not act one without the other (see CONSUL). Finally, there was the praetor, who also shared the imperium. At the heart of the republic's government we find a legislative establishment, compounded of the fathers (patres) and the "people" (populus). Originally, the people were only the patricians, but after a long struggle the nobles had to allow the plebeians to share in the offices (magistratus) and to adopt decisions of their own (plebiscita). The military assembly (Comitia centuriata) and plebs decided what laws were wanted. expressing their preferences, but only upon proposals (*rogationes*) by the magistrates. The fathers, organized as the senate, were presumably only consulted, and their decisions took the form of a *senatus consultum.* But actually the senate became the dominant body in Rome to uhich both magistrates and people deferred. Thus the letters SPQR (*Senatus Populusque Romanus,* "the senate and the Roman people") were the magic symbols of Roman power, as well as of Roman subjection to law. Among the offices, the most important were the fiscal (quaestors) and the judicial ones, primarily a number of praetors holding *jurisdictio.* Among these last, the praetor *peregrinus* exerted a profound influence upon the development of Roman law, because he interpreted the Roman civil law for the many foreigners doing business in Rome. This body of law, known as the *jus gentium,* implemented the *jus civile* and came to form the hard core of the Corpus Juris Civilis as it was eventually codified by Justinian (6th century). There were other important officers. such as the censors and the tribunes of the people. who provided a further check to the consuls and other magistrates, and, finally, there was the dictator. This office. which superseded all others, came into being only in emergencies and was strictly limited to six months. It eventually became the basis for the destruction of the republic. The subtle mixture of monarchical, aristocratic and democratic elements which has evoked the admiration of students of government ever since continued as an outward ritual long after the effective power had become completely concentrated in the hands of the Caesar imperator. (See ROME.)

It was a common trait of all the republics of the ancient world that the city or polis combined in interlocking functions the task of government with the exercise of religion. Thus, the great temples, such as the Acropolis in Athens, mere the centres of the city's life. and their architecture clearly reflects this function. While all the Greek cities acknowledged the common Olympus with its Zeus. Hera and the other gods and goddesses, each city had its own special god from whom the local gentry claimed to be descended. Citizenship was, therefore, invested with the religious halo of belonging to the cult community, and it is not surprising that to the Greeks the good life appeared inconceivable outside the polis. Patriotism, under such conditions. had a deeper foundation and a nobler appeal than within modern nations whose religious life and ideals transcend the nation and its government. Much confusion has resulted from the attempts of modern philosophers, from Machiavelli to Georg F. W. Hegel and the fascists, to apply Greek ideas concerning the polis to the modern nation-state.

This close tie between religion and politics caused the basic difficulty the Roman empire faced with the rise of Christianity. For the Christians refused to accept the deification of the emperor which had been evolved in response to problems which Roman rule in Asia had posed. Hence, the very best emperors, more especially Marcus Aurelius. were inclined to persecute the Christians most severely. because of their attachment to the religio-spiritual foundation of their empire. Even after the Christian faith had become the Roman state religion. under Constantine, the situation of the Roman government was an equivocal one: a church as a radically autonomous corporate entity, unrelated to and not seen as the creation of the Roman government (state), was not accepted until much later. Pope Gelasius I (5th century), uho is usually though incorrectly credited with stating the doctrine of the "two swords," first effectively argued this position. In the eastern part of the empire it never achieved ascendancy. But in the west, the dualism of church and government became accepted doctrine, and it is within this context that the heritage of Roman law was bequeathed to medieval Europe.

Medieval Government.—The medieval system of government was extraordinary in its rich diversity combined with a claim to resplendent unity. Centred in the unity of Christianity, the universal empire and the universal church both gloried in aspirations which they never succeeded in realizing. The doctrine of the two swords, the secular suord of worldly empire and the ecclesiastical sword of spiritual guidance toward salvation, rationalized the dominant fact of medieval government: a continuing struggle between temporal and ecclesiastical authorities to achieve supremacy. By the time the Holy Roman empire came essentially to be "of the German nation" (14th century), the emerging national monarchs, especially of England. Scotland, France and Spain, were much concerned with claiming for themselves the position of imperator and Caesar, and the curious competition for the imperial office between Francis I of France, Henry VIII of England and Charles V of Spain and Germany highlights how long this idea of universal empire persisted in spite of the obvious independence of the great kingdoms.

These kingdoms and principalities themselves underwent an interesting evolution in the course of which their governments became constitutionalized. The system of "government by estates" (Standestaat), which was common throughout Europe (except in Italy) on the eve of the Reformation, provided a genuine division of power betueen the monarch, the aristocracy and the commoners. Its pattern is most familiar through the English system of a king in parliament, but it was actually more highly developed elsewhere. Tudor absolutism foreshadowed the breakdown of this type of government by skillfully manipulating the estates into a position of impotence.

But there was a third pattern of government to be found in the medieval world; namely, city republics. These republics were strongest in Italy, but they achieved a powerful position likewise in Germany and the Low Countries. Bruges and Antwerp, Lubeck and Cologne, Strasbourg and Augsburg, Venice. Milan and Florence—all these and many more were brilliant centres of an urban secular culture which grew up under the aegis of a republican scheme of government. These city republics underwent a governmental evolution resembling that of the cities of the ancient world until they were absorbed into the rising territorial states or became, like Milan and Florence, themselves such states. But since they were, unlike the cities of Greece! embedded in a broader pattern of government — the universal realm of emperor and pope — their preoccupation with commerce as contrasted with politics made them the precursors of the great trading nations of the present time.

Modern Government. — Modern government is not a clearly defined term; but it roughly includes three different types: monarchical absolutism, constitutionalism and totalitarianism.

Monarchical Absolutism. — Of these three forms of government, monarchical absolutism is pretty much a thing of the past, but it was the predominant form from the 16th to the end of the 18th centuries. Indeed, modern government owes one of its most distinguishing features, bureaucracy, primarily to these absolute monarchs. Using the term dispassionately to designate the body of public officials engaged in administering the government's business: we are justified in saying that this bureaucracy constitutes the core of modern government. Arising in England and in the papal administration in the 14th century, and subsequently in other realms, such as France, Spain, Austria, Prussia and the Netherlands, the bureaucracy rationalized administration by regularizing its operations, such as bookkeeping, recordkeeping and correspondence, by differentiating its functions and by training its personnel. Without these achievements, modern government is unthinkable.

But modern government is likewise unthinkable without legislation; *i.e.*, a growing body of explicit, man-made rules by which the individual can live without fear of interfering with his neighbour. This point became clear in the 16th century, when the growing commerce and industry necessitated numerous alterations in existing lam. While some, like Jean Bodin (*Six Livres* de la *république,* 1576), claimed this function of legislating for the monarch, others, especially in England, claimed it for the people or their representatives. To be sure, the term "people" had a rather restricted connotation, limited as it was to the more well-to-do in town and country, but it served as a harbinger of the coming democratization.

A third element in the evolution of modern government is the courts of law. The majesty attributed to the lam was reflected in the social position of judges. Even such absolutists as Frederick the Great of Prussia found it expedient to recognize the importance of leaving a good deal of independence to the judges. While the principle that judges should be bound only by the law is actually an extension of the general principle of administration that demands objectivity, it acquired a distinct significance in Great Britain and the United States, and later in Europe, as a pillar of modern government.

Legislation by popular representatives and an independent judiciary were steps on the road toward constitutionalism. Both implied a division of power between the monarch, or crown, and others, and hence led away from the concentration of powers characteristic of monarchical absolutism. Either or both may find a place in an authoritarian pattern, such as those of Prussia and Austria after the Napoleonic Wars (1805–15), but their full development is not possible except after the establishment of genuine constitutionalism.

Modern Constitutionalism. — Constitutionalism in its broadest connotation may be defined as a government which is limited by a constitution. Such a constitution may be constructed in a great variety of ways. It may be built around a monarchy, or it may be a republican scheme; it may provide a unitary or a federal system; it may set up a parliamentary executive or some other kind; it may contain a bill of rights or it may not; but whatever the detailed arrangements, it will always seek to make sure that no one man, or group of men, is in a position to exercise legitimate power nithout some effective restraint placed upon him to relinquish it, share it or seek it periodically at the hands of the electorate. No matter how skillfully balanced. the ultimate sanction for the maintenance of any constitutionalism lies in the determination of the people to maintain it. This determination, which has been called constitutional morality and of which Jean Jacques Rousseau as a Swiss proudly spoke as the unwritten law "graven upon the hearts of the citizens," has in the last analysis decided the success or failure of constitutional government.

There used to be much concern over whether a constitution was rigid or flexible. Students comparing the situation in the United States and Great Britain, as for instance Bryce, were fond of dwelling upon this theme. More realistic analysis has disclosed this difference to be rather elusive. Rigid and flexible are ill-defined terms which hide rather than explain the real problems. The third French republic had a constitution which proved too easy as well as too difficult to change. It was not a question of general rigidity or flexibility. but rather that it was badly drawn. The U.S. constitution used to be classed as rigid, but it acquired and lost again a provision for prohibiting the sale of intoxicating liquor. such as has not been adopted in Great Britain.

Much more central and significant is the problem of federalism. A constitution which guarantees to a number of component units of government an independent jurisdiction is characterized thereby as a federal constitution. Extended controversies have raged over how to define a federal government or state. This formalistic battling over words has delayed a realistic study of the political nature of these federal schemes. Leaving the insoluble problem of uho is the sovereign in a federal setup, we may say that federalism is a system of government that divides political power territorially under a constitution. Even the most effectively centralized government will grant some measure of decentralized authority to local bodies. In terms of objectives, federalism seeks to balance. under a constitution, partly general and common objectives, and partly particular and conflicting objectives when these objectives are distributed in space. Thus, the Swiss constitution leaves all educational matters to the cantons so that cantons with a French-speaking majority may differentiate themselves from the German-speaking majority in the country as a whole.

Federal patterns of government frequently owe their existence to a preceding federation or league of governments. It is. therefore, possible to analyze such governments pragmatically in terms of the institutions which are characteristic of such federations. The United States, Switzerland and Germany, as well as several dominions, are examples of this. Three characteristic federal institutions may be mentioned here: (1) a legislative assembly composed of representatives of the component units, be they called states, cantons or provinces, as if they were equals or near-equals; (2) an executive in which, or in the selection of which, the component local units participate; (3) a judicial body or bodies for the settlement of disputes between the component local units and the union government according to the charter or constitution. (See FEDERAL GOVERNMENT.)

Even more imaortant than the question of federal government is that of parliamentary government. Is the executive dependent upon the support and confidence of the elected representative assembly or has he an independent position and a separate mandate from the people? England is the home of parliamentary government, and it is principally in England and the dominions that this system has worked well. The admirers of the system are generally inclined to credit it with the superior performance of British politics, but comparative analysis suggests at least two contravening considerations. First, it would seem that parliamentary government depends for its success upon unwritten conventions which in turn depend for their operation upon certain common beliefs and behaviour patterns found only in Britain and its dominions. Second, parliamentary government does not in actual operation correspond to the alleged theory. The supposed responsibility to the parliament is actually restricted to a few dominant issues, whereas many minor matters are decided by the party in power in accordance with considerations of expediency and tactics which may not be shared by the majority of the people or even of parliament. This may also be true of major issues.

In England, the system itself is a congeries of conventions which grew from small beginnings as the party system developed. There was an increasing tendency for the house of commons to be divided into a majority and a minority party, with the result that the majority party controlled the body and presented itself to the crown as the obvious basis of a solid government whose leader might reasonably be asked to head the government. The party leader would then naturally invite his leading associates to share the government with him, and hence Britain has always been inclined toward collective responsibility of the cabinet (see CABINET). However, since the turn of the 19th century the prime minister has become increasingly important, and general elections tend to focus attention upon him much as quadrennial elections do upon presidential candidates in the United States.

Such leading students of parliamentary government as Sir Ivor Jennings suggest that the term parliamentary government is not accurate, so far as the 20th-century British system is concerned, and that one should rather speak of cabinet government. The function of parliament seems to them to be rather that of a deliberative assembly in which various views concerning proposed policies of the government are subjected to analysis and criticism, while the actual government is carried on by a cabinet which is organized by the party and its leader on the basis of a mandate directly from the people. In support of this view one can point to the fact that since World War I no cabinet which had an actual majority in the house of commons has been overthrown by vote of parliament. Elections have been held either because the five-year term was nearly over or because the party in power deemed it strategic to do so.

In France a rather different system was constructed by men whose intention it had been to establish parliamentary government on the British model. Under the third and fourth republics the French parliament became paramount. It is important to know that this omnipotent parliament was not clearly divided into a majority party supporting the government and a minority party opposing it, but consisted of a great many groups, more or less related to a complex multiparty system. The great committees of parliament (unknown in England), and more especially its leading members, secured a considerable share in the governing functions, and in co-operation with the permanent high bureaucracy really ruled the country. This system, while giving excellent results in the sphere of administration, was characterized by stalling, when major decisions had to be taken, and finally collapsed when the fourth republic was confronted with the task of solving the M-gerian problem. A different and more authoritative system which purported to be a blend of British and U.S. (presidential) elements was established in 1958.

The French kind of parliamentary system was adopted in Germany after World War I with disastrous consequences. To be sure, there the situation was complicated by other factors, including the aftermath of a lost war and federalism, but the parallel developments in Italy and elsewhere suggest that this system of government by parliament is not viable. It should be noted that its abandonment by Germany after World War II, and the substitution of a more stable form which is a skillful adaptation of the British model, gave good results, even though combined with federalism.

The Scandinavian countries, Belgium and the Netherlands also made a reasonable success of parliamentary government. Whether this fact is attributable to a basis of beliefs and traditions comparable to those that prevail in England, or to the presence of a monarchy with a settled willingness to accept constitutionalism, or to both, it is difficult to determine.

The nonparliamentary executive may be of two prevailing kinds. In the United States, the president is, for all practical purposes, elected directly by the people and is or becomes thereby the leader of his party. In all matters of general policy involving legislation or the spending of funds he must successfully manage his party in congress, both senate and house. or his hands are tied. Grave difficulties confront him if, as a result of a congressional election, the representative assembly becomes dominated by the opposition party, as happened to Woodrow Wilson in 1918, to Herbert Hoover in 1930, to Harry S. Truman in 1946 and to Dwight D. Eisenhower in 1956. However, the lack of party discipline sometimes makes it possible to carry on with the support of votes from the opposition (as was done for many years in the state of New York where Democratic governors had to work with Republican legislatures. The nonparliamentary executive type of government of the presidential form has been vigorously attacked and critically contrasted with the parliamentary type by students of U.S. government, such as Woodrow Wilson (Congressional Government, 1885). Its failings are generally admitted, but it is doubtful that they are more serious than those of the parliamentary type.

The conciliar type of nonparliamentary executive is illustrated by Switzerland. Its stable and ably conducted democratic government is under a federal council composed of the heads of the various departments who choose a chairman as president of the republic for one year. The members of this council separate their administrative function clearly from their legislative tasks. When the legislature repudiates a proposed policy, the council does not resign, but either drops it or prepares another proposal. It is curious, indeed. that the Swiss system has not found more imitators, for it appears well adapted to the task of governing a small country on a republican basis. (See SWITZERLAND: Government.)

Totalitarian Dictatorship.--In spite of profound differences in general outlook and objective, as a pattern of government the totalitarian dictatorships have a great deal in common. They represent a distinct and ultramodern pattern of government. The totalitarian dictatorships all claim to be set up for the people and they all make a show of some sort of popular support, either through unfree sham elections, through plebiscites or through other forms of mass acclaim, customarily reinforced by denunciations of constitutional democratic regimes as capitalist and imperialist plutocracies. Yet, these regimes are usually characterized by several of the following practices and institutions.

First, totalitarian dictatorship originates in a coup *d'état* through which an organized minority seizes power by armed force or constitutional fraud or both. Second, it continues because this minority, organized as a party, takes over complete ultimate control of the government, the leader of the party becoming, in effect, the monocratic head of the government. Third, it constitutes this controlling party as an aggressive elite which seeks to abolish all other pre-existing social and class differentiations and thus atomizes the electorate, dissolving even the family into often warring individuals. Fourth, it establishes as complete a control over all forms of expression. including science, religion and the arts, as possible, subordinating all persons engaged in these creative pursuits to rigid governmental supervision and control. Fifth, it institutes an elaborate governmental propaganda which continually swamps all subjects with news and opinions, with the end of securing their allegiance or at least acquiescence. Sixth, it develops a systematic reign of terror for the purpose of crushing all opposition by spying upon, summarily arresting and liquidating all enemies of the state. using summary procedures and arbitrary sentences, including long detention in concentration camps and every species of physical torture. Seventh, it establishes complete control over all economic activities for the purposes of integrating the economy and subordinating all enterprise to the ends of the government. Eighth, it invariably includes a vast military establishment among these purposes of government, on the ground that the defense of the state is of paramount importance.

This kind of government is sometimes identified with despotism, tyranny and absolutism. These identifications are misleading. Any careful comparison of the traits just delineated with the structure of government in those older autocracies will immediately disclose striking contrasts. Most important among these is the totalitarian mass party, fired by a faith in a total reconstruction of society—a kind of secular religion—which is completely lacking in past autocratic government. It is the actual autocrat in a totalitarian dictatorship, speaking through its leader or leaders who are bound to it by faith and ritual. These governments have shown themselves capable of accomplishing extraordinary feats. The industrialization of the U.S.S.R., the near-conquest of all of Europe by Hitler Germany, the revolutionary transformation of the ancient Chinese society, politically, socially, culturally and economically—these are outstanding examples of totalitarian governmental achievement. The stupendous sacrifices in human suffering involved in these undertakings seem amply justified in the eyes of the rulers and the ruling party by the achievements. The ominous appeal of totalitarianism in Asia and Africa results from these accomplishments. Since freedom in most of these formerly colonial peoples is at best a vague hope, whereas national independence and the standard of living are pressing, ever-present realities, it appeared quite possible in the second half of the 20th century that totalitarian government would continue to spread.

So all-inclusive a system of governmental control was never before in the history of mankind developed by anyone. Even the extreme tyrannies of men such as Shih Huang Ti, Domitian and the condottieri of the Italian Renaissance lacked, because of technological inefficiencies, the asphyxiating effect of modern totalitarianism. The extraordinary effectiveness of modern weapons, such as tanks, airplanes and nuclear bombs, as well as their initial cost, render individual revolutionary effort hopeless at the outset. Consequently, not one of these totalitarian dictatorships has been overthrown from within. Only superior external force has brought on their downfall.

Local Government.—The ever-increasing size and complexity of government on the national and international level in the second half of the 20th century revived interest in the local community, and the growth of great metropolitan centres further contributed to this concern. The importance of the local community in the functioning of constitutional government is generally recognized. Even the totalitarian systems, in attempts at administrative decentralization or communalization, manifested the abiding role of the local community. These tendencies were in part motivated by the fact that local communities have proved rather resistant to the pressures of totalitarian government. Politico-sociological analysis discovered a fruitful area of field studies in the more intimate life of local communities. The slogan of "grass roots democracy" testified to the trend.

But it is one thing to recognize the importance of the local community and another to organize it effectively for self-government in an age of mass industry. While local functions increased, along with other governmental trends, these functions were continually more in need of effective integration within larger governmental units. Britain's proud tradition of local self-government, for example, had to yield to the point where the local activities became largely centrally directed. Under these circumstances, a general tendency developed to make the selection of local personnel the focal point of local autonomy. But unless such personnel have policy issues on which to contend for acceptance, their autonomy will be precarious and party bureaucracy will be able to subject them to the party will.

There is no one pattern of local government that is clearly preferable to all the rest. Britain, France, Switzerland, Germany and other European countries each evolved one or more patterns of their own, in which mayors. clerks, councils and local officials were arranged in various ways. The United States too has a number of patterns. Noteworthy are the so-called city-manager type, the newest form, in which local government is assimilated to the operation of a business enterprise, and New England town-meeting government, the oldest form, where the whole community decides basic policy. (See CITY GOVERNMENT; LOCAL GOVERNMENT; UNITED STATES [OF AMERICA]: Administration and Social Conditions: Local Government in the States.)

Military Government.—The end of World War II brought in its train military occupations on an unprecedented scale. In Italy, Austria, Germany, Japan—wherever the fascist government collapsed—the victors had to assume governmental authority for a transition period. Such military government, defined as government by the military over occupied enemy populations, when conducted by constitutional democracies, is comparable with emergency government. Military government is directed toward the establishment of a constitutional democracy, but as an emergency government it is obliged to extend its authority far beyond the usual limits. Military government is in its nature authoritarian, but according to international law it is neither lawless nor despotic. In working for the establishment of popular government in the occupied country, military government endeavours to re-establish first of all government according to law (the "rule of law") as the necessary basis for free institutions. In the process of eliminating the totalitarian elements, it is often very severe and obliged to create new law retroactively. The lawless nature of the preceding totalitarian system makes this unavoidable.

World Government.—The San Francisco charter, drafted and adopted in 1945, became the constitution of a confederation of nations, the United Nations. While originally hopes were high that this constitution might mean the start of a world government, the sharp conflicts which arose between the United States, Great Britain and their friends on one side, and the Soviet Union and its satellites on the other, made it abundantly clear that the United Nations was not going to operate as a functioning government, but rather as a permanent gathering of the representatives of most of the governments of the world. Several important governments were, in the late 1950s, outside the UN. Because of the division of Germany between Communist and non-Communist regimes, agreement on UN membership for neither could be secured. Equally symbolic was the situation of China. While the vast majority of Chinese, living under Communist rule, remained unrepresented, the nationalist government of Formosa occupied a ,permanent seat on the UN council.

The organization of the United Nations consists of two general bodies for policy decisions, the general assembly in which each member state is represented by one vote. and which in the late 1950s had over 80 members. and the Security council, composed of 5 permanent members, the U.S., the U.S.S.R., Great Britain, France and nationalist China, and of 6 nonpermanent members, elected by the assembly. The permanent members of the council have a veto on certain decisions, which protects their sovereignty (*q.v.*). These vetoes aroused a great deal of indignation and criticism, not only of the power principally exercising them, the U.S.S.R., but also of the Security council as such. Its importance accordingly declined, but this decline also reflected the fact that the UN was in process of becoming a world forum rather than a world government.

In spite of its weakness as an instrument of government, the UN must not be underestimated as a political instrument. A number of serious conflict situations were attenuated by means of its good offices, and the secretary general at times took important initiatives. Furthermore, certain of its affiliated bodies, such as the European Economic commission (EEC) and the UN Educational. Scientific and Cultural organization (UNESCO), accomplished important tasks. Thus, while the UN was not an effective world government, it was developing a number of governmental functions. Both the United States and the U.S.S.R. looked upon it as an important factor in the world community and in cooperation with their allies and satellites sought to mold it to their purposes. Yet in the long run what is perhaps more significant, since these two super powers would have readily at their disposal other means of international action, is the fact that the UN organization activates and gives a measure of real power to small nations which when well represented often wield an influence out of proportion to their position in the world of pure power politics. This influence, on the whole, proved a power for good, though there were also cases of abuse, especially on the part of some of the newly independent nations.

The various problems inherent in so loose an organization as the UN led to insistent demands for amending the charter. A great deal of devoted labour went into these reform efforts, but nothing came of them because the very conditions which led to the complaint, such as the veto of the great powers, or the position of Formosa, also prevented any change. Given a radical change in international relations, and a sharp decline of world tensions, such plans might, however, take concrete shape. The UN, it was felt by its supporters, deserved to be maintained, if only to be in existence when such a day should arrive. Genuine world government did not seem feasible, though some world governmental functions were in operation. The danger existed that the prestige of the UN might decline to the point where it could no longer be maintained, but in view of the solid work that was being accomplished in special fields, and because of the value of a meeting ground of all nations for the discussion of the world's problems, the continued operation of the United Nations was generally believed assured.

See also WORLD GOVERNMENT MOVEMENTS.

BIBLIOGRAPHY.—Systematic consideration of comparative government has been a virtual monopoly of British and U.S. scholarship. *See*, however, Gunnar Heckscher, *The Study of Comparative Government and Politics* (1957). Of the many works in this field, the most complete are Herman Finer, *Theory and Practice of Modern Government*, rev. ed. (1949, 1951, etc.) and Carl J. Friedrich, *Constitutional Government and Denzocracy*, rev. ed. (1950).

French and German studies of the same general problem usually adopt a more legalistic and juridical viewpoint. Among these works three are of outstanding merit: Léon Duguit, *Traité de droit constitutionnel*, and ed. (1921); Jean P. H. E. Esmein, *Eléments de droit constitutionnel français et compare'*, 8th ed., rev. by H. Nezard (1927–28); and Georg Jellinek, *Allgenzeine Staatslehre*, new ed. by W. Jellinek (1922). To these may be added the later *Manuel de droit constitutionnel et de science politique* by Maurice Duverger (many editions) and Georges Burdeau, *Traitd de science politique* (1949–57).

Of the more theoretical analyses of modern government, Charles E. Merriam's *Systematic Politics* (1945) supersedes earlier works. *See* also Karl Loemenstein. *Political Power and the Governmental Process* (1957); David Easton, *The Political System* (1953); Walter Lippmann, *The Public Philosophy* (1955). An abstract, systematic treatment is found in Harold Lasswell and Abraham Kaplan, *Power and Society* (1950). A. D. Lindsay's *The Modern Denzocratic State* (1947) is incomplete but valuable. For the totalitarian dictatorships *see* Sigmund Neumann, *Permanent Revolution* (1942), which constituted a useiul beginning; also C. J. Friedrich and Z. Brzezinski, *Totalitarian Dictatorship and Autocracy* (1957); and Karl A. Wittfogel, *Oriental Despotism* (1957).

There are also certain broad sociological studies of society with a major focus on government interpreted as persistently oligarchic, especially Arthur F. Bentley, *The Process of Government* (1908); Max Weber, *The Theory of Social and Economic Organization*, Eng. trans. by A. M. Henderson and T. Parsons from *Wirtschaft und Gesellschaft* (1947); G. Mosca, *The Ruling Class*, Eng. trans. by Hannah D. Kahn from *Elenzenti di scienza politica* (1939); and V. Pareto, *Mind and Society*, Eng. trans. by Andrew Bongiorno and Arthur Livingston from *Trattato di sociologia generale*, 4 vol. (1935). The studies by Bertrand de Jouvenel, *La Pouvoir* (1947) and *De la Souveraineté* (1955), deserve mention.

The works cited above contain ample bibliographical guides to the literature covering the more specialized areas of the broad subject considered in this article. (C. J. FR.)

GOVERNMENTAL ARCHITECTURE comprises those buildings whose function is to serve governmental purposes, such as town halls, capitols, courthouses, parliament buildings, post offices, customhouses and similar structures.

HISTORY

The history of governmental building goes back to the dawn of human society and may be found as an adjunct of the temple, the royal residence or the communal dwelling, according as the governmental organization was theocratic, autocratic or communal. When the king was also priest. or the primitive communism was surrounded by religious taboos, these three types overlapped. Thus, among some savage peoples, there were structures which were at once temples and meeting houses and also served as council chambers.

Primitive developments of the communal idea were found among the American Indians; the council house of the Onandagas was such a structure, 80 ft. long and 17 ft. wide. Among the town-building Indians of the southwest where the tie between religion and government was strong. round rooms called kivas or estufas, sometimes built underground, were used for secret rites and for council deliberations.

In such autocratic civilizations as that of Egypt, governmental functions were centred in the royal palace, which had halls of audience and courts where the king and his counselors met. and where executive orders and judicial decisions were rendered. The great columned halls of the Persian palaces at Susa and Persepolis (6th and 5th centuries B.C.) and the palace of Solomon at Jerusalem, especially the "House of the Forest of Lebanon" (I Kings vii, 2) were built for official rather than residential use.

Greece.—In prehistoric Greece, a combination of the autocratic and democratic appeared, as in the courtyards, reception halls and throne room of the palace of Cnossus in Crete (c. 1800–1200 B.C). On the mainland, the autocratic element prevailed, as in the residential palace of Tiryns (c. 1200 B.C.).

The growing complexity of governmental systems in the independent cities of Greece necessitated special governmental buildings. At first only subdivisions of an open place or agora, these later became well-articulated structures adjacent to the agora. The most important of these was the *bouleuterion*, or council hall, in which were located the legislative and executive functions. Nearby stood the prytaneum, or town hall, where the city hearth fire continually burned, banquets were held and the commanding general had his residence. The courts, usually held in colonnades, or stoas, were occasionally convened in open areas reserved for them. such as the Areopagus (Ares' hill) in Athens. At Priene and Miletus in Asia Minor extensive remains of the *bouleuterion* exist which show a building nearly square with seats arising in stages on three sides. At Miletus the seats are curved like those in a Greek theatre. At Megalopolis a much larger hall (late 4th century B.C.), known as the Thersilion, was built for the meeting of a large governmental council. This building, 220 ft. long by 172 ft. wide, had a roof supported on columns placed behind each other in radiating lines, thus affording the widest possible view of the centre of the hall where the speaker stood. At Olympia the *bouleuterion* was an even more complex structure, consisting of a square central hall with an apse-ended building on each side, divided by ranges of columns down the centre.

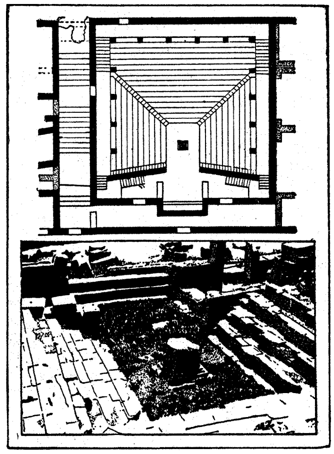


FIG. 1.—GREEK BOULEUTERION: ABOVE, GENERAL GROUND PLAN; BELOW, PORTION OF RUINS

There were two forms of prytaneum: (1) a circular primitive form, recalling the tholos, or early Greek beehive hut, and (2) a more developed sort in which the megaron or hall of the Mycenean palace is recognizable. At Priene, the resemblance to the typical Greek house was particularly strong; at Olympia, the hearth fire was kept in a hall at the front with a large court at the rear, smaller courts on each side and halls for banquets. *See* PRE-HELLENIC ARCHITECTURE; GREEK ARCHITECTURE.

Rome.—The highly developed governmental life of the Roman empire was reflected in its mature types of governmental architecture. The group of governmental buildings surrounding the Roman Forum formed, in fact, the earliest prototype of the modern national capitol. The buildings themselves, however, were merely developments of such structures in smaller Roman cities, like Pompeii. There, one end of the forum was filled by three buildings sharing a common façade, the central being the *curia* (town council chamber) and those at the sides the offices of the duumvirs and the aediles. The central building thus served the legislative function and those at the sides an executive function. All three were rectangular with apses at the end. On one side of this group was an enclosed court. thought to have been the comitium or voting place of the citizens. On the opposite side stood the basilica (*q.v.*). Thus. all the functions were housed in buildings designed for governmental purposes.

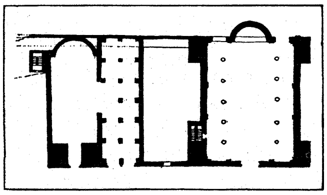
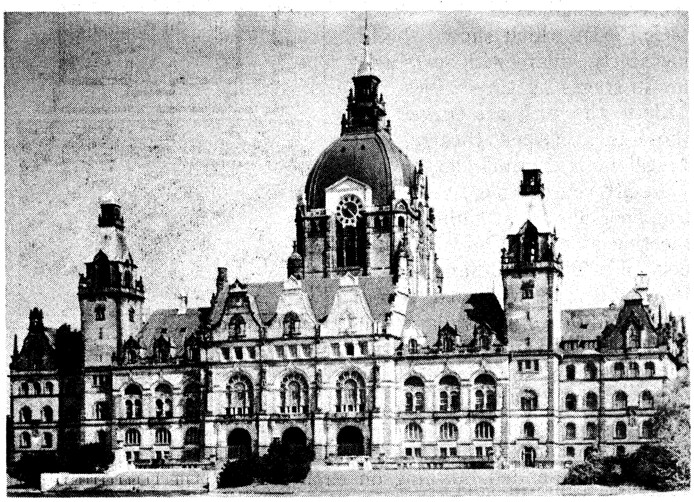


FIG. 2.—GENERAL GROUND PLAN OF A ROMAN CURIA IN THE 16TH CENTURY

In Rome itself the details were different, and additional elements appeared, yet the basic idea was the same. The Curia or senate house, whose walls still stand as the church of S. Adriano (rebuilt by Julius Caesar and Augustus, following a fire, and rebuilt again by Diocletian after the great fire of A.D. 283). was a rectangle 75 ft. wide and 85 ft. long, probably with columns dividing it into three aisles, and an apsidal tribune at the end. This senate house was at the end of a large structure; at the other end was a smaller apsidal hall, originally the *secratarium senatus,* now the church of S. Martina. Between these were two other halls used as archives and executive offices. Stairs led to the second floor. The whole formed a richly decorated and magnificent building. Not far away on the slope of the Capitoline hill stood the national archives building known as the Tabularium, built by Sulla, the massive masonry and monumental arcades of which still overlook the Forum. Across the Forum from the Curia stood the Roman treasury, incorporated into the temple of Saturn. The judicial functions were carried on in various basilicae, especially the Basilica Aemilia and Basilica Iulia.

At the opposite end of the Forum stood the regia, the Roman equivalent of the Greek prytaneum and the ritual centre of Roman life and government. The official residence of the *Pontifex Maximus,* it was closely related to the Atrium Vestae and the temple



BY COURTESY OF GERMAN TOURIST INFORMATION OFFICE

FIG. 3.— THE TOWN HALL IN HANOVER, GER.. COMPLETED IN 1913

of Vesta with the ever-burning city fire. *See* ROMAN ARCHITECTURE.

Middle Ages.—The social pattern of the feudal system was not conducive to the development of governmental architecture. With the rise of the powerful municipalities of the 12th century, however, the modern concept of governmental architecture had its origin. Throughout Europe the reaction against feudalism found expression in the building of town halls. At first the town hall was merely a meeting place for the citizens, frequently only a belfry erected adjacent to a public square. By the middle of the 12th century, types in Italy and France became definite.

In Italy, the *palazzo pubblico* resembled the town houses of the wealthy, being built around a court and having high castellated walls. Often it served as the official building. with meeting halls for governing bodies, and also as the residence of the commanding general. In Florence two separate buildings, the Palazzo Vecchio (1298) and the Bargello (1256), were used, the first as the town hall, the second as the residence of the chief magistrate and the prison. These, like most Italian town halls, have belfries attached. Other contemporary municipal halls were the Palazzo Pubblico at Siena (1293–1309) and the Palazzo della Ragione at Padua (1172–1219), whose upper hall, added in 1420, is 267 ft. long and 89 ft. wide, entirely free of interior supports. The *broletti* or town halls in many of the smaller cities are not less characteristic than the governmental palaces which have been cited.

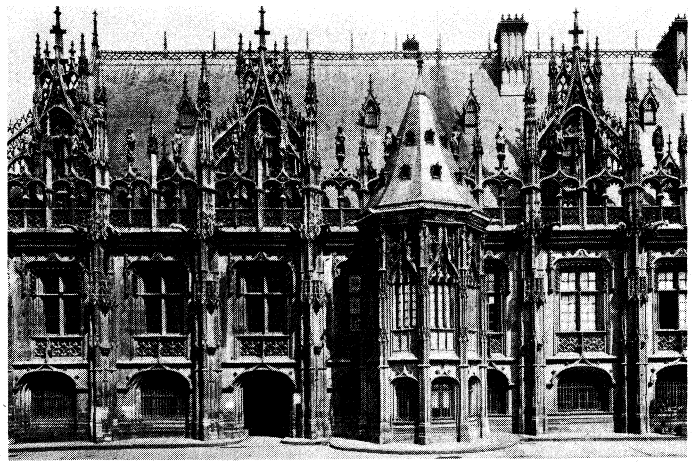
The French town halls usually combined an arcaded market hall on the ground floor with the governmental halls above and a belfry near by. The 12th-century town halls at St. Antonin, in almost perfect preservation, and at La Réole are typical of the period. As the power of the municipalities increased, the richness of the town halls did likewise, as those at St. Omer (14th century) and St. Quentin (16th century) demonstrate. Meanwhile the market hall was forced out and the entire building devoted to governmental purposes.

Between 1400 and 1600, the town hall received its greatest development in the powerful commercial cities of the north. In these a new influence was operative, that of the guildhall. The merchant guilds had become closely related to municipal government; in some cases the governing body of a city was called a guild. Thus. the hall of the corporation of the city of London is known as the Guildhall. In some towns of the Low Countries, the town hall and the guildhall were combined, as at Ypres where the town hall was known also as the Cloth Hall. This splendid building (1200–1304), a rectangle 50 ft. wide and 462 ft. long, had a cloth market on the ground floor, its upper floor containing meeting halls, law courts, banquet rooms and municipal offices. The structure was rated one of the most monumental examples of secular Gothic in Europe, before it was destroyed during World War I. Other commendable Flemish examples are those at Arras (completed in 1494, the belfry 1554), Louvain (1448–63), Brussels (1402–54) and Ghent (completed 1533). In Germany, the most beautiful town halls are those at Lübeck (13th century), Tangermünde (1373–78), with remarkable brick Gothic detail, Brunswick (14th century) and Goslar (15th century). *See* GOTHIC ARCHITECTURE.

Renaissance.—This type of town hall design continued in use throughout the Renaissance period except in Italy. The prevailing taste in Italy led to the erection of smaller but more elegant single buildings such as the beautiful Palazzo del Consiglio at Verona (*c.* 1500, by Fra Giocondo) whose exquisite early Renaissance polychrome façade has been much admired, and the equally rich Municipio of Brescia (c. 1500). The Palazzo del Senatore (1592–98), by Michelangelo, on the Capitoline hill in Rome is significant for its successful attempt to give the structure a form both dominant and monumental, yet differing from the early Renaissance forms of north Italy.

Outside of Italy, where the medieval tradition persisted, the Renaissance town halls simply applied classical details to such building types as had been developed before; *e.g.,* the town hall of Bremen (15th century, reconstructed 1609) and the old city hall of Paris (destroyed in the civil war of 1871). In rebuilding the latter, the old plan was merely enlarged and the old style preserved. The modern tradition of municipal building was founded on the medieval town hall.

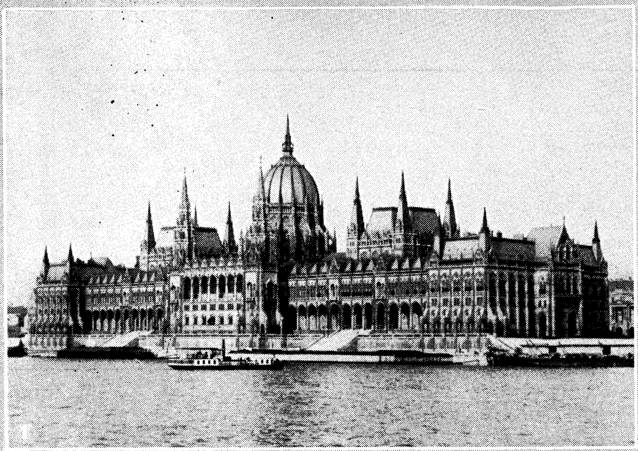
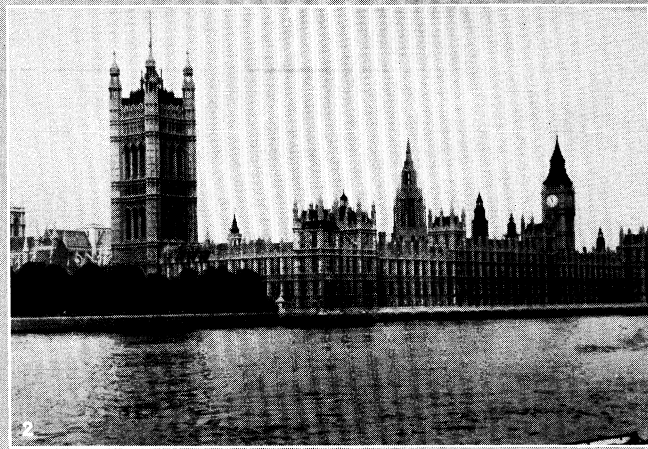
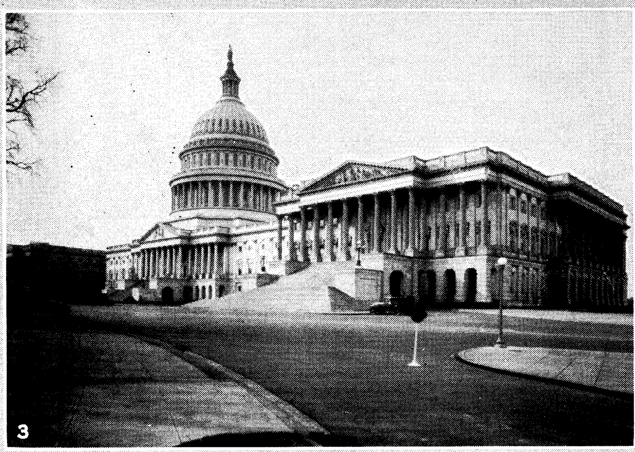
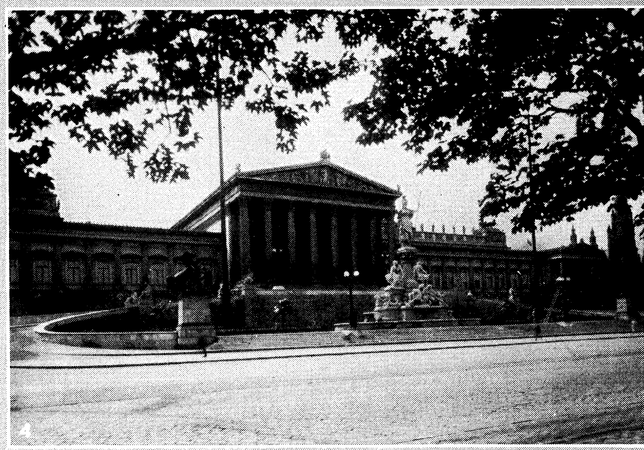
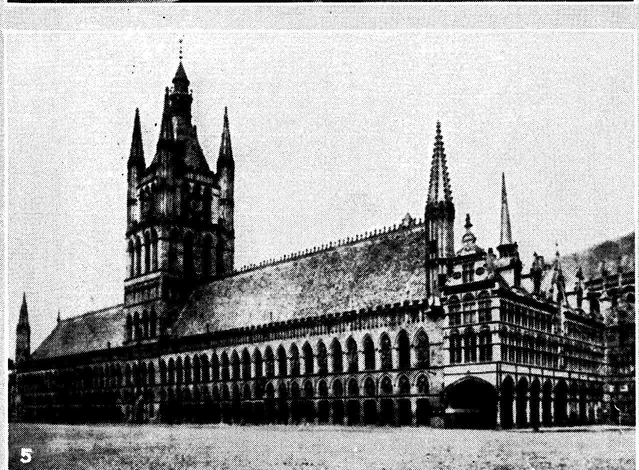
Another important type of governmental building that took form during the middle ages was the courthouse or *palais de justice.*



GIRAUDON

FIG. 4.—THE PALACE OF JUSTICE AT ROUEN. FRANCE. BUILT IN THE LATE 15TH CENTURY

Most medieval examples are of the late Gothic period because only then had judicial processes become sufficiently divorced from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LEGISLATIVE AND JUDICIAL BUILDINGS

1. Parliament House, Budapest, Hungary; Steindl, architect (1883–1902). An interesting attempt is made in this building to take a plan of the type set by the Capitol at Washington (fig. 3) — two wings, one on each side of a central rotunda — but to treat the whole in a picturesque and romantic Gothic style. The result is impressive, although the detail is sometimes crowded. 2. Houses of Parliament. London, England; Sir Charles Barry, architect (1840–50). The first great modern legislative building in an adapted Gothic style was that in London. It forms one of the most convincing examples of Modern Gothic. There is no attempt to express the plan or arrangement of the buildicg on its exterior; on the other hand there is no attempt at false or forced picturesqueness. In addition to the legislative chambers and their offices, the building contains the Speaker's residence, and many robing rooms and other quarters required for royal ceremonials. 3. The United States Capitol, Washington, D.C. Begun in the last decade of the 18th century with Dr. William Thornton as architect, it was carried on through the early 19th century by Stephen Hallet, B. H. Latrobe, and Charles Bulfinch. In its earlier form it had the central rotunda (then with a low dome) and a wing on either side, one for the Senate, and one for the House of Representatives. In 1853 these old rooms were found too small, and a great wing was added at each end, from the designs of Thomas U. Walter. At the same time the present great dome with its column-circled drum was added. 4. The former Parliament buildings, Vienna; Hansen, architect (1874–83). One of the most monumental in plan, and most gracious in its classic detail of any of the national parliament buildings, this simple composition is one of the distinguished decorations of its city. 5. Hôtel de Ville, Ypres, Belgium. 13th–15th centuries. Sometimes called the "Cloth Hall," this building (destroyed during the World War) was an expression of the close relationship of merchants' guilds and city government which was usual in Flanders. It contained the hall of the Cloth Merchacts' Guild, a market hall beneath, and the offices of the city government as well as a great banqueting hall. 6. The Palais de Justice, Brussels, Belgium; Polaert, architect (1866–83). The enormous bulk of this craggy and powerful building set on a hill top dominates the city; although lavish and in questionable taste, it conveys, nevertheless, by virtue of simple conception, monumental arrangement, and stark strength of design, a compelling impression of the dignity of government, and the power of law

PHOTOGRAPHS, (1) KNOPF-PIX FROM PUBLIX, (2, 4, 5, 6) EWING GALLOWAY, (3) MACDONALD

U.S. STATE AND MUNICIPAL BUILDINGS

1. The skyscraper state capitol of Louisiana at Baton Rouge, surrounded by a 50-ac. park
2. The civic centre at Columbus, Ohio. The building with the tower is the American Insurance Union building. The low building at the left is the city hall; at the right, the state office building
3. The Nebraska state capitol at Lincoln. The base is but two stories high; from it rises the central 400-ft. tower
4. The city hall at Buffalo, N.Y., located in the civic centre
5. New York city's civic buildings. The city hall (1802–09) is in the foreground, with the court building to the left. In the background are the municipal building and hall of records
6. The city hall at Houston, Texas

royal, monastic or feudal domination to necessitate separate buildings. The earliest existing are the Maison de Pierre at Chartres and the Salle le Roi at Montdidier (both 14th century). By far the most famous is the lavish Palais de Justice at Rouen. begun before 1474 and completed before 1509. This magnificent building. built around three sides of a courtyard, contains in addition to smaller courtrooms, two splendid halls and a beautiful chapel. It is in this use of large halls that originated the tradition for providing for every courthouse a great lobby where lawyers may confer with their clients.

No such development of national governmental buildings can be found during this period. What national unity existed was centred in the residence of the sovereign and when national councils or legislative bodies finally arose, they were housed either in a royal palace or in religious buildings. To this day the French senate sits in the palace of the Luxembourg. In England, the king's council met wherever the monarch happened to be, and the English parliament convened at the nearest convenient spot to the royal palace at Westminster, which was the chapter house of Westminster abbey, until 1547 when parliament moved to St. Stephen's chapel within the palace itself. This remained the meeting place of the house of commons until 1834 when the palace was burned. See RENAISSANCE ARCHITECTURE; BAROQUE ARCHITECTURE; MODERN ARCHITECTURE, 18TH AND 19TH CENTURIES.

MODERN GOVERNMENT BUILDINGS

In planning governmental architecture, the relationship of the working units and the means of communication between them and the outside are highly important. Simplicity of plan and beauty of form are also desirable. Many public places—lobbies, rotundas, halls and committee rooms—are treated in as monumental a fashion as is possible. and axial symmetry is an almost inevitable result.

Capitols and Legislative Buildings.—The *United States.*—

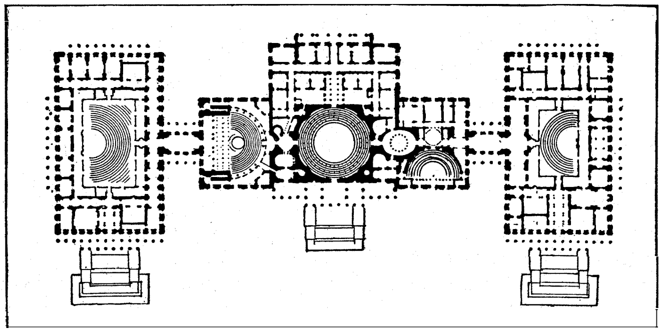

FIG. 5.—GENERAL PLAN OF THE NATIONAL CAPITOL. WASHINGTON. D.C.

A national capitol building, built solely for the housing of a national government. was first projected in the U.S. A competition for the design of the Capitol at Washington, D.C.. was held in 1792 and was won by William Thornton. His carefully articulated plan provided large halls for the senate and house of representatives. separated by a central rotunda. Begun in 1793 and burned during the War of 1812. it was not completed in its original form until the 1830s. The earlier Capitol may be described as the work of Thornton, Étienne Sulpice Hallet, Benjamin Henry Latrobe and Charles Bulfinch. successively its architects. The old House of Representatives became Statuary Hall and the old Senate was long used by the supreme court. By the 1850s, the structure was considered inadequate and a wing was added at each end to accommodate the house and the senate. The original low dome was replaced by the commanding cast-iron dome which now crowns the rotunda. these changes being completed in 1865 by Thomas U. Walter. One of the world's monumental structures, the Capitol has influenced the design of governmental architecture around the world.

The domical legislative hall became almost a convention in the building of state capitols. Even such a proper Greek temple as Gideon Shryock's old capitol in Frankfort. Ky. (1828–29), is crowned by a dome and a lantern to light the circular rotunda. The gilded dome of the earlier Massachusetts statehouse, by Bulfinch (1798–1808), added its authority to the domical convention. The old statehouse, now the city hall at Hartford, Conn., also by Bulfinch (1792–96), received its cupola in 1822. The rotunda at Ohio's statehouse at Columbus (1838–59) is lantern crowned, but the cupola is not domical. The work of several architects, it is one of the finest U.S. state capitols. Illinois's old capitol (1837), now the Sangamon County courthouse in Springfield, originally had a low dome which capped the rotunda. The capitol at Nashville, Tenn., by William Strickland (1850–55), has a lantern modeled after the choragic monument of Lysicrates. The earlier capitol at Jefferson City, Mo. (burned 1911), was something of a replica of the old capitol of Pennsylvania at Harrisburg (1810); both were designed by the same architect, Stephen Hills, who employed low, copper-clad domes.

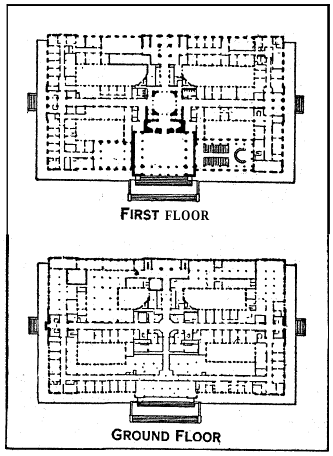

FIG. 6.—PLAN OF CITY HALL AT LOS ANGELES. CALIF.; AUSTIN. PARKINSON & MARTIN. ARCHITECTS

Many domical capitol structures have been built in the 20th century: at Providence, R.I., by McKim, Mead and White (completed 1902); at Jackson, Miss., by Theodore C. Link (1901–03); at St. Paul. Minn., by Cass Gilbert (completed 1905); at Harrisburg. Pa., by Joseph M. Hutson (1905–08); at Charleston, W.Va., by Cass Gilbert (1925–32); and elsewhere.

George B. Post. in the Wisconsin capitol at Madison (1904–14), was compelled by the nature of the site to adopt a cruciform plan with four equal wings radiating from the dome-cronned rotunda. Although some consider the plan somewhat compromised, the massing contributes to an enhancement of the dome. In his masterful Nebraska state capitol at Lincoln (completed 1932), Bertram G. Goodhue designed a vast rectangle, divided into four light courts. The legislative halls, the supreme court and such other functions as need large ground areas were placed in the base. The departmental and other offices were placed in a 400-ft. central tower which forms a monumental beacon, dominating the Nebraska landscape for miles. Of somewhat similar massing is the Louisiana state capitol at Baton Rouge (1930–32), by Weiss, Dreyfous and Seiferth. Other U.S. state capitols which reflect a different approach in planning and design are the North Dakota capitol at Bismarck and that at Salem, Ore. Several statehouses have become so crowded that state office buildings have been erected adjacent to them, but usually detached. In some western states, room for a capitol group is provided; *e.g.,* the state capitol group at Olympia. Wash., where the buildings of architects Wilder and White may expand in response to the state's needs.

Europe.—The addition to the old Palais Bourbon (the building used by the *chambre des députés* in France), by Bernard Poyet (1807), of a 12-columned, pedimented front, and the influence of the U.S Capitol, established the classical direction in modern legislative architecture for the next century. The Chambre des Députés, reconstructed (1822–23) by Jean de Joly, and the Senate in the Luxembourg palace (1836–41) by Henri de Gisors, were ornamental developments of a classical amphitheatre plan. This plan. which had been used so successfully in the U.S. Capitol. had simplicity and directness, and was widely copied in halls for bicameral legislative bodies.

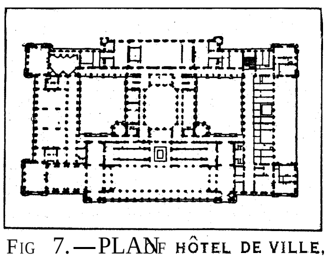

FIG 7.—PLAN OF HÔTEL DE VILLE, PARIS

The English houses of parliament on the Thames in London, by Sir Charles Barry (1840–60), form a unique group, both in style and plan. There the house of lords and house of commons are only parts of a vast unsymmetrical composition which includes members' dining rooms and libraries, the speaker's residence and all the apartments required by a lavish tradition. The picturesque details and ornament were the work of A. W. N. Pugin, a specialist in medieval design, who succeeded in harmonizing two soaring towers and the main horizontal mass of the structure with little reference to interior function. Governmental architecture at Ottawa and elsewhere in Canada was influenced by this precedent.

A somewhat baroque edifice was the Reichstag in Berlin. by Paul Wallot and Friedrich von Tiersch (1882–94; burned during World War II). The plan featured a great assembly hall approached through an arched entrance and a grand foyer. Distributed around two lateral light courts were lounges, refreshment rooms, libraries. writing rooms, committee rooms and consultation chambers. A single domical roof reflected the unicameral legislative body.

In the Budapest. Hung., Parliament House, by Emmerich von Steindl (1883–1902), a central dome and flanking pavilions were veneered with Gothic finery. The Austrian Parliament House in Vienna, by Theophilus von Hansen (1874–83), is as classic as Hungary's capitol is romantic. and compares favourably with legislative buildings around the world.

The United Nations. — The headquarters of the United Nations, fronting the East river in New York city, was designed by an international board of archifectural consultants. Construction began in 1948. The group consists of three principal structures: the General Assembly, the Conference building and the 39-story Secretariat. The Secretariat is a tall, steel-framed, glass-clad office building of rectangular form. The General Assembly encloses a great auditorium for delegations, with extensive communication facilities. The Conference building which connects the General Assembly and the Secretariat has special rooms for the Security, Economic and Social, and Trusteeship councils, and provides meeting places for committees.

City and Town Halls. — A modern town hall requires a chamber or hall for the town council meetings, offices for the mayor and councilmen and their secretaries, offices for the town clerk and offices for the financial and administrative departments of the town government; *e.g.*, the tax board, the chief of police, the building inspector. European town halls frequently contain rooms for receptions and banquets. In the U.S., the town hall frequently provides an auditorium for public gatherings.

France. — The most monumental example of the continental city hall is the Hôtel de Ville in Paris, rebuilt after the Commune by Ballu and Deperthes (1874–82). Following the original Francis I style on the exterior, it was elaborated inside with all the decorative lavishness then in vogue. Its great salles des *fêtes* and magnificent stairways make it one of the most gorgeous and effective official suites in the world. This precedent has affected French municipal building ever since. Later French city halls, showing a similar type of Renaissance classicism, lavish decoration and elaborate plan, include those at Neuilly-sur-Seine, by Dutocq and Simonet (1885) ; at Versailles, by Le Grand (1897) ; and at Tours, by Laloux (1896–1904).

Great Britain. — In England, the Gothic revival of the mid-19th century affected much municipal building. The town hall at Manchester. by Alfred Waterhouse (1868–77), with its picturesque outline and original detail, is typical of the best Gothic revival design. Most recent examples show a greater simplicity of composition and freedom of style. That at Sheffield, by Mountford (1897), in a free early Renaissance style, is representative of the larger examples; that at Oxford, by H. T. Hare (1897), in modified Jacobean, is characteristic of the smaller. The growing complexity of city government has led to a type of building in which the council chamber and mayor's suite are subsidiary to the great amount of clerical space required. The London County Council Hall. by Ralph Knott (1908–22), which best exemplifies this tendency, is a vast structure in the late English Renaissance style.

Elsewhere in Europe. — In Germany, the most interesting municipal buildings are those couched in modern forms. The somewhat bizarre Stadthnlle at Hanover, by F. E. Scholer and Paul Bonatz (1913), contains a large circular hall which functions as a municipal auditorium. As restrained as the *Stadthalle* is fantastic is the town hall at Joensuu, Fin. (1913), by Eliel Saarinen. The city hall at Stockholm. Swed.. by Ragnar Östberg (completed 1924), presents a dignified mass. surmounted by a graceful tower and skirted on the ground floor by a charming arcade. Inside, it is enhanced by brilliant colour decorations; the mosaics in the great reception hall are among the world's finest.

The United States. — Town and city halls in the United States reflect their regional environments. In the east, colonial types predominate; in the west. Spanish colonial and other sun-loving vernaculars are found, as in the Highland Park city hall in Dallas, Tex.. by Lang and Witchell. The colonial town hall at Tewksbury, Mass., by Kilham and Hopkins, and the town hall at Peterborough, N.H., by Little and Russell, illustrate smaller examples in the east, while Bigelow and Wadsworth's town hall at Wheaton, Mass., typifies the larger ones.

Perhaps New Uork city shows the evolution of the U.S. city hall better than any other municipality. By 1802, the demand for an adequate city hall resulted in the erection of an exquisite structure, long outgrown but still in use, by architects Mangin and McComb (1803–12). The French precedent is sensed, particularly in its domed rotunda, the monumental staircase, council chamber, offices and reception rooms. It was hailed as the most perfect example of U.S. municipal building. With the growth of the city, however, new and bigger quarters were called for. The solution was the New Uork Municipal building, by McKim. Mead and White (1908–10), a skyscraper of 23 stories treated in a classical vein to offset the appearance of a commercial structure. The Oakland, Calif., city hall, by Palmer, Hornbostel and Jones (1908–13), has a 3-story classical base, from which a tower of 11 stories arises, crowned by a cornice. Above it stands a lantern of baroque design. Although classical, the structure accords well with its surroundings. Sometimes cities and counties unite to erect a city-county building. Chicago and Cook county, Ill., did this (1907–11), as did Detroit and Wayne county. Mich. In 1957 Indianapolis and Marion county, Ind., collaborated on a 23-story city-county building.

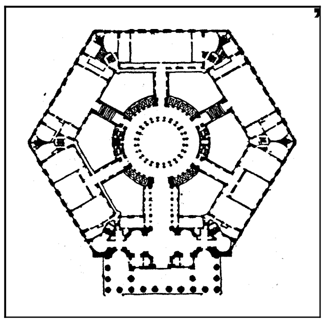

FIG 8. — PLAN OF NEW YORK COUNTY COURT HOUSE: GUY LOWELL. ARCHITECT

Sometimes the city hall is the key structure in a square or park. This is the case at Springfield, Mass., where two classical. colonnaded buildings flank a municipal clock tower, Pell and Corbett, architects (1908–13). In 1957, Toronto, Can., held an international competition for the design of the city hall and the public square.

The huge city hall at San Francisco, Calif., by Bakewell and Brown (1913), rivals a state house in scale and magnificence. It is domical. with a central pavilion in the form of a classic temple, flanked by Doric colonnades on a high basement. The dome on a high drum is beautifully profiled and carries an ornate lantern. The exterior is sedate and majestic; the interiors, of baroque design, are palatial. This structure is a part of the civic centre. (The concept of the civic centre is an outgrowth of the simpler town square, and has found wide acceptance in U.S. cities.) An auditorium, an opera house, the library and other structures are grouped together.

Perhaps the most successful U.S. solution for a metropolitan city hall is that at Los Angeles, Calif.. by Austin, Parkinson and Martin, completed in 1928. For the first time, the two elements — the town hall and the municipal office building — were combined in the same structure and given an adequate architectural expression. This building is also a part of the civic centre.

Judicial Buildings. — The modern courthouse, in its essential elements, has remained almost as close to its traditional ancestry as has the modern court system. The monumental lobby, the courtrooms and rooms for judges. lawyers and witnesses and the archives, all were found in the courthouse of the 15th century.

The differencebetween the Law Courts of London, by George E. Street (completed in 1882), and the Palais de Justice in Rouen, built 400 years earlier, is principally one of detail. The Palais de Justice in Paris is typical of the 19th-century continental courthouse. It dates fromvarious construction periods, from the 13th century onward. Its present formis largely a result of rebuildings after the Commune. Two other elaborate courthouses illustrate European precedent: the Palazzo di Giustizia in Rome, by Calderini and Basile (1883–87), monumental in composition but somewhat marred by much meaningless, small-scaled ornament; and the rather more interesting Palais de Justice at Brussels, by Joseph Poelaert (1866–83), which, set atop an eminence, dominates the city. The Peace Palace at The Hague, the Netherlands (1907–13), by Cordonnier and Van der Steur, also belongs in this category.

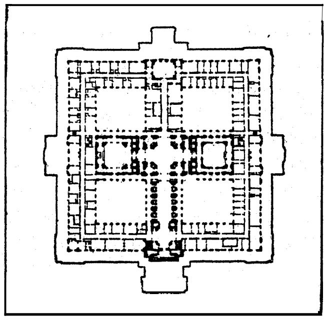

FIG. 9 — PLAN OF THE STATE CAPITOL OF NEBRASKA. BERTRAM GROSVENOR GOODHUE, ARCHITECT

The United States.—In the U.S. the courthouse received a definitive form. Such buildings go back to the somewhat medieval Talbot County courthouse in Maryland (1680–81), a brick structure with end chimney, a steep roof and dormers. The lovely brick Chowan County courthouse at Edenton, N.C. (1767), is full-blown Georgian. By 1724, the embryo of the present-day courthouse could be found in the courthouse at Chester, Va. As late as 1770, a log-cabin courthouse, 20 ft. wide by 24 ft. long with "two small sheads at each end, for jury rooms," was built in Betetourt county, Va. The annals of almost every county in the old Korthwest Territory indicate that the early county buildings were of log construction, as were the prisons and jailers' houses. These structures were much like the cabin homes which the western pioneer built. Benches, jury boxes and judges' stands in these rude centres of justice were of puncheon construction The traditional elements have remained the same. the basic unit consisting of: the courtroom proper, with space for the public, witnesses, jury box. judge's bench, counsel, clerks and the press; the judge's chambers; and the jury room

Of sourthern origin were the square, brick courthouses, popular in the southern communities of Ohio, Indiana. Illinois and as far west as Independence, Mo.. during the 1830s. Until 1870, courthouses of two types were erected: (1) a square. two-story. brick building with a hip roof, crowned by a cupola, and (2) the typical Greek Revival temple, with or without a cupola. The courtroom was generally on the second floor, with offices on the ground floor The early state capitol buildings at Corydon. Ind. (1812), built as the courthouse of Harrison county, and at Chillicothe, O. (1800), were of similar design. Since the time of the Greek Revival, the classical style has been almost universally used for judicial architecture. Many trends in courthouse design culminated in the New York County courthouse (completed 1927), built by Guy Lowell. The original design called for a circular plan but. for practical considerations. it was changed to a hexagon, with a circular rotunda and six light courts providing ideal communication. The result is a structure at once functional, beautiful and interesting.

Post Offices.—Many European governments have relegated public services to existing structures, as in Rome where a former monastery was adapted to the postal service. Naples erected a new post office, by G. Vaccaro and G. Franzi (1932–36). Other imposing postal facilities are the general post office in Paris, by Gaudet, and the general post officein London (1910), by Sir Henry Tanner. Far more interesting, honever, is J. Crouwel's post office in Utrecht. Neth (1918–24).

In the middle of the 19th century Robert Mills designed, among other governmental structures in Washington, D.C.. an officebuilding for the post office department that exhibited simple and straightfornard planning. U.S. post offices present a good cross section of the architectural vicissitudes that have befallen the nation. Some achieve real distinction, others do not. Post officesat Peoria, Ill., Gary, Ind., and Miami. Fla., illustrate high standards of design. Many postal structures throughout the U.S. have been designed by government architects in Washington, but the post office in the national capital (1911–14) was designed by private architects, Graham, Burnham and company. The post offices of New York city were designed by McKim, Mead and White (1913), and those of Denver, Colo., by Tracy, Swartwout and Litchfield. Many small officesare still housed in rented quarters.

Customhouses.— In Europe, customhouse architecture has been largely neglected. Almost the only one of dignity and adequate convenience is the customhouse in London, by David Laing (1817). partially rebuilt by Robert Smirke. Its Thames river façade is distinctive, and its long room (200 ft.). where most of the business is transacted. is much admired. The customhouses at Dublin. Ire., by James Gandon (1791), and at Liverpool (1828), by John Foster (destroyed by bombing in 1941), have been generally admired. The Port of London Authority, begun in 1912 by Sir Edwin Cooper, but not opened until 1922, is a splendid example of English neoclassical design. The absence of adequate buildings in which these services could be carried on led to the development of new types. The early customhouse in New York city (later the U.S. subtreasury), by Town and Davis (1834–41), the customhouse in Boston, by Young and Rogers (1837–47), and the customs structures at Newburyport, Mass. (1835), and at New Bedford. Mass. (1836), both by Robert Mills. constituted milestones in U.S. customhouse design. All were of Greek Revival extraction. The present Renaissance-style New York city customhouse (1899–1905) is the work of Cass Gilbert.

Administrative Buildings.— Ministries and kindred administrative structures sometimes lack distinction because they closely resemble office buildings. In European capitals, ministries are often housed in altered palaces, as in Paris and Vienna. In London, where they are assembled along Whitehall and Parliament streets. they make an impressive ensemble. although individual buildings are not distinguished. In Washington, D.C., which Pierre Charles L'Enfant laid out along classical lines, governmental architecture has closely followed classical precedent. Among the earlier classical examples were the Post Office. the Patent Office and the Treasury building, all the work of Robert Mills. The Library of Congress, by Smithmeyer, Pelz and Casey (1886–97), the Senate and House office buildings, by Carrère and Hastings (1906–09; additions 1933), the Department of Commerce. by York and Sawyer (1928–32), the Kational Archives building, by John Russell Pope (1927–35), the Supreme Court building, by Cass Gilbert (1934), and the Kational Gallery of Art are illustrative of the classical trend. On the other hand, the Smithsonian institution. by James Renwick (1846–52), and the State. War and Navy building. by A. D. Mullet (1871–88), interesting in their nay, can scarcely be said to belong in this company. The Washington

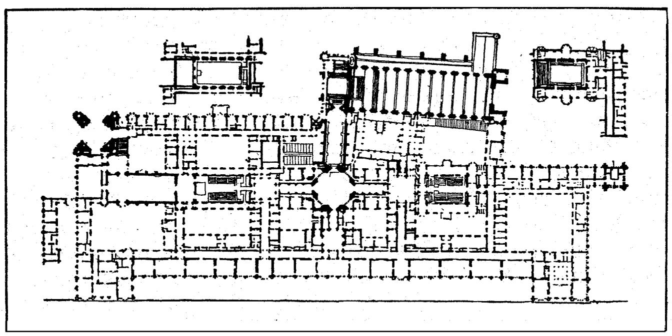

FIG. 10.— PLAN OF PRINCIPAL FLOOR. HOUSES OF PARLIAMENT, WESTMINSTER

monument by Robert Mills (1848–84), the Lincoln memorial, by Henry Bacon (1912–22), and the Jeffersonmemorial, by John Russell Pope. accord beautifully with the capital's classical pattern.

The federal government maintains ministries or embassies in all foreign capitals with which the United States carries on diplomatic relations. For some of these, the government leases existing quarters; for others, special buildings are erected. In 1956, the state department named architect Eero Saarinen as winner of a competition for the design of a new U.S. embassy "in the contemporary idiom" to harmonize with its neighbours in Grosvenor Square in London. The winning design showed a five-story mass, depending upon pleasant fenestration and sober surface treatment to achieve its dignified appeal.

At about the same time, the state department, through its office of foreign buildings, approved designs for a supplemental office building for the U.S. embassy in Manila. P.I.; A. L. Aydellot and Associates, architects, conceived a structure in the contemporary style but "sympathetic to local background and indigenous forms."

The erection of foreign embassies often gives local planners serious qualms, especially when local building regulations are disregarded.

The erection of the Pentagon was something of a break with classic precedent, but structures erected since, although contemporary in trend, harmonized with existing buildings. This was important, since something of a boom in governmental building costing upward of $300,000,000 took place in mid-20th century. All governmental agencies employ private architects on major construction projects but some departments maintain architectural staffs for the purpose of maintenance, minor repairs and alterations.

Capital City Planning. — Flexibility is not always possible except by the establishment of an entirely new capital city, such as Washington, D.C., or New Delhi, India (1910). In 1911 a competition for the design of the Australian capital city of Canberra was won by Walter Burley Griffin of Chicago. The first of the buildings was opened in 1928. For New Delhi, Sir Herbert Baker and Sir Edwin Lutyens designed a circular legislative hall. When India became independent and the state of Punjab was divided, the former capital went to Moslem Pakistan, leaving Hindu Punjab without a capital. It was decided to build a new capital city (Chandigarh), designed by world-renowned architects and planners. The design of the city was entrusted to an European team headed by Le Corbusier. Associated with him were E. Maxwell Fry, the English architect, Pierre Jeanneret and a group of Indian architects and planners. The Supreme Court is of concrete frame with brick partitions. To meet climatic conditions, a structural umbrella was raised above the roof top, cantilevered out from the main frame.

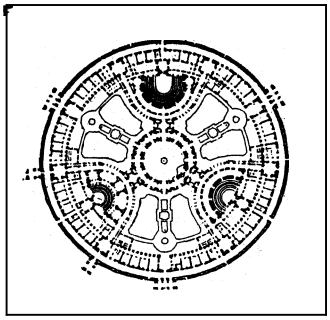

FIG. 11. — LEGISLATIVE HALL. NEW DELHI: SIR HERBERT BAKER AND SIR EDWIN LUTYENS, ARCHITECTS

In 1957, President Kubitschek of Brazil broke ground for a new capital city in the state of Goiás to be called Brasilia. Architect Oscar Niemeyer designed a "skeleton capital," consisting of a governmental palace, a presidential residence, a hotel and a chapel, which were to serve as provisional headquarters of the government while the new capital was being built. The seven-story hotel was to house the presidential assistants and other administrative personnel. The governmental palace, in the centre of the group, provided offices for the president and his staff, conference rooms for the cabinet and halls for state receptions. See also ARCHITECTURE; MODERN ARCHITECTURE, 18TH AND 19TH CENTURIES.

(T. F. H.; R. N.)

GOVERNMENT CORPORATIONS are corporate bodies that are wholly or partly owned by the government and are utilized primarily for business-type functions or services. First widely employed during World War I to provide the operating and financial flexibility required by certain emergency programs involving construction and operation of merchant vessels, trading in commodities and comparable government activities, the government corporation later became a common form of organization for public enterprises in nearly all countries and at all levels of government. The incorporated agency became the instrument for carrying out major parts of the United States economic recovery program in the 1930s; for developing great river valleys of Afghanistan, India and the United States; for administering nationalized industries in Great Britain and other countries; for financing, constructing and operating superhighways in Pennsylvania, New York and other states; and for promoting the economic development of "underdeveloped" nations, particularly in Asia and Latin America.

The activities in which government corporations have been most widely employed — transportation, communications, manufacturing, mining, resource development, atomic energy, marketing, port development and management, utility services, various types of banking, credit and insurance functions — reflect the radical change in the economic role of the state during the 20th century. Older and more traditional public enterprises such as postal services; tobacco, match and salt monopolies; and, to some extent, telephone and telegraph services are rarely incorporated, and continued to be administered in the 20th century as government bureaus. This form of organization continued to exist when the main purpose of the enterprise was to supplement public revenues. as with the football pools in Norway and other government lotteries, or to control consumption, as with liquor monopolies in a number of U.S. states and Canadian provinces.

As defined by Pres. Franklin D. Roosevelt when he recommended establishment of the Tennessee Valley authority in 1933, the government corporation's purpose is to provide an agency "clothed with the power of government but possessed of the flexibility and initiative of private enterprise." Although the organization and powers of government corporations differ significantly, not only from country to country but also within a single country, most have the following attributes which distinguish them from public enterprises organized as normal government agencies: (1) legal personality separate and distinct from the government which enables the corporation to sue and be sued, enter into contracts and acquire property in its own name; (2) independent financing from revenues and treasury or public borrowing rather than from annual appropriations by the legislature; (3) freedom from many of the restrictive statutes applicable to government supply activities and general budget, accounting and audit laws and regulations; and, in most countries, (4) authority to hire and determine the compensation of employees without regard to civil service laws.

The special powers granted to corporations are designed to enable the government, when it is acting more as a business agent than a sovereign, to render service and discharge its obligations to purchasers of its goods and services as nearly as possible in the same manner as a private business.

Use has also been made of the corporate form of organization to avoid constitutional or statutory limitations on public borrowing. As separate legal entities, government corporations may be authorized to issue revenue bonds or other evidences of debt without creating general state obligations. The desire to find means of financing public improvements that would not conflict with constitutional debt limitations accounts in large measure for the great increase in the number of incorporated public authorities such as the Alabama Building corporation and the New York Thruway authority at the state and municipal level in the United States.

Corporations may be acquired or created by the government in several ways. The government has converted a number of corporations, originally established for private purposes, to public enterprises by obtaining control of some or all of the corporation's capital stock. The United States, for example, became the owner of the Panama Railroad company (merged with Panama Canal company, 1951) when it purchased the assets of the French Canal company in 1904. The Railroad company had been chartered as a private corporation by New York state in 1849. The Renault and Gnôme-Rhône motor companies were taken over by the French government and became government corporations because their private owners had collaborated with Germany during World

War 11.

Many government corporations have been organized as joint-stock companies under authority of general incorporation lams applicable to privately owned corporations Except for the War Finance corporation. for instance, World War I corporations were chartered by the United States under general incorporation laws either of states or the District of Columbia. In 1945, however, congress prohibited this practice and required that existing state-chartered corporations such as the Commodity Credit corporation and the RFC Mortgage company either be liquidated or reincorporated by federal law. Great Britain and Canada also came to regard the joint-stock company as not well suited to a public enterprise, but this view was not fully accepted elsewhere. Joint-stock companies were set up extensively in France, Italy. Belgium. Turkey and other countries favouring mixed enterprises nhose stock is partially owned by private interests. The only examples of mixed enterprises in the United States are the federal intermediate credit banks banks for co-operatives, and the Federal National Mortgage association. The first and second banks of the Cnited States were also created on this pattern.

The trend continued toward organization of government-owned enterprises as public corporations with no capital stock. A public corporation is created by a special law defining its powers, duties and immunities and prescribing the form of management and its relationship to established departments and ministries. Great Britain pioneered in developing this type of agency with the Port of London authority (1908) and made this device the vehicle for carrying out the nationalization of the Bank of England and a number of basic industries. Examples of public corporations were the British Broadcasting corporation, British Overseas Airways corporation Tennessee Valley authority (U.S). St. Lawrence Seaway Development corporation (U.S.), St Lawrence Seaway authority (Canada), Water Resources authority (Puerto Rico), Sumerbank (Turkey) National Insurance institute (Israel) Air-India International and Overseas Telecommunications commission (Australia). State trusts in the Soviet Union also acquired many of the characteristics of public corporations.

Enterprises jointly owned by central and state governments or by two states represent a special type of government corporation. The Damodar Valley corporation (1948), as an example, was set up by the government of India and the states of Bihar and West Bengal. New Tork and New Jersey created the Port of New York authority in 1921 by interstate compact to operate bridges, tunnels, airports, port and terminal facilities serving New York city and nearby communities.

With the rapid growth in the number and economic significance of government corporations, the issue of public accountability assumed critical importance. In the effort to insulate corporations against bureaucratic red tape and partisan interference in management existing controls to assure public accountability and responsiveness to direction by politically responsible officials were abandoned without providing adequate substitutes. Except in the United States, corporations generally were made independent of established government agencies and departments. Corporate policies, budgets and accounts were subject to limited or no review by the executive or legislature. Management of government corporations was frequently vested in boards dominated by directors appointed to represent trade and professional associations and other private groups. In France public enterprises are administered by boards uhose members are nominated by the three interests represented thereon: government departments and employee and consumer organizations. Mixed enterprises partly owned by private interests have presented unique and peculiarly difficult problems of public control. These factors led some to fear that corporations might, along with the independent regulatory commissions, become an irresponsible fourth branch of government.

Great Britain, the United States. Canada and Turkey have employed various means to assure public accountability without impairing essential operating and financial flexibility. The practice in Great Britain and Canada has been to make public corporations subject to direction by the minister concerned with the program area of the corporation. While the minister is expected not to interfere in day-to-day operations and cannot be questioned in parliament about such matters, he is often empowered to issue directions of a general character when the national interest is affected. Ministers may also possess authority to veto or approve issuance of bonds, large capital outlays, pensions and comparable corporate actions 4 British Select Committee on Nationalized Industries proposed that control be further strengthened by the appointment of a house of commons committee to examine the reports and accounts of public corporations.

The United States recognized the need for developing special controls over government corporations in enacting the Government Corporation Control act of 1945 which provided for a business-type budget and audit "with due allowance given to the need for flexibility." The Canadian counterpart of the Government Corporation Control act was the Financial Administration act of 1951. The state comptroller of Israel recommended enactment of a similar law. The Law for State Economic Enterprises in Turkey provided for an annual review by the General Economic commission and an annual audit inspection by the prime minister's High Control board.

See also PUBLIC ENTERPRISE.

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GOVERNMENT DEPARTMENTS. The administration of the various governmental functions is entrusted to specialized agencies often called departments. such as the department of commerce and the department of agriculture in the United States. Taken together, the departments are sometimes referred to as the departmental system. In contrast to the legislative and the judicial branches, the executive branch is the government's arm of action, the instrument for the performance of its continuing functions. Responsible operation of the departmental system requires not only executive control in each department but also direction and co-ordination by a chief executive. After a general introductory discussion. this article considers government departments in the United States and in Great Britain.

Departmental organization is found on the several levels of government, local and state as well as national. Examples are the municipal police and fire departments on the one hand and state highway departments on the other. The departmental form of organization is also extensively used in private business. especially in large enterprises, where activities are usually divided among such departments as manufacturing, sales and advertising.

The governmental agencies which make up the departmental system in various countries frequently bear designations other than department. Illustrations of other designations are ministry. administration, service, authority. board, commission and even foundation. In many instances the choice of the designation is based on the logic of a legislative or administrative intent. even though the intent may remain obscure to the citizenry. In other cases the designation has been the fruit of passing circumstance. In most countries nomenclature has proved hard to stabilize.

Government departments may be viewed from quite different angles. To the administrative official they represent rationally designed machinery for the accomplishment of desirable public purposes. To the politician they are power structures to be captured and held in the contest for control. To the citizen they may be forbidding bastions of authority, indifferent to his own needs, but perhaps inexcusably subservient to various organized interest groups. To the rank and file of government employees who spend their working days in its offices, the department may be both an unrelenting taskmaster and an animating social centre.

In the sense of human beings who identify themselves with a department as its management or its personnel, one may speak of a departmental point of view or a departmental tradition. Usually the greatest influence on the formation of these characteristics has been exerted by the higher civil servants. But where the political leadership in the departments does not change frequently, the man at the top can impress himself strongly upon the institutional mind of his department. In the same way, however, in which departments tend to fight for their interests and their position on particular issues, so continuing struggles go on within each. department among different specialized staff groups and between these and the agents of general control. Effective direction of a department requires considerable resources of personal strength as well as of technical knowledge and experience.

While differences of internal organization and of cultural development between countries have produced inevitable differences —superficial or profound—in their governmental machinery, it will be found under modern conditions that common political, social and economic needs tend to give the same functions to government departments in one country as another, however diverse their theory of the proper arrangement and scope of governmental organs.

Organization Types.—It is less important to know that the number of departments and the allocation of jurisdictions among them differ (subject to frequent changes in the individual countries themselves) than it is to realize that the various countries follow different patterns of departmental organization. Thus, United States practice treats each department as one great administrative body, including headquarters and field agencies, all of these performing their duties under the name of the department. European tradition favours using different designations for headquarters (ministry, etc.) and field offices, and keeping the ministries small by several devices. One method is that of delegating ample discretionary powers to regional offices, called in Great Britain divisional; another is to transfer large-scale operations that must remain centralized to special agencies of a secondary, or subordinate, character. For instance, the collection of customs and internal revenues, as well as governmental minting. engraving and printing, are functions performed in the United States within the treasury department, while in Great Britain these functions are separate institutions, without cabinet rank, which in their political and financial decisions depend on the treasury but constitute no part of it; in France they are entrusted to so-called *directions générales* under (dependent on) the ministry of finance, as is the administration of state-owned land and enterprises.

The policy of detaching operations from the ministries has been systematically followed in the German *Reich,* where almost all operations that required a considerable number of employees were transferred to subordinate agencies, which in contrast with the *Oberste Reichsbehorden* (*i.e.*, the ministries) were called *Hohere Reichsbehörden,* and worked each under the supervision of one of the ministries (e.g., *Statistisches Reichsamt* under the ministry of economics. *Patentamt* under that of justice). Methodical use of this device kept the German ministries so small that at the end of the Weimar republic (1932) two of them had less than 200 employees, most had less than 400 and the largest (finance ministry) had less than 1,000. This old tradition was resumed in the Federal Republic of Germany after World War II.

It is common practice in the major countries to place each department under the administrative responsibility of a single head. The apparent exceptions to this rule in Great Britain are nominal rather than actual in most of the cases, as with the treasury and the boards of education and of trade. Collegial boards have kept practical significance, however, for the admiralty in Great Britain and for agencies with quasi-legislative or quasi-judicial functions. such as the U.S. Interstate Commerce commission. the British Transport commission or the civil service commissions in both countries, for government corporations, for some policy-forming agencies in smaller states and in local government units.

Next in line under the department head. Great Britain and Germany developed the office of the permanent undersecretary (called secretary in some British, and after 1920 *Staatssekretar* in all German. ministries), who constitutes a one-man channel that must not be by-passed in official contacts between the lower levels and the department head. The duties of U.S. undersecretaries are, in most cases, more specific and their rights less inclusive. In French ministries—except that of foreign affairs, which has a *secrétaire général—directeurs,* each in charge of one division, are placed immediately under the minister. In Germany, such division heads, called *Ministerialdirektoren,* constitute the next lower level under the *Staatssekretäre.* Likewise, in Great Britain and the United States, assistant secretaries or similar officers are often given directive functions over large fields of work under the undersecretary. But this is not always so; especially in the United States many assistant secretaries work independently of the undersecretary. Parliamentary undersecretaries have often been appointed not only in Great Britain but also in France for political or specific functions. They are unknown in the United States and in Germany.

The greatest difference in organization, however, prevails at the base of departmental headquarters. European practice favours systematic distribution of the entire work among a body of subject-matter aides, trained for ministerial service and for the consideration of over-all viewpoints; they are called principals in Great Britain, *chefs de bureau* in France and *Referenten* or *Sachbearbeiter* (in various grades, such as *Ministerialrat*—formerly *Geheimer Regierungsrat*—*Oberregierungsrat* and *Regierungsrat*) in Germany. The functions of these aides are, of course, greatly affected by the detachment or nondetachment of operational services (*see* above). The more operational functions are transferred to subordinate agencies. the less the ministerial aides have to deal with operations and the more their work concentrates on planning, advice, initial steps in the execution of decisions made at headquarters, contacts with other departments and contacts with subordinate field agencies or operating services. This is the usual situation of the *Referenten* in German ministries, of British principals and French *chefs de bureau.* On the other hand, the fact that operating services in the United States usually constitute part of the departments makes the U.S. bureau chiefs the heads of such operating services. In their respective fields they function also as the direct advisers of their superiors, with no permanent aides between them and the secretary's level. In criticizing this type of organization it has been said that the natural weight of the large operating services tends to impair the desirable balance within departmental headquarters and to make the over-all organization heavy-footed and lopsided.

In the Soviet Union, state ownership of all means of production greatly increased the operating functions of the government and, consequently, multiplied the number of departments, which has at times exceeded 50 on the national level. There are, for example, several separate departments for various branches of industry. A considerable part of the management of the national economy and of industrial operations is passed on to public trusts (government corporations) as well as to the individual republics; in the latter case, the individual republic appoints the department head in charge of the execution, who then has a dual responsibility—on the one hand to the all-union ministers, on the other to the government of the constituent republic.

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UNITED STATES

Types of Agencies.—It is not unusual in the United States to hear the three great branches of the government—legislative, executive and judicial—referred to as departments. In the more familiar sense, the departments are the apparatus by means of which the government carries on its various functions other than those of a legislative or judicial character. This broadly inclusive meaning of the term is identical with what in the usage of the federal government are called agencies. In the period after World War II the total number of federal agencies remained at about 60. But only certain of these agencies were designated as departments.

Not all agencies of the government, in the first place, are part of the executive branch, in the sense of being under the president's control. Some are agencies of the legislative branch—for instance, the Library of Congress, with its legislative reference service as a pool of experts available to the committees of congress and its individual members alike; the government printing office, headed by the pubiic printer; and the federal government's audit agency, the general accounting office under the comptroller general, who serves for an exceptionally long term of 15 years. A somewhat larger number of agencies are neither in the legislative branch nor under the president's orders. These agencies are often spoken of as the independent regulatory commissions and boards, usually created by statute as bipartisan establishments and deliberately placed outside the reach of the president's power of command. Most of the principal agencies of the federal government having quasi-legislative and quasi-judicial functions are of this type. such as the Interstate Commerce commission, the Federal Trade commission. the Federal Power commission, the Securities and Exchange commission and the National Labor Relations board.

Within the executive branch thus narrowly defined, there are further distinctions between agencies. One group is formed by the government corporations; for example, the Tennessee Valley authority, the Export-Import bank of Washington and the Panama Canal company. Another category is represented by the considerable number of agencies which are comparable in many respects to departments but lack this title. These agencies include the Atomic Energy commission, the Veterans administration, the Housing and Home Finance agency, the National Science foundation and the General Services administration. Many of them are single-headed, like the departments; others are directed by plural bodies, like the independent regulatory commissions and boards. Again, like the departments. most of these executive agencies perform functions that in some direct way affect the public or parts of it, as so-called line activities. But a few executive agencies have the task of attending to needs of management which exist throughout the executive branch—for instance, the civil service commission for recruitment, classification and other aspects of personnel administration and the General Services administration for office space, procurement of supplies and disposition of records. But the most important category of federal agencies is formed by the so-called executive departments, relatively few in number but collectively the backbone of the executive branch.

Number, Rank and Size.—The ten executive departments of the federal government, in order of their official rank, are these: state and, next, treasury, both since 1789; defense, established in 1949, with its three military departments, army (created as war department in 1789), navy (1798) and air force (1947); justice (1870) and post office (1872), both with antecedents reaching back much further; interior, since 1849; agriculture (1862), commerce (1903) and labour (1913, previously joined with commerce); and, finally, health, education and welfare (1953), as an elevation of the former federal security agency.

The executive office of the president, a staff organization created in 1939 to assist him in the general direction and co-ordination of the departments as well as the other agencies of the executive branch, is not itself a department. It is a presidential establishment for purposes of program planning, analysis of problems and issues, review and formulation of proposals, and administrative control. The executive office of the president is made up of the White House office, the bureau of the budget, the council of economic advisers, the national security council, the Office of Civil and Defense Mobilization and, when activated, an Office for Emergency Management. On the president's level, the concerns with particular functions which come forth from the departments and the other agencies of the executive branch are met by the counterpressure of a government-wide orientation. Such broader orientation is typical of the presidency, as the foremost organ for the expression of national points of view under the constitution.

Between the executive office of the president, as a staff organization looking at matters across the board, and the departments and other agencies of the executive branch, each absorbed in the particular operating functions entrusted to it, there develops a mutual challenge, a creative tension. The outcome, ideally, is a constructive interchange, with a maturing effect upon decisions. Realistically, however, it is also possible that the result, in the individual case, is determined by a crude test of strength.

Departmental strength is a product of many factors, one of which is size. By quantitative measurements, the departments, like the other agencies of the executive branch, show striking variations. Metaphorically speaking, the departmental system of the federal government resembles a chance meeting of a dinosaur and several lesser creatures, including a few mice. The dinosaur, needless to say, is the department of defense.

One measure of the growth of the departmental system is the increase in civilian and military personnel in the executive branch. The grand total rose steadily from less than 1,000 civilian employees and 1,300 military personnel during Washington's administration to more than 2,300,000 and some 3,000,000, respectively, in the second half of the 20th century.

Common Characteristics.—Like the heads of almost all executive agencies, department heads are appointed by the president with the consent of the senate. But only department heads bear the distinctive title of secretary—as, for instance, secretary of labour. The title is not common to all, however. The top officers of the department of justice and the post office department have the designation of attorney general and postmaster general, respectively, dating back to the beginnings of the republic.

Department heads have neither the right nor the duty of participation in the affairs of congress, as is normally the case under parliamentary government. On the other hand, the principle of acceptability to the senate of the president's choices for his official team carries with it certain limitations to be observed in the exercise of his appointive power. For one thing, men with a passion for unpopular causes, a reputation for unorthodox opinions or a lofty disdain for politicians do not make good material for presidential nominations, though such men may be pillars of wisdom and integrity. There is also the matter of geographic balance in picking candidates, besides other factors of political strategy which no president can ignore. But affiliation with the other party is no bar, for on occasion a bipartisan appearance is politically profitable.

As far as their relationship with the legislative branch is concerned, department heads confine their role essentially to supplying information, often as pleaders, mostly in testimony before congressional committees. In such testimony, as in other public statements, the members of the president's team are supposed to reflect his policies. But the interest they have in advancing their departmental programs may induce them to be more responsive to the legislative committee dealing with the department's affairs or to organized groups which regard themselves as the department's clientele than to the goals sought by the president. To be sure, in a formal sense, expressed by the constitution, department heads are the subordinates of the president; he can fire them at will. Yet a disciplinary action so extreme is practical only on very rare occasions, when in the nature of all circumstances its application would not inflict serious damage upon the prestige of the president's administration. As a matter of fact, therefore, department heads are able to move rather freely in a no man's land of political convenience, checked only by such factors as their loyalty to the president and their fear of the price of a full-scale conflict with him.

Only department heads are automatically members of the cabinet. But the president is free to request the regular attendance of other officials, such as the director of the bureau of the budget, who first sat with the cabinet in 1953. The practical importance of the cabinet and its efficiency in performance are roughly proportionate to the president's own intentions and working methods. For lack of a necessary constitutional function, the cabinet operates as a meeting of presidential advisers. who may also serve as the president's audience. Constitutionally. the president cannot withdraw behind the cabinet. There is thus no collective responsibility of the cabinet for the government's program, in the sense of British political doctrine.

Nevertheless, if only because of the implied exclusiveness, cabinet rank is valued highly. Automatic cabinet status also has certain small but conspicuous privileges. For example, by law only cabinet members among the heads of executive agencies enjoy the privilege of being called for at their homes in the morning and driven back at the end of the day in their own official car. On the other hand, cabinet status does not imply great willingness of the cabinet member to use the cabinet for the making of decisions. When it comes to getting the president's approval for a particular matter, a department head may be more inclined to settle the business directly with the president than to propose it for the cabinet agenda. It is then left for the president to make sure that the subject has the benefit of scrutiny by additional eyes before he commits himself.

Assurance that such scrutiny is provided as a normal procedure is perhaps most evident in the field of proposed legislation. Under arrangements made initially in 1921, the bureau of the budget became the presidential clearinghouse for legislative proposals advanced by executive agencies. The test question in this matter is whether or not the individual proposal is in accord with the president's program. In furnishing clearance, the budget bureau not only is guided by decisions made by the president but also seeks the advice of all other agencies having an interest in the particular matter, thus helping to establish a common position within the executive branch. In addition. when agencies are asked by congressional committees to convey their views on pending bills. the same clearance procedure is applied. Agencies are not censored in their replies to congress But they must add the finding of the bureau of the budget concerning the relationship of the bill to the president's program. The same kind of consultation throughout the executive branch is obtained by the budget bureau before a proposed executive order is passed on to the president for his consideration and signature.

In basic internal organization. the departments show considerable similarities. The top nucleus is generally known as the secretary's office. Upon it converge the demands for decisions which rise constantly in the normal course of business from the next lower level—the great functional groupings made up of bureaus, offices or divisions. These, in turn. are subdivided successively as need requires, down to the smallest working unit. It is natural to imagine the departments as a mighty cluster of central agencies. In actual fact, however. the headquarters organization of the departments at the nation's capital in Washington, D.C., is usually only the smallest part. More than nine-tenths of all federal employees are stationed in the field. mostly in the United States. but partly also on foreign soil, as in the case of the foreign service and various specialized missions, for example.

Departmental direction is therefore in great part a matter of communication, as in all far-flung and large-scale organizations. No department can be much more than the reflection of its sense of purpose. Such sense of purpose does not exist apart from the men and women who arrive at a specified time in the morning and fill a dead building with their devotion to duty as well as their familiar routines. But solidarity and cohesion around aims to be accomplished develop more easily in the small working group than in a vast organization. Moreover, conflicts of purposes and interests between difierent components, specialization in the performance of particular functions and the localized perspective of the personal workplace keep the individual parts of a department from appreciating the importance of the departmental mandate as a whole. Thus the objectives of the department, however frequently emphasized from the top, may yet lack a strong appeal internally. They may remain distant and rather blurred images for the rank and file, preoccupied with what is closest to the individual desk. This tendency toward personal isolation, never completely overcome by even the most resourceful kind of co-ordination, makes the department as a unified whole a rather distant objective for all but those occupied with general management.

Withdrawal into the small-scale world of the individual uorking group—a world to be kept secure, agreeable, neat and unmolested by bigger things outside—is a familiar trait of bureaucratic behaviour. It is a trait that should not be condemned rashly because. paradoxically, it also has a certain therapeutic value. It is an antidote to the growth of a bureaucracy so unified in an independent concept of mission as to rise above control by elective policy makers. The vast physical expansion of the executive branch of the federal government during the first half of the 20th century has often been lamented. It has been seen as a forerunner to what is predicted by some as the coming tyranny of the managers. But the habits of bureaucracy as they manifest themselves in the departmental operations of the federal government are all on the other side. In the United States, bureaucracy, in public administration. is a force of division; it is not a single body, with its onn sense of direction.

Lack of unity in the permanent officialdom is thus a natural condition, promoted by the absence of a recognized higher career service reaching up right below the department head and his political aides, like the British administrative class. On the other hand. the respect accorded the administrative class in England demonstrates that a higher career service. under the pervasive influence of its own ethics, can be a strong restraint upon the zest for power among its members. So indoctrinated, the civil service is able to guard itself against both excessive solidarity and bureaucratic self-aggrandizement. U.S. bureaucrats, under a weaker service spirit, are more inclined to put priority on that part of the departmental program for which they have individual responsibility, as contrasted with other parts. A strong-willed subordinate, convinced of the public benefits of his division's work, may feel free to concentrate on building up support for it. He may go out to re-enforce his position by clandestine alliances with good friends in congress and among the leaders of interest groups even though the head of his department may see things quite differently. Under auspices of a loosely organized party system, congressional-presidential government is characterized by a high degree of dispersal of power. Thus channels of command both within the departments and from the president downward can be obstructed by underlings with greater ease than one might expect at first thought.

All of this makes the job of managing a department a good deal harder than need be. Singlehanded, of course, a department secretary would accomplish little. He must multiply himself. so to speak, by leaving part of the job to lieutenants in whom he can repose his full political as well as personal confidence. These are the undersecretary and the assistant secretaries, occasionally also a deputy secretary, as in the defense department. Like the secretary himself, they are among the political officers who are appointed by the president with the consent of the senate. In contrast with past practice, these selections are rarely mere patronage appointments. The reason is the increased public pressure upon the president—in the day of the service state—to make a satisfactory record in the conduct of his administration, as a matter of good politics.

Yet presidents face considerable difficulty in persuading well-qualified citizens to undertake this kind of public service and to stay in the post after having accepted. Businessmen in particular, but also labour leaders and members of the professions, often require vigorous prompting to make themselves available for an indefinite tour of duty in Washington, D.C. This is not merely a matter of personal and family finances but also the reflection of a political environment nptorious for its frustrations and its lack of charity in public criticism. Recruitment of top calibre for high political positions, especially for the leadership of the executive departments, emerged as one of the unsolved problems of U.S. government.

In each department, the number of presidentially appointed top officials is small, although the impetus they give the department is noticeable. To extend themselves sufficiently far, both outside and inside the department, they need special assistants, mostly brought in from other walks of life as policy advisers, contact men or confidential assistants. whose appointments last usually only as long as the presidential tenure. The great bulk of the departmental personnel consists of permanent employees having regular civil service status.

Although civil servants can be shifted around to suit the preference of an incoming departmental high command, no department is easily stripped of its established ways. Like other large-scale organizations, departments carry their burden of inertia, as they also display their share of initiative, persistence and drive. Departmental management must seek to cope with these conflicting impulses in such a way as to meet desirable standards of performance. Actual performance, by and large, though shoving variations within departments and from department to department, compares fully with the standards of private business.

In their day-by-day administration, almost all departments have come to place considerable reliance on groups of management specialists. Most of these are engaged in program planning, review of operations, budgeting, organization and methods work, personnel administration, accounting and the like. In several departments. in 1950, all or most of these specialized elements of departmental management were combined under the new office of administrative assistant secretary. intended to be filled by career men. In the department of commerce the post was abolished in 1954.

Executive Reorganization. — Year upon year, new administrative activities are authorized by congress, and established ones either change or disappear because of changing circumstances and policies. In their cumulative effects, these changes make it necessary to re-examine the organizational structure of the executive branch at frequent intervals. Good organization might rapidly deteriorate in time if additions, modifications or eliminations of activities were allowed to happen without any thought of a general plan. Bad organization might fall into an intblerable state under such conditions.

Some rudimentary logic underneath the departmental system of the federal government can be discovered from the historical record of its growth. The dates, given earlier, of the beginnings of the ten executive departments supply a key. Finance, foreign affairs and defense, together with justice and the postal service, were a natural grouping for an era when the federal government was mainly concerned nith the administration of functions suitable for the common agency of an association of sovereign states. Eventually, the diversified natural resources under federal control, including the public lands. called for recognition on the cabinet level and brought forth the department of the interior. Then, with the full momentum of a development that led the republic from its agrarian start into the charged atmosphere of an industrial order, there followed the parade of clientele departments with nationwide responsibilities — one looking after the farmer, another serving the businessman, and the last acknowledging the interests of the worker. A further step was taken with the establishment of a full-fledged department underwriting important aspects of minimal economic equality — the department of health, education and welfare. Its emergence demonstrated the degree to which social policy had become accepted as one of the foremost domestic concerns of the federal government.

If that much underlying reason is conceded, it must not be concluded that the departmental system, as a product of history, ought to be left in peace. On the contrary, proposals for achieving a more rational structure of the executive branch have been made quite frequently. Many of these proposals rest on fairly abstract theories of what is variously assumed to be the essence of sound organization. The departments, however, are massive structures re-enforced by precedent and tradition and cannot be easily changed. They are singularly unresponsive to the preaching of people stirred by a sense of organizational tidiness. Moreover, all the organized interests. economic and social. that have a stake in the departmental set-up, view with deep suspicion any marked departure from familiar arrangements. Each interest is fearful of coming out the loser. As a result, a sweeping overhauling of the executive branch is practically out of the question, except under conditions of a full-scale emergency.

But real gains may be attained even by some patient, piecemeal improving. That has been done rather persistently. The usual procedure. applied on all levels of government in the United States, is to set up a formal inquiry into existing conditions, in the hope of bringing forth concrete recommendations with a fair chance of adoption. Inquiries of this type on the federal level include the president's committee on administrative management with Louis Brownlow as chairman (reporting in 1937) and the (first) commission on organization of the executive branch headed by former president Herbert Hoover (reporting in 1949). Examples on the state level were the so-called "little Hoover commissions" set up on the federal model. It was not surprising that one of the first steps taken by Eisenhower upon assuming office as president in 1953 was to add an official advisory committee on government organization, under the chairmanship of Nelson A. Rockefeller. In addition, shortly afterward a second Hoover commission was created. which was to deal with the more explosive question of the proper scope of governmental functions. Its reports proved correspondingly more subjective and controversial.

These bodies, pursuing a broadly evolutionary approach. have done useful work. Cumulatively, they managed not only to get action on a whole series of proposals for desirable changes but also to shape a working doctrine of executive reorganization. The Brownlow committee, for instance, made history by breaking ground for the concept of the executive office of the president. Implicit in this concept was the idea that executive responsibility should be matched with sufficient authority and clearly centred in the top man, but its exercise should be bolstered by a balanced grouping of staff units bringing co-ordinating skill as well as specialized judgment to bear upon decisions. Another element in the working doctrine of executive reorganization, reaffirmed by the first Hoover commission, was the demand that activities be fitted into patterns, each dominated by a basic governmental purpose. This criterion of departmentalization sounds simple but is much less simple in practical application. Still another point of doctrine is the general rule that both the number of departments and the total number of agencies of the executive branch ought to be held to a minimum; that, ideally, the lesser agencies ought to be brought into some defined relationship with one or another department, as the president's span of control is naturally limited; and that novel public functions, especially while still experimental or when undertaken for the duration of an emergency, might best be constituted as — possibly temporary — agencies rather than as new departments.

As in the federal government, so also in state and local governments, the desirable structure of the departmental system was linked with the concept of a fully responsible chief executive. The strengthening of the governor's position, on the one hand, and the gradual replacement of the weak-mayor type of municipal organization by the strong-mayor type or the council-manager plan, on the other. led to some consolidation of the executive branch. This included a reduction of the number of agencies practically accountable only to themselves. Both in local and in state government, however. various officials are elected side by side with the chief executive. who therefore has no effective control over them.

Together with placing limitations on the number of departments and making each a repository of reasonably related functions, staff units have been built around the chief executive in state and local government. In addition, the concept of a department of administration gained some popularity, especially on the state level. This department is usually visualized as an agency combining responsibilities for budgetary planning, fiscal control, improvement of management and procedures, periodic inspection and provision of central services, such as purchasing and car pools. Not surprisingly, in the states as well as the counties and municipalities, progress along the lines of executive reorganization has been slow. In state government, for example, it is not exceptional to encounter more than 30 departments and a total of more than 100 agencies. including many not subject to the governor's general direction.

With the president constitutionally the coequal partner of congress in the performance of the tasks that have fallen to the federal government with the growth of an industrial society, it might be thought that he can do as he pleases in reorganizing the executive branch. This could be regarded as an obvious inference from his role as the responsible chief executive of the nation. But it is not widely assumed that such actually is the legal authority of the president. As a practical matter. it appears accepted that the president requires congressional authorization to reorganize the executive branch. Securing adequate authority for him is doubly important because evidence shows. as could perhaps be expected, that congress, left to itself, is not a particularly good architect of executive structure.

Despite much urging from official and unofficial quarters before as well as after World War II, congress failed to see compelling reasons for granting the president continuing authority to carry out reorganizations. Instead, taking its cue from the report of the Brownlow committee. congress passed a succession of short-term reorganization acts (of 1939. 1945 and 1949, the last prolonged repeatedly by new legislation). Each of these acts laid down essentially the same procedure for setting in motion the wheels of organizational change, first written into law in the act of 1939. In briefest outline, the president would come forth with specific reorganization plans and transmit them to congress. Congress then could express its disapproval of the individual plan. If no such disapproval had been voted, the plan would take effect after 60 days. having practically the force of law. Each reorganization act, as a limitation, extended a protective hand over certain agencies for various reasons. For disapproval. the acts of 1939 and 1945 required agreement by both the senate and the house of representatives. whereas under the act of 1949 objection on the part of either of the two chambers was sufficient if expressed by a majority of the total membership of that chamber. In the consideration of the prolongation act of 1953, a move in the committee stage to whittle down this majority requirement by substituting a simple majority was stopped in the nick of time. The prolongation act of 1957 eliminated the requirement that disapproval be expressed by a majority of the chamber's "authorized membership," thus greatly increasing the chance of congressional disapproval. The legislative veto, obviously, should operate only on the basis of substantial congressional sentiment against any particular reorganization plan.

Although in part because it was never employed in disregard of political realities. this novel procedure, on the whole, was notably successful. Instances of disapproval remained the distinct exception. On the side of accomplishments, reorganization plans provided the structure of the executive office of the president, one of the most important events in the modern administrative history of the federal government: strengthened the authority of top management on the departmental level; created the department of health, education and welfare; established such other important agencies as the Housing and Home Finance agency (1947) and the U.S. Information agency (19j3); and improved the organization of the defense department. More often, reorganization plans were used to achieve a more satisfactory allocation of particular activities to existing agencies. It has also happened that congress incorporated the substance of a reorganization plan into legislation.

A number of reorganization plans were aimed specifically at creating better conditions for effective management within the individual agencies. In the first place. in regard to plural bodies like the Federal Trade commission an effort was made to build up the position of the chairman into a kind of administrative chief, without affecting the prerogative of the body as a whole to settle important business by vote. Secondly, in single-headed agencies it was sought to do away with impediments to the freedom of the man at the helm to organize his agency for greatest efficiency. This meant the elimination of statutory barriers, a difficult obstacle to overcome. The campaign in support of wider managerial lee ay at the top level in the various agencies advanced a considerable distance but also suffered telling defeats in congress.

A reorganization program of such scope calls for extensive analysis of what is wrong in the first place, careful determination as to what to tackle and what to leave untouched for the time being and shrewd exploration of the strategy and tactics of how to formulate individual proposals and when to act. Some of these judgments are necessarily political. Many of them are technical, though often involving very complex situations. Staff work for the president in the technical development of reorganization plans has been an assignment of the bureau of the budget, more particularly of its office of management and organization, until 1952 the administrative management division.

Below is outlined the machinery for the conduct of the principal executive functions of the federal government.

Foreign Affairs.—In this field the primary agency is the department of state. Its head, the secretary of state, serves as the principal adviser to the president and congress in the determination and execution of the country's foreign policy. But, as Pres. Franklin D. Roosevelt demonstrated, a chief executive, in the fullness of his constitutional powers in foreign affairs, is able to take the reins of international relations pretty well into his own hands.

The secretary of state is also a top co-ordinator interdepartmentally. He is the ranking department head in the national security council, part of the executive office of the president. A statutory cabinet committee created in 1947, the council is to assess and appraise for the president the objectives, commitments and risks of the United States in relation to the country's actual and potential defensive strength. The council also advises the president on a unified approach by the entire executive branch to the attainment of national security and to the resolution of particular issues that often burst forth unexpectedly. The head of the policy planning staff in the department of state simultaneously serves as his department's representative in the top staff organization of the national security council. The co-ordinating responsibility of the secretary of state also extends to giving policy guidance to other agencies carrying on functions in the field of foreign relations. This applies especially to the administrative organization in charge of economic and military aid to friendly nations, such aid going back to the Marshall plan. The agencies in charge were named successively Economic Cooperation administration, Mutual Security agency, Foreign Operations administration and International Cooperation administration (the last a semi-autonomous element within the state department). State department policy guidance is also supplied to the U.S. Information agency, concerned with winning understanding for the American point of vie and American ways among the leaders of public opinion in other countries.

Within the state department, attention is given to both political and economic affairs. A large task is the business of keeping together the threads of diplomacy. The business of administration includes the management of the foreign service. The members of the foreign service have traditionally formed a separate corps of career officers, distinct from the general civil service, and thus also from the departmental personnel of the state department. Pressure for a merger of the two groups increased after the end of World War I Two areas of special emphasis are effective communication of the department's goals and interests to congress and to the public, respectively. The first activity is doubly important because the relations between the department and congress have been marred by many a misunderstanding. The extensive security interests of the department are in the care of its bureau of security and consular affairs. The Passport office and the Visa office are also part of this bureau.

The steady flow of dispatches and reports, typical of the day-to-day activities of diplomacy. runs through the so-called regional bureaus of the department. Each deals with the affairs of a different section of the globe. The principal groupings are inter-American affairs, European affairs, far eastern affairs and near eastern, south Asian and African affairs.

Another group of specialized offices provides guidance and support for the participation of the United States in international organizations. It represents the headquarters staff doing much of the desk work for the role the federal government plays in the Security council, the Economic and Social council and the general assembly of the United Nations, largely through the United States mission to the United Nations.

The need for bringing standards of scientific accuracy to bear upon information coming from all corners of the earth has been the main cause of the formation of a bureau of intelligence and research. Its work, too, is divided geographically to provide the advantages of specialization of knowledge. Co-ordination of the intelligence activities throughout the executive branch is the task of the central intelligence agency, which is under the direction of the national security council.

The most striking addition to the traditional means of carrying on U.S. foreign relations occurred in 1948 with the establishment of a large program of assistance to foreign countries. The program was first outlined in the famous commencement address by Secretary of State George C. Marshall at Harvard university. For the administration of this program a specialized agency with its own country missions was created, ahich was brought into the state department only in 1955, in continuation of its separate status within the department. (See also FOREIGN AID PROGRAMS.)

Finance: Revenue and Debt.—In Great Britain the treasury, in its historic development, has become a vital factor in the operations of the entire national administrative system. Treasury control means not only co-ordination of fiscal and economic policies but also central superintendence over the departments in the performance of such management functions as budgeting and personnel. Thus the British treasury has a good deal of government-wide responsibility for the general efficiency of the executive branch.

In the United States. on the other hand, responsibilities for over-all management have gravitated toward the presidency--organizationally speaking, to the executive office of the president, especially the bureau of the budget. Basically the treasury department is a line establishment like the other departments But it also discharges indispensable staff assignments for the president.

For example, although under the Budget and Accounting act of 1921 it is the duty of the budget bureau to assist the president in the preparation of the budget, elaboration of the revenue side has always been the task of the treasury department. It is the secretary of the treasury and his experts who present to congress for the president the tax proposals of the executive branch, and who in turn serve congress as principal sources of technical information when the initiative in tax legislation is taken by the revenue committees. Legislative initiative is quite normal. under congressional-presidential government. The proposals of the executive branch in these as in all other matters are simply presidential recommendations, which congress is constitutionally free to ignore.

Another indication of the treasury's government-wide responsibilities is supplied in the secretary's role as chairman of the National Advisory Council on International Monetary and Financial Problems. in effect a cabinet committee for purposes of interdepartmental co-ordination in this field, but less important than the national security council. Of great practical consequence for the economy is the effectiveness of the treasury's relationships with the organizationally independent federal reserve system, backbone of the country's private banking business and chief guardian of sound money conditions. Although federal reserve policy may directly affect rates of interest on treasury financing. the treasury has no legal authority over the federal reserve system. Nor has the treasury effective control over all governmental lending programs, like those providing building loans or agricultural credit.

In the treasury department the fiscal and the administrative assistant secretaries represent the growth of the career idea on the highest level. The administrative assistant secretary supervises the department's work in matters of general management. The fiscal assistant secretary is in charge of financial administration, including the department's accounting activities and supervision over the bureau of the public debt and the office of the treasurer of the United States, which is essentially the banking facility for the federal government.

In the making of treasury decisions about taxation, financing and debt management, the support furnished by the analytical staff in the secretary's office is of great importance. More specialized is the office of international finance. The duties of this office include collection and analysis of current information about the economic positions and policies of other nations having a bearing upon the country's financial and monetary programs. The office also participates in negotiations with foreign governments involving questions of international finance.

The main divisions of work in the treasury demonstrate how far it is burdened nith operating functions. Its chief components are: the bureau of the mint, the bureau of engraving and printing, the United States savings bonds division, the office of the comptroller of the currency (who supervises the so-called national banks), the internal revenue service (with an extensive field service of its own), the bureau of customs (also with a field organization), the bureau of narcotics (administering the federal narcotics lams), the United States secret service (*q.v.*) (guardian also of the president's safety and that of his family, and separate from the Federal Bureau of Investigation in the department of justice) and, finally, the United States coast guard (a detachable service, so to speak, for in time of war or upon the president's direction the coast guard moves under the command of the navy department).

Defense.—The department of defense is the result of a determined effort to achieve a unification of the military services. A decisive step was taken with the creation by the National Security act of 1947 of a single national military establishment composed of army, navy and air force. The amendments to this act in 1949 strengthened the position of the secretary of defense. Reorganization plan 6 of 1953 and additional legislation passed in 1958 carried this development still further.

With installations as well as military interests spread over most of the world. the defense department became a realm by itself. It is also a necessary partner in almost all important decisions affecting the U.S. national interest. Its performance casts a broad shadow across the entire executive branch.

The machinery by which the defense department asserts its control over the three service departments is technically called the office of the secretary of defense. The secretary is a member of the national security council and such other policy-making bodies as the North Atlantic council. One of the secretary's assistants gives special attention to the application of atomic energy. another to guided missiles. Responsibility for the various segments of the department's program is distributed on such lines as manpower and personnel, supply and logistics, international security affairs, research and engineering, and public affairs. The National Aeronautics and Space administration, created in 1958 to solve flight problems within and outside the earth's atmosphere, is separate.

The armed forces policy council is advisory to the secretary. The council brings together the top men throughout the department, including the civilian secretaries of the three service departments and the military chiefs. The joint secretaries form a separate organ of advice. leaving out the military spokesmen. The joint chiefs of staff, in turn. consist of military representatives only: the chairman (who while so serving tnkes precedence over all other officers of the armed services). the chief of staff of the army, the chief of naval operations and the chief of staff of the air force. The chairman has charge of the joint staff, comprising under its director a joint strategic plans group, a joint intelligence group and a joint logistics plans group. Perhaps no other body has as much potential influence in giving unity to defense planning in its developing phases throughout the three services as have the joint chiefs of staff. On the other hand, the adequacy of this type of staff organization was questioned by various groups, including military leaders. Bringing together men from the three armed services in itself produces no higher loyalty.

There are variations in departmental organization as well as in military staff structure among the three service departments, but the formal relationship to the office of the secretary of defense is the same. The secretary of defense, below the president as the constitutional commander in chief, is the immediate superior of the secretary of the army, the secretary of the navy and the secretary of the air force. Each, in turn, has as his principal adviser in military matters the ranking officer who represents the department on the joint chiefs of staff. One navy component with a great tradition of its own is the United States marine corps. When the joint chiefs of staff deal with its affairs, the commandant of the marine corps sits with them as an equal.

The department of the army. through its corps of engineers. also performs important civil functions in improving rivers, harbours and waterways for navigation, in constructing flood control and similar projects in various parts of the country, and in administering the laws for the protection and preservation of navigable waters.

The new stature and ramifications of national defense, together with the impact of science on strategy, tactics and weapon development. have made the military a crucially important profession. Extensive schooling is therefore indispensable. The joint service schools are the National War college. the Industrial College of the Armed Forces, both located in Washington, D.C.. and the Armed Forces Staff college, Norfolk, Va. Most of the military schooling, however, is provided under the auspices of each individual service, with some participation from the others.

Justice.—Justice is administered, in the main, through the courts. In addition to the role of the judicial branch, however, certain important responsibilities in this field are discharged by executive agencies, especially by the department of justice This department provides the means, together with other agencies in their special fields, for the enforcement of federal legislation, supplies legal counsel in federal cases and construes the laws under which the other departments act. It also supervises the federal penal institutions and contains two services which conduct their business in considerable independence—the Federal Bureau of Investigation and the immigration and naturalization service. The attorney general is the federal government's chief law officer. As head of the department, he also directs the prosecuting and other activities of the United States attorneys and marshals in the various judicial districts. The solicitor general represents the federal government in litigation before the supreme court and. at the attorney general's request. before other courts as well. Formal opinions of the attorney general and informal advice to executive agencies are prepared in the office of legal counsel, which also examines proposed executive orders of the president for their legality, in connection with the clearance of the draft by the bureau of the budget. The office of alien property exercises the functions of the attorney general in controlling and vesting foreign-owned property under the Trading With the Enemy act. Applications for pardon and other forms of executive clemency are reviewed by the pardon attorney.

The main functional groupings within the department include the antitrust division, engaged in combating monopoly and restraints of trade; the tax division, the federal government's tax attorney, as it were, and also its chief of prosecution under the internal revenue laws; the civil division, which supervises all matters relating to civil suits and claims against the United States and its officers not otherwise assigned; the lands division, concerned with such cases as condemnation proceedings and protection of water rights, including litigation with respect to Indians and Indian affairs; the criminal division; and the civil rights division.

Still larger elements are the bureau of prisons, which keeps its eyes on the federal penitentiaries, reformatories and correctional institutions; the Federal Bureau of Investigation. the main detective arm of the federal government, which occupies a unique place in congressional sentiments as well as the attitude of the newspaper reader; and the immigration and naturalization service, which administers the laws that govern the admission, exclusion, deportation and naturalization of aliens, maintaining also the federal border patrol. These last two bureaus have substantial field services for their specialized functions.

Postal Administration.— Although the post office department manages the largest business in the world, ancient political practice has persisted in leaving all postmasters of the first, second and third class in the category of presidential appointments.

In addition to the bureau of the chief postal inspector. there are five basic divisions in the department. These are: the bureau of operations, as the central management for all normal post office activities; the bureau of transportation, attending to the physical means of maintaining the steady flow of mail, and also administering the so-called international postal service; the bureau of finance. with functions that extend to supervision of the conduct of the money-order system and of the sale of government savings bonds by the post offices; the bureau of facilities, including buildings and special equipment; and the bureau of personnel. The postal savings system is under a board of trustees, which also determines the proper investment of the savings paid in at the individual post offices. One of the incidental functions of the department is the prevention of the use of the mails in violation of federal law. This covers such matters as fraud. espionage and obscenity. As in other countries, the postal appraisal of literature has given rise to some memorable court decisions.

Resources and Guardianship.— In this field the most important role is played by the department of the interior. The activities of this department centre upon the management. conservation and development of the natural resources of the United States—public lands. water. power, oil, gas. other mineral assets, fish and wildlife resources and the national parks. The department also promotes the welfare of the inhabitants of the island possessions of the United States and of the trust territory of the Pacific islands. in addition to exercising guardianship over U.S. Indians and promoting the interests of the natives of Alaska, the 49th of the states. entering the union in 1959.

The principal division of work on the department's top level is in terms of fish and wildlife, mineral resources. public land management and water and power development. The technical review staff conducts studies of various programs and maintains liaison between the department and its field committees, which serve as organs of co-ordination in the main geographic areas.

The interior department is divided into these main elements: the bureau of Indian affairs, trustee of the lands belonging to the Indians and source of public services to them, as long as they are not yet absorbed into American life: the bureau of land management, responsible also for the granting of grazing permits on the public range; the bureau of mines. which has as its tasks the conservation of mineral resources, the conduct of research in mining and utilization of mineral substances and the promotion of safety in the mineral industries; the bureau of reclamation, in many respects a rival of the army corps of engineers as the builder of public works to bring water to the lands of the west, including development of power; the fish and wildlife service, part of which is the bureau of commercial fisheries; the geological survey, a research bureau engaged in compiling and publishing information about the nation's mineral, water and other resources; the national park service. with about 180 national parks, historic sites and recreation areas; and the Bonneville. Southwestern and Southeastern Power administrations, which market electric power generated at federal reservoirs.

Agriculture.— It is the foremost goal of the department of agriculture to promote the general interests of those who produce from the soil—"agriculture" being a collective term that includes enterprises organized as private corporations, owners of family farms, homesteaders, tenants and sharecroppers. The difficulty of establishing a common denominator among all these groups—even in the department's extensive educational publication program—has often been a source of political trouble for the department.

One functional grouping concentrates on federal-state relations, under which are co-ordinated the agricultural conservation program service, the agricultural research service, the farmer cooperative service, the extension service (carrying the fruit of research to the farms through county agents), the forest service with its 150 national forests and the soil conservation service. Another functional grouping is marketing and foreign agriculture, including the agricultural marketing service, the Commodity Exchange authority (overseer of fair commodity trading) and the foreign agricultural service. Agricultural stabilization is promoted by the Commodity Credit corporation, the commodity stabilization service and the Federal Crop Insurance corporation. The Farm Credit administration being an independent agency, the department's agricultural credit services are limited to the Farmers Home administration and the Rural Electrification administration, both in the main being loan programs.

More specifically, the agricultural research service lends support to the experiment stations and carries on work in agricultural and industrial chemistry, animal industry, dairy industry. entomology and plant quarantine, human nutrition and home economics. plant industry, soils and agricultural engineering. The farmer co-operative service carries on research and educational and service activities of help to the large number of farmers who belong to agricultural co-operatives. The extension service operates on the basis of a co-operative relationship between the department. the land-grant colleges and the county governments in the provision of educational programs in rural communities. Like the extension service, the soil conservation service, through soil conservation districts organized and managed by farmers and ranchers. deals directly with local needs The agricultural marketing service provides research and statistics as well as marketing services, including the standardization of farm products and the administration of the school lunch program, financed from federal and state funds. The foreign agricultural service has primary responsibility for developing markets abroad to absorb U.S. surplus production. The commodity stabilization service is responsible for such matters as acreage allotment and marketing quotas with respect to agricultural commodities for which supplies are out of line with demand; it also administers price supports by loans. purchase agreements or purchases. A body loosely related to the department is the U.S. Department of Agriculture Graduate school. a nonprofit institution of higher learning for federal employees at Washington. D.C.. supported essentially by student fees.

Commerce. — The responsibilities of the federal government in the field of commerce, broadly defined, are widely scattered. The commerce department is essentially a service agency. with almost no regulatory duties. These are exercised for the most part by such independent bodies as the Federal Trade commission. which seeks to guard fair competition; the Securities and Exchange commission. which polices the stock market; and the Interstate Commerce commission, the Civil Aeronautics board, the Federal Communications commission and the Federal Power commission. with regulatory powers over surface transport, air transport. aire and radio communication and hydroelectric power and natural gas, respectively.

The department of commerce deals with both domestic and international commercial affairs. The first field is handled by the office of business economics. devoted to long-range as well as short-run analyses of the national economy. which are made generally available in the form of the monthly *Survey of Current Business;* the Business and Defense Services administration, and the bureau of the census The second field falls within the competence of the bureau of foreign commerce. which publishes the *Foreign Commerce Weekly*

The department performs a number of basic national services. These are represented by the bureau of the census as one of the federal government's major fact-finding and statistical agencies; the weather bureau; the national bureau of standards. conducting for the government fundamental research and related technical activities in physics, mathematics chemistry and engineering; the patent office; and the coast and geodetic survey. which carries on studies to provide data for navigation charts. In addition. there are tno major services which concentrate on different forms of transportation The Maritime administration is concerned with aid to shipping and related functions. The bureau of public roads develops the country's highway system in co-operation with the states on the basis of federal financial aid to the states. The Federal Aviation agency, created in 1958 outside the commerce department, has mainly promotional aims with respect to civil air traffic. but also enforces air safety regulations.

Of considerable importance to the national economy, in addition to the commerce department, are such independent agencies as the Housing and Home Finance agency. the Federal Home Loan Bank board. the Federal Deposit Insurance corporation and the Atomic Energy commission.

Labour. — The fundamental mandate of the department of labour is to foster the welfare of the nage earners. improve their working conditions and advance their opportunities for profitable employment.

One of the most important bureaus of the department is the bureau of labour statistics. It is the main repository within the federal government of information about employment and manpower, productivity, earnings, hours and wages, industrial relations, accidents, price trends and costs as well as standards of living. This information is made public in special bulletins and in the *Monthly Labor Review.* The bureau also keeps abreast of labour conditions in other countries, on which it reports in its *Labor Developments Abroad.* The bureau of labour standards is a service to state labour departments and organized groups interested in better working conditions. This bureau promotes industrial safety and health, develops standards for labour legislation and its administration and assists in giving effect to international labour standards. The women's bureau looks after the interests of all women at work or seeking work; its directors have traditionally been women of exceptional calibre.

Other principal services maintained by the department are the bureau of apprenticeship. which formulates standards for the training of skilled workers in industry; the bureau of employees compensation, charged with the administration of the accident compensation program for federal employees and certain types of private employment subject to federal legislation; the bureau of employment security, providing a combined placement and unemployment insurance system, the insurance part being a joint federal-state responsibility under the social security legislation; the consolidated wage and hour and public contracts divisions, the former assuring minimum rates of pay in general and protection of youthful workers against exploitation in particular, and the latter supervising the observation of stipulations in government contracts with respect to minimum wages and other safeguards of fair employment; the bureau of veterans' re-employment rights: and the office of international labour affairs, which has primary responsibility for the participation of the United States in the International Labour organization, in line with the general policies of the department of state. This office. in addition, serves as the secretariat to the trade union advisory committee on international affairs appointed by the secretary of labour

Essential additional functions are carried out by such separate agencies as the National Labor Relations board concerned with protecting collective bargaining and eliminating unfair labour practices; the Federal Mediation and Conciliation service; and the National Mediation board, applicable to railway labour.

Health, Education and Welfare. — The department of health, education and welfare was established in 1953 as an elevation of the Federal Security agency. As one of the department's big operating bureaus, the public health service, under the surgeon general, strives to protect and improve the health of the people. Its main parts are the bureau of medical services. which administers hospitals and outpatient stations for seamen, coast guard personnel and other beneficiaries as defined by law. enforces quarantine regulations and supplies office health services for the employees of federal agencies: the bureau of state services. attending to federal-state programs for the control of communicable and other diseases and for such related matters as public-health nursing and education; and the national institutes of health as the research arm of the public health service. dealing with cancer, heart disease. dental research mental health. arthritis allergy. infectious diseases, neurological diseases and blindness. The office of education is an agency of specialized information and technical advice, especially to state and local school officials. It also administers a grant-in-aid program — a customary form of federal participation in the conduct of nationally important functions not within the immediate jurisdiction of the federal government.

The Social Security administration, another large component of the department, is divided into the bureau of old-age and survivors insurance, the bureau of public assistance, the children's bureau and the bureau of federal credit unions. The first of these supervises the great direct federal insurance system under the social security legislation, whereas the second — more typically — provides a federal financial contribution in support of what was originally an exclusively local responsibility. The children's bureau. like the women's bureau in the labour department, is in the main a clearinghouse of research and technical information. The bureau of federal credit unions is the supervisor of co-operative associations organized to foster thrift among their members and to meet their credit needs.

The office of vocational rehabilitation is the ambassador of the vocational interests of the mentally as well as the physically handicapped. The Food and Drug administration deals for the most part with the enforcement of the federal laws that aim to assure standards of manufacturing purity and truthful labeling. Saint Elizabeths hospital, Washington, D.C., in the care of the department, is a government institution for the mentally ill. A looser supervisory relationship exists between the department and three federally aided corporations: the American Printing House for the Blind, Louisville, Ky.. Gallaudet college for deaf students, Washington, D.C., and Howard university. Washington. D.C., founded in 1867 to mitigate the lack of higher educational facilities for Negroes.

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GREAT BRITAIN

The executive powers of the central government in Britain are, by law or convention. vested in ministers who sit in parliament. Each minister is individually answerable to parliament for any exercise of the powers vested in him. whether action is taken by him personally or in his name by subordinates. Each minister has a retinue of officials who form a single establishment over which he presides personally. Some ministers in addition are responsible for other establishments which are separately organized and are often distinct legal entities, but which through constitutional evolution have come to work in ultimate subordination to a particular minister. All these official establishments are generally called government departments. Those over which ministers preside personally, and through which they perform their main executive duties, are often referred to collectively as ministries, and taken together form the heart of the central administration. Most of the others are charged with routine and relatively uncontroversial administrative tasks. The two groups comprise an immensely variegated collection of institutions, the range of whose functions and internal organization makes accurate brief generalization almost impossible. Three characteristics are common to all but a few. however: each is the entire responsibility of a minister, each is financed by direct grants from parliament voted by an orthodox procedure and each is staffed by members of a centrally recruited and integrated civil service.

All the ministries and a few of the other establishments can usefully be classified as major departments. and the rest as minor departments, but there is much room for argument as to exactly where the line between them should be drawn. Moreover, there is even doubt in some cases as to whether an institution is or is not a government department. There are a host of public authorities. variously entitled generically "nondepartmental bodies." "independent administrative authorities." "public corporations." etc., which are usually collegiate in form and in respect of which ministers have certain statutory powers. A few of them have certain characteristics—for instance in their financing and staffing—similar to those of unmistakable government departments. while a few of those institutions usually referred to as departments share certain characteristics common to public bodies which could not conceivably be regarded as government departments. In short, the very term government department cannot be precisely defined. In this context. the most that can be said safely is that in the late 1950s there were some 25 to 30 major and at least 50 minor government departments.

General Background, Nomenclature and Status.—Contemporary Britain is used to the concept of a government department as a body of officials having its own continuous existence. its own traditions and philosophy. apart from the ministers who preside over it or are responsible for its actions for at most a few years at a time and often for much shorter periods. This does not imply that the minister is a mere cipher whose presence is nothing more than a necessary constitutional formality: indeed. while the strengths of ministers vary widely, the impact of the weakest on a department will have at least the effect of lowering its status in relation to other departments. whereas a strong minister can not only raise a department's relative status but can mold its stored traditions and procedures into a powerful and characteristic personal instrument which may bear the impress of his suzerainty for a generation. Nonetheless, his mastery is based on a delicate balance betneen his own personal and political authority on the one hand. and his officials' expertise and experience on the other hand.

This whole concept reflects complete acceptance of the modern system of responsible cabinet government, but that system only came to full maturity in the middle of the 19th century. The origins of the oldest departments go back centuries before that, to a time when the central government was contained in the personal household of the medieval king: when there mas no question of responsibility to anyone except the king. no "constitutional" opposition and, therefore, no distinction between a "political" executive and a "neutral" civil service.

The present major departments have sprung from three main sources—from individual officers of household and state, from the privy council and from parliament. The first source had produced by the end of the Tudor period at least the embryo forms of the lord chancellor's department, the treasury, the admiralty. the post office and the ministry of works. It also produced the office of secretary of state, which was shared by two men of equal standing as early as 1540 and, while remaining a single office, has since been divided between as many as eight heads of departments simultaneously. The board of trade (set up in the 17th century) and four scientific research organizations are in form committees of the privy council, while the ministry of education and the ministry of agriculture. fisheries and food derive from similar committees. The remaining ministries or their immediate forerunners were created by acts of parliament in the 19th and 20th centuries. Until 1915, it was usually the practice of parliament to establish in each case a board composed of some existing ministers plus a new minister who was made president of the board. Since 1915, new ministerial offices have been set up by statute without any hint of collegiate authority.

The variety of origins is reflected in the variety of titles and constitutions of departments, because the British have indulged an indigenous weakness for retaining outward institutional forms after the realities have long ceased to correspond with them. Thus, the basic constitutional simplicity and uniformity of the system is by no means apparent from a list of contemporary ministers and departments. The straightforward "minister of . . ." and "ministry of . . ." is used for less than half the departmental chiefs and their major departments. The other ministries are either the "offices" of secretaries of state or have unique collegiate forms and are headed by ministers with equally unique titles—the board of trade with its president, the admiralty and its first lord, the treasury answerable to the chancellor of the exchequer, and so on.

It would be incorrect to declare that government departments form a hierarchy, if by this is implied the existence of a strict line of command running downward from one supreme department through various strata of major and minor departments. Each minister must answer personally to parliament for anything done in his name by his officials: he cannot escape responsibility by claiming that he was merely carrying out the instructions of a "senior" colleague, for the constitution does not recognize any inequality between ministers, and therefore cannot do so between their departments. But just as the prime minister has become more than the traditional "first among equals" in a ministerial context, so there is to some extent if not a hierarchy at any rate a degree of aristocracy among departments in Whitehall which perhaps has to be felt rather than explained. Some of the departments which are in the front rank are also among the most ancient, simply because they deal and have dealt for centuries with the most fundamental functions of government. But formal precedence derived from origins and nomenclature is no longer a safe guide to relative status. Tangible proofs of current political and administrative importance, rather than antiquity or title, are the hard main bases of such distinctions as exist. Thus, now that there are too many ministries for all their chiefs to be members of the cabinet, those which are directly represented in the highest council of the state are inevitably lifted a little above their fellows. A department whose minister was unknown to the constitution 20 years ago but who now sits in the cabinet may carry more weight, for the nonce at any rate, than a department headed by a secretary of state and dating back to the 15th century.

Departments are shown in a proper perspective if they are grouped roughly according to their functional affinities, though there can be no absolute precision about what each major function of government comprises. In the following sections all the ministries are mentioned, but only a selection of the minor departments is included. Administrative organization exclusively concerned with Scotland and Wales is referred to briefly in a final paragraph. (See also SCOTLAND: Government.) Most of the text treats of departments which deal with the whole of the United Kingdom or with England and Wales as one unit. The first section, while covering financial administration, has pride of place because it includes the treasury, whose position in the central administration is unique and whose influence extends far beyond normal financial boundaries.

The Treasury and Associated Departments.— The treasury began in the 12th century as one part of the financial machinery of the kingdom which was concerned exclusively with the receipt and issue of money. At its head was the lord high treasurer, but his office was put "in commission" on several occasions in the late 17th century, and permanently in 1714. The lords commissioners of the treasury are the formal heads of the department, but the first lord is now always prime minister, the junior lords are government whips in the house of commons, and the effective ministerial chief is the second lord or chancellor of the exchequer, who first appeared on the treasury scene in the reign of Henry III.

The modern treasury is the nearest equivalent in Britain to a ministry of finance and economic affairs, but it does both more and less than the ministry of finance in other countries. The treasury does not collect revenue: this is done mainly by two large departments also answerable to the chancellor of the exchequer—the board of inland revenue and the board of customs and excise. Moreover, much specialized financial work is carried on by such minor departments as the national debt commission, the paymaster general's office, the royal mint and the public works loan board, all ultimately responsible to the chancellor of the exchequer. The treasury itself is a relatively small department, concerned primarily with the big aspects of fiscal policy, domestic and external, including the preparation of the annual budget. Between 1947 and 1953, it also became, and continues to be, the departmental home of a central staff of economists and planning officers whose tasks are to co-ordinate the economic policies of other departments and to advise the chancellor of the exchequer on the making of national economic policy.

But the function which gives the treasury its peculiar prestige in British administration is its responsibility for controlling departmental expenditure—a responsibility always latent in the department though forced into great prominence by parliamentary pressure for economy in the mid-19th century. This control gives the treasury far-reaching powers over the structure, the pay and the conditions of work of the civil service. It also extends its influence into the sphere of organization and methods, and into the general arrangement of the whole central administration. The control is not simply a straightforward exercise of crude authority. The treasury does not have officers attached to other departments to watch over their spending, nor is it concerned with the audit of departmental accounts. Control is achieved rather through continuous and delicate negotiations between the treasury and departments before the former gives its approval for proposed expenditure by the latter. In the last resort, treasury control depends for its effectiveness on the strength of the chancellor of the exchequer in the cabinet, but as the chancellor is always a very senior minister his political strength is usually considerable. In addition, the connection of the prime minister with the department (even if largely nominal), the high calibre of the treasury staff, the conventional high status of the department and the well-understood "rules of the game" in Whitehall combine to make the treasury, though not the master, at least more than the equal of the other departments.

The permanent headship of the treasury has been formally recognized as the most important post in the home civil service since 1920. In the 20th century, it has on a few occasions been shared by two or three men, and since 1956 it has been held jointly. One permanent secretary holds the title of head of the home civil service: he is at the same time secretary of the cabinet and thus presides over the cabinet office, a nonpolicy-making secretariat whose origins go back to the secretariat of the committee of imperial defense set up in 1904, and which took its present form in Dec. 1916. This secretary, in his threefold capacity, advises the prime minister and the chancellor of the exchequer on all matters of personnel and organization; his colleague answers to the chancellor of the exchequer for the fiscal and economic side of the treasury's work.

Justice and Public Order.—One of the most distinctive characteristics of British government, which marks it off from the other countries of western Europe, is the relatively low degree of central executive control over local administration, particularly in the context of police power. There are over 150 police forces, and all save the metropolitan police, whose area covers Greater London, are under local control. Nor are there any "regional" officers equivalent to the French prefect whose primary loyalty is to, and whose supervisory powers over local units are wielded primarily in the interests of, the central government. In British central administration the extent of local autonomy is also reflected in the lack of any departments which a continental European would readily recognize as ministries of the interior and of justice. Central powers relating to matters of justice and internal order are exercised in England and Wales by the home office and the lord chancellor's department. Neither is charged, however, with any general supervision over the local government system; insofar as there is such supervision it is undertaken principally by the ministry of housing and local government, a department mainly interested in social service matters.

The home office is the main department of the secretary of state for the home department (or home secretary) and took its present basic form in 1782. It was throughout most of the 19th century the natural choice for any new functions needing domestic administration, but as this sphere of government grew, various blocks of work were removed and became the nucleus of the business of new departments. The practice of turning first to the home office has remained, however, with the result that in addition to its major continuing functions, the department is responsible for exercising a miscellaneous group of powers to which no other department has a better claim. Its major continuing task is helping to ensure the maintenance of public order—a term which covers inspecting and giving advice to local police forces, the organization of the lower criminal courts, a general interest in the working of the criminal law and the promotion of necessary amendments, and the duty of advising the home secretary on the exercise of the prerogative of mercy. It also deals with such matters as immigration and naturalization: civil defense, aliens, certain safety regulations, election administration, control of dangerous drugs, inspection of local fire services, liquor licensing, etc. Prison administration is the responsibility of a separate prison commission; the metropolitan police is headed by a commissioner. Both he and the prison commissioners are answerable to the home secretary.

In England and Wales, the organization of the lower civil courts and all the superior courts, the appointment of minor judicial officers and the duty of advising the crown on the appointment of judges of the supreme court are the principal administrative functions of the lord chancellor, whose small department has grown from the dimensions of a mere private office in the course of the 20th century. The lord chancellor is also answerable to parliament for the work of the public trustee, the land registry and the public record office. Responsibility for the conduct of the most important crown prosecutions and for all litigation to which government is a party rests in England and Wales with the attorney general and solicitor general, who are served by a small professional staff comprising the law officers' department. The attorney general also supervises the work of the director of public prosecutions.

External Affairs.—The earliest secretaries of state were primarily occupied with diplomatic duties. and from 1640 divided their interests geographically, one secretary taking the countries of northern Europe as his sphere of influence, the other dealing with southern Europe and with the relatively little domestic administrative business which came the way of the secretaries. In the 17th and 18th centuries. Scottish and colonial business was added and a third secretary of state held office from 1707 to 1725. from 1741 to 1745, and between 1768 and 1782. In the latter year, the geographical division of interest was changed: the northern secretary became in effect the foreign secretary, and the southern secretary became responsible for home and colonial affairs. In 1801, a third secretary of state was appointed. this time for war and colonies, and in 1854 these two subjects each became the responsibility of a separate secretary. Meanwhile, since 1786, the British government had assumed certain responsibility for India, where the East India company still held sway, and had appointed a board of commissioners for the affairs of India. Full governmental control followed in 1858, under a new secretary of state for India. For the next 70 years, there were three "external" departments—the foreign, colonial and India offices. After World War I, as a result of the development of self-government in some of the larger colonies—called dominions after 1907—the dominions branch of the colonial office was made into a separate dominions office in 1925, and a new office of secretary of state for dominion affairs was created. In 1937, a Burma office was established, though it and the India office remained the responsibility of a single minister. Ten years later, the dominions office was renamed the commonwealth relations office. and its work steadily extended as relations with formerly dependent territories passed either to it or to the foreign office. The India and Burma offices disappeared in 1947–48.

The foreign office conducts relations with all independent noncommonwealth states except the Republic of Ireland, and with the United Nations It is unique among government departments in that it is staffed by members of a foreign service whose posts are interchangeable uith posts at missions overseas. The commonwealth relations and colonial offices are staffed by members of the home civil service. who are liable to be posted overseas. The personnel of the commonwealth relations office and of the British high commissioners' offices in commonwealth countries is, however, practically a separate service whose members are moved about as frequently as their counterparts in the foreign service. The commonuealth relations office is responsible for relations with all the self-governing nations of the commonwealth. with the sultanate of the Maldive Islands and with the Republic of Ireland; it is also responsible for the administration of three territories within or adjacent to the borders of the Union of South Africa—Basutoland Bechuanaland and Swaziland. The colonial office is concerned with direct administration and with the constitutional, economic and social development of the remaining dependent British territories. *See* also FOREIGN SERVICE.

Defense.—The evolution of two departments to deal comprehensively with the administration and control of the navy and army was slow and complicated. The admiralty and war office are, in short, the results of bringing together over a long period of time a large assortment of naval and military administrative authorities, and the air ministry, established in 1918 by removing the relevant sections of the two older departments and merging them, took the same constitutional form, which reflects a compromise between the special military need for operational flexibility and the insistence of parliament on ultimate civil control. Each department is headed by a board or council comprising the highest service officers together with the minister as chairman, a junior minister and the secretary, who is a civil servant. In the event of disagreement, the minister's will ultimately prevails, but the strong professional body of advisers and the special character of the function of defense means that the administration of the armed forces is more a matter for genuine collegiate authority (this is particularly so in naval matters) than any other branch of central administration.

The concept of a single, interservice strategy, of co-ordinated naval and military planning, was first given institutional recognition in the creation of the committee of imperial defense and its secretariat in 1902–04. The value of this device was demonstrated by its being the basis in World Wars I and II of the war cabinet organization, and in 1946 the military secretariat was adapted and extended to form a ministry of defense. The minister of defense sits in the cabinet and his powers in general defense matters have been steadily increased. In 1958 a defense board on the lines of the board of admiralty and the army and air councils was appointed with the minister of defense as chairman. The three service departments have retained a direct responsibility for the detailed administration of the navy. army and air force, but their ministers have not sat in the cabinet since 1946.

A fifth unit makes up the set of modern defense departments. This is the ministry of supply, whose most ancient predecessor was the board of ordnance set up in the 15th century and abolished in 1855 during the Crimean War, when the need to consolidate administrative authority in the war office was the prevailing view. In World War I, the task of supplying the army was entrusted to a ministry of munitions which was disbanded in 1921. The ministry of supply was established in 1939, and in 1946 took over the functions of a wartime ministry of aircraft production. For some years during and after World War II, the ministry of supply had, as well as its military duties, wide civil responsibilities, especially in connection with the control of raw materials for industry, and under the Labour government of 1945–51 was charged with the general supervision of the iron and steel and heavy engineering industries. After 1951, however, the department was relieved of much of its nonmilitary work, and concentrated on supplying the army and air force with most of their stores. It has relatively little to do for the navy; the admiralty remains both an operational and a supply department.

Trade, Industry, Agriculture, Communications.—One of the features of contemporary British administration is the existence of recognized channels of contact between the state and every trade and industry. through uhich there is a two-way traffic—various degrees of control, advice and assistance passing down from the government, and information and requests for help and co-operation passing upward from producers and traders. The responsibility for dealing with these economic units or groups is widely distributed among the major departments. Some trades and industries have special links with departments whose primary administrative interests are not economic—for example, the shipbuilding industry turns to the admiralty, the manufacturers of drugs and medical appliances look to the ministry of health, and so on. But there are departments whose whole concern is with either one or more groups of producers and traders, or with a range of administrative matters of general concern to the commercial world. In addition, there is the post office, which is sometimes regarded as a revenue department but deserves to be treated as an industry in itself.

The post office is, in fact, the oldest of these departments. A master of the posts was appointed about 1512, and a general post office was established by Cromwell in 1657. It has remained a self-contained unit whose enormous growth has encompassed not merely the postal service but also a near monopoly of telecommunications; it is, in addition, a savings bank and it provides a ubiquitous "counter" service which is used extensively by various other departments on an agency basis. (*See* also POSTAL SERVICES.)

The board of trade has been the main progenitor of departments dealing with economic matters. As a committee of the privy council, the board has had an almost continuous existence since 1621, but its present constitution dates from 1786, and its formal duties laid down in an order-in-council of that year are "the consideration of all matters relating to trade and foreign plantations." Until the middle of the 19th century, the board's role was mainly consultative and advisory. but thereafter it became. under the unequivocal leadership of its president, a powerful executive department exercising regulatory powers over commercial practice, over shipping and railways! over patents, over fisheries, etc., while also developing further as the central department concerned with domestic industry and external trade.

The range of the board of trade's functions was greatest in 1914, but as a result of two world wars and a further expansion of governmental activity the board's wide jurisdiction was later divided among several departments. The board itself now plays a triple part: As the senior trade and industry department it has a general advisory, stimulative and consultative role in relation to the whole world of manufacture and commerce; it is a regulatory department with many routine functions concerning companies, bankruptcy. patents, etc.; and it is the department which all trades and industries other than those allotted to other departments consider to be "their" channel of communication with the central government. But the board's previous responsibilities relating to employment matters, to transport and to public utilities are now exercised in an extended form by three additional departments. The ministry of labour and national service, first detached from the board of trade in 1917, offers a wide range of services to employers and employees, mainly through a national network of employment exchanges. The ministry of transport and civil aviation, set up in a more limited form in 1919, has within its jurisdiction all the mediums of transportation. The ministry of fuel and power, dating from 1942 and renamed the ministry of power in 1957, is concerned with the development and regulation of power resources. The last two ministries are the central departments most in touch with the nationalized transport and power industries.

Government did not become administratively interested in agriculture until 1883, when a privy council committee was set up which gave place six years later to a statutory board of agriculture with its own president. It had very limited functions and in 1903 was strengthened by acquiring responsibility for fisheries from the board of trade, thereupon taking the title of board of agriculture and fisheries. After 1912, it was only concerned with agriculture in England and Wales, and it was never concerned with fisheries in Scotland. In 1919, the board became a ministry. During World Wars I and II, the department had no part in the administration of controls on the distribution of food, which was handled on both occasions by a separate ministry of food. After 1945, the interest of government in agriculture was sustained at almost its wartime intensity, and the greatly expanded ministry of agriculture and fisheries continued to administer an enormous range of subsidies, technical advisory services and a variety of controls. In 1955, when the second ministry of food was abolished, most of its remaining functions were handed over to the ministry of agriculture and fisheries which has since been known as the ministry of agriculture. fisheries and food. The department has within its purview domestic food production and marketing in England and Wales, all external procurement and the internal distribution of foodstuffs.

Social Services.—It is now regarded as the duty of the state to ensure that the welfare of its citizens is enhanced by the provision of personal medical attention, education, housing, environmental health services. insurance and assistance to soften the economic effects of unemployment, sickness, old age, widowhood, etc.

Governmental concern for education began in the 1830s with a modest grant of public money for schools, and in 1839 a committee of the privy council was set up to take charge of the distribution of subsequent grants. A department appeared under the committee in 1856, and in 1899 both gave place to a board of education with its own president. In 1944, the board became the present ministry of education, and the central supervision of the service (the whole of the detailed administration being handled by local education authorities) is compact and self-contained.

The other social services have three main roots—one the ancient concern for the state of the poor. with a starting point so far as government is involved in the Poor Law act of 1601; the second a by-product of industrialization—the mid-19th century movement to improve the health of towns; and the third the adoption in 1911 of the insurance principle as the basis of national schemes of social security. Between 1830 and 1930, the adaptation of the poor law and the various manifestations of interest in public health brought about the evolution of two new administrative phenomena—a national structure of "all-purpose" elected local councils, and central departments whose main work was to co-operate with and in some respects to supervise those councils. In the period between World Wars I and II, the principal central department in this context was the ministry of health. which was set up in 1919 to replace the local government board of 1871, whose antecedents in turn go back to the poor law commission of 1834 The ministry of health was responsible not only for the central supervision of poor law work and public health services, and for the general constitutional and financial aspects of the local government system, but was also involved in the supervision of most of the growing contributory insurance schemes. Unemployment insurance, however, was administered first through the board of trade and then through the ministry of labour. Mass unemployment in the interwar years disorganized the scheme so badly that a special body had to be formed in 1934—the unemployment assistance board—to relieve the strain on both the unemployment insurance scheme and on the local authorities who were providing public assistance.

The acceptance of the basic proposals of Sir William (later Lord) Beveridge's *Report on Social Insurance and Allied Services* during World War II made it inevitable that the central administrative organization of the relevant social services, which had grown up piecemeal, should be much extended but at the same time be concentrated in fewer departments. In 1944, a ministry of national insurance was established and in 1953 it was combined with the ministry of pensions—a department which dated from 1916 and had been charged with the care of war pensioners—to form the present ministry of pensions and national insurance. It deals with the whole of the schemes of national insurance, industrial injuries insurance, war pensions and family allowances; it is, in fact, a "cash payments" department with a national jurisdiction and no connection at all with the work of local authorities.

Betueen 1943 and 1951 there was a separate ministry of town and country planning which relieved the ministry of health of part of its general responsibility for environmental services. During that period, the national health service began to operate (1948), and at the same time the old unemployment assistance board, which had been renamed the assistance board in 1940, became the national assistance board and was made responsible for all necessary residual financial assistance, thus "nationalizing" public assistance and freeing the local authorities and the ministry of health of all their old poor law functions. Even with these changes and with the loss of insurance work, the burden on the ministry of health became very great, and in 1951 the department was divided. The older sections, which dealt with general local government matters and with environmental services such as housing, water supply and sewerage, were combined with the ministry of town and country planning to form what is now the ministry of housing and local government—the direct descendant of the local government board of 1871–1919. The central administration of the national health service was left to the ministry of health. *See* also SOCIAL SECURITY.

Common Services.—There is a very considerable amount of work done by departments for each other on an agency basis, and there are also a number of departments whose main purpose is to provide services common to all or a large number of departments. The largest of these is the ministry of works, the modern counterpart of the surveyor general of works, whose immediate predecessor was the office of works set up in roughly its present form in

1851 and converted into a ministry in 1940. Its main task is to provide accommodation, furnishings, heating and cleaning, etc., for departments. but in addition it has certain responsibilities for parks and palaces, museums and ancient monuments, and it is the government's channel of communication with the building industry. No other common service department is presided over by a minister personally; her majesty's stationery office, which provides stationery and printing services and is concerned with the supply of mechanical office equipment, is ultimately responsible to the chancellor of the exchequer. So, too, is the treasury solicitor, whose department handles the legal work of various departments which do not wish or whose functions do not demand their own legal officers, and the central office of information which provides publicity material on request from other departments. Among minor departments which are largely if not always primarily concerned to provide common services are the government chemist, the ordnance survey, the government actuary, the central statistical office and the general register office.

Scientific Research. — Large-scale participation in scientific research by the government only began in the 20th century. Research for defense purposes is carried on mainly by the service departments and the ministry of supply. Research for civil purposes by private organizations and universities is assisted by government grants, but in addition there are several governmental research establishments. The largest is the department of scientific and industrial research, first set up in 1916. It is unequivocally a government department, and its operating units are some 14 laboratories or groups of laboratories. Three other research organizations — the medical research council, the agricultural research council and the nature conservancy — are not, in the normal sense. government departments, as they are financed by grants-in-aid and only in a few instances do their staffs include civil servants. They and the department of scientific and industrial research are linked, however, by their constitutional form: all four answer in theory to committees of the privy council, which means in practice to the lord president of the council, a minister whose other light and nonscientific duties are carried on by the privy council office.

Ministerial supervision of scientific work is much less stringent, however, than it is in the case of orthodox departments — a practice which reflects the conviction that the organization of scientific research must be flexible and that as much autonomy as possible should be guaranteed to the scientists.

Scotland and Wales. — Since the appointment of a secretary for Scotland in 1885, there has been a steady process of domestic devolution from Whitehall to Edinburgh. Scotland's minister—now a secretary of state — exercises his powers through four departments — home, education, agriculture and health. Much of the legal administration in Scotland is carried on through the lord advocate's department. Many London departments have jurisdiction in Scotland, however, and all "English" domestic departments operate in Wales. Several of those departments have established decentralized organizations for dealing with Wales, and since 1951 one of the departmental ministers in the cabinet has been charged specifically with a general responsibility for Welsh affairs.

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(F. M. G. W.)

GOVERNOR, a common political title for the official head of a dependent or component unit in a larger constitutional structure. Governorships of one type have existed in the British, French, Dutch and other empires; those of another type exist in the states of the Cnited States, and in Brazil and Mexico. (For the first type, see Governor-General.)

In the state governments of the United States, the governorship derived from British origins but traced a separate course. The earliest state constitutions, through reaction against nonresponsible colonial executives, subordinated the executive branch to the legislative. In 11 states governors were elected by the legislatures, generally for short terms. Subsequent discontent with overpowerful legislatures. and the analogy of the strong presidency, created a counteraction to emancipate the governor from legislative dominance. In the mid-19th century, further constitutional changes in many states, conforming to the doctrines of Jacksonian democracy, necessitated a long ballot to fill the principal executive positions, the governorship included, by popular election. The governor. co-ordinate with the legislature. consequently lacked adequate authority over the officials elected with him. By 1900, as state governments assumed new functions, legislatures also proceeded to multiply the number of separate administrative agencies. These were largely exempt from control by the governor, because they were too numerous to supervise and many were headed by virtually independent boards.

In a state whose executive branch was structurally unfit for its growing burdens, leadership sometimes gravitated from constitutionally elected officials to a party "boss" beyond the people's reach.

A reform movement, gathering momentum before World War I, proposed to democratize the government by simplifying its machinery and throwing squarely upon a strengthened executive branch the responsibility of public service. Following World War II, renewed interest in the improvement of state government resulted in further recommendations and action.

Among specific remedies suggested were the short ballot, reducing the number of elective officials; reorganization of administrative agencies by a reduction in their number and consolidation of their functions; the executive budget, prepared and proposed by the governor; and centralization of many administrative and finance management functions in departments of administration or finance.

Governors increasingly emerged as leading figures in most state governments. By the late 1950s, they served for terms of four years in 34 states and of two years in the remaining states. More truly than in the 19th century, they functioned as chief executives. wielding effective authority over most administrative agencies and shouldering political responsibility.

Simultaneously, governors with public appeal actively initiated legislative policy. When occupying the position of party leaders, they placed between the executive and legislative branches a political link belying the dogma of the separation of powers.

Of the nine United States presidents between 1900 and 1950, four were former state governors.

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GOVERNOR, an automatic device designed to regulate the speed of a steam or gasoline engine or other prime mover. In most governors this speed is measured 'with the aid of centrifugal flyneights. The flyweights are driven at a speed proportional to that of the prime mover. The centrifugal force of the flyweights is

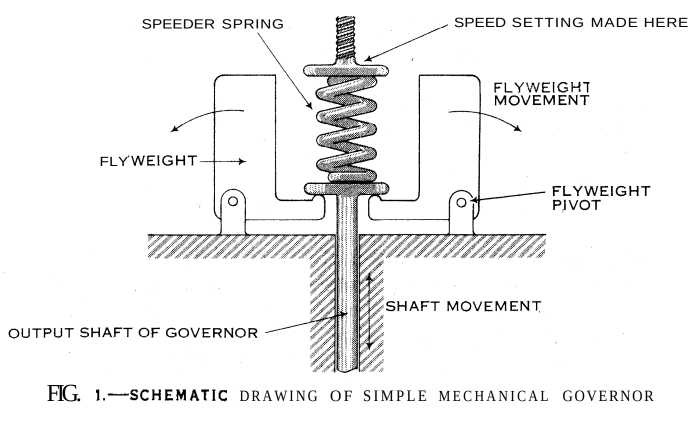

FIG. 1.—SCHEMATIC DRAWING OF SIMPLE MECHANICAL GOVERNOR

balanced; completely or in part, by the force of compression of a speeder spring. In the simplest governor the motion of the flyweights is mechanically transmitted through the output shaft of the governor to the throttle or some equivalent device that meters the rate at which energy is fed to the prime mover (fig. 1). The steady state speed of the prime mover is set by the position of the end of the speeder spring opposite to that at which the flyweight force is applied.

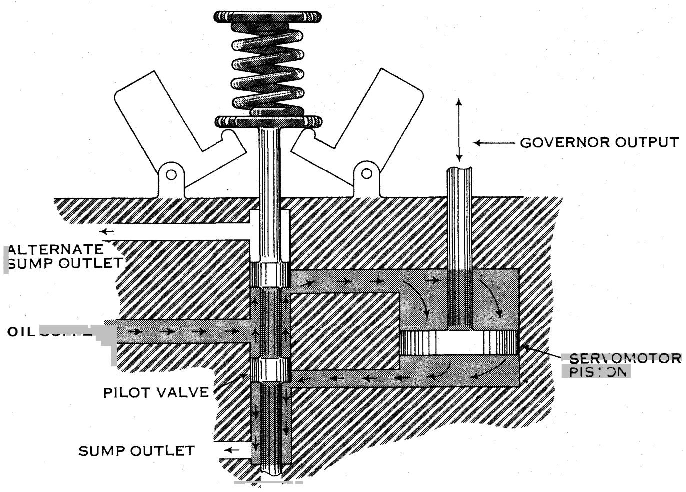

FIG. 2—SCHEMATIC DRAWING OF SIMPLE ISOCHRONOUS HYDRAULIC GOVERNOR

A governor is designed to keep the prime m'over speed at its assigned value regardless of variations in the load and changes in ambient conditions.

Where precise control is required, or an appreciable amount of power must be drawn from the governor to move the energy metering mechanism, a hydraulic governor is generally employed. A hydraulic governor (fig. 2) has as one component a mechanical governor. called in this instance a ballhead, similar to that shown in fig. 1. The output of the ballhead is amplified by a pilot valve and servomotor. The servomotor is usually a cylinder containing a piston and the output shaft of the governor is connected to the piston.

The valve controls the flow of oil to the two sides of the piston in the cylinder. In the case of a gasoline engine, or a dual fuel oil and gas engine operating on gas, the governor output shaft is often attached to the throttle.

An aircraft propeller governor controls the speed of the engine driving the propeller by varying the pitch of the propeller and thus changing the engine load. A diesel engine is controlled by connecting the governor output shaft to the rack which meters the rate at which fuel is injected.

On a steam turbine the governor positions the steam valve or valves which control the steam flow to the turbine. Similarly, a governor for a hydraulic reaction turbine of the Francis type positions the gates which vary the rate of water flow to the turbine. For a Kaplan turbine the governor also varies the pitch of the propeller blades through an extra servomotor. Governors for Pelton impulse turbines vary the areas of the jets of water striking the turbine buckets. The areas are varied rapidly by cutting into the jets with blades, and at the same time varied slowly by positioning needles in valves from which the jets emerge.

The output shaft of a gas turbine governor is connected to the fuel valve of the turbine. Provision is normally made to bring a combustion chamber temperature measurement, obtained directly or through the use of a computer, to the governor so as to limit the maximum and minimum fuel rates and thus keep this temperature within design limits. Computation of the combustion chamber temperature is necessary for fast limiting, and is based on the laws of thermodynamics relating this temperature to other physical variables.

Governors on oil and gas pipeline turbine-compressor units actually control pressure in the line. With the aid of pneumatic components the governor speed setting is adjusted from a measurement of this pressure.

The speed of the compressor is increased or decreased so as to keep the pressure constant.

Hydraulic positive displacement pump-motor units are used to provide infinitely variable speed ratio drives. The governor is driven by the motor. while the governor output is connected to a "wobble plate" which adjusts the rate of fluid flow out of the pump to the motor.

The speed of the output shaft of a hydraulic torque converter is controlled by a double governor, one driven by the engine and the other by the convertor, with the governors in a series combination rather than parallel.

The simplest mechanical governor is of the proportional type. 4 governor is said to be proportional if its output mechanism takes a position in proportion to the prime mover speed. For a speed droop governor, or governor on droop. on an isolated prime mover, the steady state prime mover speed is a function of the load, decreasing when the load is increased, and increasing when the load is decreased.

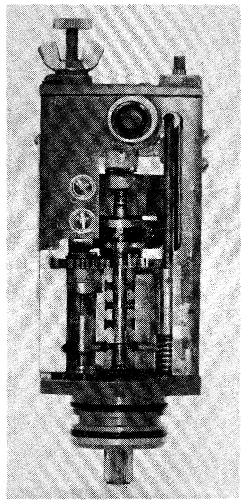

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FIG. 3.—CUTAWAY VIEW OF ISOCHRONOUS DASH-

The simplest type of mechanical governor is both a proportional and speed droop governor.

The simplest type of hydraulic governor is of the constant-speed isochronous type. Such a governor will continue to make a correction as long as the prime mover speed deviates from the set value. The standard aircraft propeller governor is of this type.

The simple isochronous governor is an integral or reset governor. in that the output is a mathematical integral of the input. Since such a governor will often indulge in "hunting," or self-oscillation about the preset value of speed, a governor with a dashpot (fig. 3) is often employed to yield both proportional and integral control.

The dashpot is a differentiating device whose output is the rate of change of the input.

The input to the dashpot is the servomotor piston position, while the output of the dashpot is a force applied to the ballhead of the governor in parallel with the speeder spring force. The addition of the dashpot to the governor makes the governor sensitive to engine acceleration as well as speed.

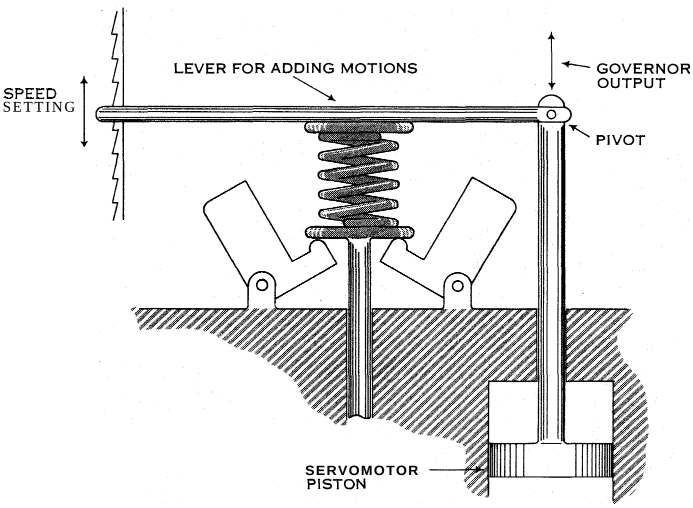

FIG. 4.— SPEED DROOP GOVERNOR

The amount of acceleration sensitivity increases with the time lag in the dashpot.

An inertial element in parallel with the flyweights is sometimes employed in place of the dashpot.

Any governor may be made into a speed droop governor (fig. 4) by the proper use of feedback from the output of the governor to the ballhead.

When two or more prime movers are operated in parallel, as when they drive alternators connected to the same electrical load, only one of the governors can be isochronous. The others must be on speed droop. Through adjustment of the amounts of feedback in the governors arbitrary division of load between the units can be achieved.

The load on a prime mover may be measured directly to produce a load control governor whose output depends on this load as well as the speed of the prime mover.

The speed of a prime mover is sometimes measured by a pump instead of a ballhead, using the output pressure of the pump as a measure of speed.

Electrical governors are employed in various installations where the prime mover drives an electrical generator whose output is an indication of prime mover speed. (R. O.)

GOVERNOR-GENERAL. The term governor-general indicates primarily that the officer holding the title is set over a number of officers holding that of governor or even lieutenant-governor.

An alternative term sometimes used was governor-in-chief, which in British usage still survives in the formal title of the governor of Jamaica which is captain-general and governor-in-chief. In this sense governor-general has occurred in the usage of most colonial powers.

In British constitutional practice the powers of a governor-general, like those of a governor (*q.v.*), must be derived either from the commission which he has received from the crown, or from some other statute either of imperial or local legislation, but in the case of dependent territories the title governor-general is now usually restricted to federations, such as that of The West Indies.

During the evolution of the British empire into the Commonwealth of Nations, the status and function of the office of governor-general have undergone changes corresponding to the progress of territories toward self-government and independence. These changes have been of the same character as those in the status and functions of governor from the time of the earliest colonies to the 20th century. in which local legislatures have developed from official and nominated bodies into elected bodies with, eventually, full autonomy.

By 1890 it had become the practice that the government of a self-governing colony should be asked to approve the selection of the governor made by the British government, and when the Irish Free State was created in 1922, a further advance was made. for the governor-general was chosen by the Free State government and approved only by the crown.

Prior to this the representative of the crown in Ireland held the rank of viceroy, but the Government of Ireland act of 1920 constituted the office of governor-general for the Irish Free State and that of governor for Northern Ireland, the former being appropriate for the Irish Free State since it had dominion status.

In 1926, in the course of developing events in Canada, it was decided that the functions of the governor-general should be limited to representation of the crown, unless any dominion preferred that he should also perform any functions on behalf of the British government.

Following the recommendations of the Imperial conference of 1926, the Statute of Westminster was enacted in 1931 to give legal effect to a constitutional relationship which already existed, but New Zealand did not fully adopt it until 1947.

In 1930 the Imperial conference laid down that appointment of a governor-general should rest on the authority of the commonwealth nation concerned. It concluded that the following statements flowed naturally from the governor-general's new position. The parties interested in the appointment are the croun and the dominion concerned; the constitutional practice that the crown acts on the advice of responsible ministers applies; the ministers who tender advice and are responsible for it are those in the dominion concerned; they tender formal advice after informal consultation with the crown; the channel of communications between the crown and any dominion government solely concerns the crown and such government.

In 1932 the Irish Free State asserted successfully its right to secure removal by the king of a governor-general who was *persona non grata:* this revealed the difference between the position of the governor-general and that of the crown, for it showed that the former held office only at the pleasure of the government of the day. In the exceptional constitutional position of the Federation of Rhodesia and Nyasaland the position of governor-general in all matters in which he has no discretion under the constitution is similar to that in an independent commonwealth country. In cases in which the constitution authorizes him to use his discretion in exercising any power conferred on him, he may do so either contrary to ministerial advice or without it, though in practice he ought to act in accordance with such advice unless either the advice conflicts with instructions given by the crown or he considers he ought to reject it even at the risk of causing the ministers to resign.

In India, the evolution of the office of governor-general was slightly different. In accordance with the provisions of the Regulating act of 1773 Warren Hastings became the first governor-general. When the rule of the East India company came to an end and the Indian empire was created, Lord Canning, the first governor-general of the imperial government, received also the title of viceroy. The holder of the office was generally known by that title until the Indian Independence act of 1947 which constituted the offices of governor-general for India and for Pakistan. The filling of these posts necessitated a departure from normal practice because there could be no ministers formally to advise the crown until a governor-general had been appointed and ministers had taken office. In these circumstances the leaders of the Congress party and the Moslem league were consulted and their advice was formally tendered to the crown by the U.K. government. Much the same happened in the case of Ceylon in 1948 and Ghana in 1957. On commonwealth nations' becoming republics recognizing the crown as head of the commonwealth the office of governor-general disappears and a president takes his place. In the case of Malaya, which became an independent commonwealth nation in 1957, a new form of limited monarchy was devised.

(W. H. Is.)

GOW, NIEL (1727–1807), Scottish musician of humble parentage, famous as a violinist and player of reels, but more so for the part he played in preserving the old melodies of Scotland. His compositions, and those of his four sons, Nathaniel, the most famous (1763–1831), William (1751–1791), Andrew (1760–1803) and John (1764–1826), formed the "Gow Collection," comprising various volumes edited by Niel and his sons. a valuable repository of Scottish traditional airs.

The "Gow Collection" includes *A Collection of Strathspey Reels* (1784); *Second, Third, Fourth* and *Fifth Collections* (1788, 1792, 1800. 1809, 1822).

GOWER, JOHN (d. 1408), English poet, died at an advanced age in 1408, so that he may be presumed to have been born about 1330. He belonged to a good Kentish family and owned the manors of Feltwell in Suffolk and Moulton in Norfolk. In a document of 1382 he is called an "Esquier de Kent," and he was certainly not in holy orders. That he was acquainted with Chaucer we know, first because Chaucer in leaving England for Italy in 1378 appointed Gower and another to represent him in his absence, secondly because Chaucer addressed his *Troilus and Criseide* to Gower and Strode (whom he addresses as "moral Gower" and "philosophical Strode") for criticism and correction and thirdly because of the lines in the first edition of Gower's *Confessio amantis,* "And gret wel Chaucer whan ye mete," etc. There is no sufficient ground for the suggestion, based partly on the subsequent omission of these lines and partly on the humorous reference of Chaucer to Gower's *Confessio amantis* in the introduction to the *Man* of *Law's Tale,* that the friendship was broken by a quarrel. From his Latin poem *Vox clamantis* we know that he was deeply and painfully interested in the peasants' rising of 1381; and by the alterations which the author made in successive revisions of this work we can trace a gradually increasing sense of disappointment in the youthful king, whom he at first acquits of all responsibility for the state of the kingdom on account of his tender age. That he became personally known to the king we learn from his own statement in the first edition of the *Confessio amantis,* where he says that he met the king upon the river, was invited to enter the royal barge, and in the conversation which followed received the suggestion which led him to write his principal English poem. At the same time we know, especially from the later revisions of the *Confessio amantis,* that he was an admirer of the king's brilliant cousin, Henry of Lancaster, afterwards Henry IV., whom he came eventually to regard as a possible saviour of society from the misgovernment of Richard II.

The first edition of the *Confessio amantis* is dated 1390, and this contains, at least in some copies, a secondary dedication to the then earl of Derby. The later form, in which Henry became the sole object of the dedication, is of the year 1393. Gower's political opinions are further embodied in the *Cronica tripartita.*

In 1398 he was married to Agnes Groundolf, and from the special licence granted by the bishop of Winchester for the celebration of this marriage in John Gower's private oratory we gather that he was then living in lodgings assigned to him within the priory of St. Mary Overy, and perhaps also that he was too infirm to be married in the parish church. It is probable that this was not his first marriage, for there are indications in his early French poem that he had a wife at the time when that was written. His will is dated Aug. 15, 1408, and his death took place very soon after this. He had been blind for some years before his death. A magnificent tomb with a recumbent effigy was erected over his grave in the chapel of St. John the Baptist within the church of the priory, now St. Saviour's, Southwark.

The effigy on Gower's tomb rests its head upon a pile of three folio volumes entitled *Speculum meditantis, Vox clamantis* and *Confessio amantis.* These are his three principal works. The first of these was long supposed to have perished, but a copy of it was discovered in the year 1895 under the title *Mirour de l'omme.* It is a French poem of about 30,000 lines in 12-line stanzas, and under the form of an allegory of the human soul describes the seven deadly sins and their opposing virtues.

Gower's next work was the *Vox clamantis* in Latin elegiac verse, in which the author takes occasion from the peasants' insurrection of 1381 to deal again with the faults of the various classes of society. In the earlier portion the insurrection itself is described in a rather vivid manner.

Gower's chief claim, however, to reputation as a poet rests upon his English work, the *Confessio amantis,* in which he displays in his native language a real gift as a story-teller. He is himself the lover of his poem, in spite of his advancing years, and he makes his confession to Genius, the priest of Venus, under the usual headings supplied by the seven deadly sins. These with their several branches are successively described, and the nature of them illustrated by tales drawn from very various sources and often extremely well told. The metre is the short couplet, and it is very smooth and regular. The great fault of the *Confessio amantis* is the extent of its digressions.

Gower also wrote in 1397 a short series of French ballades on the virtue of the married state (*Traitié pour essampler les amantz mariés*), and after the accession of Henry IV. he produced the *Cronica tripartita,* a partisan account in Latin leonine hexameters of the events of the last 12 years of the reign of Richard II. About the same time he addressed an English poem in seven-line stanzas to Henry IV. *(In Praise of Peace),* and dedicated to the king a series of French ballades *(Cinkante Balades),* graceful and even poetical in expression. Several occasional Latin pieces also belong to the later years of his life.

On the whole Gower must be admitted to have had considerable literary powers; and though not a man of genius, and by no means to be compared with Chaucer, yet he did good service in helping to establish the standard literary language, which at the end of the 14th century took the place of the Middle English dialects. The *Confessio amantis* was long regarded as a classic of the language, and Gower and Chaucer were often mentioned side by side as the fathers of English poetry.

A complete edition of Gower's works in four volumes, edited by G. C. Macaulay, was published in 1899–1902, the first volume containing the French works, the second and third the English, and the fourth the Latin, with a biography. Before this the *Confessio amantis* had been published in the following editions: Caxton (1483); Berthelette (1532 and 1554); Chalmers, *British Poets* (1810); Reinhold Pauli (1857); H. Morley (1889, incomplete). The two series of French ballades and the *Praise of Peace* were printed for the Roxburghe Club in 1818, and the *Vox clamantis* and *Cronica tripartita* were edited by H. O. Coxe for the Roxburghe Club in 1850. The *Cronica tripartita,* the *Praise of Peace* and some of the minor Latin poems were printed in Wright's *Political Poems* (Rolls series, 14) The *Praise of Peace* appeared in the early folio editions of Chaucer, and has been edited also by Dr. Skeat in his *Chaucerian and other Pieces.* Reference may be made to H. J. Todd, *Illustrations of the Lives and Writings of Gower and Chaucer* (1810); the article (by Sir H. Nicolas) in the *Retrospective Review* for 1828; F. J. Child, "Memoirs on the Language of Chaucer and Gower," in *Early English Pronunciation* (1869 etc.); H. Morley, *English Writers* (1887 etc.), vol. iv.; B. ten Brink, *History of Early English Literature* (Eng. trans., 1883, etc.), vol. ii.; and W. J. Courthope, *History of English Poetry* (1895), vol. i. (G. C. M.)

GOWER, a Welsh seigniory and district in the county of Glamorgan (*q.v.*), lying between the Tawe and Loughor rivers and between Brecknockshire or Breconshire and the sea, its length from the Breconshire border to Worms head being 28 mi.. and its breadth about 8 mi. It corresponds to the ancient commote of Gower (in Welsh, *Gwyr*) which in early Welsh times was grouped with two other commotes stretching westward to the Towy, and so formed part of the principality of Ystrad Tywi. What is meant by Gower in modern popular usage, however, is only the peninsular part or "English Gower," with its striking coast line. lying mainly to the south of a line drawn from Swansea to Loughor.

The numerous limestone caves of the coast are noted for their animal remains, and finds of Palaeolithic flints and a skeleton of Upper Palaeolithic date have been made (*see* W. J. Sollas, "Paviland Cave: an Aurignacian Station in Wales," *J. R. Anthrop. Inst.,* xliii, London, 1913). The bones, found in the Goat cave, Paviland, near Rhossili, by Dean W. Buckland, were known for a time as the "Red Lady of Paviland," but turned out to be those of a young man. Red ochre was sprinkled on them and there were remains of ornaments of ivory and sea shell.

The high ground of the centre of the peninsula has megaliths and tumuli. Mesolithic remains have been found. The south coast has evidences of a Bronze Age culture, while hilltop camps seem to have been occupied by different groups up to the time of the Viking raids. At Loughor was a Roman settlement. In the Arthurian romances Gower appears in the form of Goire, as the island home of the dead. It was also surmised by Sir John Rhys that Malory's *Brandegore* (*i.e.,* "Brân of Gower") represents the Celtic god of the other world (J. Rhys, *Studies in Arthurian Legend,* pp. 160, 329 *et seq.,* 1891). Traces of the more or less temporary Scandinavian occupation are found in such place names as Burry Holms, Worms head and Swansea.

About 1100 Gower was conquered by Henry de Newburgh, earl of Warwick, whose followers settled for the most part on the southern side of the peninsula. These invaders were probably reinforced later by Flemings from south Pembrokeshire. bloated mounds, which in some cases developed into castles, were built for the protection of the various manors. The castles included those of Swansea, Loughor and Oystermouth. These were repeatedly attacked and burned by the Welsh during the 12th and 13th centuries.

About 1189 the lordship passed from the Warwick family to the crown and then to the De Braoses, in whose family it remained practically continuously for over 120 years. In 1208 the Welsh and English inhabitants received each a charter from King John. Later the king's officers of the newly organized county of Carmarthen repeatedly claimed jurisdiction over Gower. De Braose resisted the claim and organized the English part of his lordship on the lines of a county palatine. Troubles befell the De Braose family and the region passed to John de Mowbray.

Gower frequently changed hands between the Mowbrays and the Beauchamps, representatives of the original owners (earls of Warwick). The 4th duke of Norfolk (the Mowbrays) exchanged it in 1489, for lands in England, with William Herbert, earl of Pembroke. It passed through Charles Somerset to the dukes of Beaufort. Gower was included in 1535 in Glamorgan.

The characteristically English part of Gower lies to the south and southwest of its central ridge of Cefn y Bryn. The present line of demarcation between English and Welsh is one drawn from Swansea in a west-northwest direction to Llanrhidian on the north coast. The boundary nearly coincides with the outcrop of the Coal Measures, the industrial population to the north being Welsh-speaking, the agriculturists to the south English.

GOWN, formerly the term for a loose outer garment worn by either sex but now generally for that worn by women. It is also the name for the distinctive robes worn by holders of particular offices or by members of particular professions or universities, etc. *(see* ROBES).

GOWRIE, JOHN RUTHVEN, THIRD EARL OF (*c.* 1577–1600), Scottish conspirator, was the second son of William, 4th Lord Ruthven and first earl of Gowrie (?1541–1584), by his wife Dorothea, daughter of Henry Stewart, second Lord Methven. The Ruthven family was of ancient Scottish descent; the earldom dated from 1581. The first earl of Gowrie and his father Patrick, third Lord Ruthven (c. 1520–1566), had both been concerned in the murder of Rizzio in 1566; and both took an active part on the side of the Kirk in the constant intrigues of the period. Gowrie had been custodian of Mary, queen of Scots, during her imprisonment in Loch Leven, and had also been the chief actor in the "raid of Ruthven" in 1582 when King James VI. was seized while a guest and kept prisoner. Though pardoned, he continued to plot, and was executed for high treason in 1584.

When, therefore, on the death of his elder brother the second earl in 1588 John Ruthven succeeded to the earldom, he inherited family traditions of treason and intrigue. He received an excellent education at the grammar school of Perth and at the University of Edinburgh, after which he joined with Atholl and Montrose in offering to serve Queen Elizabeth, and had thus already been engaged in conspiracy when, in 1594, he went to study at Padua. On his way home in 1599, moreover, it is probable that he communicated at Paris with the exiled Bothwell.

In 1600 the earl and his brother, Alexander Ruthven, were murdered at Gowrie house in mysterious circumstances. Three solutions of the mystery of this "Gowrie conspiracy" have been suggested: first, that Gowrie and his brother had plotted to murder or to kidnap King James at Gowrie house; second, that James visited Gowrie house with the intention of murdering the two Ruthvens; third, that the tragedy sprang from a brawl.

According to James the facts were as follows: on Aug. 5, 1600, James was asked while hunting near Falkland to go to Gowrie house to examine a prisoner with a quantity of foreign gold there. When he arrived with a small retinue, he was taken alone into a small turret by Alexander Ruthven. Here, instead of the prisoner with the foreign gold, he found an armed man. His retainers, who had been told that the king had left, were setting out to overtake him when they saw him struggling at a window, and heard his cry for help. They thereupon forced an entrance to the turret, and in the struggle Ruthven and Gowrie were killed.

The tragedy caused intense excitement throughout Scotland and the investigation of the circumstances was followed with much interest in England also. The preachers of the Kirk. whose influence in Scotland was too extensive for the king to neglect. were only with the greatest difficulty persuaded to accept James's account of the occurrence. Their belief was that the king had invented the story to cover his own design to extirpate the Ruthven family and James gave some colour to this belief by the severity with which he pursued the two younger, and unquestionably innocent, brothers of the earl.

GOWRIE, a belt of fertile alluvial land in Perthshire, Scot Occupying the northern shore of the Firth of Tay, the Carse of Gowrie extends east of Perth city to the confines of Dundee. It measures 15 mi. in length and is one of the richest tracts in Perthshire, being especially suitable for small fruit cultivation of which the strawberry is the most famous. The district is noteworthy for the number of its castles and mansions, among which may be mentioned Megginch castle near Errol, dating from 1575; Kinnaird castle, erected in the 12th to 15th centuries and restored in the 1850s; Rossie priory, the seat of Lord Kinnaird; and the 15th-century Huntly castle.

GOYA, a town and port of Corrientes province, Argentina, on the east bank of the Paraná river. 618 mi. N. of Buenos Aires and 147 mi. S. of the city of Corrientes. Goya is a distributing centre for agricultural products and timber on the Urquiza railway. It dates from 1807. Pop. (1956 est.) 25.208.

GOYATACAN, an independent linguistic stock of South American Indians, so called from the Goyatacas, one of its important tribes. The Goyatacas (so named from the Brazilian state of Goyaz, in which, however, few of these Indians appear to have lived) occupied a large part of the state of Minas Geraeas and the southern edge of the state of Bahia, in the highlands of eastern Brazil. In early times tribes of this stock probably occupied the Atlantic coast in this region, but at the time of arrival of the Portuguese, the coastal strip was in the hands of Tupian (*q.v.*) tribes. The bow and throwing-club were their chief weapons.

GOYA Y LUCIENTES, FRANCISCO JOSÉ DE (1746–1828), Spanish artist and engraver, who, trained in the foreign traditions fashionable in 18th-century Spain, became one of the most characteristically Spanish artists of all times and a foremost European painter and engraver of the 19th century. He was born on March 30, 1746, at Fuendetodos, near Saragossa, and died in Bordeaux, France, on April 16, 1828. His enormous and varied production of paintings, drawings and engravings, relating to nearly every aspect of contemporary life, reflects the period of political and social upheavals in which he lived.

Goya began his studies in Saragossa under José Luzán, a local artist trained in Naples, and was later a pupil in Madrid of the court painter Francisco Bayeu, whose sister he married in 1773. He went to Italy to continue his studies and was in Rome in 1771. In the same year he returned to Saragossa where he obtained his first important commission for frescoes in the cathedral, which he executed at intervals during the next ten years. These and other early religious paintings made in Saragossa are in the baroque-rococo style current in Spain and are influenced in particular by the great Venetian painter G. B. Tiepolo, who spent the last years of his life in Madrid (1762–70), where he was invited to paint ceilings in the royal palace.

Goya's career at court began in 1775, when he painted the first of a series of over 50 cartoons (mostly preserved in the Prado, Madrid) for the royal tapestry factory, Santa Barbara, on which he was engaged until 1792. These paintings of scenes of contemporary life, of aristocratic and popular pastimes. were begun under the direction of the German artist A. R. Mengs, the great exponent of neoclassicism who. after Tiepolo's death, had become undisputed art dictator at the Spanish court. In Goya's early cartoons the influence of Tiepolo's decorative style is modified by the teachings of Mengs, particularly his insistence on simplicity. The later cartoons reflect his growing independence of foreign traditions and the development of an individual style, which began to emerge through his study of the paintings of Velizquez in the royal collection, many of which he copied in etchings (c. 1778). Later in life he is said to have acknowledged three masters: Velázquez, Rembrandt and, above all, nature. Rembrandt's etchings were doubtless a source of inspiration for his later drawings and engravings. while the paintings of Velizquez directed him to the study of nature and taught him the language of realism.

In 1780 Goya was elected a member of the Royal Academy of San Fernando. Madrid. his admission piece being a "Crucifixion" (Prado), a conventional composition in the manner of Mengs but inspired by the naturalistic style of Velázquez' "Crucifixion." then in the royal palace. In 1785 he was appointed deputy director of painting at the academy and in the following year painter to the king. Charles III. To this decade belong his earliest known por-

BY COURTESY OF MUSEO DEL PRADO, MADRID

"FAMILY OF CHARLES IV" BY FRANCISCO GOYA. IN MUSEO DEL PRADO. MADRID

traits, of court officials and members of the aristocracy, whom he represented in conventional 18th-century poses. The stiff elegance of his figures, in full-length portraits of society ladies as the "Marquesa de Pontejos" (National gallery, Washington), and the fluent painting of their elaborate costumes also relates them to Velázquez' court portraits; and his representation of "Charles III as Huntsman" (of which several versions exist) is based directly on Velázquez' royal huntsmen.

The death of Charles III in 1788, a few months before the outbreak of the French Revolution, brought to an end the period of comparative prosperity and enlightenment in which Goya reached maturity. The rule of reaction and political and social corruption that followed, under the weak and stupid Charles IV and his clever. unscrupulous queen Maria Luisa Teresa, ended with the Napoleonic invasion of Spain. It was under the patronage of the new king, who raised him at once to the rank of court painter, that Goya became the most successful and fashionable artist in Spain; he was made director of the academy in 1795 (but resigned two years later for reasons of health) and first court painter in 1799. Though he uelcomed official honours and worldly success uith undisguised enthusiasm, the record that he left of his patrons and of the society in which he lived is ruthlessly penetrating. After a serious illness in 1792, which left him permanently deaf, his art began to take on a new character which gave free expression to the observations of his searching eye and critical mind and to his newly developed faculty of imagination. During his long convalescence he painted a series of small compositions which he described in a letter to the director of the academy (1794) as enabling him "to make observations for which there is no opportunity in commissioned works, in which fantasy and invention have no scope." He referred to the subjects as "popular diversions" but those that survive (Academy of San Fernando, Madrid) include a "Madhouse," a "Procession of Flagellants," a "Tribunal of the Inquisition," these unconventional themes being painted in a bold, sketchy technique and strong colours with an effect of exaggerated realism that borders on caricature. For his more purposeful and serious satires, however, he now began to use the more intimate mediums of drawing and engraving. In the "Caprichos," a series of 80 etchings published in 1799, he attacked political, social and religious abuses, adopting the popular imagery of caricature, which he enriched with highly original qualities of invention. His masterly use of the recently developed technique of aquatint gives them astonishing dramatic vitality and makes them a major achievement in the history of etching (*q.v.*). Despite the veiled language of designs and captions and Goya's announcement that his themes were from the "extravagances and follies common to all society." they were probably recognized as references to well-known persons and were withdrawn from sale after a few days. However, a few months later Goya was made first court painter. Later he was apparently threatened by the Inquisition and in 1803 he presented the plates of the "Caprichos" to the king in return for a pension for his son.

While uncommissioned works gave full scope for "observations," "fantasy" and "invention," in his commissioned paintings Goya continued to use conventional formulas. His decoration of the church of San Antonio de la Florida, Madrid (1798), is still in the tradition of Tiepolo; but the bold, free execution and the expressive realism of these popular types used for religious and secular figures are unprecedented. In his numerous portraits of friends and officials a broader technique is combined with a new emphasis on characterization. The faces of his sitters reveal a lively discernment of personality which is sometimes appreciative, particularly in his portraits of women, as that of "Doña Isabel Cobos de Porcel" (National gallery, London), but is often far from flattering as in his royal portraits. In the group of "Charles IV and His Family" (1800, Prado), which recalls the composition of Velázquez' "Meninas," Goya. despite his position as court painter, has portrayed the ugliness and vulgarity of the principal figures so vividly as to produce the effect of caricature.

In 1808 Goya was at the height of his official career when Charles IV and his son Ferdinand were forced to abdicate in quick succession. Napoleon's armies entered Spain and his brother Joseph was placed on the throne. Goya retained his position as court painter to the usurper; but in the course of the war he portrayed Spanish as well as French generals and in 1812 he painted an equestrian portrait of the "Duke of Wellington" (Apsley house, London). It was, however, in a series of etchings, "Los Desastres de la Guerra" (first published 1863), for uhich he made drawings during the war, that he recorded his personal reactions to the invasion and to the horrors and disastrous consequences of the war. The violent and tragic events. which he doubtless witnessed, are represented not with documentary realism but in dramatic compositions—in line and aquatint—with brutal details which create a vivid effect of authenticity.

On the restoration of Ferdinand VII in 1814, after the expulsion of the invaders, Goya was pardoned for having served the French king and reinstated as court painter. The "Charge of the Mamelukes" and "Execution of the Defenders of Madrid" (Prado) were painted to commemorate the popular insurrection on May 2, 1808. Like the "Desastres" they are compositions of dramatic realism and their monumental scale makes them even more powerfully moving. The impressionistic style in which they are painted foreshadowed and influenced later 19th-century French artists, particularly Edouard Manet, who was also inspired by the composition of the "Execution." In several portraits of Ferdinand VII, painted after his restoration: Goya evokes more forcefully than any description the personality of the cruel tyrant, whose oppressive rule drove most of his friends and eventually Goya himself into exile. He painted few other official portraits but those of his friends and relations and his "Self-Portraits" (1815, Prado; Academy of San Fernando) are equally subjective. Some of his religious compositions of this period, the "Agony in the Garden" and "Communion of S. Joseph of Calasanz" (1819, 1820, Madrid) are more suggestive of sincere devotion than any of his earlier church paintings. The enigmatic "black paintings," with which he decorated the walls of his country house, the "Quinta del Sordo" (1819–23, now in the Prado) and the "Proverbios" or "Disparate~,'à series of etchings made at about the same time (though not published until 1864) are, on the other hand, nightmare visions in expressionist language, that seem to reflect cynicism, pessimism and despair.

In 1824, when the failure of an attempt to establish a liberal government had led to renewed persecution, Goya applied for permission to go to France for reasons of health. After visiting Paris he settled in voluntary exile in Bordeaux, where he remained, apart from a brief trip to Madrid, until his death. There, in spite of old age and infirmity, he continued to record his impressions of the world around him in paintings and drawings, and in the new technique of lithography, which he had begun to use in Spain. His last paintings include genre subjects and several portraits of friends in exile: "Muguiro" (Prado), "Moratin," "Pio de Molina" (private collections), which show the final development of his style toward a synthesis of form and character in terms of light and shade, without outline or detail and with a minimum of colour. If there is no evidence for the legends of Goya's rebellious character and violent actions, he was undoubtedly a revolutionary artist. He had no immediate followers, but his many original achievements, from the "Caprichos" to his late paintings, profoundly impressed later 19th-century French artists—Eugène Delacroix was one of his great admirers—who were the leaders of new European movements, from romanticism and realism to Impressionism; and his works continued to be admired and studied by the Expressionists and Surrealists in the 20th century.

See also PAINTING: *Spain: Goya.*

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GOYAZ: *see* GOÍAS.

GOYDER'S LINE, named after G. W. Goyder (1826–1898), a surveyor general of South Australia, was an early and interesting use of ecological principles to assist in determining limits of pioneer settlement.

As the colony was suffering from severe drought conditions, Goyder made a survey of the northern portion of South Australia (about 1864) and laid down a line beyond which it was not feasible for the wheat farmer to settle. He used the southern limit of the "Saltbush, Mulga and dwarf Mallee country" as his criterion. Later, this line was found to agree fairly with the 12-in. isohyet (line of rainfall). It runs from Moonta to Pekina, then southeast to Murray bridge. Wheat is grown on the dry side of this line, but it illustrated a principle which was of value in determining the expansion of Australian agriculture. *See* also SOUTH AUSTRALIA: *Agriculture and Industry.*

GOYEN, JAN JOSEPHSZOON VAN (1596–1656), one of the most gifted of Dutch landscape painters, was born at Leyden on Jan. 13, 1596, learned painting under several masters at Leyden and Haarlem, and settled at The Hague about 1631. He was one of the first to emancipate himself from the tradition of minute painting of detail embodied in the works of Brueghel and Savery. Though he preserved the dun scale of tone peculiar to those painters, he studied atmospheric effects in black and white with considerable skill. His influence on Dutch art was marked. He died at The Hague on April 27, 1656.

Between 1610 and 1616 Goyen wandered from one school to another. In the latter year he joined Esaias van der Velde, and some of his earlier pictures show the influence of Esaias very perceptibly. The landscape is minute; details of branching and foliage are given, and the landscape serves as a stage for genre scenes After 1625 these peculiarities gradually disappear. Atmospheric cool tints are the principal feature of Goyen's landscapes His buildings, water and shipping sometimes have the strength. if not the colour, of Albert Cuyp.

Though he visited France once or twice, Goyen chiefly confined himself to the scenery of Holland. One of his largest pieces is a view of The Hague, executed in 1651 for the municipality, and now in the town collection of that city. Most of his panels represent reaches of the Rhine, the Waal and the Maas. But he sometimes sketched the downs of Scheveningen, or the sea at the mouth of the Rhine and Scheldt; he liked to depict the inshore calm and rarely painted seas stirred by more than a cooling breeze. He painted winter scenes, with ice, skaters and sledges. More than 1,000 of Goyen's pictures are catalogued by Hofstede de Groot. They may be seen at museums in Boston, New York city (Metropolitan Museum of Art), Detroit and Toledo, among others. The National gallery, London, has several of his works.

GOYENECHE, JOSÉ MANUEL (1775–1846), South American royalist soldier, was born in Arequipa, Peru, June 13, 1775. In 1795 he went to Spain. where he remained until 1808. In that year he returned to South America as the agent of the junta of Seville. It is thought that he had been instructed by the French (whose armies had recently invaded Spain) to promote the French cause in South America, but in Seville he transferred his affiliation to Ferdinand VII and when he arrived in South America devoted himself to winning loyalty to the Spanish king. At that time several South American colonies were beginning to break away from Spanish rule and Goyeneche became a leader of the antirevolutionary army. He was responsible for several victories in Argentina, but the defeat of a subordinate forced him to abandon much of the territory he had captured. He returned to Spain (1813) and served against the French. He was count of Guaquí and held the rank of lieutenant general in the Spanish forces. He died in Madrid, Oct. 15, 1846.

GOZLAN, LÉON (1803?–1866), French author, was born at Marseilles. His father had been a wealthy man but lost his money during Gozlan's youth, forcing the latter to leave school and ship as an apprentice on a coastal trading vessel. His experiences in Senegal during this period of his life later formed the basis for several of his novels and short stories. After his return to France, he became a clerk in a Paris bookstore, but in a short time his stories began to be published in various French magazines and thereafter he was able to devote himself to writing. Gozlan was a prolific writer, and his work was characterized by a great deal of spirit and charm. His most successful works were his novels, which included *Le Notaire de Chantilly* (1836), *Washington Levert et Socrate Leblanc* (1838), *Le Mkdecin du Pecq* (1839), *Aristide Froissart* (1843) and *Les Emotions de Polydore Marasquin* (1857). He also wrote *Balzac en pantoufles* (1865), a light biography of the French writer; *Les Tourelles,* a history of French châteaux, later reprinted under the title of *Les Châteaux de France,* a moderately valuable historical study; and numerous short stories and plays. Two of his plays, *La Pluie et le Beau Temps* and *Une Tempête dans un verre d'eau* became part of the repertory of the Comédie Française and achieved some success, but most of the rest were insignificant, even during Gozlan's lifetime. Gozlan died in Paris, Sept. 14, 1866.

GOZO or Gozzo, an island of the Maltese group in the Mediterranean sea. It lies N.W. and $3\frac{1}{4}$ mi. from the nearest point of Malta, is 9 mi. in length and $4\frac{1}{2}$ mi. in extreme breadth, and has an area of 26 sq.mi. Its chief town, Victoria, formerly called Rabat (1957) 6,350, stands near the middle of the island on one of a cluster of steep conical hills. The prehistoric temple "Gigantia" is of the same type as Hagiar Kim in Malta but larger. Population (1957) 27,475.

GOZZI, CARLO, CONTE (1720–1806), Italian dramatist and a fanatical controversialist with a persecution mania, who spent his life in defending Italian culture against foreign influences, was born at Venice on Dec. 13,1720. He joined the purist *Accademia dei Granelleschi* and in a satirical almanac called *La tartana degli influssi* (1757) directed his wit against the theatrical innovations of Pietro Chiari and Carlo Goldoni. Between 1761 and 176j Gozzi produced ten grotesque *Fiabe* (*L'amore delle tre melarance*— the basis for Prokofiev's *The Love of Three Oranges, Turandot*— the basis of Puccini's opera, and *L'augellin belverde;* modern ed. by E. Masi. 1885) or dramatizations of popular and oriental tales: with which he sought to revitalize the dying *commedia dell'arte.* His other works include the *Marfisa bizzarra* (1761–68; modern ed. by C. Ortis, 1911)—a verse satire on 18th-century Venice—and the *Memorie inutili* (1797; modern ed. by D. Bulferetti, 1928; Eng. trans., 1890), an autobiography in which he described, vividly and with humour, his military experiences in Dalmatia (1741–44), his stormy relations with the actress Teodora Ricci and with Pier Antonio Gratarol, his rival in her affections, and his many literary polemics.

Gozzi died at Venice on April 4, 1806. His *Opere* were published in 8 vol. (1772–74) and in 14 vol. (1801–03).

See T. Mantovani, *Carlo Gozzi* (1926); G. Ziccardi, *Forme di vita e d'arte nel Settecento,* pp. 111–180 (1931). (D. M. WE.)

GOZZI, GASPARO, CONTE (1713–1786), Italian poet and essayist, elder brother of Carlo Gozzi (*q.v.*), was born at Venice Dec. 4, 1713. He published (1760–62) the *Gazzetta Veneta* (modern ed. by B. Romani, 2 vol., 1943), a chronicle of Venetian life, and the *Osservatore* (modern ed. by E. Spagni, 1914), both written in a pure Italian style. His other works include satirical verse *Sermoni* (1763), the *Difesa di Dante* (1758) against Saverio Bettinelli, which marks the beginning of the revival of interest in the *Divina Commedia* in Italy, and a program for educational reform. He died at Padua, Dec. 27, 1786. His *Opere* were edited by A. Dalmistro, 16 vol. (1818–20).

See M. A. Viglio, *Gasparo Gozzi* (1916) G. de Beauvillé, *Gasparo Gozzi, journaliste vénitien* (1937). (D. M. WE.)

GOZZOLI, BENOZZO (1420–1497), Italian painter, whose masterpiece is the fresco cycle in the chapel of the Palazzo Medici, Florence, was born in Florence in 1420. In 1444 he was engaged with Lorenzo and Vittorio Ghiberti on work on the third bronze door of the baptistry in Florence and in 1447 was active as an assistant of Fra Angelico in Rome, where his hand has been identified in a number of Xngelico's frescoes in the chapel of Nicholas V in the Vatican. In 1447 he was engaged, as Angelico's principal assistant, on the fresco on the ceiling of the Cappella di S. Brizio in the cathedral at Orvieto, which he appears to have completed after Xngelico's return to Rome (1448/49). In the second half of 1449 he was employed at Montefalco (near Foligno). From Montefalco, Gozzoli moved to Viterbo, where after 1453 he painted nine frescoes of scenes from the life of St. Rose of Viterbo (destroyed). and then to Perugia in connection with an altarpiece for Collegio Gerolominiano (signed, dated 1456; Galleria Nazionale dell' Umbria, Perugia).

ALINARI

SELF-PORTRAIT DETAIL FROM "PROCESSION OF THE MAGI" BY BENOZZO GOZZOLI. IN THE PALAZZO MEDICI, FLORENCE

In 1458 he was in Rome, and thereafter returned to Florence. Gozzoli's masterpiece, the frescoed chapel of the Palazzo Medici. dates from 1459/60. By 1463 he was at work at San Gimignano on a cycle of 17 scenes from the life of St. Augustine in the choir of S. Agostino (last scene signed and dated 1465) and in 1464 completed a fresco of St. Sebastian there.

Between 1469 and 1485 Gozzoli's attention was monopolized by his most extensive commission, for a series of 25 frescoes of Old Testament scenes for the walls of the Camposanto at Pisa. He is mentioned in Florence in 1497 and died at Pistoia on Oct. 4 of that same year. An exceptionally prolific artist. Gozzoli made extensive use of studio assistants and his work as a whole has a rather empty facility. His work at Orvieto is distinguished from Angelico's by its dry schematic forms. In the "Procession of the Magi" on the walls of the Palazzo Medici, on the other hand, he emerges as an artist of great decorative talent. with a pronounced gift for landscape and portraiture. The views of the Val d'Arno which form the background of these frescoes and the portraits of the Medici included contributed to their enduring popularity.

See R. van Marle, *The Development of the Italian Schools of Painting,* vol. xi (1929); B. Berenson, *The Drawings of The Florentine Painters,* 2nd ed. (1938). (J. W. P.-H.)

GRAAF, REGNIER DE (1641–1673), Dutch physician known for his studies on the pancreas and on the reproductive organs of mammals, was born July 30, 1641, at Schoonhoven. He was educated at Louvain, Utrecht. Leiden and Angers and for a short time practised medicine in Paris but returned to Delft in 1667 and remained there until his death. Aug. 17, 1673.

Graaf was the discoverer of the ovarian follicles, which are still known as Graafian follicles. His writings include *Disputatio medica de natura et usu succi pancreatici* (1663); *Epistula de nonnullis circa partes genitales inventis novis* (1668); *Tractatus de virorum organis generationi inservientibus* (1668); *De mulierum organis in generatione inservientibus* (1672); and *Partium genitalium defensio adversus J. Swammerdam* (1673). An edition of his complete works was published in 1677.

GRAAFF REINET, a town in the Cape Province of the Union of South Africa 32° 15′ S., 24° 32′ E. Alt 2.463 ft. Pop. (1951) 14,136 (4,902 white, 3,409 natives, 5,759 "coloured," 46 Asiatics). It was founded by the Dutch in 1786, and named after the then governor of the Cape, C. J. van de Graaff, and his wife. The town was built near the Sunday river, from which water is led to irrigate the gardens, and across which a large dam has been constructed just above the town to create a reservoir, capable of irrigating 17,000 ac. of adjacent land. The average annual rainfall is about 17 in. The surrounding country is Karroo Veld, in the midst of which the tonn stands as an oasis. The district produces considerable quantities of mohair and merino wool. (R. U. S.; X.)

GRABAU, AMADEUS WILLIAM (1870–1946), U.S. paleontologist, mas born at Cedarburg. Wis., Jan. 9, 18jo, educated at hfassachusetts Institute of Technology (Sc.B., 1896) and Harvard (Sc.D., 1900). He served as assistant and instructor in paleontology at Massachusetts institute, 1892–97, professor of geology at Rensselaer Polytechnic institute. Troy. N.Y., 1899–1901 and at Columbia university as lecturer, adjunct professor and professor of paleontology 1901–19. In 1919 he became professor of paleontology at the National university in Peking, China. and also chief paleontologist of the Chinese geological survey. He accompanied the third Asiatic expedition of the American Museum of Natural History as research associate in paleontology.

The subjects of his special researches include *North American Index Fossils* (with H. W. Shimer, 1909–10); *Palaeozoic Corals of China* (1921); *Ordovician Fossils of North China* (1921); *Stratigraphy of China,* vol. 1 (1924–25); *Silurian Fossils of Yunnan* (1926). He died in Peking in March 1946.

GRABBE, CHRISTIAN DIETRICH (1801–1836), German dramatist, was born at Detmold on Dec. 11, 1801. He lived an extremely irregular life, and though both Tieck and Immermann tried to reform him, he died prematurely as a result of his excesses on Sept. 12, 1836. His tragic life provided the matter of a play by E. Johst, *Der Einsame* (1917) and a novel by P. Friedrich (192j). Many of Grabbe's dramas contain fine passages and a wealth of original ideas; though they are little suited to the requirements of the stage. The boldly conceived *Don Juan und Faust* (1829) and the historical dramas *Friedrich Barbnrossa* (1829). *Heinrich VI* (1830) and *Napoleon oder die Hundert Tage* (1831), the last of which places the battle of Waterloo upon the stage, are his best works.

GRABSKI, WLADYSLAW (1874–1938), Polish statesman who reorganized his country's monetary and financial system, was born at Borow, near Lowicz, on July 7, 1874. He studied history in Paris and economics in Halle, Ger. A Socialist in his youth, he later joined the National Democratic party and was elected a member of three successive Russian *dumas* (1906–12). In Jan. 1919 he was elected a member of the Polish constituent sejm, but soon left for Paris as third Polish delegate at the peace conference. Returning to Warsaw, he became minister of finance in Dec. 1919. From June 23 to July 24, 1920, he was prime minister. In this capacity he went to Spa. Belg., to ask the Allied supreme council for immediate aid to Poland in arms and munitions. He served again as minister of finance from Jan. to Sept. 1923. On Dec. 19, 1923, he became prime minister again. To stop inflation he created, on Feb. 1, 1924, a new Polish currency, the zloty (exchanged at 1,800.000 Polish marks for one zloty, the U.S. dollar being equivalent to 5.18 zlotys); and on April 28. 1924, he founded the Bank of Poland, whose capital was subscribed by the nation. In the summer of 1925, however, he had to face a new crisis. Germany declared a "tariff war" on Poland, and the Deutsche Bank sold massive quantities of zlotys on the money markets of Berlin and Vienna. The new Polish currency declined in July, losing almost 50% of its gold value. Criticized in the *sejm*, Grabski resigned on Nov. 14, 1925. After Pilsudski's *coup d'état* of May 1926, Grabski retired from active politics, becoming professor at the Warsaw Agricultural high school. He published his own account of his greatest achievement. Dwa lata *pracy u podstaw państwowości naszej* ("Two Years' Work at the Foundation of Our State"), in 1927 and a summary of his democratic political philosophy, Idea *Polski* ("Poland's Mission"), in 1935. Grabski died in Warsaw on March 1, 1938. (K. SM.)

GRACCHUS, in ancient Rome, the name of a plebeian family of the Sempronian *gens.* Its most distinguished representatives were the famous tribunes of the people, Tiberius and Gaius Sempronius Gracchus, mentioned below, usually called "the Gracchi."

GRACCHUS, GAIUS SEMPRONIUS (153–121 B.C.), younger brother of Tiberius, was a man of greater abilities, bolder and more passionate, although possessed of considerable powers of self-control, and a vigorous and impressive orator. When 20 years of age he was appointed one of the commissioners to carry out the distribution of land under the provisions of his brother's agrarian law. At the time of Tiberius's death, Gaius was serving under his brother-in-law Scipio in Spain, but probably returned to Rome in the following year (132). In 131 he supported the bill of G. Papirius Carbo, the object of which was to make it legal for a tribune to offer himself as candidate for the office in two consecutive years, and thus to remove one of the chief obstacles that had hampered Tiberius. The bill was then rejected, but appears to have subsequently passed in a modified form, as Gaius himself was re-elected without any disturbance. Possibly, however, his re-election was illegal, and he had only succeeded where his brother had failed. For the next few years nothing is heard of Gaius. Public opinion pointed him out as the man to avenge his brother's death and carry out his plans, and the aristocratic party, warned by the example of Tiberius, were anxious to keep him away from Rome. In 126 Gaius accompanied the consul L. Aurelius Orestes as quaestor to Sardinia, then in a state of revolt. Here he made himself so popular that the senate in alarm prolonged the command of Orestes, in order that Gaius might be obliged to remain there in his capacity of quaestor. But he returned to Rome without the permission of the senate, and, when called to account by the censors, defended himself so successfully that he was acquitted of having acted illegally. The disappointed aristocrats then brought him to trial on the charge of being implicated in the revolt of Fregellae, and in other ways unsuccessfully endeavoured to undermine his influence. Gaius then decided to act; against the wishes of his mother he became a candidate for the tribuneship, and was elected for the year 123.

Legislative Work. — The following is a summary of his legislation, apart from special measures aimed at his brother's opponents. He revived his brother's agrarian law, which, although it had not been repealed, had fallen into abeyance, and stabilised the price of corn in Rome. He founded the first over-sea colony at Iunonia, on the site of Carthage, with a citizen status. He also remodelled the voting system of the comitia centuriata in such a way as to reduce the influence of the aristocrats. A further group of laws aimed at strengthening the hands of the equites, to whom he gave the right to farm the taxes of Asia, and at the same time he provided that the members of the *quaestiones perpetuae,* which included the court that dealt with extortion in the provinces, should be drawn from the equites. These measures raised Gaius to the height of his popularity, and during the year of his first tribuneship he may be considered the absolute ruler of Rome. His legislation also involved him in an immense amount of administrative work, at which according to Plutarch he was very successful. Store-houses were built for the state-controlled corn (*Horrea Semproniana*), roads built and improved in the country districts to facilitate transport, and so on. He was chosen tribune for the second time for the year 122. To this period is probably to be assigned his proposal that the franchise should be given to all the Latin communities, and that the status of the Latins should be conferred upon the Italian allies. This proposal would have saved the Social War, but of course lost him favour with his own supporters, and the senate put up Livius Drusus to outbid him with proposals never meant to be carried out. On his return from superintending the organisation of his new colony he failed to secure the tribunate again, and the new consul, L. Opimius, at once proposed the abandonment of Iunonia. A riot during the voting resulted in Gaius being proclaimed a public enemy — the consuls were given plenary powers, and Gaius, who escaped over the Tiber, was found dead next day.

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GRACCHUS, TIBERIUS SEMPRONIUS, consul in 238 B.C., defeated the Ligurians, and, at the conclusion of the Carthaginian mercenary war, was in command of the fleet which took possession of Sardinia.

GRACCHUS, TIBERIUS SEMPRONIUS, probably the son of the preceding. Consul in 215, during the-second Punic War, he defeated the Capuans, and in 214 beat Hanno near Beneventum with the help of slave volunteers, fighting under promise of freedom. In 213 Gracchus was consul a second time and carried on the war in Lucania; in the following year, while advancing on Capua, he was betrayed by a Lucanian and trapped and killed by Mago.

GRACCHUS, TIBERIUS SEMPRONIUS (c. 210–151 B.C.), father of the tribunes, and husband of Cornelia. Although an opponent of the two Scipios (Asiaticus and Africanus), as tribune in 185 he was a member of the commission sent to Macedonia to investigate the complaints made by Eumenes II. of Pergamum against Philip V. of Macedon. In 181 he went as praetor to Hither Spain, where he was successful both as a soldier and administrator. Censor in 169, he was associated with the somewhat reactionary policy of his colleague Claudius Pulcher. They tried to curb the growing power of the capitalists (the equites), and restricted the political influence of the freedmen by confining them to the city tribes. He visited Asia as an ambassador in 165 and 161, and was consul again in 163.

GRACCHUS, TIBERIUS SEMPRONIUS (163–133 B.C.), son of the preceding, whose agrarian reforms, together with the reforms of his younger brother Gaius Sempronius Gracchus (*q.v.*) raised constitutional issues of great importance in the history of the Roman republic (see ROME: Ancient History). He and his brother were brought up by their mother Cornelia, assisted by the rhetorician Diophanes of Mytilene and the Stoic Blossius of Cumae. He served under his brother-in-law, the younger Scipio Africanus, in Africa during the last Punic War (147). Quaestor in 137, he served in the Numantine Wars in Spain, and saved the army by concluding an agreement with the enemy. This agreement was repudiated by the senate.

As tribune in 133, he was obsessed with the problem, which contemporary census figures reflect, of declining Roman manpower, from the particular point of view of recruitment for the legions. Much of Italy had been depopulated of Romans in the previous half-century through the absorption of independent small farms into the great ranches (*latifundia, saltus*), and Tiberius proposed to reclaim state land (ager publicus) occupied, often since several generations, by squatters (possessores; chiefly owners of the large estates), and to distribute it in small holdings, probably of 30 iugera (roughly 19 ac.) each; he aimed thus to improve and increase Roman stock by putting Romans back on the land. He hoped to soften opposition on the part of the possessores by allowing them to convert part of their existing holdings of ager *publicus* (500 to 1,000 iugera, according to the size of their families) into privately owned freehold. For the administration of the scheme a permanent board of three with, in all probability, a rotating chairmanship, was to be established. Romans alone were to be beneficiaries of the scheme, but as Latins and Italians were among the possessores, the scheme was bound to have repercussions on Roman relations with them.

A tribune, M. Octavius, having vetoed the proposal when it came before the concilium plebis ("assembly of the people"), Tiberius, in an altogether unconstitutional fashion, secured his deposition by vote of the plebs, and the bill was passed. The three commissioners elected were himself, his brother and his father-in-law, Appius Claudius Pulcher. The difficulties in establishing title were far more difficult and the practical issues more complicated than Tiberius had foreseen. When the senate tried to sabotage the bill by voting the commissioners no money for its implementation. Tiberius proposed that the wealth recently bequeathed to Rome by Attalus III of Pergamum be applied to this purpose. He then offered himself as a candidate for re-election to the tribunate for 132. While re-election without interval in the case of the curule magistracies was forbidden by law, the position concerning the tribunate was uncertain. The presiding tribune was undecided. Rioting started, Tiberius being at a disadvantage because his supporters, chiefly men living outside Rome, were working in the harvest fields and were not available. The consul P. Mucius Scaevola refused to intervene, and P. Scipio Nasica Serapio (consul in 138) assumed the responsibility of leading out a party of senators. in conflict with whom Tiberius was killed. The consuls of the following year, acting as a tribunal, tried and executed many of his supporters. Wisely, however, the work of the commission (on which Tiberius' place was taken by P. Licinius Crassus) was allowed to continue. That it was active down to 129, when Scipio Aemilianus secured a restriction of its powers. is evident from surviving boundary stones which record its adjudications. The problem of the inadequacy of recruits for the Roman legions, which Gracchus' land bill could never have solved, was solved in the event partly by Marius (*q.v.*) and partly by the enfranchisement of the Italians after the Social War of 90–89 B.C.

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GRACE, EDWARD MILLS (1841–1911), English cricketer, was born at Downend. near Bristol on Nov. 28, 1841, and was an elder brother of William Gilbert Grace (*q.v.*). He played first at Lord's cricket ground, London. in July 1861, for South Wales against the Marylebone Cricket club. and by 1862 his reputation was established. He played 12 times for Gentlemen v. Players. 1863–69, and for the last time in 1886. In 1880 he and his brothers William Gilbert and George Frederick (1850–SO), played together for England against Australia. He died at Thornbury. May 20, 1911.

GRACE, WILLIAM GILBERT (1848–1915), greatest English cricketer of Victorian times, was born July 18, 1848, at Downend. Gloucestershire, and died at Eltham, London, Oct. 23, 1915. During his career he scored 54,896 runs (including 126 centuries) and took 2.876 wickets in first-class cricket, which he played from 1865 until 1908. He could still handle a bat much later: in his last match his not-out score was 69 for Eltham v. Grove Park on July 25, 1914, when he was 66. At 16 he went in first for Gentlemen v. Players at Lord's cricket ground, London, and on his last appearance for the Gentlemen at the Oval cricket ground, London, in 1906, he made 74 on his 58th birthday. In 84 matches for Gentlemen v. Players he amassed 6,000 runs and took 271 wickets. His prowess and achievement were comprehensive: in Aug. 1876 he scored, in consecutive innings, 344 out of 546 for Marylebone Cricket club v. Kent; 177 out of 262 for Gloucestershire *v.* Nottinghamshire; and a not-out score of 318 for Gloucestershire v. Yorkshire at Cheltenham. In 1880 he was on the team which played the first match against Australia in England.

The legend of "W. G." presents him as shaggy and ponderous with a huge yellow cap atop a swarthy head and face; the earliest extant photographs show him bearded like the pard. But in his heyday he was an athletic figure, a swift runner and able to throw a ball 100 yd. At 24 his weight was not more than 12 stone, 7 lb. (175 lb.). Grace evolved the first principles of modern batting, combining forward and back techniques; many of his performances were achieved on rough and untrustworthy wickets, such as are unknown to modern players. His personality, his inexhaustible energy and gusto and his physical power of dominance made him a national figure. He was Johnsonian in that cricket was his life and dictionary, though in his spare time he practised medicine. "I puts the ball where I likes," said J. C. Shaw, famous and accurate bowler of the period, "but he ["W. G."] puts it where he likes."

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GRACE is a word with several meanings; all are related to the notion of favour. The English word is derived through the French and Latin (*grâce* and gratia) from the Greek *charis,* which has four principal meanings: (1) a pleasing quality, gracefulness; (2) good-will, beneficence; (3) gift, benefit; (4) gratitude. Of these four meanings, the second and third contain the theological sense accepted by all theistic religions. The same idea is contained in the Hebrew words חן (favour, good-will) and חֶסֶד (loving-kindness, a benefit conferred gratuitously).

History shows positively man's need for religion. Religion is the submissive acknowledgment of man's complete dependence on a power exterior and superior to human nature. If this power is recognized as a person, the generic notion of grace must be accepted as an inseparable factor of human existence; for then the life of man is a series of objective benefits, which depend ultimately on the beneficent will of a personal and supramundane power. Granted this basic notion of grace common to all theistic religions, one can see that all further particularizations of the concept of grace will depend on one's understanding of a personal God, the nature of man and the nature of the relations between man and God. The major developments of grace have occurred in Christian thought. Since this article is limited in length, only a brief analytic statement of the views of the chief adherents of Christianity is possible.

The Roman Catholic view on grace is distinguished from others mainly by its affirmation of a supernatural order. The word "supernatural," as applied to grace, is a relative term, and denotes a benefit, conferred by God alone gratuitously, which elevates its recipient to a perfection to which he has no right or title whatsoever. It is natural for God to have complete happiness in the intuitive knowledge and love of His infinite perfection; but an intuitive knowledge of divine perfection is not in any way due to any finite nature. The fundamental Roman Catholic doctrine on grace is that God has destined men to a supernatural share in His divine life, and actually confers upon them supernatural gifts, intrinsically proportioned to the direct vision of His essence, even as the seed is proportioned to the full flower.

God intended that the supernatural gift of divine life, originally conferred on Adam, should be transmitted to the newly created soul of each individual. It was to have been a supernatural property of human nature, even as sense faculties are natural properties. The gift on God's part was absolute; the transmission was conditioned solely on Adam's not sinning. But Adam sinned and in his sin all men shared, not by wilful co-operation, but by physical incorporation in him as the head of the human race. By his sin, Adam lost for himself and for all men his share in divine life and the attendant, subordinate, preternatural gifts of immortality and immunity from suffering and from internal conflict (concupiscence). In the Roman Catholic view, the transmission of hereditary guilt is possible only in the hypothesis of supernatural gifts, whose loss has left human nature essentially unchanged.

God could have left men in original sin; He could have condoned it; but to show forth equally His mercy and justice, He freely determined that man's supernatural life should be won back through the meritorious and redemptive death of the second Adam, the incarnate Son of God. The positive will of God as to the application of Christ's merits has been revealed in the New Testament. Infants receive justification in baptism without any personal co-operation; adults. however, can be justified only by the free consent of their wills co-operating with actual (*i.e.*, transitory) supernatural graces. These free acts must include the intellectual assent of faith to revealed truth because of the authority of God, and, in the case of those who have sinned seriously, an act of penance; *i.e.,* a sincere detestation of sin with a firm purpose of amendment.

These acts constitute a positive, supernatural and internal preparation for the permanent gift of justification, infused into the soul by God alone either in actual baptism, or in the baptism of desire which is contained implicitly in any supernatural act of perfect love of God.

Justification is the complete remission of all serious sin and a complete internal renovation; it includes sanctifying grace, the infused virtues of faith. hope and charity and the indwelling of the Holy Spirit. By justification, man is elevated supernaturally to the very life of God; he is made an adopted son of God entitled to see Him face to face after death, and is capable of performing free acts which merit before God an increase of justification itself and a correspondingly greater clarity in the future vision of the divine essence. By every serious sin, this supernatural life is lost, but may be regained through the sacrament of penance received with proper dispositions. In justification, the lesser effects of original sin, especially concupiscence, are not removed, although their power as stimuli of sin is tempered by internal transitory and supernatural graces of intellect and will.

In the Roman Catholic system of grace and salvation, the whole initiative lies with God. No grace, no free acceptance of grace are possible except by the efficacy of God's eternal decree. No man is ever saved unless he has been elected and predestined by God. Nevertheless, neither God's eternal decrees nor His internal graces impede the exercise of man's liberty, which is equally necessary for the salvation of adults. The sacraments, which are the divinely chosen channels of grace, cannot exercise their effect in adults, unless they are freely received with proper dispositions. Christ died that all men should possess supernatural life; therefore all men receive from God sufficient grace for salvation. There is no antecedent positive reprobation of any man on the part of God. Damnation is due to the free rejection of sufficient grace on the part of man. However. the distribution of grace is unequal. This inequality is due, not to any merits or demerits of men, but to the good pleasure of God. Therefore all adults who are saved receive supernatural helps decreed by God from eternity with the foreknowledge that they would be accepted freely and that perseverance in justification would last until death. The Catholic view is objective and ontological rather than subjective and psychological. Its validity depends, not on human experience, but on the question whether it is the revealed truth of God.

The doctrine of the early Protestant reformation (Lutheran, Calvinist and Anglican) is based on a denial of the supernatural order. The original justice of Adam, his immortality and freedom from concupiscence are conceived as natural. By original sin, which consists essentially in concupiscence, human nature is no longer integral, but totally corrupt; the human will has no freedom to do good rather than evil; all human actions are sinful. The sole remedy for original sin is the expiatory death of Christ. But the merits of Christ are not applied to sinful men in the form of internal sanctification and a total destruction of sin. Men are justified externally by fiducial faith; *i.e.,* a subjective conviction that their sins are covered by the merits of Christ and are no longer imputed by God, even though the soul remains internally corrupt. Justification is merely an external declaration of God and not an internal renovation of man. Calvinism particularly insisted that men are saved or lost, not by their free wills, but solely by the antecedent predestination or reprobation of God.

In later Protestantism, the harsh views of the early Reformers, founded on private interpretation of Scripture and St. Augustine, were greatly modified by the Arminian controversy, the rise of Deism and the influence of Rationalism. The Arminian insistence on human liberty, the Deistic denial of divine providence and the Rationalistic rejection of scriptural inspiration, original sin, Christ's divinity and the sacramental system brought large sections of Protestantism to a view on grace not far removed from Pelagianism, namely, to a belief in the unaided power of human nature to attain complete perfection and ultimate happiness. The influence of World Wars I and II (1914 and 1939) with the intervening spiritual unrest of two decades dealt a severe blow to the gospel of indefinite human progress without divine aid and caused a more serious investigation into the entire question of religion and of man's absolute need for divine help, not merely for the spiritual welfare of the individual, but also for his temporal prosperity as a member of national and international society. Among English speaking theologians of the 20th century, Reinhold Niebuhr's works manifested a trend in Protestantism away from the Pelagian naturalism of the preceding century. This tendency is a praiseworthy attempt to sift and synthesize basic elements of traditional Christian thought on grace into a new system, which may exercise a more profound and practical influence on men's lives.

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(P. J. D.)

GRACES, Greek goddesses of fertility. The name (cf. Venus) refers to the ".pleasing" or "charming" appearance of a fertile field or garden. (Gr. Charites, Lat. Gratiae.) Their number varies; sometimes only one Charis is mentioned, but usually they are three: Aglaia (brightness), Euphrosyne (joyfulness) and Thalia (bloom). They are daughters of Zeus and Hera (or Eurynome, daughter of Oceanus), or of Helios and Aegle, a daughter of Zeus. At Sparta there were two Graces, Kleta and Phaenna; at Athens two, Auxo and Hegemone, associated with the goddess Aglauros in the oath taken by youths belonging to the military college of the ephebi. Frequently the Graces are taken as goddesses of charm or beauty in general and hence are associated with Aphrodite, Peitho, Hermes; the union of Hephaestus with Charis in the Iliad is probably a mere allegory (Craftsmanship weds Beauty). In works of art they were represented in early times draped, later as nude female figures.

GRACIÁN Y MORALES, BALTASAR (1601–1658), the most important 17th-century Spanish prose writer after Quevedo (*q.v.*), was baptized at Belmonte near Calayatud, Jan. 8, 1601, studied at Calatayud and Saragossa, became a Jesuit (1619) and later rector of the Jesuit college of Tarragona. His educational and literary theories, enunciated respectively in El *discreto* (1646; Eng. trans. The Compleat *Gentleman,* 2nd ed., 1730) and in his rhetorical treatise on the "conceited" style, Agudeza y *arte* de ingenio (definitive version, 1648), are exemplified in his masterpiece. the great philosophical novel El Criticdn (1651–53–57; monumental ed. by M. Romera-Navarro. 3 vol., 1938–40; Eng. trans. The Critick, 1681), published pseudonymously in defiance of his superiors, whose disciplinary action precipitated his unsuccessful petition for release from the society. He died at Tarazona. Dec. 6. 1658. There are numerous modern editions and studies of his major works. which also include El hkroe (1637; Eng, trans. The Hero, 1726) and El *Oráculo manual* (1647; Eng. trans. *The* Oracle, 1953); his influence on Schopenhauer was notable.

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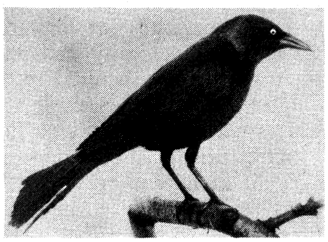
GRACKLE, a name given to various birds of the family Sturnidae in the old world and of the Icteridae in the new world. The former include the hill mynas of India and southeastern Asia, especially *Eulabes* religiosa, which is about 10 in. long and has black iridescent plumage, a white patch on the wing and yellow wattles behind thb eyes. The bill is orange and the legs are yellow. It feeds on fruit and can be taught to talk.

The American grackles include 12 species classified in 8 genera restricted to or best represented in the tropics. Most have uniform glossy black plumage, but the females of *Quiscalus, Holoquiscalus* and Cassidix are dingy gray or brownish, and certain tropical species are in part bright yellow or scarlet. Their habits vary, but most grackles are omnivorous and when in abundance may damage crops locally. They also destroy the eggs and young of other birds. and the rice grackle (*Scaphidura oryzivora*) of Central and South America customarily lay their eggs in the nests of other birds. Best known is the common grackle (*Quiscalus quiscula*) that occurs in most of eastern North America. It is a beautiful bird, purplish or bronzy black in colour with a long. graduated tail, and grows to a length of about 12 in. The boat-tailed grackle (Cassidix *mexicanus*), which ranges from Delaware and the Gulf toast to Colombia, is much larger (16 in) and has a more expansive, keellike tail It is known locally as the crow blackbird. or jackdaw, the latter in reference to its imagined similarity to the common jackdan (*Corvus monedula*) of Europe. (E R. BE.)



BY COURTESY OF THE CHICAGO NATURAL HISTORY MUSEUM

AMERICAN BRONZEDGRACKLE. FOUND THROUGHOUT NEW ENGLAND AND THE MISSISSIPPI VALLEY

GRADIENT WIND, a generalization of the geostrophic wind (*q.v.*) for flow along curved trajectories. Friction is disregarded. and the wind is assumed to be parallel to the isobars (lines of constant pressure). The gradient wind gives a better representation of the true wind than the geostrophic, particularly when the wind speed and trajectory curvature are large, as in the case of hurricanes. and fast jet streams between 25,000–50,000 ft. elevation.

Whereas the geostrophic wind needs for its computation only the pressure distribution along a constant level surface or the slope distribution of a constant pressure surface, the gradient wind needs in addition the knowledge of trajectory curvature. In general this is not known; however in cases in which the wind speed is much greater than the speed of the flow patterns (a condition generally satisfied when the gradient wind is most useful), the curvature of the stream lines is a good approximation to the trajectory curvature. Further, streamline curvature above the friction layer is well represented by curvature of isobars or contour lines of isobaric surfaces (see EKMAN SPIRAL). The figure illustrates the theory of gradient wind. Conditions in the northern hemisphere, *i.e.,* where the Coriolis force acts to the right of the mind, are assumed (see MOTION, PRINCIPLES AND LAWS OF). When the Coriolis force exceeds the pressure gradient force (fig 1) the air is continually deflected to the right, leading to anticyclonic (clockwise in the northern hemisphere) curvature of flow. This situation can be represented by a balance between the

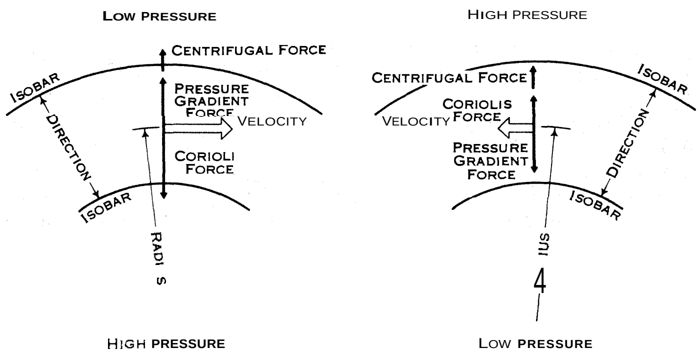


FIG. 1 AND 2.—THE BALANCE OF FORCES FOR GRADIENT WINDS IN THE NORTHERN HEMISPHERE WITH (FIG. 1) CLOCKWISE ROTATION AND (FIG. 2) COUNTERCLOCKWISE ROTATION OF THE AIR

Coriolis force and the sum of pressure gradient and centrifugal forces. Then, the wind speed is larger than geostrophic. Since the centrifugal force depends on the square of the wind speed. and the Coriolis force only on its first power, gradient equilibrium in the anticyclonic case is impossible for fast winds; hence anticyclones (high pressure centres) cannot become intense.

Figure 2 illustrates the case in which the pressure gradient force exceeds the Coriolis force so that the flow is curved in a counterclockwise sense (cyclonically). Here. the pressure gradient force balances the sum of Coriolis and centrifugal forces. Under these conditions, the wind is less than geostrophic; however, the speed of the wind is not limited, so that the strength of counterclockwise storms (cyclones) may be very large.

In the southern hemisphere, where the Coriolis force acts to the left of the wind, the term cyclonic refers to clockwise flow and anticyclonic to counterclockwise flow. The discussion of gradient wind above can be applied to the southern hemisphere, provided that the terms "cyclonic" and "anticyclonic" are used in this sense throughout. However, clockwise must be replaced by counterclockwise, and vice versa. (H. A. A. P.)

GRADO, an island of the province of Gorìzia, It., 4 mi. from Belvedere. Pop. (1951) 8,733. The inhabitants of Aquileia took shelter there in 452 and 568 and the patriarchate of Grado began in 557–569 and continued till 1451 when it passed to Venice. The cathedral was rebuilt in 571–586.

GRADUATE, in Great Britain, a verb now used only in the academic sense intransitively, *i e.,* "to take or proceed to a university degree." and figuratively of acquiring knowledge of or proficiency in anything. The original transitive sense of "to confer or admit to a degree" is still preserved in the U.S. where the word is not strictly confined to university degrees, but is used also of those successfully completing a course of study at any educational establishment. As a substantive, a "graduate" (Med. Lat. *graduatus*) is one who has taken a degree in a university. Those who have matriculated at a university but not yet taken a degree are known as undergraduates. The word student. used of undergraduates in the U.S. and. in Scottish universities. is not applied generally to those of the English and Irish universities At Oxford the only students are the "senior students" (fellows) and "junior students" (undergraduates on the foundation or scholars) of Christ Church The verb "to graduate" is also used of dividing anything into degrees or parts in accordance with a given scale. For scientific applications, *see* GRADUATION AND CALIBRATION. It may also mean "to arrange in gradations" or "to adjust or apportion according to a given scale." Thus a graduated income tax refers to the system by which the perceniage paid depends on the income level.

GRADUATION AND CALIBRATION. Graduation is the process of dividing an interval into a number of smaller ones. Usually these divisions are of equal magnitude but occasionally they are related to each other according to some mathematical formula, as is the case for the distances between graduating marks on the dial of an alternating-current electric meter.

The word "graduation" is derived from the Latin *gradus*, "step," implying that graduation is performed by "stepping off" equal intervals in the larger interval to be divided.

Calibration is the process of comparing an article with a standard to determine the extent to which it meets specified requirements. The term is most frequently applied to the testing of measuring devices; *e.g.*, electric meters, surveying tapes, speedometers, thermometers, etc. It applies equally well to the testing of precise machine articles, *e.g.*, bearings, shafts, screw threads, etc., which must fit to close tolerances.

The word "calibration" is derived through the French *calibre* and Italian *calibro* from the Arabic *qálib*, a "form" or "mold." in connection with gunnery terms introduced at the beginning of modern times. Thus the meaning is clear since the mold for the bullets had to conform to the bore or calibre of the gun.

The term is also used by some instrument manufacturers to describe the process of adjusting an instrument and its scale reading at the time of manufacture so that the indications of the instrument will be correct. They prefer the term "standardization" for subsequent processes of determining residual errors or errors which develop after the original adjustment. Graduation usually means the placing of the original marks on a scale or dial; and calibration, the determination of the correctness with which they were placed.

Development of modern technology owes much to the art of precise graduation for without it parts would not work properly when fitted together. Prior to the 18th century all graduation was performed strictly as handwork. During the 18th century a number of dividing engines were developed. Henry Hindley, about 1739, constructed an engine for accurately cutting the teeth in clock gears. Jesse Ramsden, in 1766, constructed an engine to divide circles for surveying and navigating instruments.

Graduating engines attained a high state of development during the 19th century. Machines were developed for ruling optical diffraction gratings with as many as 30,000 equally-spaced lines per inch *(see* SPECTROSCOPY: *Grating Spectrographs).* Toward the end of the century most well-equipped instrument shops were capable of performing both linear and circular graduation with high accuracy since the facilities required for precise machining, gear cutting, etc., and precise graduation are similar.

Most precise graduation is accomplished by special engines designed for this purpose, Modern graduating engines are commercially available with guaranteed accuracies of 1 sec. of arc for circular graduation (better than 1 part per 1,000,000) and of .0001 in. for linear graduations. Special ruling engines for optical gratings have been developed in nhich the position of the ruling tool is electronically controlled and guided by means of photocells which are actuated by interference fringes, thus governing its position to within a fraction of the wave length of light.

Process of **Graduation.**—Original graduation can be performed in two ways. One involves bisecting the interval to be graduated with a beam compass, or similar instrument, and successively bisecting the intervals obtained until the desired fineness of division is attained. The other involves the use of a trial subinterval and stepping off intervals of the larger interval with a pair of dividers or a similar device. This process can be repeated until the desired accuracy of the divisions is attained. The former process can be employed if the total number of divisions desired is a power of 2; if not, the second process must be employed. Both may be used if the number of divisions is a multiple of a power of 2 and other numbers.

The accuracy with which graduation can be performed is limited only by the care and patience of the graduator. After a graduation has been performed the subdivisions may be compared with each other and the errors of each subdivision assessed. A new graduation can then be made by copying the original with corrections for its known errors and the process repeated until the desired accuracy is achieved.

The precise commercial graduating engines incorporate automatic correcting mechanisms. Although the gears, racks and screws which position the graving tool in each engine are fashioned with great care, some residual errors remain. A system of levers operated by a correcting cam adjusts the position of the graving tool to correct for the errors of each engine. Another device which is used in graduating and ruling engines to improve accuracy is the employment of multiple lead screws and multiple ways so that irregularities in any single part will be averaged out. By means of these devices and by allowing for measured errors in earlier graduations, successive graduations can be carried out to any refinement desired.

Calibration. — The concept of calibration involves measurement. In its broadest sense it includes comparison with a standard which may result in acceptance or rejection of the article because it does not conform closely enough to the specifications set forth for it, issuance of a certificate or construction of a table or chart for it stating the extent to which it departs from the standard or adjustment of the article so that it conforms with the standard to within allowable errors. Underlying this must be a sound science of measurement and a statistical theory of errors.

Importance of Calibration. — The high technological development of modern life has resulted in increased importance for the process of calibration. In earlier times only the weights and measures used in commerce were subjected to any verification, and often even this was not done well or at all. Most manufactured articles consisted of parts that were individually made according to the pattern of the particular artisan. Parts of an article made by one person were not required to fit with parts made by another. With the development of quantity production, however, this procedure had to change. Large plants began to manufacture goods for commerce, and different parts of various articles were made by different individuals. After manufacture these parts were required to fit together, and this was possible only if they had been made to specified dimensions. Therefore, gauges had to be distributed in the various departments of each manufacturing plant to serve as standards by which the dimensions of each part were fixed. As these gauges were used continually they would change and therefore they required calibration by comparison with master gauges.

At the present stage of technological development various component parts are not made in the same plant or even under the same proprietorship, but are purchased as finished parts from another manufacturer. Often the end use of a part is not known to its manufacturer; sometimes the manufacturers are in different countries. Such a system is workable only because the individual manufacturers produce their goods in accord with accepted standards of measurement.

Calibration of measuring devices is also important in the exchange of scientific information between various laboratories, both intranationally and internationally. The information of modern physical science is highly quantitative and is usually expressed to high precision in terms of the relationship of units of one quantity to units of another. In order that one scientist be able to collate his work with another it is necessary that there be agreement between them on the sizes of units and that the measuring devices which each uses be calibrated by comparison with agreed upon standards.

International Standards. — The first great step toward realization of an international system of standards was taken by 17 nations when they signed a treaty on May 20, 1875, to establish an organization to improve and maintain the metric system of units. The metric system was brought into being by the French national assembly through decisions made between 1791 and 1795. Its use in commercial transactions was made compulsory in that country on July 4, 1837, and by many other nations subsequently, and its commercial use was made permissive in the United States and the British empire. It is based on the metre as a unit of length and the kilogram as a unit of mass.

In order to carry out its mission, the organization set up by the treaty of 1875 had a number of prototype standards fabricated and distributed among the participating nations. They were standards of length, consisting of bars of platinum-iridium on which were engraved two parallel lines 1 m. apart; and standards of mass, consisting of platinum-iridium cylinders weighing 1 kg. each.

One of the prototype metre bars and one of the prototype mass standards were selected as the international standards and placed in the International Bureau of Weights and Measures at Sèvres, a suburb of Paris. The various national standards are frequently sent to the international bureau for comparison with the international standards to determine how much change, if any, has occurred in them.

The standards of length and mass, together with a standard of time fixed by the motion of the earth, and a standard of temperature, fixed by the temperature at which water is in equilibrium with its vapor and ice, serve to fix the sizes of all other units of measurement in accordance with certain agreed upon definitions. The major standardizing laboratories of the world construct standards for other units such as the volt, the unit of electromotive force, and the ohm, the unit of electrical resistance. The standards so constructed are intercompared and a "best" value for each national standard is adopted by international agreement.

Because of this system the metric standards of all nations are kept on a uniform basis. Instruments calibrated in terms of the standards of one nation agree with those calibrated in standards of another to within the error of observation.

Prior to an international agreement in 1959 some differences existed between certain units used by the English-speaking countries. For example, one U.S. yard was approximately equal to 0.9144018 m. by its definition and the British yard was equal to 0.9143986 m. as given by comparison with the British standard yard. The U.S. and British pounds mere 0.4335924277 kg. and 0.453592338 kg., respectively. Although these differences are trivial for most purposes, they become bothersome in precise calibration work. For this reason the directors of the national standardizing laboratories of the English-speaking countries agreed to adopt an international yard (0.9144 m., exactly) and an international pound (0.54359237 kg., exactly) and to use these equivalents in all calibrations from 1959 on unless otherwise required. This makes the international inch equal to 2.54 cm., exactly. However, for most international comparisons the metric system is used and scientific results are usually stated in metric units. Electric units are based on the metric system.

Accuracy of Calibration. — In order that required accuracy be achieved in the calibration of a device it is necessary that the accuracy of the standard with which it is compared be considerably greater, since some uncertainty is bound to be attached to any intercomparison. Suppose that some instrument. which we will designate as A, is compared with another, which we mill designate as B. We will designate the uncertainty in the value given by A as the result of this intercomparison by ϵ_{AB}. B. in turn, mas previously compared with another, C, and the uncertainty involved is ϵ_{BC}. Then the best estimate of the uncertainty in A as compared with C is $\sqrt{\epsilon^2_{AB} + \epsilon^2_{BC}}$. If there is a long chain of such intercomparisons by which the value of A is related to the basic standard then considerable uncertainty is involved in the calibrated value of A, since the uncertainties of all the calibrations must be added together in quadrature to give the uncertainty of A. For example, the uncertainty in the length of a 50-m. surveying tape expressed in terms of the international prototype metre is bound to be considerably greater than the uncertainty in a national prototype metre; and a 1-lb. weight certified by a local sealer of weights and measures is subject to considerably more uncertainty than a national prototype kilogram.

To assure adequate precision of intercomparison a very high standard of accuracy is maintained in national standardizing laboratories. High-quality metre bars can be compared with each other with a probable error of 3 parts in 10^8. (The meaning of this is that in a large number of repeated intercomparisons 50% of the results will agree to within this range.) Masses of 1 kg. may be intercompared with a probable error of 4 parts in 10^9. Frequency and time standards may be compared with probable errors of a few parts in 10^{10}, using atomic standards of frequency introduced in the later 1950s. although these comparisons may not be referred to the defined standard of time—the tropical year 1900 at 12 hr. E.T. (see TIME MEASUREMENT: *Uniform* Time)—with equal accuracy. Some of the electric standards may be intercompared with probable errors smaller than 1 part in 10^6, although standards for the defined units themselves are not realized with this accuracy. Lower accuracies are associated with the best practice in calibrating standards for some other quantities.

Where the magnitude of the quantities being measured differs appreciably from the defined standard, lower accuracies result. Thus 50-m. base-line tapes are calibrated with probable errors of 2 or 3 parts in 10^7 and end gauges of 1 in. with probable errors of 1 part in 10^6, at best.

Another illustration of the importance of accuracy in calibration of measuring devices is afforded by the application of quality control. Suppose a commodity such as sheet metal is required to be produced having a certain thickness with a tolerance of plus or minus 0.003 in. If the gauge used to test specimens of the material has an uncertainty in its calibration of plus or minus 0.001 in., any specimen which gauges more than 0.002 in. from the specification must be rejected because the gauge error plus the measured departure from specifications may add to more than 0.003 in. Obviously, many satisfactory specimens will be unnecessarily rejected if the unknown gauge error and the measured departure are opposite in sign. If the uncertainty of the gauge calibration is as small as 0.0001 in. the number of specimens unnecessarily rejected will be greatly reduced.

Laboratory Calibration. — Many laboratory instruments are, by nature, so variable in performance that frequent calibrations are required. This is also true for relatively stable equipment when results of the highest accuracy are required. Under such conditions calibrations of the instrument are conducted before and after each measurement, or as often as circumstances require. This calibration is performed by making measurements with the instrument on a standard sample similar to the unknown to be measured.

A few illustrations: In determining the composition of a gas of unknonn composition with a mass spectrometer, a gas of similar but known composition is often tested by the spectrometer before and after the unknown. If a certain component of the known gas is found to be 1% loner in abundance than it is known to be, then the same component in the unknown gas will be estimated to be 1% higher then it was measured to be. Similarly when a chronometer is used in timing astronomical events such as eclipses, the chronometer is checked with radio time signals immediately before and after the event is observed. The checking of the chronometer constitutes a calibration of that instrument and a more correct timing of the event is obtained through the use of radio time signals as a standard than if complete reliance had been placed on the chronometer alone.

See also WEIGHTS AND MEASURES; METROLOGY.

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(A. G. McN.)

GRADUS (GRADUS AD PARNASSUM, "a step to Parnassus"), a Latin (or Greek) dictionary, in which the quantities of the vowels of the words are marked. Synonyms. epithets and poetical expressions and extracts are also included under the more important headings. the whole being intended as an aid for students in Greek and Latin verse composition. The first Latin gradus was compiled in 1702 by the Jesuit Paul Aler (1656–1727), a famous schoolmaster. There is a Latin gradus by C. D. Yonge (1850); English-Latin by A. C. Ainger and H. G. Wintle (1890); Greek by J. Brasse (1828) and E. Maltby (1815), bishop of Durham.

GRADY, HENRY WOODFIN (1850–1889), U.S. journalist and orator, was born in Athens, Ga.. May 24, 1850. He graduated from the University of Georgia in 1868 and took postgraduate work at the University of Virginia. A letter to the *Atlanta Constitution,* written while he was a student, evidenced his journalistic talents and led him into journalism. He became the editor of several small newspapers and then Georgia representative of the *New York* Herald before buying a quarter interest in the *Atlanta Constitution* in 1880. He was editor of that paper until his death. A capable journalist, he was also a talented orator. During the late 1880s he made a number of famous addresses. including one on "The New South" in Dec. 1885, that helped to pacify north-south animosities of the post-Civil War period. He died in Atlanta. Ga., Dec. 23, 1889. (H. J. SG.)

GRAECO-PERSIAN WARS, 546–466 B.C. The great Assyrian kingdom which had ruled and terrorized Asia for centuries came to an end with the fall of Nineveh in 612 B.C. Of it the Greeks knew little or nothing. Only the Greeks of Cyprus had come into contact with it, and that only on one brief occasion. It had never ruled within the peninsula of Asia Minor.

For half a century after the fall of Nineveh the old dominions of Assyria were divided between two Powers, the Median and Babylonian kingdoms. The Median monarchy conceived ambitions beyond the Taurus, so that a war arose between it and Lydia, which was brought to a practical, though not formal, conclusion by that strange incident on the Halys in 585, when the armies, prepared for battle, withdrew from the unfought fight in consequence of an eclipse of the sun. Freed from danger from the east, Lydia turned her attention westwards, and in the next 40 years brought into subjection those Greek cities of the Asiatic coast of the Aegean on whose liberties the Lydian kings had been making desultory attacks for more than a century past.

Rise of **Cyrus.**—The independent kingdom of Media had lasted little more than half a century when there came a change of dynasty within it, a change which seems, judging from the contemporary records of Nabonidus, king of Babylon, to have been little more than a domestic matter. The history of the next two centuries makes it almost certain that the Persians in the southwest of modern Persia were either a Median tribe or of a race near akin to the Medes. In 552 Cyrus the Persian king of Anshan, a part of Elam, revolted and set himself up as ruler of the Median kingdom. Lydia and Babylonia got alarmed at his vigour and success, and concluded an alliance which aimed at checking, or even suppressing, Cyrus. Of that alliance he got wind; so about 546 he made an attack on Croesus of Lydia which ended in the capture of Sardes, the fall of the Lydian kingdom, and the passing of the continental Greeks of the Asiatic coast under Persian dominion.

The fall of Lydia made a great impression on the Greek world, for it had loomed large as an oriental empire in contrast to the small and comparatively poor States of Greece.

Of the relations between the Persians and the Greeks during the later part of the reign of Cyrus and during the reign of his successor Cambyses but little is known. The islands of the eastern Aegean, with the exception of Samos, seem to have fallen early under Persian rule.

A certain Polycrates ruled at Samos as tyrant for some years, and used the wealth he acquired in trade in carrying out some great architectural and engineering works. But about 424 he fell into the hands of the Persians and was put to death. In 516 a Persian force captured the island. Thus Persian rule now extended to a line drawn north and south through the middle of the Aegean. Cambyses had died in 522, and had been succeeded by a pretender who was slain by certain Persian nobles, of whom the leader, Darius, succeeded to the throne.

Reign of Darius.—Everything that is known of him suggests that Darius was one of the greatest men that the ancient world produced, at least capable—perhaps great—as a commander in war, and in peace a ruler and organizer such as the world was never to see till the days of Augustus. The system of government which he established is all the more remarkable because it is in strong contrast with the crude and often barbarous methods of government which races ruling before him in the East had applied to the peoples which they had brought into subjection; for it was a system which recognized the wisdom, if not the justice, of respecting the rights of subjects of various races, and of allowing them as much local freedom as was consistent with the calls which the interests of the empire as a whole made upon them. The Greek cities were left with considerable local autonomy under tyrants of their own race, who were indeed agents of Persia, but do not seem to have been harsh in their rule. Tribute had to be paid; but not even the Greeks themselves ever alleged that it was a crushing burden. They had also in time of war to provide military and naval contingents for the Persian forces. But, however lightly the hand of Persia lay upon them, the Greeks of Asia, being Greeks, resented any form of subjection which circumscribed their political freedom.

Scythian Expedition.—Either before or after Darius' accession the Persians had acquired two *têtes-du-pont* in Europe, the Thracian Chersonese (Gallipoli peninsula), and Byzantium. This may have signified nothing more than a desire to control the narrow passages of the Hellespont and Bosporus. But somewhere about 512 Darius took a step which has seemed to some writers, ancient and modern, to have signified a deliberate policy of extending the empire into Europe. This is what is known as the Scythian expedition. For this incident Herodotus is the chief authority among ancient writers, though Ctesias and Strabo contribute matter of importance. The outstanding element in the ancient tradition is that the expedition was directed against the Scyths. Darius may have wished to teach that people the lesson that they must keep their hands off Asia and Asiatic kingdoms. It was much easier to attack the Scyths through Thrace than through the twofold barrier of the Armenian mountains and the Caucasus.

Misled, it would seem, by exaggerated reports of some disaster having overtaken the Persians in Scythia, the Greek cities of the Propontis region, which had submitted to Darius on his march northwards, revolted; so, when Darius himself returned to Asia, he left Megabazus in Europe to deal with those towns. Herodotus represents him as having subdued all Thrace, a statement inconsistent with the story of some years later; nor is the story of Macedonia having given the earth and water of submission at this time quite free from suspicion. The only element in the story of this aftermath of the Scythian expedition which lends colouring to the Greek conception of its having been preparatory to a future advance into Europe, that is to say, against Greece, is the tale of what happened at Myrcinus. That leads to the next act in the Perso-Greek tragedy—the Ionian revolt.

A certain Histiaeus, tyrant of Miletus, had been rewarded for his services in the Scythian expedition by the grant of Myrcinus, a town which commanded the narrow route along the north Aegean coast which was practically the only line of communication from the Hellespont region westwards. When he proceeded to fortify this place the suspicions of Megabazus were aroused. Representations made by him to Darius caused the latter to recall Histiaeus and to take him with him to Susa, where he would be out of mischief. Histiaeus did not like detention at Susa, and was anxious to get back to his own people. But, before he took any measures to bring about his return, certain other events of great significance in the relations between Persia and Greece took place.

Political Movements at Athens.—In 510 the Athenians, aided by the Spartans, had expelled the tyrant Hippias, who had alienated the sympathies of Sparta by making an alliance with its sworn foe Argos. The expulsion of the tyrant Hippias was followed by a struggle at Athens between the oligarchs, or, more probably, the conservative[1] element and the extreme democrats, in

[1]The term "conservative" in relation to Athenian politics will be used hereafter to denominate the moderate democrats at Athens together with the oligarchs, who voted with the moderates because the oligarchical vote was too small to carry any policy.

which Sparta intervened in a half-hearted and ineffective way on behalf of the former, a half-heartedness due to the fact that a strong party at Sparta was opposed to incurring obligations abroad which might keep Spartan troops away from home; and events at Athens had shown that an oligarchy could only be maintained by something like permanent military support from Sparta. But to the democrats it seemed as if they had to face political foes who were backed by the strongest military power in Greece, against which no alliance with any other Greek State would be of effective value. Thus they turned to Persia for support, having no suspicion that Persia had any designs on the Greeks in Europe. An embassy was sent to Artaphernes, the satrap of Sardis, asking for an alliance. He demanded earth and water from the envoys, which they gave, evidently under the impression that it was part of the contract of alliance. Artaphernes did not regard it in that light; but assumed that the Athenians had accepted subjection to the Great King. Not till the time of Marathon were the Athenians undeceived on this point. The date of this embassy is not known; but it must have been about 507. Matters became complicated a year or two later when Artaphernes took up the cause of the exiled Hippias, and demanded of the Athenians that they should receive him back as tyrant. The Athenian democrats who had expelled him had to swallow that bitter pill as the price of the continuance of the supposed alliance, for politics at Athens were finely balanced.

The **Ionian** Revolt.—Such was the position when Histiaeus at Susa found means of intervening in the affairs of the Greek cities of the Asiatic coast. His hope was that if Persia had trouble in those parts he might be sent down to settle it. It is evident, however, from incidental references in Herodotus' account of the preliminaries to the Ionian revolt that, before Histiaeus moved, a conspiracy had been formed. The prime mover in the matter was a certain Aristagoras, a cousin and son-in-law of Histiaeus, and his successor in the tyranny of Miletus. Certain exiles from Naxos applied to him for help against political opponents. The main difficulty of the conspirators would be the question of getting together at the outset of the revolt such a force as could cope successfully with the Persian fleet. To the astute Aristagoras the affair of Naxos afforded such an opportunity, for, if Artaphernes could be induced to take up the matter, he would almost certainly mobilize an Ionian Greek fleet. Artaphernes was quite ready to add Naxos to the empire of the Great King, and did mobilize the Greek fleet, whereon someone—almost certainly Aristagoras—warned the Naxians of what was impending and they, being prepared, beat off the attack. Aristagoras came back with the fleet, apparently a disgraced man, but, in fact, a man who had got what he wanted. Just about that time, says Herodotus, he received from Histiaeus at Susa a message tattooed on the head of a slave urging revolt. The first act of Aristagoras and the conspirators was to seize certain tyrants who were on the fleet and to depose the rest. This must have taken place in the autumn of 499. Then Aristagoras went off to Greece to get help. Sparta refused assistance; but at Athens, where the conservatives were for the moment controlling affairs, he was offered help. The story of the revolt, as told by Herodotus, shows that it was a brave venture bravely carried out; it took all the power of Persia six years to suppress the effort.

In the spring of 498 twenty ships from Athens and five from Eretria in Euboea arrived on the Asiatic coast. The hoplites which they brought over seem to have taken part in a march on Sardes, which was partly taken. The danger to Sardes, so Plutarch says, forced Artaphernes to raise the siege of hliletus and come to the rescue of his capital. The Greeks had to fall back to the sea, and were, according to Herodotus, badly defeated near Ephesus. Subsequent events suggest that he exaggerated the disaster. Be that as it may, the Athenian fleet sailed home shortly afterwards, recalled, it may be presumed, by the democrats who had once more got control of affairs. So the year closed for the rebels. They opened the next year 497 by sending their fleet to Byzantium and winning it and the cities of the Propontis over to their side. The absence of the Persian fleet from Herodotus' story of the revolt up to this time is perhaps to be explained by a story preserved by Plutarch to the effect that the Ionians had defeated that fleet in a battle off the Pamphylian coast. This had probably taken place in the summer or autumn of 498, and it would account for the unimpeded action of the Ionian fleet in 497.

The news of the revolt of Ionia had stirred the Cypriote Greeks to action. The Greeks proceeded to attack Amathus, the stronghold of the Phoenician minority in the island. Onesilus, the leader of the revolt, sent urgent messages to the Ionians for help. Before coming to the aid of the Cypriote Greeks the Ionian fleet brought about the revolt of Caria, a formidable addition to the resources of the rebels. The Hellespontine and Carian ventures must have taken some time, so that it is not possible to put the arrival of the Ionian fleet at Cyprus earlier than the late summer of 497. In a sense it arrived too late, for a Phoenician fleet had shipped a Persian force over to the island, and, though the fleet gained another naval victory over the Phoenicians, treachery in the Greek land force led to disaster, and by the beginning of 496 the island was again in the hands of the Persians.

After the recapture of Cyprus by the Persians the chronology of the revolt, always shadowy, vanishes for some years into thin air. One thing seems certain—that the spread of the revolt in 497 must have called for great efforts on the part of Persia. It was not till 496 that Persia was ready. In the earlier half of that year Daurises seems to have subdued the Asiatic side of the Propontis. The Greeks on the European side and the Thracians behind them seem to have thrown off whatever allegiance they had had to Persia at the time when north-west Asia Minor revolted. Caria, with a population which had apparently for some centuries past made a living by fighting the battles of others, was a much more serious problem for Persia. Three great battles took place there, the first on the Marsyas river, in which the Carians were defeated; the second shortly afterwards at Labraunda, in which they were again defeated, and a third near Pedasus, in which they inflicted a terrible defeat on the Persians. These three battles took place, it would seem, in the campaigning season of 496. It was probably after the two defeats in Caria that Aristagoras proposed and carried out the plan of establishing, in case of the failure of the revolt, a refuge for the surviving rebels at that Myrcinus on the Strymon which had been granted to Histiaeus. But there he and all his company perished in battle with the Thracians.

Just about the time of Aristagoras' death Histiaeus arrived at Sardes. His own plan had so far worked excellently, in that he had won his escape from Susa by persuading Darius to let him go down to the coast and settle the revolt; but on his arrival there he found that nobody trusted him. At last the Mytilenians gave him eight ships with which he set himself up as a pirate in the Propontis in the rebel interests, making things unpleasant for the merchant ships of any city which showed a tendency to weaken in its enthusiasm for the continuation of the revolt. These doings of Histiaeus form probably the sum of all that Herodotus has to tell of the events of the revolt in 495. In 494 the Persians began to besiege Miletus as being the true centre of the revolt. Nothing further is told of the fate of Caria, save that after the fall of Miletus some of its cities submitted, while some were subdued by the Persians. To aid in the attack on Miletus the Persians brought up a large fleet composed of Phoenician, Cilician, Cypriote and Egyptian contingents, numbering in all 600 vessels. Against this the rebels put to sea with 353 ships, Miletus, Chios, Lesbos and Samos furnishing the largest contingents. The fight took place at Ladé off Miletus. The story of it as told by Herodotus is much distorted by anti-Ionian bias; but the battle ended in a great defeat of the Greeks. This defeat was practically the end of the revolt. Miletus fell late in 494. Histiaeus was finally caught and executed by Artaphernes. After that the Persians spent part of 493 in extinguishing the dying embers of the rising.

Even from Herodotus' account it is clear that the revolt was one of the most glorious incidents in the story of the Greek race. It took the Persians six years to suppress it, and taxed severely the resources of the greatest empire of the time.

Very little is known of the history of Athens during these years; but what is known suggests that a lively and varying struggle for supremacy was going on between the ultra-democrats and the conservatives. The end of the revolt in 493 brought it indirectly to a climax. Phrynichus, in his play, *The Capture of Miletus,* attacked the democrats who five years before had withdrawn Athenian aid from the rebels, and was prosecuted and fined for so doing. Also Miltiades returned a fugitive from his tyranny in the Thracian Chersonese and was prosecuted by the democrats for tyranny, but acquitted. This acquittal was a conservative victory of such a decisive character that that party seems under the leadership of Miltiades to have controlled Athenian affairs up to the time of Marathon three years later.

Mardonius in **Thrace.**—After sweeping up the mess in Asia in 493 the Persians proceeded in the next year to bring Thrace and Macedonia once more under their control; but the expedition of 492 was not confined to these limited aims. It was commanded by Mardonius who had been appointed to supreme authority in the control of this extreme western part of the empire. He seems also to have received at Susa orders for the settlement of affairs in the Asiatic Greek cities, a settlement showing a policy which aimed at the abolition of the recent discontents. But when it comes to the expedition into Europe it is clear that its object was larger than the mere re-establishment of Persian authority in Thrace and Macedonia. Herodotus says that it was aimed at Athens and Eretria in punishment for the aid they had sent to the Ionian rebels. That it was intended to advance beyond Macedonia is shown by the fact that the disaster which stopped its further progress took place after Macedonia had been pacified. That it was an expedition of great magnitude and importance is shown by the employment of the fleet to co-operate with the land army. The expedition of 492 seems to have aimed at a large, perhaps complete. conquest of Greece. It was brought to an end by a great disaster to the fleet in a storm off Mt. Athos.

But Darius did not forget Athens and Eretria. They at least must be taught the lesson that it did not pay to interfere with Persian rule on the east side of the Aegean. The year 491 passed without movement on the part of Persia; but in 490 came the famous Marathonian Expedition.

The Marathon Expedition. — The story of Marathon soon became a legend, a legend in which the truth was both exaggerated and suppressed. The most important suppression was the successful elimination from the tale of the part which the Athenian ultrademocrats had played in the matter. On the side of exaggeration the magnitude of the Persian numbers was multiplied many times. As far as numbers are concerned the only trustworthy element in the legend is that the army was transported across the Aegean in 600 ships. That may be an overstatement; but it is not likely to be an understatement. It would imply that the land force cannot have been more than 60,000, and possibly not more than 40,000.

Since the return of Miltiades in 493 the Athenian ultrademocrats had been viewing with apprehension the possibility of an oligarchical reaction. Kow, if ever, was that alliance [sic] with Persia, which had been made with a view to provide against such a contingency, to bear fruit. Therefore they regarded the expedition as in their interest, and were quite ready to co-operate with it, Even Herodotus cannot disguise the fact, though he tries to tone it down in the interests of the democracy of 30 or 40 years later. Pindar and Aristophanes, however, backed by the evidence of the 20 years preceding Marathon, make the situation clear.

In the course of its passage across the Aegean the expedition attacked Naxos and did damage there; but the inhabitants escaped to the hills. Delos was treated with respect, for the Persians did not wish to arouse the whole Greek world against them. Then, after visiting some other islands, they came to Eretria. In answer to an appeal for help the Athenians ordered the 4,000 Athenian κληροῦχοι (allotment holders) who had been settled in Chalcis after its capture in 506 to go to the assistance of Eretria. This they did not do, urging, so Herodotus relates, certain excuses which are not very credible. The siege of Eretria only lasted six days. The resistance was brave; but then the Persians got into the town — through treachery, so Herodotus says. It was destroyed, and the inhabitants were carried away to be eventually settled at Ardericca near the mouth of the Euphrates. After capturing the place the Persians took ship across the Euripus and landed on the plain of Marathon 24 mi. northeast of Athens.

There can be little doubt that the strategy of the Persians in the brief campaign which ensued in Attica was dictated by the assumption that they would receive considerable aid from their ultrademocratic sympathizers. The country party, the moderate democrats, from which the hoplite force was mainly drawn, seem to have been aware that the ultrademocrats were prepared to support the invaders. The latter were probably hampered by the presence of the hoplite force in Athens, and the suggestion of the landing at Marathon, at the extreme end of Attica, may have come from them. When the news of the landing reached Athens a council of war was held. A message had already been sent to Sparta for assistance, a natural measure on the part of those conservatives who had looked for, and to a certain extent obtained aid from Sparta in the internal political struggles of the last 20 years.

The council of war was composed of the polemarch and the ten generals, the commanders of the regiments of the ten tribes. Herodotus reads into the Athenian army organization of 490 that of the time at which he wrote, some 30 or 40 years later. The application in 487 of the lot to the election of archons rendered it thenceforth impossible to entrust the supreme military command to the polemarch; and thereafter the direction of military and naval affairs passed to the board of ten generals, and the command on active service to one or more appointed for the expedition or campaign. But at the time of Marathon the polemarch still had the supreme command in battle, though the strategy of a campaign was decided by a council of war in which the generals had each an equal vote with the polemarch. It is evident from the story that the council was at first very nervous about leaving Athens for Marathon. But this nervousness seems to have vanished; and the army marched out. Moreover, no movement of the ultrademocrats took place, though their leaders, the Alcmaeonid family, did not renounce their connection with Persia.

Battle of **Marathon.**—Miltiades was not commander in chief of the Athenian forces, though the council of war adopted his advice and design. He may have advised the march of the Athenians from Athens to Marathon. He was almost certainly the conceiver of the strategy they adopted when they got there. The council of war decided that it was safe for the hoplite force to leave Athens for Marathon, and thither it went. The Persians, who did not as yet know the change of feeling among their quondam friends at Athens, regarded the Athenians as having fallen into the trap set for them — as having left Athens exposed to a surprise attack which would be supported by sympathizers within the city. It may be assumed that Miltiades' idea was that, as the Persian army had landed at Marathon, it could not, if the Athenians were there, either re-embark the army without exposing a covering force to attack and possible destruction, or advance on Athens without fighting its way through one or other of the narrow passages which led from the plain to Athens. That is why, in accordance with his advice, the Athenian army remained inactive at Marathon until the Persians developed one of these two designs. On arriving at Marathon the Athenians took up a position at the Heracleum, a sanctuary and precinct the remains of which have been discovered high up the valley now called the valley of Vrana, but called in old times the Aulon or Funnel. There they were amid rugged hills on the actual upper road to Athens, and within striking distance—about 2 mi.—of any force which either tried to cover an embarkment or attempted to use the lower road. Either there or at Athens 1,000 Plataeans had joined them, assistance sent in gratitude for the protection which Athens had given to Plataea against Thebes for some 29 years past. Then ensued some days of inactivity, the Athenians waiting for the Persians to move, and for the arrival of the promised Spartan assistance, the Persians for a signal that their partisans in Athens were ready. But the Persians moved before the signal came, anxious to decide the matter before the Spartans arrived. The Persian plan was to re-embark a part of their army under the protection of a covering force, and, while the latter held the Athenians at Marathon, to land at Phalerum and make a dash on Athens. So soon as the design developed its general nature must have become clear to the Athenian command, also it was quite evident that the Athenian army must be back at Athens before the Persians landed at Phalerum.

That being so, the Athenians attacked the Persian covering force without delay. The remains of the mound which was raised over the Athenian dead after the battle show that the covering force was drawn up between the lower end of the Aulon and the sea with its back to the latter. Down the Aulon the Athenians advanced and took up battle formation at the mouth of the valley, probably about three quarters of a mile from the Persian front. For the actual tactics in the battle the polemarch Callimachus, who took the unusual step of strengthening both wings and weakening the centre, with the idea, actually realized in the course of the battle, that the enemy's centre would force back the Athenian centre, follow it up, and so expose both its flanks to attack by the troops massed on the Athenian wings.

As has been said, the battle developed as Callimachus had foreseen. The enemy drove in the Athenian centre with their own centre which, advancing in pursuit, was defeated and apparently wiped out by the Athenian wings. The rest of the army fled to the ships, on which, after a struggle, most of them managed to escape. That the battle was not by any means a walk-over for the Athenians is clear from their own account of it. Later tradition represented the numbers of the Athenians as 10,000, which was probably the truth. The number of the Persians was exaggerated at discretion. The Persian losses are said to have amounted to 6,400, a loss which must have fallen mainly on the centre, and perhaps included nearly the whole of it. If this number be accepted, and be taken as about one-third of the Persian troops in the battle, then their total number was about 20,000.

From Marathon the Athenians marched with all speed to Athens in order to anticipate the arrival of the Persian fleet and the rest of the Persian army at Phalerum. The latter did not attempt a landing. The rapid movements of the Athenian army had rendered their plan hopeless, and so they sailed back to Asia. The expected signal came late—probably after the battle was already engaged. After the Athenian army arrived in Athens the promised force from Sparta, 2,000 strong, arrived at the city. The battle made an enormous, indeed an exaggerated, impression on the Greek mind. This great Persia, which to the Greek stood for all that was great in the contemporary world, had been defeated in battle by a Greek State which was at the time hardly a first-class Power in contemporary Greece. The Athenian State had suddenly emerged from a position of second-rate obscurity into a blaze of reputation. Exaggerated or not, Marathon was a great victory, and in one sense epoch-making in the history of warfare. It demonstrated the superiority of the Greek hoplite over any form of soldiery that Persia could put into the field. Nevertheless, the glory of Marathon nearly proved the undoing of Greece, in that it made the Greek world incredulous as to the reality and the extent of the danger which threatened it from Persia ten years later, so that it was caught only half prepared to meet it.

The Ten Years After Marathon.—Of the history of Greece in the decade following Marathon very little is known, and of that little less still has a bearing on the relations between the Greek and the Persian. Aegina, jealous of the growth of Athenian rivalry in trade, renews a war with Athens which the events of 490 had interrupted. Miltiades comes to political ruin the year after Marathon; and a miscellaneous list of prominent Athenian politicians are ostracized in the years which follow. The legislation of 487, to which reference has been made already, brings about a change in the Athenian military and naval organization. Then comes the great increase of the Athenian fleet—of which more later. That Darius intended to take vengeance for Marathon is undoubtedly the case. He lost no time in beginning preparations with that end in view. Their magnitude prolonged them, and Greece was saved by a revolt in Egypt which broke out in 486. It was not suppressed till 484, and Darius had died the previous year.

During these years there had been coming to the front in the ultra-democratic party a new leader not of the Alcmaeonid family. Themistocles had been archon in 493; but his name does not come into prominence until the second half of this decade, when he comes to the front as the advocate of the increase of the Athenian fleet. The silver mines at Laurium were bringing in a much larger income than aforetime to the State, an income which Themistocles proposed to use in the building of a great fleet instead of distributing it in doles among the citizens.

There were political circumstances which were probably the real efficient cause of the support given by democracy to his naval policy. If the democratic position had been an anxious one before Marathon, it was certainly still more anxious afterwards, even allowing for the fact that Miltiades had in 489 prejudiced conservative supremacy by his failure at Paros. Sparta was still to all appearance ready to support the conservatives, and the democrats had lost the support of Persia. There was nothing in Greece to substitute for it. A great fleet would give security for the vital import of foreign corn; but it could also be used to cut off the supply: in other words the crews of the fleet would have the last say on the fate of Attica, and any oligarchy which might be set up there could be starved to death. During those years, there came to Greece reports of great preparations being made in Asia for a repeated attack on the Greeks of Europe.

Preparations of **Xerxes.**—Xerxes had inherited the policy of Darius, and from the time when in 484 the revolt of Egypt was suppressed, he began preparations for a grand attack on the Greeks of Europe. By the autumn of 481 all was ready for an advance. Athens had no delusions on the object of the expedition. Corinth and Aegina with their trade connections with Asia would be in a position to ascertain the truth, and it was perhaps Corinth that convinced Sparta of it. The Peloponnese, with the exception of Argos, took the patriotic side. Boeotia, so Herodotus says, medized outright, a statement which Plutarch (*De Herodoti Malignitate* 31) indignantly denies. Phocis took the patriotic side because, so Herodotus says, the Thessalians took the other. In Thessaly the feudal barons, led by the Aleuadae of Larissa, medized; but the mass of the population took the other side. Corcyra was inclined to be neutral. The Sicilian cities had their hands full with a Carthaginian attack arranged by Persia.

Meanwhile Xerxes had marched from Sardes to the Hellespont, where he had caused two bridges to be constructed, a considerable engineering feat across a wide strait with a strong current; also a canal had been cut across the peninsula of Mt. Athos to avoid the stormy and ill-omened passage round the cape. Its line is traceable at the present day.

Greek Plans of Defence.—The Greek council of war now knew that no help was to be expected from outside Greece; so it planned the defence on that assumption. As in the expedition of 492 the Persian strategy centred on the co-operation between army and fleet. The plan's one drawback was that it limited the mobility of the fleet, since it had to keep in close touch with the army. That the Greeks recognized this is apparent from their designs, even if they were not unanimous as to how and where they should be carried out. That lack of unanimity came nigh to bringing the cause of the Greeks to ruin. There was only one State north of the isthmus, Athens, which really counted in the defence. The minor Peloponnesian States were therefore anxious to concentrate the defence at the isthmus, and there can be little doubt that Sparta and Corinth were in sympathy with them. According to this design Athens was to sacrifice her territory for the time being, and her population was to take refuge in Peloponnese. With this intent the Peloponnesians set about fortifying in feverish haste the four and a half miles breadth of isthmus. It is plain that the Athenians refused to assent to a plan which involved at least the temporary sacrifice and devastation of their territory. It is also plain that the Peloponnesians or, at any rate, the Spartans, knowing that the Athenian fleet was necessary even for a defence of the isthmus, made a show of falling in with the Athenian designs.

The co-operation of fleet and army in the Persian attack rendered a similar co-operation necessary on the part of the defence. But it is possible that the question arose whether the main effort of the Greeks should be on land or on sea. Physiography decided the question. The passage from the north frontier of Thessaly to the isthmus is, owing to the difficult nature of the country, a well-defined line, which offers no alternatives save in Thessaly itself. There it is possible, in passing from Larissa to Thermopylae to go either via Halos and Larissa Cremaste to Lamia, or to take a more inland route over the pass of Thaumacium. South of Thermopylae the line is single, through Thermopylae and a low passage through the Oeta range near Abae; then by the narrow passage between the foot of Helicon and Lake Copais, and so by one of the passes of Mt. Cithaeron — preferably the Dryoscephalae — into the Megarid and Attica. There were various defensible points on this route: at Tempe, where, however, the very narrow passage through that valley could be turned; at Thermopylae, where a turning movement involved great difficulty and danger; and at the narrow strip of traversable ground in Boeotia on the route between Coronea and Haliartus. By sea, on the other hand, there was no place where the passage of the Persians could be blocked. The Euripus could be turned by passing outside Euboea. The Athenian plan of campaign assumed rightly that, if either arm of the invaders' force could be brought to a stand, the other would be brought to a stand also. Physiography determined that this could only be done in the case of the army. At the same time the Greek fleet would have to cooperate with the Greek army to prevent the landing of troops in the rear of any position the latter might take up. Had this design been carried out it is probable that the invaders would never have got south of Thermopylae. That it was not carried out was due to the Peloponnesian dislike of any defence north of the isthmus, and to the further fact that, when forced into compliance with the Athenian designs, their compliance was at best half-hearted.

The first attempt at land defence was made at Tempe, where the Peneius river breaks through the mountains between Ossa and Olympus. The available passage is very narrow indeed. To this place they despatched 10,000 hoplites. This must have been in the spring of 480. The Thessalian commons had begged them to come thither. But, says Herodotus, the Greeks found that the pass could be turned by a route through Gonnos, and so gave up the idea of defending it, and so the Greek army and fleet went back to Attica and the isthmus.

Battle of **Thermopylae.**—There must have been much controversy as to the next line of defence to be adopted; but the views of the Athenians again prevailed, and it was determined to send a force to Thermopylae, and the fleet to the north Euripus to cover the rear of the defenders of the pass. The tale of this episode of the war as told by Herodotus, a Spartan version of a story of which there was much that the Spartan Government would be glad to conceal, is one of the strangest in literature. So far as it goes it is true. Only 7,300 men, nearly all hoplites, were sent to defend the pass. About 4,000 came from the Peloponnese, and the rest from Phocis and Boeotia. No Athenians could be spared, for, now that the 200 vessels of the fleet were mobilized, all the Athenian hoplites would be serving as marines aboard the fleet. This land force was but a fraction of what the Peloponnesians could put into the field. This force, says Herodotus, was represented by Leonidas, the Spartan king, as a sort of vanguard of a larger army; but no other troops were ever sent, not even when Leonidas sent an urgent message asking for reinforcements.

Leonidas was, however, prepared to make a desperate defence of the pass; and it might have succeeded had not the Phocians who guarded the very narrow path of the Anopaea been taken unawares. The Middle Gate of Thermopylae was at that day of such a nature that the front of an attacking force could only be a few men wide. The light-armed Persian or the Persian bowmen could not make any impression on a Greek hoplite force in such a strong position. The path of the Anopaea was a mere forest track on which a small force could have stopped an army. The defence of Thermopylae showed the grandeur of the Spartan nature at its best; but for the Spartan Government it was fortunate that the circumstances of the battle made it possible for it to give its own version of a very embarrassing story. The Greek world all but accepted in full a tale which redounded to the glory of the Greek race as a whole; but there were those who, in moments of irritation and candour, were inclined to remind Sparta of the truth: "the Mede had time to come from the ends of the earth to Peloponnese ere any force of yours worthy of the name went out to meet him," said a speaker to the Spartans some 50 years later (Thuc. i. 69).

While these things had been going on at Thermopylae the Greek fleet in the north Euripus had successfully prevented the Persian fleet from landing troops behind the pass, and had, generally speaking, tried conclusions with the enemy. The Persian fleet had suffered greatly in a storm near Cape Sepias off the mouth of the Euripus, and in a later srorm a Persian detachment of 200 vessels had been wrecked in the Hollows of Euboea. After the disaster at Thermopylae the Greek fleet withdrew southwards to the strait of Salamis on the Attic coast.

Athenian Retirement to Salamis. — That the Athenians had expected the defence of the pass to be a real effort on the part of the land army is evident from the fact that they did not until after the disaster take any measures to secure the safety of their people. Moreover, Herodotus says that, even after the disaster, they had expected a Greek army to oppose the Persians in Boeotia. The miscalculation was such that, though some of the Attic population could be shipped over the Saronic gulf to Troezen, a large number could only, owing to lack of time, be transferred to the island of Salamis, less than a mile from the Attic coast. That was why the fleet went to the Salamis strait. The refugees in the island had to be protected. The fleet in the strait did not in any sense cover the fortifications at the isthmus 30 miles away. The Persian fleet might have ignored it, and sailed on to land troops south of the fortifications, in which case the Greek fleet would have been forced to give battle in open waters, which was what the Persians wished to force it to do, and exactly what the more intelligent of the commanders of the Greek fleet wished to avoid. That the subsequent battle in the strait was brought about by Themistocles is doubtless a fact; but Eurybiades, the Spartan commander-in-chief of the Greeks, seems to have shared his views. The enemy's fleet was not merely superior in numbers to that of the Greeks, but some of its contingents, especially the Phoenician, must have been superior to it in manoeuvring power. The great Athenian contingent of zoo ships, more than half of the 366 triremes in the fleet, was manned by imperfectly trained crews. Even after the disasters at the Sepiad strand and in the Hollows of Euboea, the Persian probably outnumbered the Greek fleet by two to one. With regard to the army, calculations of a more convincing kind may be made which reckon the total numbers at this period of the war at about 400,000 fighting men. The passage of the Persian army from Thermopylae to Attica was marked by a raid on Delphi. A considerable interval must have intervened between its departure from Artemisium and its arrival at the bay of Phalerum on the Attic coast, a few miles outside the eastern end of Salamis strait. It put in there, not apparently with any intent of attacking the Greeks, but to afford supplies to the Persian army in Attica.

Battle of Salamis. — The extant evidence as to what occurred at Salamis is contained in Herodotus and Diodorus together with a few but important details which may be gathered from the Persae of Aeschylus. Diodorus' version is plagiarized from Ephorus, whose story, though not so dramatic as that of Herodotus, gives what is probably a more correct account of the course of events in and before the great fight. The transhipment of the population to Troezen or Salamis seems to have been all but complete. A few, indeed, seem to have deliberately remained behind on the Acropolis. The Greeks inside the strait of Salamis were in a very divided state of mind. The Peloponnesian contingents in the fleet wanted naturally to sail to the isthmus; but any move thither without the Athenian contingent would have been suicidal. As far as the Athenians were concerned it was plain that they could not desert the refugees on the island of Salamis. At the same time if the fleet remained in the strait the Persians would be able to land troops behind the isthmus defence, which would have been a capital disaster to the Greek cause. Strategically the position of the Greeks before the battle of Salamis was a very desperate one. There was only one way out, and Themistocles saw it—to induce the Persians to attack the Greek fleet in the strait. The less experienced seamen had to make up for inferior skill by resorting to boarding tactics, which could only be really effective in narrow waters. Moreover, the Persian superiority in numbers would be discounted if the battle were fought on a necessarily narrow front.

In view of these considerations, Themistocles took what was the desperate measure of simulating treachery by sending a message to Xerxes saying that the Greek fleet was ready to betray the Greek cause. This message reached Xerxes in the late afternoon of the day preceding the battle. Unfortunately for the Persian he had had too many experiences of treachery within the ranks of Greek opponents to suspect the genuineness of the message; and so, early in the night, Xerxes moved the main part of his fleet from Phalerum bay to the eastern entrance of Salamis strait, to a line of which the small island of Psyttaleia formed more or less the centre. To prevent any escape of the Greeks through the western strait of Salamis he sent the Egyptian squadron of 200 vessels to block its passage. What actually took place on the day of battle may be deduced from the Persae. The Persian fleet had to advance into the strait. Up to that time it had been hidden from the Greeks by the promontory of Cynosura; but the latter were aware that they were shut in, since Aristides had arrived at Salamis from Aegina during the night, and had informed them of the Persian movement.

North of Psyttaleia the strait of Salamis turns at right angles from north to west, and thus the Persian fleet, advancing on both sides of Psyttaleia, had to execute a wheeling movement. The strait after turning becomes somewhat narrower, a fact for which the Persians do not seem to have allowed, so that when they tried to advance into the inner strait with as broad a front as they had had when south of Psyttaleia a certain amount of confusion arose. It was during this confusion that the Greeks, who had advanced eastwards down the inner strait, attacked. Everything must have been in favour of the Greeks. The two fleets must have become almost literally jammed in the strait to the north of Cynosura, and that would favour the boarding tactics of the Greeks who had on their vessels hoplites serving as marines. Of the details of the fight a few are related by Herodotus, but they are rather picturesque stories than real contributions to its history. Before the day was done the Persians had been either driven, or forced to retire, from the strait.

The Greeks themselves seem not to have realized the extent of their victory until, shortly afterwards, the Persian fleet retired altogether from European waters and their army fell back northwards, part of it to winter in Thessaly with a view to further attack next year, part of it to Asia. Though Salamis was not decisive of the war, for the attack of Mardonius in 479 was very formidable, yet it is one of the decisive battles of the world in that, had it turned out otherwise, Greece would have fallen under the dominion of Persia. When the Greeks discovered that the Persian fleet had retreated they sailed as far as Andros. Proposals were made to break down the Hellespont bridges; but these were overruled.

In this same year Gelon of Syracuse inflicted on the Carthaginian invaders of Sicily such a defeat that, had he followed it up on the African coast, the career of Carthage might have come to an end. Thus the great scheme of Persia had failed in both east and west. When the year 479 opened, the Persian fleet seems to have been on the Ionian coast with a view to preventing any movement of revolt in the Ionian cities. Mardonius was in Thessaly with an army which Greek authors reckoned at 400,000 men. Half that number would probably be nearer the truth. In the campaign of 480 Themistocles had held supreme command of the Athenian contingents, both naval and military; but in 479 he vanishes from the picture. No Greek author gives any explanation of his disappearance.

Battle **of Plataea.**—In the spring the Persians seem to have made, through a certain Alexander of Macedon, an attempt to detach Athens from the Greek cause. Sparta intervened, perhaps superfluously, and the attempt came to nothing. Then Mardonius started from Thessaly on his march south. It is evident that at the back of what follows is a resuscitation of the Peloponnesian design to concentrate the land defence at the isthmus. Sparta was reluctant to move northwards, but fearing that Athens might desert the Greek cause, the Spartans, whose army was mobilized, made a surprise march northwards at the very time that an Athenian embassy was at Sparta imploring them to act. But meanwhile Mardonius had overrun Attica. When, however, he heard that the Greek army was marching north he retreated to Boeotia with a base at Thebes. The Peloponnesian contingents of the Greek army now moved north from the isthmus, advancing to Eleusis, where the Athenian army met them. Then the whole force marched through the Dryoscephalae pass into Boeotia, and took up a position low down on the north side of the pass. Here the position was across a valley, the Greek centre being on low ground, and the wings on higher ground on either side. The position was close to the little town of Erythrae. The Persians were encamped on the Asopus river about three miles north of this point. The Persian cavalry assailed the Megarians in the Greek centre but the Athenians went to their help, and the cavalry attack was driven off. During the night the Greeks moved in a north-north-westerly direction to a hollow on the north side of which rose a ridge, the Asopus ridge. The Persians got wind of the movement, and moved up the Asopus to a position fronting the Greeks. About this time reinforcements were coming in which raised the numbers of the Greek army to a total of 108,200. The number of hoplites, the real fighting force, was about 39,000. The Persians numbered about 200,000. With them, however, were some Phocians and a large force of Thebans.

A position of stalemate then supervened, neither side attempting anything for eight days. Then, as the Greeks were some two miles from the passes which debouch on to the field, the Persians began to send cavalry round their flanks, which attacked and interfered with the Greek provision trains. Then came a grand attack by the Persian cavalry which harassed the Greeks with long-range missiles, and destroyed the spring of Gargaphia on which the Greeks were dependent for water. It lay in a hollow behind the Greek line. The Greek position on the Asopus ridge became untenable, and a retreat was necessary. The new position which was to be taken up was at the "island," which is a mound on a ridge at the foot of Cithaeron about a mile east of the town of Plataea, and almost surrounded by two branches of the Ōeroë river. But, though the army generally was to make for this position, it is evident from what followed that the Spartans were to go in the first place to the relief of the Greek baggage trains in the passes. As the retreat was to be made at night there was every possibility of confusion. The Greek centre started first, but missed the "island" and arrived at the town of Plataea. The Spartans started later south-south-east towards the pass of Dryoscephalae. The Athenians, who had waited for the Spartans to move, then started for the "island." Neither the Spartans nor the Athenians reached their objectives, for the Spartans, after they had gone a little more than a mile from the summit of the Asopus ridge, were assailed by the Persian cavalry and brought to a standstill at a point near a temple of Eleusinian Demeter, which stood on the ridge next east of the Asopus ridge. Mardonius seems to have thought that the Greek retirement meant defeat, and to have determined to make the rout complete. So long as the Persian cavalry employed missiles the Spartans suffered considerable loss. Then the Persian infantry came up. The battle was an unequal one, for the light-armed Persian had no chance against the hoplite. In the mêlée Mardonius himself perished, and eventually the Persians were driven back in rout and tried to take refuge in their camp. Meanwhile the Athenians on the Greek left had started for the "island." They had only reached the plain south-west of the Asopus ridge when they received a message from the Spartans asking for assistance, and seem to have started off in their direction. But in the hollow south of the Asopus ridge they were assailed by the Greeks who were fighting on the Persian side. They defeated the Thebans after an obstinate fight. The Greek centre at Plataea had by this time received news of the two battles, and part of it seems to have hurried to aid the Spartans, while the other part went to help the Athenians. The latter were badly cut up by the

Theban cavalry, and so never reached the Athenians, while the former may possibly have taken part in the last stages of the fight beneath the temple of Demeter. The last phase of the battle was a combined assault by the Greeks on the Persian camp and a general massacre of the enemy, 30,000 of whom are said to have perished. The Greeks celebrated their victory by dedicating to Delphi a tenth of the spoils and setting up the famous serpent column surmounted by a bowl, the remains of which still survive at Constantinople. The leaders of the medizing party at Thebes they captured and executed. Plataea set the seal on Salamis. The two battles saved Hellenism in Europe from becoming orientalized, and thus modified the history of the world.

Naval Operations in the Aegean: Mycalk.—While these things were taking place in European Greece, a Greek fleet was operating on the Asiatic coast of the Aegean. The Ionians had appealed for help. The fleet was commanded by the Spartan Leutychides. For some unknown reason the Phoenician contingent of the Persian fleet had been sent home, and therefore the weakened remnant dared not try conclusions with the Greeks on the open sea. They sought refuge at Mycalé where was a strong land army which had been overawing the Greek cities. As the Persians declined a naval battle, Leutychides disembarked his troops and attacked them on land. The result was an obstinate battle but a great Greek victory to which the Ionian contingent on the Persian side contributed by turning against their masters. From that time forward the fate of the Greek cities of Asia became a factor in the relations between Persia and the European Greeks. The year 478 was spent partly in the reconstitution of Attica and in that rebuilding of the walls of Athens which the Spartans would have prevented had they not been tricked by Themistocles.

The Delian Confederacy.—As far as the patriotic Greeks were concerned the action of the Ionians at Mycalé had practically committed them to the liberation of the Greek cities of Asia from Persian rule, and so the war had to be carried on in the form of an attack on the Persian hold on the Greek cities of the Aegean, the Propontis and Cyprus. Pausanias the Spartan who had commanded at Plataea led in 478 what was probably a very miscellaneous fleet drawn from the Greek mainland and islands in an attack on the Persian possessions. Under his command Cyprus and Byzantium were taken, the former a base for Persian attack on the Aegean, the latter the key to the corn route from the Euxine. At Byzantium Pausanias developed certain strange habits which the Greek patriots interpreted as medism. Sparta recalled him, and sent out a successor whom the Greeks refused to accept as commander; and so the leadership passed to Athens. Sparta withdrew from the war, and it is probable that all the other States of the mainland save Athens withdrew at this time. With the new league came the tribute from those States which paid Athens to furnish ships and crews on their behalf, an ever-increasing number as time went on. How long it took to set free the Greek cities of the Asiatic coast is not known. It is probable that one of the main motives of the campaigning was the complete restoration of the passage through the Hellespont and Bosporus to the Euxine corn region. The restiveness of the allies culminating in the revolt of Naxos in 467, shows that there were many of them who thought that the danger from Persia was over by that time. Whatever may have been the case before 466 the battle of the Eurymedon in that year put Persia completely out of action as far as the Aegean was concerned. That great victory by land and sea was less dramatic and less decisive of the future than Salamis had been; but for 50 years after the battle Persia left Greece alone. Still the experience of 50 years later was to show that those members of the league who supposed that the danger from Persia was over for ever were mistaken. It was the continued existence of the great Athenian fleet which kept the Persians from interfering in Greek affairs. Within a brief period after its destruction at Syracuse the interference began again, and within 30 years of that time Persia had become arbiter even in the internal politics of Greece.

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GRAECO-TURKISH WAR, 1897. This war between Greece and Turkey (*see* GREECE: *Modern History*) involved two practically distinct campaigns, in Thessaly and in Epirus. Upon the Thessalian frontier the Turks, early in March, had concentrated six divisions (about 58,000 men), 1,500 cavalry and 156 guns, under Edhem Pasha. A seventh division was rendered available a little later. The Greeks numbered about 45,000 infantry, 800 cavalry and 96 guns, under the crown prince. On both sides there was a considerable dispersion of forces along the frontier. The Turkish navy, an important factor in the war of 1877–78, had became paralytic ten years later, and the Greek squadron held complete command of the sea. Expeditionary forces directed against the Turkish line of communications might have influenced the course of the campaign; but for such work the Greeks were quite unprepared, and beyond bombarding one or two insignificant ports on the coast-line, and aiding the transport of troops from Athens to Volo, the navy accomplished nothing. On April 9 and 10 Greek irregulars crossed the frontier, either with a view to provoke hostilities or in the hope of fomenting a rising in Macedonia. On the 16th and 17th some fighting occurred, in which Greek regulars took part; and on the 18th Edhem Pasha, whose headquarters had for some time been established at Elassona, ordered a general advance. The Turkish plan was to turn the Greek left and to bring on a decisive action, but this was not carried out. In the centre the Turks occupied the Meluna pass on the 19th, and the way was practically open to Larissa. The Turkish right wing, however, moving on Damani and the Reveni pass, encountered resistance, and the left wing was temporarily checked by the Greeks among the mountains near Nezeros. At Mati, covering the road to Tyrnavo, the Greeks entrenched themselves. Here sharp fighting occurred on the 21st and 22nd, during which the Greeks sought to turn the right flank of the superior Turkish central column. By the 23rd the Turkish forces had drawn together, and the Greeks were threatened on both flanks. In the evening a general retreat was ordered, and the loose discipline of the Greek army was at once manifested. Rumours of disaster spread among the ranks, and wild panic supervened. There was nothing to prevent an orderly retirement upon Larissa, which had been fortified and provisioned, and which offered a good defensive position. The general *débâcle* could not, however, be arrested, and the mass of the Greek army fled southwards to Pharsala. There was no pursuit, and the Turkish commander-in-chief did not reach Larissa till the 27th. Thus ended the first phase of the war, in which the Greeks showed tenacity in defence, which proved fruitless by reason of initially bad strategic dispositions entailing far too great dispersion, and also because there was no plan of action beyond a general desire to avoid risking a defeat which might prevent the expected risings in Macedonia and elsewhere. The handling of the Turkish army showed little skill or enterprise.

Larissa being abandoned, Velestino, the junction of the Thessalian railways, where there was a strong position covering Volo, seemed to be the natural rallying point for the Greek army. Here the support of the fleet would have been secured, and a Turkish advance across the Othrys range upon Athens could not have taken place until the flanking position had been captured. Whether by direction or by natural impulse, however, the mass of the Greek troops made for Pharsala, where some order was re-established. The importance of Velestino was recognized by sending a brigade thither by railway from Pharsala, and the inferior Greek army was thus split into two portions, separated by nearly 40m. A Turkish reconnaissance on Velestino was repulsed, but on May 5 the Greeks were driven from their positions in front of Pharsala by three divisions. Further fighting followed on the 6th, and in the evening the Greek army retired in fair order upon

Domokos. It was intended to turn the Greek left with the first division under Hairi Pasha, but the flanking force did not arrive in time to bring about a decisive result. The abandonment of Pharsala involved that of Velestino. Again delaying, Edhem Pasha did not attack Domokos till the 17th, giving the Greeks time to entrench their positions. The attack was delivered in three columns, of which the right was checked and the centre failed to take the Greek trenches and suffered much loss. The left column, however, menaced the line of retreat, and the Greek army abandoned the whole position during the night. No effective stand was made at the Furka pass, which was evacuated on the following night. Colonel Smolenski, who arrived on the 18th from Velestino, was directed to hold the pass of Thermopylae. The Greek forces being much demoralized, the intervention of the tsar was invoked by telegraph; and the latter sent a personal appeal to the sultan, who directed a suspension of hostilities. On the 20th an armistice was arranged.

In Epirus at the outbreak of war about 15,000 Greeks under Colonel Manos occupied a line of defense from Arta to Peta. The Turks, about 28,000 strong, under Achmet Hifsi Pasha, were distributed mainly at Iannina, Pentepagadia and in front of Arta. On April 18 the Turks commenced a three days' bombardment of Arta; but successive attempts to take the bridge were repulsed, and during the night of the 21st they retired on Philippiada, 26 mi. distant, which was attacked and occupied by Manos on the 23rd. The Greeks then advanced to Pentepagadia, but the position held by their advanced force near Homopulos was attacked on the 28th and 29th, and no Greek reinforcements were forthcoming when needed. The Evzones made a good defense, but were driven back by superior force, and a retreat was ordered, which quickly degenerated into panic-stricken flight to and across the Arta. Reinforcements were sent to Arta from Athens, and on May 12 another incursion into Turkish territory began, the apparent object being to occupy a portion of the country in view of the breakdown in Thessaly and the probability that hostilities would shortly end. The advance was made in three columns, while 2,500 Epirote volunteers were landed near the mouth of the Luro river with the idea of cutting off the Turkish garrison of Prevesa. The centre column attacked the Turks near Strevina on the 13th, but although the Greeks fought well, they ultimately had to retreat. The volunteers landed at the mouth of the Luro, were attacked and routed with heavy loss.

The campaign in Epirus thus failed. Under the terms of the treaty of peace, signed on Sept. 20, and arranged by the European powers, Turkey obtained an indemnity of £T4,000,000 and a rectification of the Thessalian frontier. (G. S. C.)

GRAF, URS (c. 1485–1527), Swiss draftsman, engraver and goldsmith, was born at Solothurn, the son of the goldsmith Hugo Graf, and probably studied under his father and then at Basel. His art is inspired by that of Durer and of Baldung Grün. After a period of travel he settled in Basel in 1509. In 1514 he executed a reliquary of St. Bernard for the monastery of St. Urban. This, his chief work as a goldsmith, was sold by the city of Lucerne in 1850 and has since disappeared. Graf is best known for his dra ings, executed in sure and bold line work. There are extant 100 woodcuts for which he made the drawings; a number of engravings, etchings and nielli, and some zoo drawings by his hand.

The greater part of Graf's work is dated and signed by his monogram.

GRÄFE, the name of a German family noted for its contributions to medicine and surgery.

KARL FERDINAND VON GRAFE (1787–1840), surgeon, was born in Warsaw, Pol., on March 8, 1787, studied in Germany and became professor of surgery in Berlin. He was a pioneer in German plastic surgery and was responsible for significant surgical innovations including technical improvements of blood transfusion, Caesarean section, rhinoplasties and repair of cleft palate. Grafe has been called the father of modern plastic surgery. He died at Hanover on July 4, 1840.

ALBRECHT VON GRAFE (1828–1870), his son, considered the founder of modern ophthalmology and a pioneer in ophthalmic surgery, was born on May 22, 1828, at Berlin. He studied in Berlin, Vienna, Prague, Paris, London, Dublin and Edinburgh as an ophthalmic specialist and became one of the greatest eye surgeons of the century and an authority on diseases of the brain and nervous system. He was noted also as a great and revered teacher and as the founder, with F. C. Donders (*q.v.*), of the Archiv fur *Ophthalmologie*, which contains most of his important publications. Albrecht von Grafe is connected historically with the operation for cataract by linear extraction (1867–88). He is best known to medical students for the eye sign in exophthalmic goitre which is named for him. Among his other contributions are iridectomy for glaucoma (1857), the establishment of sympathetic ophthalmia as a clinical entity (1866), his demonstration that often blindness and visual defects connected with cerebral disorders are traceable to optic neuritis (1860) and the introduction of the use of Helmholtz' ophthalmoscope in diagnosis. He died of tuberculosis at the age of 42, on July 20, 1870.

ALBRECHT VON GRAFE (1868–1933), his son, a German politician and army major, was born at Berlin on Jan. 1, 1868. He was a member of the German National party in the Weimar national assembly (1919), a member of the Reichstag (1920–28) and was cofounder (1922) and leader of the German National Independent party. He joined Hitler's National Socialist party but soon left it. He died on April 18, 1933. (I. H. L.)

GRAFFITO, from the Italian word meaning "scribbling" or "scratching," has been adopted by archaeologists as a general term for the casual writings, rude drawings and markings on ancient buildings, in distinction from the deliberate writings known as inscriptions. These graffiti, either scratched on stone or plaster by a sharp instrument or, more rarely, written in red chalk or black charcoal, are found in great abundance, *e.g.,* on the monuments of ancient Egypt. The subject matter of these scribblings by boys, street idlers and the casual passer-by, includes scrawls, rude caricatures, election addresses and lines of poetry. Apparently private owners of property felt the nuisance of the defacement of their walls; at Rome near the Porta Portuensis was found an inscription begging persons not to scribble (scariphare) on the walls.

Graffiti are important to the paleographer as illustrating the forms and corruptions of the various alphabets used by the people, and may guide the archaeologist to the date of the building. But their chief value is twofold. First, they are important to the linguist for the information they furnish about the spoken language of the period and place and occasionally about other languages as well, as in the case of the ancient Greek mercenaries who scribbled their names, in the Cypriote dialect and syllabary, on an Egyptian sphinx, or the Greek "tourist" from Pamphylia who carved his name on the great pyramid at Giza. And secondly, graffiti are invaluable to the historian for the light they throw on the everyday life of the man in the street of the period, and for the intimate details of customs and institutions. The graffiti dealing with the gladiatorial shows at Pompeii are in this respect particularly noteworthy.

The most famous graffito is that generally accepted as representing a caricature of Christ upon the cross found on the walls of the Domus Gelotiana on the Palatine in Rome in 1857, and now preserved in the Kircherian museum of the Collegio Romano.

GRAFT HYBRIDS: see CHIMERA.

GRAFTING (IN PLANTS), is the operation of placing a portion of one plant (bud or scion) into or on a stem, root or branch of another (stock) in such a way that a union will be formed and the partners will continue to grow. This term includes bud grafting, scion grafting and approach grafting or inarching. The first two differ only in the amount of wood used for the scion. In modern horticulture grafting is used for many reasons: to repair injured trees, to produce dwarf trees and shrubs, to avoid certain diseases, to retain varietal characteristics, to adapt varieties to adverse soil or climatic conditions, to insure pollination, to produce multifruited or multiflowered plants and as the only method of propagation for some species.

Although grafting was known to the ancients, it was not fully understood by them. Many records existed before the birth of Christ calling attention to instances of grafts which occurred in nature. Pliny the elder, writing on the various kinds of natural grafting, called attention to combinations of cherry growing on willow, plane on laurel and laurel on cherry, which resulted from the germination of foreign seeds that were caught in a crack or hollow of an established tree. The subsequent independent growth of the seedling, upon hasty observation, might be construed as resulting from actual tissue union between the two plants. Many of these reports can be attributed to the observer's imagination, since plants having widespread genetic make-up are not generally compatible.

In theory any two plants which are closely related botanically and which have a continuous cambium can be grafted. Grafts between species are often successful, between genera occasionally so, between families nearly always failures. Within the genus closeness of botanical relationship is not an infallible guide as to probable success, but in the absence of recorded experience it is the best available. The ability of two plants to continue to grow or be compatible when joined together by the asexual practice of grafting is mediated by many complex physiological and environmental factors.

Compatibility or congeniality in grafting is of various degrees. Apple grafted on oak fails immediately; apple grafted on pear may grow well for one or two years, but gradually weakens and dies. Some lilacs exist for a number of years on privet stocks, but fail ultimately. The common apricot is, other things being equal, the best stock for apricot varieties, but in moist soils in cool regions apricot trees flourish better on certain plum stocks than on apricot. These differences in adaptability of closely related plants that can be successfully grafted permit a greater degree of adjustment to soil conditions than would ordinarily be possible.

The establishment of union between grafted components is effected through the formation of a loose growth of cells (callus) contributed by both elements. These cells fuse into a mass so continuous in compatible grafts that the precise location of the line of union is frequently impossible to determine. There is, however, no evidence of a fusion of individual cells. At the initial union the cells are usually isodiametric; in the secondary stage tissue differentiation begins. Just as in wound healing, union proceeds more rapidly if the wounded areas are protected against drying out, and in most forms of grafting rapid knitting is essential to maintenance of life in the scion.

The principles involved in grafting are based on the matching of scion and stock cambiums (meristematic tissue, the cells of which are undifferentiated and capable of frequent cell division). Cambial tissue in most woody trees and shrubs is an inconspicuous single cell layer covering the central core of wood and lying directly beneath the bark.

The success or failure of any grafting operation is based upon the compatibility of each plant part, closeness of fit and cambial contact. The union is initially held in place by pressure exerted by the stock, grafting tape or by rubber budding strips applied over the point of union.

The numerous operative procedures by which grafted plants are produced fall into two major groups known as budding and grafting. Though these terms are well understood in ordinary usage, definite separation between them is impossible in some cases. Perhaps the best differentiation between budding and grafting is that offered by Charles Baltet, who defined grafting as any method which employs as a scion, a portion of a plant comprising the complete circumference, no matter how long it may be. This distinction considers only the mechanical operations involved with no reference to the manner in which union is established.

Budding. — As generally understood, budding is effected by raising or removing a segment of bark of the stock and inserting a segment of the scion, containing a bud, into the wound thus made. The piece inserted may be shield or patch shaped. In budding apple, pear, peach, orange, etc., the bark is lifted away from around an upright or inverted T-shaped incision (fig. 1 A) and the bud is then inserted under the bark (fig. 1 B) and tied securely in place with raffia or rubber budding strips (fig. 1 C). In budding nut trees better results are usually obtained by removing a piece of bark, generally rectangular in shape, from the stock and replacing it with a piece of bark carrying a bud from the tree whose

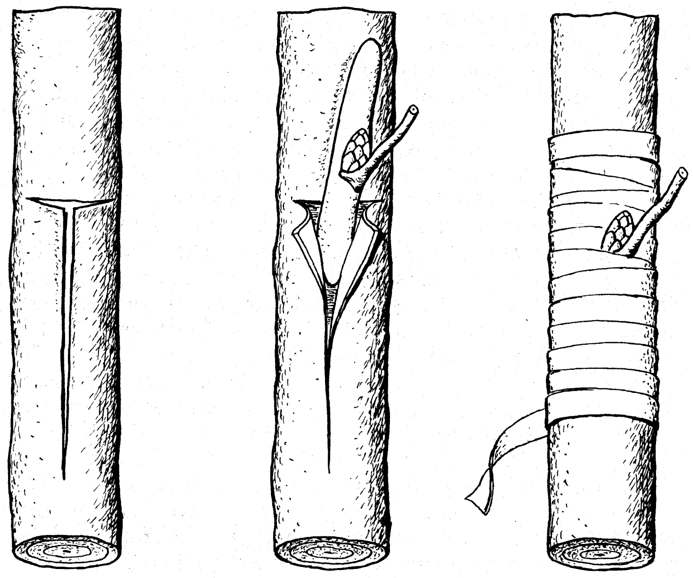

FIG. 1.—THE TECHNIQUE OF BUDDING SHOWING (A) BARK OF STOCK OPENED FOR INSERTION OF BUD; (B) METHOD OF INSERTING BUD INTO INCISION; (C) STOCK WITH BUD TIED IN PLACE WITH A RUBBER BUDDING STRIP

reproduction is desired. In these cases tying and waxing are generally employed in order to insure cambial contact and to protect the bud from desiccation and disease organisms.

Ordinarily budding is practicable only during the period in which the bark slips freely on the stock. Most budding operations in nurseries in temperate zones are done from midsummer to late summer. The shield of the inserted bud usually unites with the stock within 14 days, but growth from the bud is not expected or desired until the following spring when the stock is cut back close to the inserted bud to force its development.

In southern and Pacific coast states of the United States the long growing season permits June budding of peach and other stone fruits as early as stocks are workable, *i.e.,* when the stock is pencil-size in diameter. Stone fruit seedlings growing from seed planted in early spring or the preceding fall are budded actually in May rather than in June in many nurseries. The top of the stock being broken over at once (to stimulate bud growth) but not removed until the bud has grown several inches; this procedure produces a budded tree ready for planting in the orchard in the autumn of the same propagating year in which the seed for the stock was sown.

Budding may also be employed in producing double-worked trees. A bud of the intermediate variety is first placed on the selected rootstock in the usual manner and forced. The following year the desired scion variety is budded on the intermediate; the whole process taking about three years.

Grafting. — In one form or another, grafting proper is used on plants either in the growing or dormant stage. Deciduous fruit trees are grafted ordinarily with dormant scions and frequently when the stocks are also dormant. In many of them (*e.g.,* apple) callus formation takes place at relatively low temperatures while the plant is dormant, thereby resulting in a graft which at planting time has an incipient union. This permits bench grafting, a process in which dormant scions are grafted on small roots or pieces of roots, also dormant, during winter by workmen indoors. The grafted plants are stored in moist sand, sawdust or peat moss until spring, when they are lined out in nursery rows. Dormant scions may be grafted onto growing trees throughout the growing season, but the growth of the scion and healing of the stub consequent upon late grafting are much inferior to those obtained from spring grafting.

In grafting plants having evergreen foliage, such as the orange, the leaf blades are removed from the scion in order to restrict moisture loss while the union is forming. Grafted conifers, however, are not defoliated, but are placed in a somewhat shaded position in a closed case. In many plants, including most conifers, root regeneration is so slow that they seldom can be grafted successfully bare rooted, and therefore the stocks must be well established in pots previous to the time of grafting. In grafting the mango, which is particularly difficult, small potted stocks are sometimes placed close to young shoots of the mother tree which may then be united to the stock by inarching or approach grafting (see below). In this procedure the scion remains attached to the mother tree, being cut free only after it has united with the potted stock.

The various types of operation by which stock and scion are so fitted together that they may unite by grafting number into the hundreds. Six methods, however, will satisfy almost all requirements, since choice depends principally on ease of execution and on the relative sizes of the stock and scion. When the stock is much larger than the scion the cleft graft (fig. 2 A, B) or a bark (crown) graft (fig. 2 E) is more advantageous.

Cleft Grafting.—The cleft graft, usable when the stock is dormant (*i.e.,* its bark does not slip) involves sawing the stock at right angles to its stem, splitting the stem and then inserting scions with the bases cut approximately wedge shaped so that their cambial zones (between the bark and wood) lie alongside the cambial zones of the stock.

Bark *(Crown)* and Inlay *Grafting.*—These methods involve cutting off the stock, as with the cleft graft, and either inserting a wedge-shaped scion between bark and wood of the stock (true bark graft) or removing a portion of the bark into which is fitted exactly the scion from which half the circumference of the basal portion has been removed (inlay graft). The bark graft is practicable only when the bark of the stock separates readily from the wood. Since these grafts are usually made above the ground, all cut surfaces should be coated with one of the proprietary grafting compounds or with grafting wax; to protect against drying out. These grafts can be made on stems of any size, but satisfactory healing is rarely obtained without undue effort when the stubs exceed 2 in. in diameter.

Splice and Tongue Grafting.—The splice graft and its modified form, the tongue graft (fig. 2 C, D), are suited to cases in which stock and scion are very nearly of the same diameter. A straight slanting cut, at a rather narrow angle, removes the top of the stock. A similar cut is made at the base of the scion. The two are joined so that the cambial zones match, after which they are tied securely in place. The tongue graft adds to the slanting cut a longitudinal split in the cut surfaces of stock and scion, in each case about one-third of the distance in toward the centre from the longest lip. These two pieces are then fitted together giving increased contact of the cambium zones and one which is less easily displaced than the simple splice graft. Both splice and tongue grafts which are to stand above ground are waxed or coated with grafting compound in order to prevent excessive drying from sun and wind exposure. Similarly, if these grafts are to stand below ground it is common to wrap the graft union with cloth-backed grafting tape.

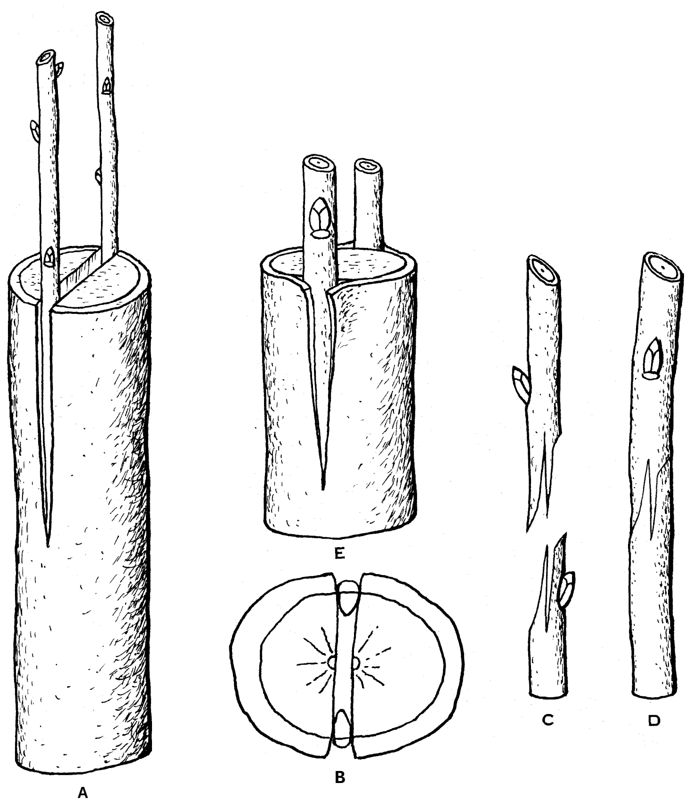

FIG. 2.—(A) CLEFT GRAFT; (B) CROSS SECTION OF CLEFT GRAFT; (C, D) TONGUE (WHIP) GRAFT: (E) BARK (CROWN) GRAFT

Side and Veneer Grafting.—With conifers and with some other plants one of the side grafts is generally employed. Into the stem of the stock, generally rather close to the soil line, a long diagonal downward cut, traversing about a third of the diameter, is made; into this is fitted the scion with its base trimmed to a wedge shape. If the cut portion of the wood is removed and the scion, cut only on one side, is fitted against the exposed surface of the stock, the operation is known as veneer grafting. These two methods are suitable for use in cases where union of stock and scion are slow to take place.

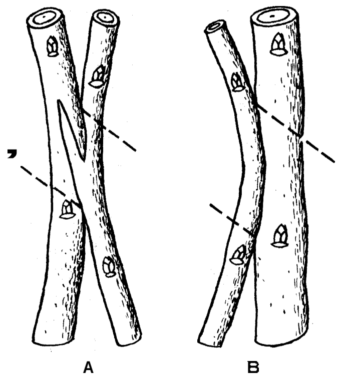

FIG. 3.—TYPES OF INARCHING

Scion on left, stock on right. Dotted line shows where cuts are made after scion and stock grow together

Inarching.—This may be accomplished by making an upward diagonal incision in the scion and a similar downward incision in the stock, fitting together the two tongues thus created, tying in position and treating with a grafting compound (fig. 3 A). It may also be effected by removing a small longitudinal piece of bark and wood from the scion and fitting exactly the exposed portion of the scion into a slot on the stock from which the bark has been removed (fig. 3 B). Both of these methods permit union of stock and scion to be established before either is severed.

Bridge Grafting.—Closely related to the above methods in the structure of the approaches made is bridge grafting, but its use is in tree repair rather than in propagation. Where a portion of the bark of a tree has been removed by an injury (severe frost or foraging animals), the wound may be bridged over by a number of long scions, whose ends eventually unite with the healthy tissue above and below the wound.

See also ARBORICULTURE; CHIMERA; HORTICULTURE; PLANT PROPAGATION.

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GRAFTON, DUKES OF. The English dukes of Grafton are descended from HENRY FITZROY (1663–1690), the natural son of Charles II by Barbara Villiers (countess of Castlemaine and duchess of Cleveland). In 1672 Henry was married to the daughter and heiress of the earl of Arlington and created earl of Euston; in 1675 he was created duke of Grafton. At James II's coronation he was lord high constable. In the Monmouth rebellion he commanded the royal troops in Somersetshire; but in 1688, with Churchill (duke of Marlborough), he seceded to William of Orange. He died of a wound received at the storming of Cork.

AUGUSTUS HENRY FITZROY, 3rd duke of Grafton (1735–1811), grandson of the preceding, was educated at Westminster and Cambridge. In 1765 he was secretary of state under the marquis of Rockingham; but retired the next year, and Pitt (becoming earl of Chatham) formed a ministry in which Grafton was first lord of the treasury (1766) but only nominally prime minister, until

Chatham's illness at the end of 1767. Political differences and the attacks of "Junius" led to his resignation in Jan. 1770. He was lord privy seal in Lord North's ministry (1771), but resigned in 1775, being in favour of conciliatory action toward the American colonists. In the Rockingham ministry of 1782 he was again lord privy seal. In later years he was a prominent Unitarian.

GRAFTON, RICHARD *(c. 1513–1573)*. English chronicler and printer of "The Great Bible" *(1539)* and the first and second *Book of Common Prayer*, received the freedom of the Grocers' company in 1534 and was its warden, 1555–56. In conjunction with Edward Whitchurch he published a modified version of Miles Coverdale's English Bible, which was printed in Antwerp in 1537 and known as the Matthew Bible *(see* ROGERS, JOHN *[c. 1500–1555])*. In 1538 he went to Paris, where the revised Coverdale New Testament was reprinted "for Richard Grafton and Edward Whitchurch." They began printing the folio known as "the Great Bible," by special license obtained from Francis I at Henry VIII's request. The work was suddenly stopped by the French government and the presses seized. Grafton fled, but his patron, Thomas Cromwell, bought the presses and type, and printing was completed in England. In 1544 Grafton and Whitchurch secured the exclusive right of printing church service books, and on Edward VI's accession Grafton was appointed king's printer. In this capacity he produced the *Book of Homilies (1547)*. the *Book of Common Prayer* (1549 and 1552) and the *Acts of Parliament (1552* and *1553)*.

In 1553 he printed Lady Jane Grey's proclamation and signed himself the queen's printer. For this he was imprisoned for a short time by Mary; he seems thereafter to have retired from active business.

His historical works include a continuation (1543) of John Hardyng's *Chronicle* from the beginning of the reign of Edward IV to Grafton's own times. After retiring from printing he published *An Abridgement of the Chronicles of England* (1562), *A Manuell of the Chronicles of Englande* (1565), *Chronicle at large, and meere Historye of the affayres of England* (1568). Grafton was interested in London hospitals, being master of Bridewell, 1559–60, and of Christ's hospital. 1560.

He died in London in 1573 and was buried on May 14.

See J. A. Kingdon, *Incidents in the Lives of Thomas Poyntz and Richard Grafton (1895)* and *Richard Grafton, Citizen and Grocer of London* (1901). *(Rd. C. G.)*

GRAFTON, a city of Clarence county, N.S.W., Austr.. on the Clarence river 42 mi. from its mouth and 342 mi. N.E. of Sydney. Pop. of Grafton and South Grafton (1954) 14,201. It became a municipality in 1859 and a city in 1861. Grafton is the seat of an Anglican bishop. The river is navigable to the city for ships of moderate burden and for small vessels to a point 35 mi. beyond. The entrance to the river and the river channel is being artificially improved for deep-sea ships. Rail and air services link the city with Sydney and Brisbane. Primary industries include dairying, production of sugar cane, maize, vegetables, timber, fruit and beef cattle. Secondary industries are the processing of timber, meat and dairy products, match manufacture and brewing. It is a popular tourist resort.

GRAHAM, SIR JAMES ROBERT GEORGE, BART. *(1792–1861)*, English statesman who played an important part as Sir Robert Peel's confidant and adviser, was born at Netherby, Cumberland, on June 1, 1792, and educated at Westminster and Christ Church, Oxford. Member for Hull and then for St. Ives from 1818 to 1820, Graham withdrew from politics to manage the family estates in Cumberland, gaining repute as an expert in agricultural economics and technique. Returning to parliament for Carlisle in 1826, he sat for Cumberland from 1827 until 1837, and from 1838 for Pembroke, Dorchester and Ripon, before representing Carlisle from 1852 until his death at Netherby, Oct. 25, 1861.

From the beginning an advanced Liberal, Graham became first lord of the admiralty under Lord Grey in 1830. He proved an efficient, economical administrator and was a member of the cabinet committee which drafted the first Reform bill. In office Graham's radicalism rapidly waned, and in 1834 he resigned with his friend Lord Stanley (later Lord Derby) over proposals to divert revenue from the Irish Church. While refusing to join Peel's first ministry, he abandoned the Whigs in 1835. and soon emerged as Peel's most valuable lieutenant in the commons, bitterly hostile to his old colleagues. Home secretary from 1841 to 1846, Graham's influence upon social and economic policy was considerable, notably over the corn laws; but, despite his talents. his record in his own office was neither popular nor successful since he was particularly disliked by protectionist Tories. After 1846 Graham readily accepted Peel's support for the Whigs, though refusing office several times. When the latter died in 1850, Graham became the leading Peelite in the commons and helped to promote the Aberdeen coalition of 1852 in which he returned to the admiralty. The performance of the navy in the Crimean War suggests that his insistence upon economy did not conduce to efficiency. Graham resigned soon after the formation of Palmerston's ministry in 1855 and ceased to play any prominent part in politics, though remaining active behind the scenes.

Industrious, well informed and authoritative, Graham never attained the success his ability merited. Pompous and repellent in manner, incapable of conciliation, he was unpopular in parliament, being regarded as both vindictive and unreliable. Nevertheless, he was highly esteemed by all leading politicians, and his importance lies in his standing as an adviser and consultant. Next to Peel, he was the main architect of the new conservatism, and acted as Peel's right-hand man in his most famous administration. Moreover, after 1850 the younger generation of Peelites, such as W. E. Gladstone and Sidney Herbert, looked mainly to Graham for guidance if not leadership; and his counsel tended toward collaboration with the Whigs and Radicals, out of which the later Liberal party was to develop, rather than Conservative reunion. (A. F. T.)

GRAHAM, MARTHA *(1895–   )*, U.S. dancer, choreographer and teacher, one of the most important and controversial exponents of the modern dance, was born in Pittsburgh. She was educated in California, and in 1916 began dance studies there under Ruth St. Denis and Ted Shawn. Following her debut with the Denishawn company two seasons later, she was given the leading role in Shawn's Aztec ballet *Xochifl (1920)*.

In 1923 Martha Graham left the Denishawn company to appear in the *Greenwich Village Follies*. She made her debut as a concert soloist in 1926. in New York city. She had already begun to formulate her personal technique, exploring uncharted worlds of movement in her search for the form of dance which would most clearly express inner emotion.

A theatrical artist of intense power and individuality, she has drann her subjects from such diverse sources as the American Indian *(Primitive Mysteries,* El *Penitente)*, American frontier life *(Appalachian Spring)*, literature *(Letter to the World, Deaths and Entrances)*. and Greek legend *(Cave of the Heart, Night Journey)*. Vitally concerned with contemporary music, she has commissioned scores from Aaron Copland, Norman Dello Joio, William Schuman and other distinguished American composers.

In 1955, under the auspices of the C.S. state department's cultural exchange program, Martha Graham toured the orient. (Ln. Me.)

GRAHAM (afterward CUNNINGHAME-GRAHAM), **ROBERT** (d. 1797?), Scottish poet famous for his lyric "If Doughty Deeds My Lady Please," was the son of Nicholas Graham of Gartmore and Lady Margaret Cunninghame. He started life as a planter in Jamaica, where he was for a time receiver-general. In 1784 he was elected rector of Glasgow university and from 1794 to 1796 was M.P. for Stirlingshire. Politically he is remembered as the mover of a bill of rights, in which the Reform bill of 1832 was foreshadoued, and as an ardent advocate of the ideals of the French Revolution; but it is for his lyrics that he has remained famous.

GRAHAM, THOMAS (1805–1869), British chemist often referred to as "the father of colloid chemistry" was born at Glasgow on Dec. 21. 1805. He was educated at Glasgow university, now the Royal Technical college, under Thomas Thomson and then at Edinburgh under Thomas Hope. His father, a wealthy businessman, wished him to become a clergyman and when the boy persisted in his intention to become a chemist. withdrew his support. He then made his living by teaching and writing. He was professor of chemistry in the Anderson institution. Edinburgh (1830–37), then at University college. London (1837–55) and master of the mint (1855–69). He succeeded Edward Turner at London in 1837. being chosen from among numerous aspirants for this desirable post. He was a fellow of the Royal society (1836), and one of the founders of the London Chemical and the Cavendish societies. He was the first president of the London Chemical society (1841) and president of the Cavendish society in 1846.

His first paper, published in 1825, dealt with the absorption of gases by liquids, and the first of his important memoirs on gaseous diffusion appeared in 1829. By measuring the rate at which gases diffuse through a plug of plaster of Paris. Graham developed the law, known by his name. "that the diffusion rate of gases is inversely as the square root of their density." *(See* DIFFUSION.) He further studied the flow of gases through fine tubes, and by effusion through a minute hole in a platinum disk; he found that the relative rates of effusion of gases are, like their rates of diffusion, inversely proportional to the square roots of their densities.

His early work led him to examine the diffusion of one liquid into another. and as a result of the experiments he divided bodies into two classes — crystalloids. such as common salt and colloids, of which gum arabic is a type — the former having high and the latter low diffusibility; this division has since been modified. He invented many of the terms used in colloid chemistry. Graham observed that in the passage through a parchment membrane these differences still held. and so was led to devise a method. "dialysis." for the separation of colloids from crystalloids. He also proved that the process of liquid diffusion causes partial decomposition of certain chemical compounds, the potassium sulfate. for instance. being separated from the aluminum sulfate in alum by the higher diffusibility of the former salt.

In 1833 Graham studied the three forms of phosphoric acid (ortho, meta and pyro). The differences among them were attributed to the fact that they contained different amounts of basic water. replaceable by metallic oxides, united n·ith a given quantity of phosphoric anhydride. (See *Alembic Club Reprint,* No. 10, 1906.) From this work the important concept of polybasic acids developed (see ACIDS AND BASES). In 183j he published the results of an examination of the properties of water of crystallization as a constituent of salts: definite compounds of salts and alcohol. analogous to hydrates. can be obtained. and these were called "alcoholates." In his final paper he described palladium hydride. the first known instance of a solid compound formed from a metal and a gas. He was led to assume the existence of a metal hydrogenium. Although his lectures were characterized by accuracy and breadth. his manner was nervous and hesitant and he was not fluent of speech. Graham never married. His health was not robust and his tastes were simple. His quiet life was devoted entirely to scientific pursuits. He died on Sept. 16. 1869.

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(R. E. O.)

GRAHAME-WHITE, CLAUDE (1879–1959), English aviator and engineer, who pioneered in British aviation, was born on Aug. 21. 1879. He was educated at Bedford and studied engineering. He owned one of the first gasoline-driven motorcars in England, and worked at a motor engineering business in London until he became interested in aeronautics in 1909. In that year he gained an aviator's certificate of proficiency, being the first Englishman to do so. The following year he entered many flying races in Europe and in the United States. where he won the Gordon Bennett cup. He founded the first British flying school at Pau in France, in 1909. In 1910 he joined a company to run the Hendon aerodrome of London. At the outbreak of World War I in 1914, he mas commissioned in the royal flying corps, but later was recalled to superintend the construction of government planes. He wrote many treatises on aircraft, dealing with its history, its technical development and its use in warfare, including: *The Aeroplane, Past, Present and Future* (1911); *The Aeroplane in War* (1912); *Flying, an Epitome and a Forecast* (1930).

Grahame-White died in Nice, France, Aug. 19, 1959.

GRAHAMSTOWN, a town in Union of South Africa. 33° 19′ S., 26° 31′ E.; alt. 1.769. Pop. (1951) 23.789 (8.630 white, 11.814 native. 3,117 "coloured." 178 Asiatics). It is 106 mi. from Port Elizabeth and is reached by a branch line from Alice Dale, on the main Port Elizabeth-Pretoria line. The first settlement, established here in 1812, near the headwater of the Kowie river, and on the slopes of the Zuurberg. was a military post. founded by Col. John Graham. to hold in check the Kafir tribes. The town is named after its founder. After the arrival of the 1820 settlers. the site was chosen as a central rallying point in case of need. Since that time. in spite of its present somewhat isolated position. Grahamstown has retained its importance. It is the capital of the Eastern province of Cape Colony, and here the Eastern province law courts are placed. It is also the seat of Anglican and Roman Catholic bishops. The town is pleasantly laid out with broad, straight streets. often lined with trees. It is often regarded as the most English town in Cape Colony. The slopes of the neighbouring ridge are planted with trees, and from the top a magnificent view of the surrounding country can be obtained; a view of much geological interest. The town is also an important educational centre. It has several good schools. and a training college. The Rhodes University college. a constituent college of the University of South .Africa, stands in its own grounds. and is equipped with fine hostels. college buildings and playing fields. Among the public buildings mention may be made of St. George's cathedral (Anglican). built from designs by Sir Gilbert Scott. St. Patrick's cathedral (R.C.), and the commemoration chapel (Wesleyan), erected in 1845 by the British 1820 settlers. The Albany museum ranks high for its specimens of South African fauna and its collection representing early African cultures. (R. U. S.; X.)

GRAHN, LUCILE (1819–1907), Danish ballerina and choreographer, was one of the most celebrated dancers of her time: noted for lightness and technical virtuosity. Especially memorable was her appearance with Marie Taglioni, Fanny Cerrito and Carlotta Grisi in Jules Perrot's famous *Pas de Quatre* at Her Majesty's theatre, London, in 1845.

Born June 30, 1819, in Copenhagen, she studied under Auguste Bournonville, and in 1836 was the first to dance the title role in his version of *La Sylphide* at the Danish Royal theatre. A quarrel with Bournonville led to her virtual exile from Denmark after 1839. but she danced successfully throughout Europe and was choreographer at the Munich opera, 1869–75. She died April 4, 1907, in Munich. (LN. ME.)

GRAIL, THE HOLY, the famous talisman of Arthurian romance. the object of quest on the part of the knights of the Round Table. It is mainly. if not wholly, known to English readers through the medium of Sir Thomas Malory's translation of the French *Quête del Suint Graal*, where it is the cup or chalice of the Last Supper. in which the blood which flowed from the wounds of the crucified Saviour has been miraculously preserved. Students of the original romances are aware that there is in these texts an extraordinary diversity of statement as to the origin and nature of the Grail. and that it is extremely difficult to determine the precise value of the differing versions.

The word *grail* undoubtedly originally signified *dish;* we read in an early French text of "boars' heads on grails of silver," and Robert de Borron. the author of the first Christian Grail romance, represents it as the dish on which. at the Last Supper, the Paschal Lamb was served. Helinandus describes it as a "wide and somewhat shallow dish." This is certainly the primary sense of the word. which later on became attached to the varying manifestations of this mysterious object. Thus it may be a direct food-providing talisman. as in the version attributed to the Welshman. Bleheris (probably identical with the Bledhericus to whom Giraldus Cambrensis refers as "*famosus ille fabulator*"). Here the king and his guests are fed by the "rich" Grail. which acts automatically, "*sans serjant et sans seneschal,*" the butlers providing the wine. Or it may be indirectly such a talisman. as in the *Perceval* romances and the Galahad *Queste*, where its appearance synchronizes with the feast provided, but we are not told that it is, as in the first case, the actual source of the food. It may be a crystal vase. filled with blood, from which the Fisher king drinks. through a golden reed (*Diu Crône,* first visit) or a reliquary containing the Host (*ibid.*, second visit). It may be a cup or dish, accompanied by a lance, which bleeds into it (Bleheris and *Perlesvaus*); the dish of the Last Supper (Borron's *Joseph*), or the cup (*Queste*). It may be a stone, as in the *Parzival;* or its place in procession may be taken. as in the Welsh *Peredur,* by a bleeding head on a dish. The task of the critic is to discover a solution which shall admit of all these diverse objects being one and the same, all equally "the Grail." Modern criticism is gradually arriving at the conclusion that there is only one solution which will meet these apparently contradictory demands: that which lies in the direction of what is now termed the "ritual" origin, rather than in that of purely Christian legend or modified folk tale. The theory of a Christian origin. once very generally accepted. has now been practically abandoned in face of the fact that no story of Joseph of Arimathea and the Grail exists in any legendary; it makes its first appearance in the romance of *Joseph of Arimathea* by Robert de Borron. composed in the closing years of the 12th century, and by no means the earliest Grail romance. The connection of Joseph with Glastonbury. still credited in some circles, is even later, and is obviously imitated from the much earlier "Saint Sang" legend of Fescamp, of which Nicodemus is the protagonist. Glastonbury and Fescamp were alike Benedictine foundations, both enjoyed royal patronage, and their abbots were closely connected by family ties both with each other and with the royal family of England. The *Joseph-Glastonbury* story, which in its earliest form knows nothing of the Grail, is thus easily to be accounted for. The folk-tale theory has more in its favour, as there are undoubted folklore features in some of the romances, such as, *e.g.*, the food-providing powers of the Grail, but we have no popular tale. even fragmentary, which provides us with the requisite *mise en scène*.

On the other hand. it is now very generally recognized that the machinery of the earlier romances—the Fisher king. sick, wounded or in extreme old age, whose incapacity entails disastrous consequences upon his land and folk, both alike ceasing to be fruitful; the quester, whose task is to heal the king, and restore fruitfulness to the land—bear a striking resemblance to the cults associated with such deities as Tammuz, Adonis and Attis, the object of which was the renewal of vegetation and the preservation of life. Further, we now know that a certain early Christian sect, the Naassenes, identified the Logos of the Christian worship with these earlier deities, practised a triple initiation into the sources of life, physical and spiritual, and boldly proclaimed themselves to be "alone the true Christians, accomplishing the mystery at the Third Gate." The evidence for the connection between Christianity and the Attis cult in particular is clear, and has been commented upon by A. B. Cook in the second volume of his monumental work on *Zeus*. Scholarly opinion is steadily coming round to the view that the only interpretation of the obscurities and apparent contradictions of the Grail story is to regard it as the confused record of a form of worship, semi-Christian, semi-pagan, at one time practised in these islands, the central object of which was initiation into the sources of life: physical and spiritual. This. and this alone, will account for the diverse forms assumed by the Grail, the symbol of that source. Thus it may be the dish from which the worshippers partook of the communal feast; it may be the cup in juxtaposition with the lance, symbols of the male and female energies, source of physical life, and well-known phallic emblems. It may be the "Holy" Grail, source of spiritual life, the form of which is not defined, and which is wrought of no material substance—"'twas not of wood, nor of any manner of metal, nor was it in any wise of stone, nor of horn, nor of bone"; it is a spiritual object, to be spiritually discerned. but always, and under any form, a source of life. Thus Wolfram's stone, the mere sight of which preserves all inhabitants of the Grail castle. not only in life, but in youth, is what is popularly known as "the philosopher's stone," that stone of the alchemist which was the source of all life. Even the bleeding head of *Peredur* may be interpreted on the same lines. A passage in the Tork Breviary, for the Feast of the Beheading of St. John the Baptist. states "*Caput Johannis in disco signat Corpus Christi quo pascimur in sancto altari.*" When the Grail had once been elevated to the purely Christian orthodox plane, as was done by Borron, and became the source, no longer of physical, but of spiritual life, such a substitution, by one familiar with the York Breviary, wns possible. even as the author of Wolfram's source. or one before him, had introduced the alchemical stone. As the record of the perennial, too often unsuccessful, quest for the source of life, all the puzzling features of the Grail story are capable of satisfactory explanation. There is no other clue to the maze.

The versions of the Grail Quest which have come down to us are (1) those of which Gawain is the hero: the version by Bleheris, incorporated in the first continuation of Chrétien de Troyes' *Perceval*, and *Diu Crône*, a long and rambling series of *Gawain* adventures. the source of which is unknown. (2) The important group of which Perceval is the central figure: the *Conte del Graal* or *Perceval* of Chrétien, with its three continuations, respectively due to Wauchier de Denain. Gerbert (probably Gerbert de Montreuil, author of *Lc Roman de In Violette*), and Manessier; the *Perceval* of Robert de Borron; *Perlesvaus*, by an unknown writer. and *Parzival*, by Wolfram von Eschenbach. the finest romance of the cycle. Of the three continuations of Chrétien's poem that of Gerbert is the most interesting, as it witnesses to the existence of a tradition connecting the Swan Knight with the Grail hero, a tradition known also to Wolfram and to the author of *Sone de Nansai*, and familiar to the present generation through the medium of Wagner's *Lohengrin*. (3) The latest of the Grail romances is the *Queste*, or *Quête del Saint Graal*, a section of the prose *Lancelot*, known to English readers through the medium of Malory's translation. Thus we have two romances of which Gawain is the hero; seven, if we include the three continuations of Chrétien, connected with Perceval; one only which knows Galahad, with Perceval as a good second. To treat Galahad as Grail hero *par excellence*, as is too often done, is a grave mistake.

See J. L. Weston, *From Ritual to Romance* (1920); J. D. Bruce, *The Evolution of Arthurian Romance* (1923); J. Armitage Robinson, *Two Glastonbury Legends* (1926); R. S. Loomis, *Celtic Myth and Arthurian Romance* (1927). (J. L. W.)

GRAIN, the fruit or caryopsis of cereals, and hence cereal plants generally (from Lat. *granum*, "seed"). (*See* GRAIN PRODUCTION AND TRADE.) The word also refers to the malt refuse of brewing and distilling, and to many hard rounded small particles, such as grains of sand, salt, gold, gunpowder, etc. A grain is also the smallest unit of weight, both in Great Britain and the United States. Its origin is supposed to be the weight of a grain of wheat. The troy grain $= \frac{1}{5,760}$ of a pound, the avoirdupois grain $= \frac{1}{7,000}$ of a pound. In diamond weighing the grain $= \frac{1}{4}$ of the carat $= .7925$ of the troy grain. The word "grains" was early used of the small seedlike insects supposed formerly to be the berries of trees, from which a scarlet dye was extracted (*see* COCHINEAL). The imitating in paint of the grain of wood is called graining.

GRAIN ELEVATORS: *see* GRANARIES AND GRAIN ELEVATORS.

GRAINGER, PERCY ALDRIDGE (1882–1961), Australian pianist and composer, was born at Melbourne, on July 8, 1882. He studied there with Louis Pabst, with James Kwast at Hoch conservatorium. Frankfurt-on-Main, Ger., and later with Ferruccio Benvenuto Busoni. From 1901 to 1914 he lived in London, making extensive concert tours and also collecting the folk tunes of which his effective arrangements became widely known. In 1914 he settled in the United States. In 1935 he founded the Grainger museum at Melbourne. Grainger died at White Plains, N.Y., on Feb. 20, 1961.

Grainger's compositions include: *Molly on the Shore; Shepherd's Hey; Mock Morris; Irish Tune from County Derry;* a clog dance, *Handel in the Strand;* paraphrase on the "Flower Waltz" from Tschaikovsky's *Casse Noisette,* choruses with instruments; *Brigg Fair; Country Gardens;* and many settings from Rudyard Kipling's *Jungle Book.*

GRAIN PRODUCTION AND TRADE. True grains are the fruits of the grasses (*q.v.*), members of the botanical family Gramineae. They are characterized by monocotyledonous seed kernels, as contrasted to the pulses (peas, beans, etc.) and oilseeds (castor-oil seed, linseed, etc.), most of which are members of Leguminosae and have dicotyledonous seeds. These grains are grown primarily for their starch or calorie content. The pulses and oilseeds are cultivated largely for their protein and fat content. The cereal grains contain from 70% to 80% starch by weight, except for oats, barley, paddy rice and millet, which because of their fibrous hulls, have somewhat less.

This article deals with the principal uses of grain, including its importance in human diet, grain production and competition among grains for land, marketing arrangements and functions and world trade. Additional information on production will be found in the *Agriculture* sections of articles on countries, states and provinces, as ARGENTINA; INDIA; MICHIGAN; SASKATCHEWAN. *See* also articles on specific grains: BARLEY; CORN; RICE, etc.

USES

Importance in Human Diets.—Since the dawn of civilization, the true grains have been fundamental to human life. No considerable densities of population can be sustained without either considerable production of grain within the area or access to imports. Hunting and pastoral production yield much less food per hectare. Root crops such as potatoes, yams and cassava usually yield more calories than grain; however, these crops require more labour, are difficult to store and transport and provide a less balanced diet.

TABLE I.—*Comparison of Pre- and Post-World War II Total Per Capita Calorie Supplies and Per Cent From Cereals and Other Foods by Regions*

Region	Total calories		Cereals				Other foods			
	Prewar Cal. per day	Postwar Cal. per day	Prewar		Postwar		Prewar		Postwar	
			Cal. per day	%	Cal. per day	%	Cal. per day	%	Cal. per day	%
Western Europe.	2,885	2,855	1,285	44.5	1,170	41.0	1,600	55.5	1,685	59.0
North America	3,140	3,085	895	28.5	715	23.2	2,245	71.5	2,370	76.8
Latin America	2,250	2,470	835	37.1	890	36.0	1,415	62.9	1,580	64.0
Far east	1,995	1,830	1,370	68.7	1,245	68.0	625	31.3	585	32.0
Africa and Near east	2,395	2,465	1,665	69.5	1,615	65.5	730	30.5	850	34.5
Oceania	3,290	3,095	985	29.9	965	31.2	2,305	70.1	2,130	68.8
World*	2,445	2,360	1,240	50.7	1,145	48.5	1,205	49.3	1,215	51.5

*Based on data from 36 countries comprising about 65% of the world's population but excluding China and the U.S.S.R. Postwar data refer to 1954–55 and 1955–56 levels of consumption. Prewar data from Food and Agriculture Organization of the United Nations, *Second World Food Survey.*

Source: Food and Agriculture Organization of the United Nations, *Monthly Bulletin of Agricultural Economics and Statistics,* Oct. 1956.

The cereals are grown principally for their energy content, but they also provide a considerable share of the proteins needed in human and animal diets. The protein content of whole wheat is 11% to 13%, and that of ordinary white wheat flour about 10% to 12½%. Oatmeal has a slightly higher protein content; rice contains only 7%; corn (maize), 9%; millets, 6½% to 12%; and sorghum, 10%. Relatively low-income countries heavily dependent on cereal diets balance their protein needs primarily with pulses, oilseeds and fish. Relatively high-income countries, which consume a high proportion of animal products, get their protein from this source and use oilseed cake and meal to supplement the cereals and roughage fed to their animal populations.

Low-income countries with limited land and other resources are forced to consume a large share of their grain production directly for human food. A much greater population can subsist on a given level of agricultural resources by utilizing the primary cereal production directly instead of feeding it to livestock.

The world (excluding the Chinese mainland and the U.S.S.R.) obtains about half of its calorie intake from cereals (Table I), about one-fourth from other crops and one-fourth from animal products. In the pre-World War II period, China obtained an estimated 70% to 80% of its calorie intake from cereals. Little data are available on the U.S.S.R. However, after the death of Stalin in 1953, the government stated that animal numbers had changed little from Czarist times, indicating a heavy dependence on cereals and other crops to feed the growing population. The diets of the northern European countries, the United States, Canada, New Zealand and Australia have the lowest proportion of cereals ranging from one-fourth to one-third of the total calorie intake. *See* also CEREALS.

Declining Proportion of Cereals in Human Diets.—All regions except Latin America, Africa and the near east had a decline in total calorie intake after World War II as compared to the prewar period. All regions except Oceania had a decrease in the percentage of calories supplied by cereals. Any considerable shift in human diets from cereals to animal products would have to be accompanied by large increases in the production of the feed grains (oats, barley, sorghums, corn) relative to that of the food grains (wheat, rye, rice). However, for a large proportion of the world's population, the primary problem is securing a higher level of calorie intake; improving the quality of diets is of secondary importance.

Industrial Uses.—In addition to their use as human food and animal feed, grains have long been the principal raw material for the brewing and distilling industries. Cereals are also used for industrial alcohol, starches, films, polymers and other products. Total utilization for these purposes is small, however. Even in the United States where supplies are abundant and relatively cheap, industrial uses account for only 5% to 7% of cereal grain production. Industrial uses for cereals are probably declining in spite of considerable research effort aimed at finding new uses.

PRODUCTION

The importance of cereal production to human nutrition is indicated by the proportion of arable land devoted to it. In the world (excluding U.S.S.R.) approximately half the estimated area of arable land, fallows and orchards is used for cereal production (Table II). In the far east where there is heavy population pressure upon the land resources, approximately three-fourths of the land area is devoted to the cereals. In other parts of the world where population pressures are not so great, the proportion devoted to cereals is smaller, amounting to only one-fifth in Africa. When allowance is made for the necessary fallow in dry areas, somewhat over half the world's arable land is devoted to cereal grains.

TABLE II.—*Area Used for Cereals as a Per Cent of Total Arable Land and Orchards by Regions**

Region	Total arable land and orchards† (in 000,000 ha.)	Used for cereal crops	
		Area in grain (in 000,000 ha.)	% of total
Europe	150	73.5	49.0
North America	228	97.1	42.6
Latin America.	96	33.9	35.3
Near east.	78	12.0	41.0
Far east	355	272.5	76.8
Africa			19.0
Oceania			25.8
World total (excl. U.S.S.R.).	1,150		48.4

*1954–56 average. †Including fallows and temporary grass lands.

Source: Food and Agriculture Organization of the United Nations, *Yearbooks of Food and Agriculture Statistics.*

Regional Production Patterns.—The results of different combinations of environmental, consumer preference and economic factors are shown in Table III. Wheat, because of wide adaptation and high favour with consumers, is an important grain in all regions. Rye is important only in Europe and the U.S.S.R. where the combination of infertile soils and a cool climate restrict the choice of crops. Barley, like wheat, is important in all regions. Oats production is confined to Europe, North America and Oceania; the remaining regions are largely too hot or dry for it.

Corn (maize) is produced in all regions of the world, but the major concentrations are in the western hemisphere countries (the United States, Mexico, Brazil and Argentina); and in Africa (the Union of South Africa). The millets and sorghums are important crops in only three regions: the near east, far east and Africa. They are the best cereal crops for the extensive hot, dry areas in these regions.

Rice production is geographically the most concentrated of any of the cereals. It is the dominant crop in the far east. It is not a very important crop in any other region as a whole, but is important in individual countries; *e.g.,* Brazil, Spain, Italy and Egypt. The bulk of the crop is grown in the alluvial plains around the edge of the Asian land mass from India to China and in the Japanese, Philippine and Indonesian islands off the coast of Asia.

Relative Importance and Requirements of the Individual Cereal Grains.—Farmers' and peasants' chbices of the crop or crops grown depend on a number of environmental and economic considerations. The individual grains compete with each other and with other crops for land. Estimates of the proportion of cereal land occupied, the proportion of the total cereal crop accounted for by each cereal by region and world totals (exclusive of the U.S.S.R.) are given in Table III.

TABLE 111.—*Relative Importance of the Principal Cereal Crops by Area and by Production, by Regions**

Region	e a t	R e	Barley	Oats	o n	Millet and sorghum	Rice
			(% of total area in cereal crops)				
Europe	38.8	15.5	14.0	15.6	15.2	0.3	0.6
North America	30.6	1.0	9.3	20.3	32.8	5.2	0.8
Latin America	26.5	3.3	5.0	2.9	49.9	1.5	10.9
Near east	48.8	1.9	20.9	1.2	6.6	18.1	2.5
Far east	15.9	....	7.8	1.2	8.0	29.3	37.8
Africa	16.1	....	12.0	1.0	26.7	37.2	7.0
Oceania	62.9	....	12.9	21.0	1.6	1.6	....
World total (excl. U.S.S.R.)	24.6	2.6	9.8	6.7	17.1	19.2	20.0
U.S.S.R.†	50.4	15.9	10.1	12.5	7.6	3.4	0.1
			(% of total cereal production)				
Europe	37.0	14.3	16.5	16.2	14.4	0.2	1.4
North America	22.7	0.8	7.7	15.2	48.5	3.6	1.5
Latin America	28.1	2.0	4.8	3.1	46.2	1.3	14.5
Near east	44.8	1.9	19.7	1.3	9.5	13.3	9.5
Far east	11.1	....	7.4	1.0	7.8	16.1	56.6
Africa	16.3	....	10.5	0.6	31.6	29.7	11.3
Oceania.	68.6	....	14.9	11.9	1.5	1.5	1.6
World total (excl. U.S.S.R.)	21.4	2.8	9.6	7.1	21.5	10.0	27.6
U.S.S.R.‡							

*Average 1954–55. Total areas harvested and total production by regions shown in Table IV. †1955. ‡Data not available.

Source: Food and Agriculture Organization of the United Nations, *Yearbooks of Pood* **and** *Agricultural Statistics; Monthly Bulletin of Agricultural Economics and Statistics.*

Wheat occupies the largest area, about one-fourth of that devoted to cereals, followed by rice (20%), millet and sorghum (19%) and corn (17%). Barley occupies about 10%, oats 7% and rye less than 3%. Much of the U.S.S R is either too dry or too cold for rice or corn. Almost two-thirds of the U.S.S.R. cereal area was devoted to wheat and rye in 1955 (Table III). Only about 11% was in corn, millet and sorghum and rice combined.

Rice accounted for 28%, and wheat and corn about 21% each of world cereal production in the second half of the 20th century (Table III). Sorghums and barley accounted for about 10% each, oats 7% and rye less than 3%.

In general, three factors determine the competitive position of the individual cereals within a region: (1) biological adaptation to the physical environment; (2) consumer preferences; and (3) economic considerations.

Biological Adaptation to the Physical Environment.—*Wheat.*—Wheat grows well under a wide variety of conditions in the temperate regions of the world. It grows best where the natural vegetation is grass, but also does well in many of the more fertile. temperate forested areas. The greater part of the world's wheat is fall-sonn winter wheat. It is relatively winter hardy; however, it will not thrive in many localities above 55°–60° N. latitude or 40° S. latitude. Wheat is damaged by high temperatures in the maturing stages; therefore, little wheat is grown (except in a few localities at higher altitudes) between 30° N. and 30° S. latitude, because temperatures warm up too rapidly in the spring.

Rye.—Rye is noted for its hardiness to cold, disease and pests, and for its ability to perform more satisfactorily than wheat on poor, sandy soils. This combination of characteristics has relegated rye to the marginal land in the temperate climates.

Barley.—Barley grows where wheat and other temperate region cereals are adapted but is less winter hardy than wheat and rye. It usually competes with corn, oats, rye and low-grade wheat as feed, although special types are grown in the United States and Europe for the malting industry for beer production.

Oats.—The oat is less winter hardy than wheat or barley but is more successful in wet climates. Like barley, it is used largely for animal feed.

Corn.—Corn (maize) requires a combination of warm, humid weather. Generally nighttime temperatures must remain above 58° F., and annual precipitation should total 30 in. or more with the bulk falling within the growing season.

Millets and Sorghums.—These are warm-weather crops more tolerant to drought than corn. Millet yields considerably less than sorghum, but will make a crop in a very short season under soil and climatic conditions too rigorous for sorghums.

Rice.—Unlike the other cereals, rice thrives in hot, humid weather on alluvial soils. The lowland varieties, which comprise the bulk of the crop, require waterflooding. Only the upland varieties important in some parts of China and a few other localities compete for land with other cereals.

Consumer Preferences—Wheat is the preferred grain for human consumption in most of the western world. It makes a white bread of light texture because of the elastic nature of the protein or gluten in the wheat flour. In the U.S.S.R. and Europe, rye bread is eaten where wheat yields are unsatisfactory, but rye makes a heavy, less satisfactory, dark bread. Wheat is gradually displacing rye as a bread grain as world real incomes rise. Further decreases in the use of rye for food are likely.

Rice is the preferred food grain in the greater part of the orient. Wheat and other grains are substituted where rice cannot be grown or is not available.

The remaining so-called coarse grains are more likely to be used for animal feed than for human food and compete on the basis of relative yields rather than consumer preference. Human populations ordinarily use these coarse grains for food only where the relative costs of producing wheat or rice are too high for them to afford. Corn is used extensively in parts of Latin America and the millets and sorghums are used in the relatively poorer and drier sections of Asia and Africa.

Economic Considerations.—The returns from grain production are the result of yields, prices and the costs of production. Thus, while the costs of producing the small grains (wheat, rye, barley and oats) are not greatly different, wheat is so much favoured by consumers that it has a considerable price advantage over all the other temperate region grains.

Corn derives its competitive position by virtue of its very high yield relative to the other cereals and its consequent low cost per unit of production. This makes it the most competitive livestock feed in regions environmentally suited to corn production.

Rice has relatively high costs of production because of the labour involved, but its adaptation to hot, humid climates and favour with oriental consumers makes it the staple food crop in south and east Asia. including Japan, the Philippines and Indonesia.

Area Harvested and Production.—An average of 557,000,000 ha. (1 ha. equals 2.471 acres) was devoted to cereals in the world (excluding the U.S.S.R.) in the middle 1950s (Table IV). This was an increase of about one-fifth from 1934–38. The largest increases in cereal area were in the near east and the far east with increases of over 40%. Latin American and African areas each increased more than 25%. There were small decreases in North America, Europe and Oceania.

The U.S.S.R. had apparently just about regained its prewar level after a decline caused by World War II disruptions.

An average of 733,000,000 metric tons of cereals were produced in the world (excluding the U.S.S.R.) in 1954–56 (Table IV).

TABLE IV.—*World Cereal Production by Regions, 1934–38, 1948–52 and 1954–j6*

Region	Area in cereals (in 000,000 ha.)			Production (in 000,000 metric tons)		
	1934–38	1948–52	1954–56	1934–38	1948–52	1954–56
Europe	79.7	73.2	73.5	1180	110.4	124.8
North America	99.3	103.9	97.1	108.5	169.1	171.1
Latin America	27.1	27.7	33.9	31.0	30.9	39.2
Near east	21.9	26.7	32.0	21.8	25.0	31.5
Far east	192.0	244.2	272.5	244.8	260.8	328.4
Africa	32.3	36.2	41.6	19.0	24.4	31.3
Oceania	6.3	6.3	6.2	5.2	6.8	6.7
World total (excl. U.S.S.R.)	458.6	518.2	556.8	548.3	627.4	733.9
U.S.S.R.*	107.0	92.5	109.4	79.5†	86.5‡	102.6

*U.S.S.R. area information adapted from Commonwealth Economic Committee *Grain Crops*, 1957. †1940. ‡1950–52

Source: Food and Agriculture Organization of the United Nations, *Yearbooks of Food and Agricultural Statistics; Monthly Bulletins of Agricultural Economics and Statistics.*

This represents an increase of about one-third from 1934–38. All regions of the world shared in the gains, the largest increases being in Africa and North America.

The increased world production was the result of the increase of about one-fifth in harvested area coupled with about a 10% increase in average yields as compared to the 1934–38 period (Table IV). All regions except the near east and far east had higher average yields Increased yields in Europe, North America and Oceania permitted these regions to increase production substantially in spite of decreased areas harvested. What sketchy information was available on the U.S.S.R indicated it about kept pace with world increases in cereal production up to the middle 1950s. Extensive plans to increase grain production by adding to planted area and increasing average yields were under way.

Competition Among Grains.—As noted above, the percentage of cereals in human diets appeared to be declining, particularly in the western hemisphere and Europe. with some tendency for replacement by animal products Barley, corn and sorghum production grew at a faster rate than wheat and rice. while world rye production actually decreased (Table V). Only oats of the feed grains showed a very modest growth in production, probably because of the increasing replacement of horses with tractor power. The same general trends also applied to the U.S.S.R. where rye production decreased and strenuous efforts were under way to increase corn and other feed grain production.

While in some limited cases there may be substitution of corn for wheat or rice, resulting in a lower quality diet, the net effect of the rapidly rising production of feed grains should be an increase in the world animal numbers and a move to better quality diets. The increase in barley production was general over most of the world; however, a large share of the increase in corn and sorghums was concentrated in North America, which already had a high-quality diet. Africa and the far east also shared in the corn and sorghum increase.

Until the second half of the 20th century wheat had historically exceeded corn production because of its wide regional adaptability and high preference with consumers. The gradual increase in world real incomes and the slow replacement of cereal food by animal products in many areas permitted corn and sorghum production to expand faster than wheat after World War II. The gradual adoption of hybrid corn and sorghum varieties should both increase yields and permit extension of the corn and sorghum growing area. These developments should permit corn and sorghum to continue their rapid growth in production and compete successfully with other cereals for a larger share of both land area and total cereal production.

TABLE V.—*Indices of World (excl. U.S.S.R.) Production of Individual Crreal Crops, 1934–38, 1948–52 and 1954–56*

Crop	1934–38	1948–52	1954–56
Wheat	100	108.5	120.9
Rye	100	94.8	96.7
Barley	100	130.1	169.4
Oats	100	111.1	115.7
Corn	100	128.7	143.1
Millet and sorghum	100	117.6	147.5
Rice	100	107.4	133.9
Seven cereals	100	114.4	133.7

ARRANGEMENTS AND FUNCTIONS IN MARKETING

The marketing system for grain consists of a chain of intermediary firms which value, transfer title, store. process and transport the grain as it moves through the channels of trade from producers to consumers. The organization of the system varies somewhat among countries, but in general the following pattern is used by the major exporters.

The first points of assembly are local country elevators which buy from producers. From local elevators part of the grain is shipped to processors, but most of it goes to large terminal or subterminal elevators for storage and distribution to domestic users or exporters. Grain sold for overseas export is delivered to port elevators, from where it is shipped to port elevators in importing countries. In the major importing countries many processors have riparian locations in the port cities. Inland users procure their supplies by rail from the port elevators. (See also GRANARIES AND GRAIN ELEVATORS.)

The Marketing System.—In markets with flexible prices, the stimuli for keeping supply and demand in balance are provided by prices developed by the marketing system. The major function of an efficient price-oriented marketing system is to develop prices which perform the following functions:

First, guide production by reflecting to producers both short-term and long-term changes in demand with respect to kind, quantity and quality. The demand for grain is constantly changing with changes in consumer income, preferences. population. changes in price relative to competing commodities and improvements in processing and merchandising.

Second, move supplies through the channels of trade and into uses where the net return is highest. Grains have several alternative uses, and the marketing system must allocate available supplies to their highest value uses.

Third maintain economically justified stocks within and between marketing seasons. Stocks must be maintained to provide a continuous supply. but storage charges generally prevent stocks from being carried longer than from one marketing year to the beginning of the next, governmentally owned stocks excepted.

Fourth, reflect quality differences. To a large extent this is facilitated by grading systems which make possible different prices for different qualities.

Fifth. organize the marketing system as efficiently as possible and maintain marketing charges at a minimum.

Prices.—In order to perform these functions, prices must be free from manipulation and should deal alike with all producers, marketing firms and consumers. Prices should at all times accurately reflect all the forces of supply and demand. This implies perfect commercial intelligence, and an absence of price discrimination and monopoly control, but these conditions seldom, if ever, exist.

In actual operation the marketing system is affected by numerous institutional arrangements. These arrangements are designed to improve the functioning of the system and are generally thought to be in the interests of the countries concerned. National goals for self-sufficiency in grain production and a desire to protect domestic producers and consumers from adverse price changes take the form of various trade restrictions, export subsidies, price supports, governmental storage operations, consumer subsidies, etc. These arrangements give rise to administered prices. both governmental and private. and tend to make prices less flexible and of less importance in the marketing system.

Risk.—In markets with flexible prices risk is inherent in the ownership of grain. Grain must be owned as it moves from producer to consumer, and the owner is constantly confronted with monetary losses resulting from price declines unless such risk is shifted. To a large extent such risk can be shifted. Three methods are commonly employed. One is by forward sales by which the owner contracts to deliver a specified amount of grain or grain products (*e.g.,* wheat flour) at a specified time and place at a specified price. Another is by governmental pricing in which the price is set by the government, and owners of stocks no longer face the risk of losses resulting from price changes.

Risk can in many instances be shifted by hedging in the futures market. In hedging the owner makes an offsetting sale to speculative interests who then assume the risk. If the price of cash grain declines, the owner can usually recover at least part, if not all or more, of the loss by profit on his original sale in the futures market when he makes an offsetting purchase in the futures, or delivers on his sale in the futures.

The futures market is essentially an institution to assist in the determination of prices which will move supplies through the channels of trade. Prior to World War II the major futures market for wheat was the Liverpool market. In the second half of the 20th century international wheat prices have been largely determined by the United States governmental price policy. The range of fluctuation in the price of wheat tended to narrow, and the major market for futures shifted from Liverpool to Chicago. Other futures markets of primary importance are for rye and barley in Winnipeg, and for corn and oats in Chicago.

Other Arrangements.--Other important arrangements prerequisite to an efficient marketing system include a grading system and grades meeting the needs of the trade, a uniform system of weights and measures, organized and readily available trading places, provisions for arbitration in case of dispute concerning terms of contract, standardized forms of contract, ample credit facilities, determination of financial responsibility and a system for dissemination of information relating to the marketing system in general and to supply and demand factors in particular.

In markets not organized along lines of flexible prices, the functions of the marketing system are generally performed by governmental agencies. The functions that must be performed are essentially the same as those performed by price oriented markets. It is only the methods employed that are different.

See also AGRICULTURAL ECONOMICS.

TABLE VI.—*World Trade* in Wheat,† Rye, Rice, Barley, Oats and Corn, Geographical Regions and Selected Countries*

(in 000,000 metric tons)

Region or country	Wheat	Rye	Rice	Barley	Oats	Corn	Total
Per cent of world production exported	13.2	3.5	2.6	7.5	1.9	3.4	...
Gross regional exports:							
Europe	2.9	0.3	0.3	0.6	0.1	0.4	4.6
U.S.S.R.	0.7	0.2	‡	0.1	0.1	0.1	1.2
North and Central America	16.3	0.4	0.7	2.9	0.6	2.6	23.5
South America	3.5	0.4	0.2	0.6	0.4	1.3	6.4
Asia	0.7	‡	3.8	0.7	‡	0.2	5.4
Africa	0.4	‡	0.2	0.5	‡	1.1	2.2
Oceania	2.7	‡	‡	0.5	0.1	‡	3.3
World total5	27.2	1.3	5.2	5.9	1.3	5.7	46.6
Gross regional imports:							
Europe	15.0	1.2	0.5	4.3	0.9	-4.7	26.6
U.S.S.R.	0.2	‡	‡	‡	‡	‡	0.2
North and Central America	1.0	0.1	0.2	0.6	0.3	0.3	2.5
South America	2.8	‡	‡	‡	‡	‡	2.8
Asia	5.6	‡	3.9	0.9	‡	0.4	10.8
Airica	1.3	‡	0.3	‡	‡	0.2	1.8
Oceania	0.3	‡	‡	‡	t	t	0.3
World total§	26.2	1.3	4.9	5.8	1.2	5.6	45.0
Selected exporting countries:							
Denmark	‡	‡	‡	0.2	‡	‡	0.2
France	2.0	‡	‡	0.2	‡	‡	2.2
Germany, western	0.2	0.2	‡	‡	t	‡	0.4
Italy	‡	‡	0.2	‡	‡	‡	0.2
Canada	7.5	0.2	‡	1.6	0.3	‡	9.6
United States	8.8	0.1	0.6	1.3	0.3	2.6	13.7
Argentina	3.1	0.3	‡	0.6	0.4	1.2	j.6
Burma	‡	‡	1.7	‡	‡	‡	1.7
China, mainland	‡	‡	0.3	‡	‡	‡	0.3
Thailand	‡	‡	1.2	‡	‡	‡	1.2
Union of South Africa	‡	‡	‡	‡	‡	0.7	0.7
Australia	2.7	‡	‡	0.5	0.1	t	3.3
Total	24.3	0.8	4.0	4.4	1.1	4.5	39.1
Unspecified	2.9	0.5	1.2	1.5	0.2	1.2	7.5
World total5	27.2	1.3	5.2	5.9	1.3	5.7	46.6
Selected importing countries:							
Belgium-Luxembourg	0.6	0.1	0.1	0.5	0.1	0.4	1.8
Denmark	0.3	0.2	‡	0.3	0.1	‡	0.9
France	0.7	‡	0.1	0.1	‡	0.3	1.2
Germany, western	2.9	0.1	0.1	1.2	0.2	0.6	5.1
Netherlands	0.9	0.2	0.1	0.7	0.3	0.6	2.8
United Kingdom	4.8	‡	0.1	0.9	‡	1.5	7.3
United States	0.2	0.1	‡	0.6	0.2	‡	1.1
Brazil	1.7	‡	‡	‡	‡	‡	1.7
Ceylon	0.3	‡	0.4	‡	‡	‡	0.7
India	0.6	‡	0.4	‡	‡	‡	1.0
Indonesia	0.2	‡	0.4	‡	‡	‡	0.6
Japan	2.3	‡	1.1	0.8	‡	0.3	4.5
Malaya-Singapore	0.2	‡	0.5	‡	‡	‡	0.7
Total	15.7	0.7	3.3	5.1	0.9	3.7	29.4
Unspecified	10.5	0.6	1.6	0.7	0.3	1.9	15.6
World total§	26.2	1.3	4.9	5.8	1.2	5.6	45.0

*1954–56. Partly estimated. †Including wheat equivalent of wheat flour. ‡Less than .05 million metric tons. Not included in grain or world totals. §World export-import totals do not necessarily balance because of differences in reporting procedures, losses in shipment and variations in quantity afloat.

Sources: Food and Agriculture Organization of the United Nations, *Monthly Bulletins of Agricultural Economics* and *Statistics;* Statistical Office of the United Nations, *Commodity Trade Statistics;* Commonwealth Economic Committee, *Grain Crops.*

WORLD TRADE

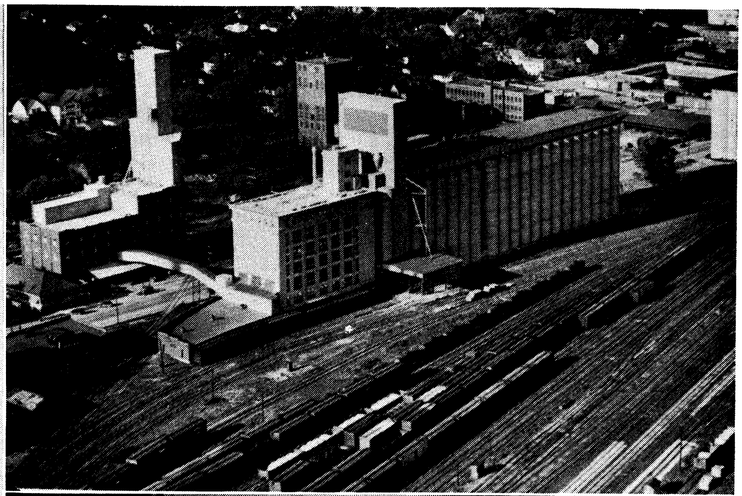
Most of the import supply of grain is utilized as human food, and only a relatively small proportion is used as animal feed and in industrial uses. The major food grains traded are wheat, rye and rice. The major feed grains are barley, oats, corn and sorghums and millets. The lower grades of wheat, a considerable proportion of rye. in addition to millfeeds (by-products of the milling industry), are also utilized as animal feeds and in industrial uses. Feed grains are also widely consumed as food in relatively low-income countries, but most imports are used as animal feed.

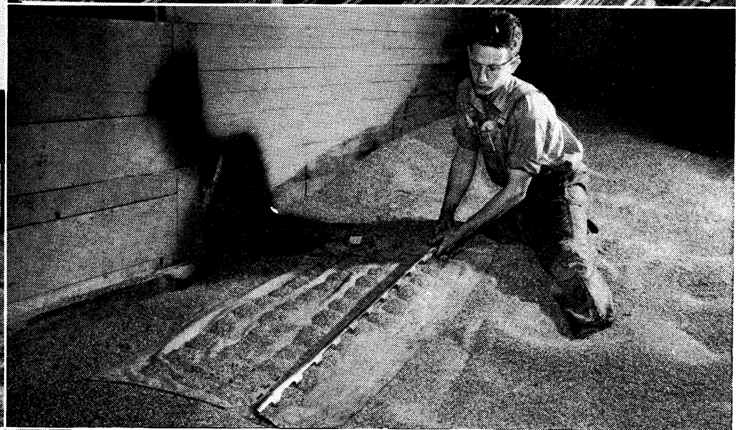
The largest exporting countries have a high per capita consumption of animal food products, a declining per capita consumption of grain as food, seaports within their territorial boundaries and, for the most part, relatively high per capita incomes. Grain used in the production of animal food products has a relatively low value use compared to its use as a human food. Because of the relatively stable consumption of grains as food in the major surplus areas, and its low value use as animal feed, the importing countries are able to outbid producers of animal food products for part of the grain supply in spite of generally higher transportation costs and, in many instances, lower per capita incomes. For many importing countries, imports supplement domestic production by serving as a source of grain with special characteristics, and by evening out swings in production. As a result many countries both export and import grain, as indicated by Table VI. Wheat in particular is imported by numerous countries. It is not produced in sufficient quantities in many countries and because it is used in many food products with wide consumer acceptance it has a world-wide market. For several countries (*e.g.*, western Germany, United Kingdom, Japan, Brazil) imports are a major source of supply because domestic production is consistently well below their requirements.

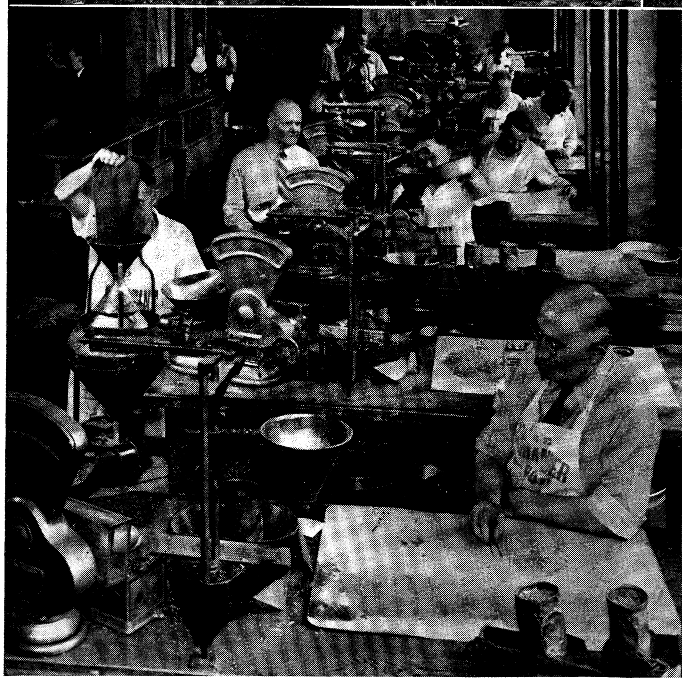
On a per capita basis trade in grains stagnated in the period following World War II. From 1934–38 to 1954–56, exports of the six grains listed in Table VI declined from 43 lb. to 38 lb. per capita. Smaller exports of the feed grains accounted for most of the decline, per capita exports declining from 14 lb. to 10 lb. Exports of the food grains declined from 29 lb. to 28 lb. Total rice exports declined 46% (4,400,000 metric tons) between the two periods, but total wheat exports increased 57% (9,900,000 metric tons). The larger wheat exports went largely to Asian countries who substituted wheat for rice because of the smaller supply of rice available for importation.

The stagnation in grain trade was due to both economic and institutional factors. Many countries, especially the relatively underdeveloped. found it necessary to use their holdings of foreign exchange for the importation of capital goods to implement industrialization programs and attempted to become self-sufficient in grain production in order to reduce imports. A few countries also reduced their per capita consumption in order to conserve their foreign exchange holdings. Other countries were able to increase production because of improved technology and cultural practices. Governmental subsidies in other instances resulted in increased production and a reduced dependence on imports. The formation of politically oriented trading blocs further tended to restrict international trade. Increased per capita incomes in western Europe, the major importing region, failed to increase net imports significantly because with higher incomes consumers substituted relatively expensive protective foods (primarily animal products and fresh fruits and vegetables) for starchy food grains.

The chief institutional arrangements which affect the pattern of world trade include import and export controls in the form of tariffs, quotas, embargoes, currency convertibility restrictions, cartel agreements and export and import subsidies. Other factors, such as production and marketing controls, production subsidies,







BY COURTESY OF (TOP LEFT, CENTRE RIGHT, BOTTOM LEFT) MINNEAPOLIS GRAIN EXCHANGE, (TOP RIGHT, BOTTOM RIGHT) BOARD OF TRADE OF THE CITY OF CHICAGO

GRAIN HANDLING AND TRADING IN THE UNITED STATES

Top left: Loading freight cars at rural elevator for shipment of grain to market centres

Top *right:* Large grain processing plant and storage tanks typical of the facilities in or near terminal market cities

Centre right: Taking a grain sample in a freight car. The metal probe collects grain at several locations and levels, assuring a typical sample for testing

Bottom left: State inspectors testing grain. Weight, moisture content, odour, presence of foreign matter and other factors determine the final grading of the sample

Bottom right: Futures trading on the floor of the Chicago board of trade. Cash sales are conducted at tables in background. Price quotations are indicated on the blackboard to the right, above

subsidies for diversion to lower value uses, etc., also affect production and consumption and thereby the pattern of world trade. The International Wheat agreement, first signed by participating countries in 1949 and periodically extended and modified subsequently, was designed to stabilize supplies and the price of wheat in international trade. Under this scheme signatory importing countries agreed to purchase a specified amount of wheat. usually about one-third of world trade, at a specified minimum price and the exporting countries agreed to supply this amount at a price of not more than the specified maximum price. The agreement had no provision for production controls, but United States domestic price supports and export subsidies stabilized the price of wheat in international trade.

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GRAINS OF PARADISE, the seeds of *Aframomum melegueta,* a reedlike plant of the Zingiberaceae family. also called guinea grains and Nelegueta pepper. It is a native of tropical western Africa, and of Prince's and St. Thomas islands in the Gulf of Guinea, and is cultivated in other tropical countries. The seeds are contained in the acid pulp of the fruit and have a glossy dark-brown husk, with a conical light-coloured membranous caruncle at the base and a white kernel. They contain a neutral essential oil. and a viscid, brown resin. Grains of paradise were formerly used as a drug and a spice. the wine known as hippocras being flavoured with them and with ginger and cinnamon. They are exported almost exclusively from Ghana.

GRAM or GRAMME, the unit of mass in the metric system, equivalent to 15.4323564 grains avoirdupois or to 0.2572 drachms (drams) or to 0.7716 scruples. This metric unit is very nearly equal (it was intended to be exactly equal) to the mass in a vacuum of one cubic centimetre of pure water at maximum density. The scientific definition of the gram. accepted by international convention, is that it be a mass of 1/1000 part of the mass of the "International Prototype Kilogram," a platinum iridium alloy block carefully preserved at the International Bureau of Weights and Measures at Sèvres, France. The gram of force is defined as g dynes of force where g is the acceleration of gravity. It is the *weight* of a gram of mass and varies slightly from place to place on the earth as the factor *g* varies. *See* WEIGHTS AND MEASURES.

GRAM or CHICK-PEA, called also Egyptian pea or Bengal gram. *Cicer arietinum,* so named from the resemblance of its seed to a ram's head. It is a member of the family Leguminosae (*q.v.*), largely cultivated as a pulse food in the south of Europe, Egypt and western Asia as far as India. but is not known undoubtedly wild. The plant is an annual herb with flexuose branches, and alternately arranged pinnately compound leaves, with small, oval leaflets. The flowers are borne singly in the leaf axils on a stalk about half the length of the leaf and jointed and bent in the middle; the corolla is blue-purple. The inflated pod, 1 to 1½ in. long, contains two roundish seeds. It was cultivated by the Greeks in Homer's time under the name *erebintlzos.* Alphonse de Candolle (*Origin of cultivated Plants*) suggests that the plant originally grew wild in the countries to the south of the Caucasus and to the north of Persia. In the east the seeds are eaten raw or cooked in various ways, both ripe and unripe, and when roasted and ground serve the same purposes as ordinary flour. In Europe the seeds are used as an ingredient in soups.

The seed of *Phaseolus Mungo,* or green gram. a form of which plant with black seeds is termed black gram. is an important article of diet among the labouring classes in India. A variety, *var radiatus,* also known as green gram, is perhaps the most esteemed of the leguminous plants of India. where the meal of its seed enters into the composition of the more delicate cakes and dishes. Horse gram, *Dolichos biflorus,* which supplies in Madras the place of the chick-pea. affords seed which. when boiled. is used as a food for horses and cattle in south India, where also it is eaten in curries.

GRAMINEAE, the grass family (*see* GRASSES), comprising about 450 genera and 4,500 species.

GRAMMAR. According to the definition given by Henry Sweet a grammar gives the general facts of language, while a dictionary deals with the special facts of language. But the two domains frequently overlap, so that one and the same fact finds its place in the grammar as well as in the dictionary; this is because in order to state a rule correctly we must also state its limitations, *i.e.*, the special cases in which it does not hold good. If we give the rule that English substantives form their plurals in *-s,* we must add that besides this regular formation we have the irregular plurals *men, women, oxen,* etc. And as languages are not constructed after ideal patterns, such exceptions to the rules must necessarily take up much space in all books on grammar.

To the ordinary man, grammar means a set of more or less arbitrary rules which he has to observe if he wants to speak or write correctly. This is especially the case if he is engaged in the study of a foreign language, but he is often led to the same point of view by the grammar of his own native language, as taught in schools. Grammar treated in this way may be called *normative* or *prescriptive* grammar.

But to the scientific grammarian the subject has a different aspect: to him the rules are not what he has to observe but what he observes (in a different sense) when he examines the way in which speakers and writers belonging to a particular community or nation actually use their mother tongue. His attitude toward linguistic phenomena is therefore much more that of a naturalist observing the facts of nature; he stands more objectively outside the language he is studying, and perhaps never has to form one single sentence in it for himself. This we term *descriptive* grammar.

The grammatical observer, like the observer in other fields, seeks, wherever possible, to go beyond the mere facts in order to find their explanation. This is the function of *comparative historical* grammar, a creation of the 19th century (*see* PHILOLOGY). Many things which seem strange from the point of view of merely descriptive grammar find their natural explanation when viewed in the light of earlier periods of the same language or of related languages. Take such an abnormal plural as *feet* from *foot:* the historian finds that its long vowel goes back through a regular phonetic development to an earlier *ōē* which, wherever it was found, was treated in the same way (thus in *feed, green, sweet*) and like other *ōē's* was a mutated form of a still earlier *ō*—the vowel that is better preserved in the singular *foot,* where, however, it has now been shortened and raised. The mutation was here, as elsewhere, because of the existence of an earlier *i* in the final syllable, which was dropped in all analogous cases. Now we know that the ending in the plural in the earliest Germanic was very often *-iz,* which corresponds to a still earlier *-es,* preserved in Latin and Greek; the form *feet,* which from the one-sided Modern English point of view was an isolated fact, is thus seen to correspond to the Greek plural πόδες and to be connected with that form through a long series of perfectly normal historical changes, which do not only affect such plural forms but find parallels in other words as well. The historical and comparative method of explaining grammatical facts has been carried to a rare degree of perfection, but it is clear that it can only be employed to the full where we have early linguistic documents of the same language or of nearly related languages to refer to. The great majority of languages are only known to us in quite recent stages; here, however, a similar method of explanation may be used if there are other now existing languages that are akin to that we are examining, and the comparative method then sometimes allows us within certain limits to reconstruct a common basis from which the several languages have started, as with the numerous African languages known as Bantu.

Grammatical reconstructions should always be made with great caution, for the ways in which languages develop are not always easy to calculate. We may take the Romanic languages (Italian, French, Spanish, etc.) as a test case: all these languages have been known to us for several centuries; now in some cases it would be possible from existing forms in them to infer what the common basis must have been, and the forms thus reconstructed would agree pretty closely with the forms of what we know to have been the basis, namely Latin; but the method fails utterly, as has been well remarked, with regard to many other forms: no one would be able, for instance, to conclude from the forms of Romanic substantives that Latin had ever had an accusative in *-m*, for the only remnant is French rien from Latin *rem* "a thing"—and that now means "nothing" and can no longer be called an accusative.

The method of comparative grammar was especially developed in the study of our own family of languages, the Aryan or Indo-European (*q.v.*) family, and at a certain stage of its development scholars were naturally tempted to dwell on and to a certain extent exaggerate those features that were common to these languages, and to take less account of features which were peculiar to one or a few of them. There was always a tendency to think that these were survivals of primitive common phenomena which were lost in the other languages of the group. This may be true in some cases, but more often we see that something found in one language only is a recent development that has really nothing to do with the rest of the family and may constitute a new grammatical type or phenomenon. Comparative grammar should therefore always be supplemented by separative grammar which does full justice to what is peculiar to each separate language and treats each on its own merits.

Differences of Structure.—Languages differ very considerably in their grammatical structure; subtle nuances which in one language are considered absolutely necessary are utterly disregarded in others. Things which we should naturally look upon as belonging necessarily to the grammar of any language, are in other languages either not expressed at all or expressed by means that are utterly different from ours. We have separate forms for the superlative, but French simply uses the comparative form with a defining word: mon meilleur ami, "my best friend," la chose la *plus nécessaire*, "the most necessary thing." Semitic verbs originally had no indications of the three time distinctions, past, present and future, but possessed two forms that showed whether an action was completed or not, no matter whether it was in the past, present or future time—distinctions which were later partly utilized to show time relations as well. Chinese substantives have no separate forms for singular and plural, and their verbs none for different tenses. Inversely, where we have only one "third person," American Indian languages very carefully distinguish between the first and second "third person" mentioned; the English sentence "John told Robert's son that he must help him" is capable of six different meanings which in Chippeway would be carefully distinguished by different forms of the pronouns for "he" and "him." Many languages have separate reflexive pronouns, like Latin se, himself, herself, themselves, suus his, her, their (own); these indicate identity with the subject of the sentence, but their sphere of application varies very considerably from one language to another; sometimes they refer to all three persons, sometimes only to the third, sometimes only to the singular, not to the plural, etc. In the oldest English we find sin as a reflexive possessive pronoun, but afterwards this solitary survival of the reflexive pronouns beginning with s disappeared from English, while such forms are still found in German, Scandinavian, etc.

Thus not only separate grammatical forms, but whole grammatical categories may be dropped in course of time. Generally this does not take place all at once but gradually, those forms which are in constant use being sometimes preserved for a long time after the others have been given up. The old Aryan (Indo-European) languages had separate forms for the dual number, distinct from the plural, but that distinction has been nearly universally lost. In Greek the dual was an archaism in Homer, though it lived on as a colloquialism in Attic till finally it disappeared there too. In the oldest English a few pronominal forms such as *unc* us two, *inc* you two, are the only survivals of a separate dual, and from about 1250 they go completely out of use. In Russian the dual, which ended in -a, has left some curious traces which are no longer felt as a separate number: some words denoting parts of the body which are found in pairs, form their plural in -a: *glaza* eyes, roga horns, etc.; after the numerals 2, 3, 4 a form that looks like a genitive singular is used instead of the usual plural form: it is the old dual in -a, which is extended to three and four.

In dealing with any definite period of a language it is important to state exactly which categories are found and which not. Old English had, but Modern English has not, a dative case. When the old forms were given up in the Middle English period, traces of them were still preserved in some survivals, *e.g.*, in Chaucer of towne (with e pronounced as a separate syllable), yeer by *yere*, by weste; a few isolated remnants exist still, though no longer felt as separate case-forms: *alive*="on life" (dat.), *Atterbury*="at the (dat.) borough." In a sentence like "he gave his children food" or a phrase like "from his children," Old English used the form *cildrum*, while the form was cildru in the nominative and accusative plural. Now the distinction has disappeared. To say that English still uses a dative case in these combinations is just as unhistorical as to say that Normandy and Massachusetts still form parts of the British Empire. This does not, of course, amount to denying that children in the sentence above is an indirect object, to be distinguished from the direct object (food). If we were to speak of a dative case here we might just as well say that in "Tom and Mary are children" the last word is grammatically in the dual number, but who would say this?

A word or form belonging to one grammatical category may in course of time be shifted insensibly into another one. Thus near at first was the comparative of nigh, with a superlative next; but in such a sentence as "Come near!" the meaning might be equally well taken as "closer" or "close," and thus the word passed into its modern use as a "positive" and it became possible to form a new comparative and superlative nearer, nearest, while the old superlative next was specialized in its use, and nigh became obsolete.

New grammatical categories may develop; examples are the English "expanded" or "progressive" tenses: he is running, was *running*, has been running, etc., as distinct from he runs, ran, has run. The distinction between "absolute" (primary) and "conjoint" (adjunctive) possessive pronouns, e.g., mine, yours as distinct from my, your, is another case in point. There is in some languages a tendency in regard to personal pronouns to merge the distinction of nominative and objective in that of conjoint and absolute, the old nominative being used only when it stands in immediate connection with a verb as subject, and the old objective in all other positions. This has become the rule in French, where je is used only in combinations like je dis, dis-je (I say, say I) and *moi*, which is the stressed form of the accusative me, is found in *c'est* moi and Qui *l'a* dit? Moi (Who said it? I). In Italian we see similar tendencies, and in modern colloquial English me tends to supersede the literary I in *It* is me and Who's there? Me.

As languages are thus seen to be in constant flux, and as grammatical categories may to a certain extent change from language to language and even from one period to another—and as exotic and "savage" languages possess many categories unknown to our European languages, it will easily be understood how injurious it is to a scientific conception of grammar to measure it always and everywhere by the same standard. But that is what grammarians of former centuries and even recent writers have been and are in the habit of doing; for Latin was for centuries the only language studied grammatically, and its privileged position made people think it a pattern by which to measure all other languages. Not only those languages that were similar in structure to Latin, but even the most heterogeneous languages were indiscriminately saddled with the elaborate Latin system of tenses and moods, and by means of such Procrustean methods the actual facts of many languages were distorted and misrepresented. Discriminations which had no foundation in reality were nevertheless insisted on, while discriminations that happened to be non-existent in Latin were apt to be overlooked. As A. H. Sayce writes in the 9th edition of the *Encyclopædia Britannica*, "The endeavour to find the distinctions of Latin grammar in that of English has only resulted in grotesque errors, and a total misapprehension of the usage of the English language." Happily things are improving very considerably in this respect.

Spoken and Written Language.—A modem philologist always looks upon the spoken language as the essential thing to study; in languages with a traditional spelling he must constantly be on his guard against misconceptions arising from that source. To the uniform English plural ending in the written words *kings, dukes, princes* correspond three different forms in the spoken language; on the other hand the French forms *(je) donne, (tu) donnes, (ils) donnent,* though differently spelt, are the same in sound, and thus in numerous cases. Many things of great grammatical importance, like intonation, stress, etc., are not shown in our traditional spellings. Grammars of spoken as distinct from written English have been written by Henry Sweet and Harold Palmer. Dialect grammars and grammars of the languages of uncivilized races deal of necessity only with spoken words.

THE SYSTEM OF GRAMMAR

Most grammars, at any rate most of those dealing with our own family of speech, are built up in the traditional way with the following main divisions:—

I. Phonology. This treats of the general theory of the sounds and sound-combinations of the language concerned, and expounds the orthography, where there is occasion.

II. Accidence or Morphology, the theory of forms (German *Formenlehre* is a better term than those used in English). This generally treats of the traditional "parts of speech" in their usual order, substantives, adjectives, etc. The main subject is the changes words undergo in flexion, paradigms being given which show all the forms of one and the same typical word; but the point of view is not pursued consistently, for under "numerals" we generally find an enumeration of all these words in their natural order, though most of them are subject to no formal changes.

III. Word-formation, dealing with prefixes, suffixes and other means of forming one word from another.

IV. Syntax, generally in its first part taking the parts of speech separately as in II. and stating the rules for the use of each case, tense, mood, etc. A second part then deals with word-order, etc.

This system, which varies a good deal in details, has been repeatedly criticized (by J. Ries, Noreen, Jespersen), but no other system has been universally accepted. In France, F. Brunot has proposed basing the teaching of grammar not, as is usually done, on the forms from which the pupils proceed to their syntactical use, but on the inner meanings expressed by grammatical phenomena, stating in each case secondarily the external forms, etc., which are used to express them.

As a matter of fact, grammatical phenomena can be viewed from two different angles: one that of the hearer (reader), to whom a certain series of sounds (letters) is presented, the inner meaning of which it is his task to understand: he begins from the outside and moves inwards; the other that of the speaker (writer) : he has certain ideas which he wants to communicate to others; he therefore has to choose the forms (sounds, etc.) that serve best to express these ideas: he moves from within to without.

We are thus led to the following two main divisions of grammar: I. The theory of Forms. II. The theory of Notions. Both deal with the same grammatical facts but from opposite points of view.

I. The Theory of Forms.—The following is a systematic survey of the external means used in languages for grammatical purposes.

(1) A simple sequence of words. This is seen, for instance, in compound substantives like *post-ofice.* The importance of the order in which words are arranged, is seen in cases like *garden-flower* and *)lower-garden,* where the first element limits and defines the meaning of the second, and in the distinction between *Paul loves Ann* and *Ann loves Paul,* where word-order shows which is subject and which object.

(2) "Empty words," *i.e.,* words which have no proper meaning of their own, but merely serve to indicate the relations of other words. Examples: of in "the father of the boy" (=the boy's father), "the City of Rome," "that scoundrel of a servant"; to in "I want to hear," "he refused food to the poor"; *that* in "I saw that he came," etc. There is no hard-and-fast distinction between full and empty words; *to* in "I give food to the poor" has still something of its local meaning found in "go to London," etc.

(3) Prefixes, e.g., *for-* in *forbid, be-* in *besiege.*

(4) Infixes, e.g., *n* in Latin *vinco,* cf. the perfect *vici,* English *stand,* cf. *stood, messenger,* cf. *message.*

(j) Suffixes, e.g., *-ness* in *goodness, -en* in *blacken;* these cannot be separated from such "inflexional endings" as *-s* in *kings, -en* in *oxen.*

(3) (4) *(5)* together may be termed affixes. The origin of some of these is quite obvious: they were at one time independent words joined to other words like those in (1). A word may easily be accentually subordinated to another with which it is continually combined, especially if the combination acquires a meaning of its own, independent of that of each element, as in *blackbird;* in *postman,* the vowel of the second element is obscured, and in other cases further phonetic changes take place; *gentlemanlike* and *gentlemanly* show two stages in the development of a suffix from what was originally an independent word; *for-* in *forgive* is an old preposition, though perhaps not exactly identical with the ordinary *for; be-* is a weakened form of *by.* But it is not all affixes that originate in this manner from independent words: *-en* in *oxen* originally belonged to the stem of the word in all its forms, and it was only through the accident of this syllable having been lost in the singular, but not in the plural, that it came to be felt as an affix to denote the plural number. The origin of most of our affixes is hopelessly obscure.

(6) Change in intonation, stress or quantity, e.g., *Yes?* with a rising tone in a question, *Yes* with a falling tone as an affirmative answer; *object* with varying stress according as it is a substantive or a verb.

(7) Consonantal changes, e.g., *send, sent; half, halve; use* as a substantive with unvoiced, as a verb with voiced consonant.

(8) Vocalic changes, e.g., *feed, fed; see, saw; man, men; drink, drank, drunk.*

(6) (7) (8) are phonetic changes, which may be due to the most different causes; some are recent, others go back to the most remote times; some have only in various circuitous ways acquired significative grammatical importance.

(9) Combined changes, affixes like those in (3) (4) (5) being joined to phonetic changes like those in (6) (7) (8). Examples: *forgot* (3) (8), *forgotten* (3) (8) (5), *drunken* (5) (8), *halves* (5) (7), *men's* (5) (8), *won't* (5) (7) (8).

(10) Supplementing with different stems: *I, me, we, us; am, is, was, been; good, better.*

Some languages make a more extensive use of some of these grammatical means than of others. Chinese uses scarcely anything but word order and empty words; some languages are predominantly prefix-languages, as for instance, the Bantu family; others predominantly suffix-languages, *e.g.,* Eskimo and Turkish. As will be seen from the examples, English uses all these means freely, though there are few examples of infixes.

We must here mention a classification of all the languages of the world according to their morphological system, which played a great rôle in the discussions of the 19th century, but has now been given up as superficial, namely, into (1) isolating languages or root-languages like Chinese, (2) agglutinative languages like Finnish and Turkish, which use affixes, but have no internal changes in the roots, (3) flexional languages like those of the Aryan and Semitic families. The last were also supposed to have gone through the isolating and agglutinative stages in their prehistorical development, while Chinese was thought to represent the earliest childlike linguistic structure. The latter supposition has been shown to be wrong, as the earliest Chinese in some respects was "flexional," and those hundreds of languages that were formerly classed together as "agglutinative" represent the most diverse types of morphological structure. The world is more complex than our ancestors imagined:

II. The Theory of Notions.—A comprehensive system of all the notions that find expression in language would be impracticable on account of the infinite complexity of mental and physical phenomena. But we are here concerned with those notions only that have found grammatical expression, and this makes our task somewhat less difficult, though far from easy. The following necessarily very brief survey does not claim to be either complete or final.

(1) Parts of speech. It is usual to divide words grammatically into the following classes and to define them somewhat as is here (very succinctly) indicated: —

(a) Substantives — denoting "persons" and "things."
(b) Adjectives — showing qualities.

Substantives and adjectives are often classed together as "nouns." but many grammarians make the term "noun" equivalent to "substantives," and do not comprise under it adjectives.

(c) Pronouns — used instead of nouns "to designate a person or thing already mentioned or known or forming the subject of inquiry." Various well-known subclasses: personal, demonstrative, relative, interrogative, indefinite. The so-called articles, as well as numerals, are best treated as subdivisions of pronouns.
(d) Verbs — denoting actions, states or happenings.
(e) Adverbs — serving to modify adjectives or verbs.
(f) Prepositions — marking relations between words.
(g) Conjunctions — used to connect clauses or to co-ordinate words in the same clause.
(h) Interjections-ejaculations, standing outside ordinary sentences.

This division and the definitions usually given have, however, been subjected to severe criticism and should not be taken at their face value. One of the chief difficulties with substantives is the existence of such words as arrival and *kindness,* which are undoubtedly substantives and are treated grammatically as such, but cannot be termed names of "things"; they represent "nexus" (see below). Adverbs, prepositions and conjunctions are best classed together as "particles."

(2) Rank. While the division under (1) concerns words separately, we here have a distinction that has regard to words or word-groups in combinations, namely into:

(a) Primary
(b) Secondary
(c) Tertiary — words or word-groups.

The three ranks to some extent, but only to some extent, correspond to substantives, adjectives and adverbs respectively. Secondary elements serve to modify or delimit primaries, tertiary elements to modify or delimit secondaries, as will be seen from the following examples in which those words or groups are italicized which belong to the rank under which they are classed: —

(a) The King's palace. The King arrived. I know when he arrived.
(b) The *King's* palace. *A* big palace. The palace that he built.
(c) A really big palace. I was present when he arrived.

The combination of a primary and a secondary element in the way exemplified under (b) is termed junction; the adjective or (relative) clause standing as secondary is called an adjunct. Tertiaries are also termed *subjuncts.*

(3) Other classifications. Many languages classify words in such a way that a class is indicated either in the word itself or in the form required in those adjuncts, etc., which belong to it. Sometimes the distinction is into animate and inanimate, sometimes into big and small things, sometimes into male, female and sexless; but such distinctions are rarely indicated with what we should call consistency; some languages, for instance, that have the main distinction "animate: inanimate," reckon certain parts of the human body as animate, others as inanimate. Sometimes it is impossible to see what is really the notional basis of a classification. When the distinction is connected with sex, as in most of the Aryan languages, we speak of gender; but the actual distinction between masculine, feminine and neuter gender does not correspond at all exactly with that between male and female beings and sexless things; very often it is impossible to discern why one word belongs to one gender rather than to another. In Old English, for instance, *stan* stone, *daeg* day, *finger, wifmann* woman were masculine; niht night, ecg edge, hand feminine; and *treow* tree, gear year, *blod* blood, wif wife neuter. This word-gender, which is still found in German, and which influenced the flexion of the words and the form of the article and adjective belonging to them, disappeared gradually from English in the Middle English period. In Semitic languages, the sex of the subject influences the form of the verb.

(4) Number: On the dual number see above. The distinction between "one" and "more than one" is very easy from a notional point of view, but not always so easy grammatically, partly because some things may be looked upon either as units (as German brille) or as composite (Engl. spectacles), partly from other causes. A collective is a word which though singular in form denotes a plurality, hence such anomalies as twenty police; cf. also "my family is an old one" and "my family are early risers." Number properly belongs to primaries only, but many languages require secondaries to agree in number with their primaries, e.g., *those* trees, and German die hohen baume the big trees, where in English the article and adjective are invariable. In English verbs the distinction has been given up in all past tenses, e.g., he went, they went (except he was, they were), in the present tense it is preserved in the third person only: I go, we go; *he* goes, *they* go.

(5) Person, *i.e.,* the distinction between the speaker, the person (or persons) addressed, and what is neither speaker nor spoken to. The distinction is shown in pronouns and in many languages also in the verb. The plural "we" does not mean two or more "first persons," but "I+you" or "I+some one or more persons besides," and some languages make a distinction according as the second person is included or not. Such a pronoun as French on, Engl. one, may be considered a "common person." (On reflexive pronouns, see above.)

(6) Space. Some languages have different forms according to distance from the speaker, etc. Case-forms denoting existence in or at a place and movement to, towards or from a place are very frequent. In our languages, with a view to greater precision, such case-forms were frequently supplemented by adverbs, and these in time became prepositions governing the cases which at first were sufficient in themselves to denote the spatial relation; eventually the case-endings were often dropped as superfluous.

(7) Time. With substantives the same means (case-forms, adverbs, prepositions) as are used to indicate spatial relations are as a rule also used to denote time relations. But with verbs many, or perhaps most, languages have separate means of denoting time-relations, which cannot surprise us, as the idea of time is naturally associated with that of action or happening. But while the notional division of time into past, present and future is quite simple, mankind has not, as a rule, found correspondingly simple grammatical expressions for time and its subdivisions, such distinctions as that between permanent and transitory, or between finished and unfinished, or between once and repeatedly, or between stability and change, or between resultative and non-resultative action being often inextricably connected with real time-indications in the "tenses" of verbs. Expressions for the future are often much more vague than those for the past, and frequently expressions which at first had and still to some extent have the meaning of volition or obligation or motion are made to do duty as a kind of future tense, as in "he will come," "I shall come," "they are going to start" (French "on va partir"), etc. Some languages have very elaborate tense systems with separate forms for imperfect, aorist, perfect, pluperfect, future in the past, etc., others rely more on the context or on adverbs for such nuances, if they are conceived at all.

(8) Comparison. The superlative ("strongest," etc.) is really a kind of comparative: "he is the strongest of the boys" means the same thing as "he is stronger than the other boys," the difference being only that the result in the former sentence is stated with regard to all boys, himself included, while in the latter he is excluded. A comparison results in expression of inequality or equality, as in "he is stronger than X" (a), "he is as strong as X" (b), "he is less strong than X" (c); of these (a)

and (c) are closely connected as they both denote inequality and therefore use the comparative. Many languages even for this sense use the positive form and say "strong from X" or the like.

(9) Nexus. This is a comprehensive term for the combination of two words (or word-groups) which stand to another in the relation of subject to predicate. The simplest case is a sentence with a subject and a verb, as "the doctor arrived" or with a subject, an "empty" verb ("copula") and a predicative, as "the doctor is clever." Compare also sentences without a verb like "Happy the man who. . . ." and "He a doctor!" There are other cases of nexus, in which the nexus does not in the same way as here form a whole sentence, but only part of one, as in "the doctor's arrival," "the doctor's cleverness," "(I saw) the doctor arrive," "(we thought) the doctor clever," "(we count on) the doctor to arrive," "(he slept with) the window open," "every thing considered (he must be clever)."

A nexus of a different kind exists between a verb and its object, as in "we saw the doctor," or its two objects, as in "we offered the doctor money." Further, the theory of nexus leads to a contemplation of the relation between the active and the passive expression for one and the same thought: what in the active turn is an object, is made into a subject in the passive turn: "the doctor was seen (by us)," "money was offered (to) the doctor," "the doctor mas offered money."

(10) Affirmation and negation. In some languages the verb has special forms for negation: this is to a certain extent true of English, especially in its colloquial form: *won't,* cf. *will, shan't,* cf. *shall;* note also the use of the auxiliary *do* in most negative sentences which contain no other auxiliary: "The doctor did not arrive."

(11) Subjective attitude of the speaker. By the side of simple ("flat") assertions me find others in which the speaker does not want to commit himself, but speaks with a certain hesitation, doubt, hope or fear. and such emotional repressions often manifest themselves grammatically, either in particles like Greek αν or in special forms of the verb (chiefly the subjunctive mood). The same means are frequently applied in conditioned clauses, which range from those in which doubt is not expressed at all or slightly hinted at, to those in which unreality is expressly indicated. In the latter kind some languages use a special conjunction, while others show that "the condition is rejected" by shifting the mood into the subjunctive and the tense into the preterite or by the latter means alone. In connection with this must be mentioned the expression of diffidence or modesty in questions like "Could you (Would you) lend me a pound?" as against the simple and direct "Can you (Will you) . . . ?" and the difference between the unrealizable wish in "Would he were still alive!" and the realizable wish in "May he be still alive !"

(12) Relation to the will of the hearer. In one class of utterances (ordinary statements and exclamations, for example) the speaker does not want to influence the will of the hearer. The aim of another class is to influence the will of the hearer, that is, to make him do something. This may be effected by requests, which range from brutal commands or orders through demands, implorations, invitations, etc., to the most humble entreaty or supplication. One of the linguistic forms for requests is the imperative, other forms are seen in "One minute!" and "Hands off !" Questions belong to requests, as they imply a request (command, prayer, etc.) to give the original speaker a piece of information. They are of two distinct kinds according to the existence or nonexistence of an "unknown quantity" expressed by means of an interrogative pronoun or adverb: "Who said that?" "What did he say?" and "When did he say that?" are examples of one kind, "Did he say that?" of the other kind. Questions, and requests generally, are naturally liable to those influences which were dealt with under (11) ; questions are likewise notionally related to negations, whence they often employ similar grammatical means; this is seen, for instance, in the English use of the auxiliary *do* in both kinds of sentences.

The system here given shows how a notional arrangement leads to the separation of things which in the ordinary grammatical system are placed together. Under case, accordingly, we have thinrs which have relation to junction (the chief use of the genitive is to make a word the adjunct of another word), to space (the so-called locative cases) and to nexus (nominative to denote the subject, accusative and dative, for various kinds of objects). Here, as elsewhere, we see that linguistic phenomena are capable of being viewed from different angles and that they present all kinds of intersections and overlappings.

In the treatment of each particular language we meet with units which are units neither from the purely formal nor from the purely notional point of view, but which nevertheless must be taken together as what might be called functional units. Take the English preterite: it is not a formal unit, because it is formed in different ways: *ended* from *end, sent* from *send, thought* from *think, put* from *put, saw* from *see, was* from *be,* etc. Neither is it a notional unit, for sometimes it indicates the past time pure and simple, sometimes unreality ("if he came"), or modesty ("Could you . . . . ?") or even future time ("it is time you went to bed"), and it has even more spheres of application. Yet all these formal and notional things go together and form one separate unit in English grammar, which is different from such units in any foreign grammar as in some ways correspond to it: in French, for instance, we have two or three tenses (*je finissais* and *je finis* or colloquially *j'ai fini* corresponding to I *ended),* each of which is a unit in the' same way as the English preterite is. But all the units we arrive at through our analysis of grammatical phenomena are at best symbols or shadowings of the innermost notional categories. (O. J.)

GRAMME: *see* GRAM.

GRAMONT, ANTOINE AGENOR ALFRED, DUC DE, DUC DE GUICHE, PRINCE DE BIDACHE (1819–1880), French diplomatist and statesman, was born in Paris, Aug. 14, 1819. He was educated at the École Polytechnique, but entered the diplomatic service. On May 15, 1870 he was appointed minister of foreign affairs in the Ollivier cabinet, and was thus concerned in the bungling of the negotiations between France and Prussia arising out of the candidature of Prince Leopold of Hohenzollern for the throne of Spain, which led to the disastrous war of 1870–71. The famous declaration read by Gramont in the chamber on July 6, the "threat with the hand on the s ord-hilt," as Bismarck called it, was the joint work of the whole cabinet; the original draft presented by Gramont was judged to be too "elliptical" in its conclusion and not sufficiently vigorous. The history of the affair is given by Emile Ollivier himself in his *Empire libéral* (vol. xii, 1909). It was Gramont who pointed out to the emperor, on the evening of the 12th, the dubious circumstances of the act of renunciation of the prince of Hohenlohe-Sigmaringen on behalf of his son. On the same night, without informing Ollivier, he dispatched to Benedetti at Ems the fatal telegram demanding the king of Prussia's guarantee that the candidature would not be revived. The supreme responsibility for this act must rest with the emperor, "who imposed it by an exercise of personal power on the only one of his ministers who could have lent himself to such a forgetfulness of the safeguards of a parliamentary régime." says Ollivier.

Gramont resigned office with the rest of the Ollivier ministry (Aug. 9) and after the revolution of September went to England, returning after the war to Paris, where he died on Jan. 18, 1880. He published various apologies for his policy in 1870, notably *La France et la Prusse avant la guerre* (1872).

GRAMONT, PHILIBERT, COMTE DE (1621–1707), French courtier of Gascon origin, the hero of Anthony Hamilton's *Mémoires du comte de Grammont,* was the younger son of Antoine II de Gramont, viceroy of Navarre, whose mother Diane d'Andouins, comtesse de Gramont, called "la belle Corisande," had been a mistress of Henry IV of France. Philibert was educated for the church but preferred a secular career. Known at first as the chevalier de Gramont, he served in the French army at the siege of Trino in Piedmont under Thomas of Savoy (1643) and in Germany under his half-brother the marshal Antoine III de Gramont and under the duc d'Enghien. When the latter became prince de Condé he gave Gramont a high post in his household. Gramont remained with Condé's faction during the Fronde until 1654, when he made his peace with the French government after Condé's withdrawal to the Spanish Netherlands. In 1662, however, he was exiled from France — some said for competing with Louis XIV for Mlle. de la Mothe-Houdancourt's favours. Arriving in England in Jan. 1663, he found a congenial atmosphere at Charles II's court. There he paid such attentions to the beautiful Elizabeth Hamilton, his future biographer's sister, that her brothers made him marry her in Dec. 1663. Allowed to return to France in 1664, he made three visits to England (1670–71) in connection with the negotiations preceding and following the treaty of Dover. Between campaigns in the Dutch Wars of 1672–78 he was in England again in 1676; he conveyed Louis XIV's congratulations to James II on the birth of a son in 1688. In his old age he provided Anthony Hamilton (*q.v.*) with the material for the *Mémoires.* After an apoplectic stroke in 1706, he died in Paris in the night of Jan. 29–30, 1707.

Hamilton portrays his hero candidly but with such skill that Gramont's grand air imposes on the reader just as it did on his contemporaries. But the subject matched the artist. Hamilton calls him an inimitable character, an amazing compound of good and bad, in fact *"l'admiration de son siècle"* (the wonder of his age). Even Gramont's enemies agreed as to his wit, impudence and ebullience. He was the sort of man about whom stories gather. He scandalized those about his deathbed who were repeating the Lord's Prayer, by remarking that it was a beautiful prayer, who had written it? He would seem to be the original of the outburst that Gascon noblemen would never have deserted Christ as His disciples, common fishermen, did. The duc de Saint-Simon, who hated him and accuses him of cowardice, has left a living picture of this "vieux sacripant de cour et de monde" (old court and society blusterer) with the face of an old monkey and never-failing success with ladies and with kings. a man to whom "everything was permitted and who permitted himself everything."

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GRAMOPHONE: see PHONOGRAPH.

GRAMPIANS, THE, mountains forming a part of the Scottish Highlands. The name is applied by some authors to the whole mountain mass lying between Glenmore and the great fault which runs from Stonehaven on the North sea to Dumbarton on the Clyde. This is now more frequently called the Central Highlands. Others limit its application to the southern edge of this mountain mass where it overlooks the Lowlands. The name originated in a misreading of Mons Graupius, the site (not ascertained) of the battle in which Agricola defeated the Picts in about A.D. 83–84. This was shown on Hector Boece's map of 1527 as Mons Grampius. On historical grounds the latter usage therefore would appear to be the more correct. This southern edge is the most striking relief feature in Scotland. From the Lowlands it presents the appearance of a continuous mountain range, stretching for over 100 mi. without a break and including peaks reaching to over 3,000 ft. (Ben Lomond 3,192, Ben Alder 3,757). It is not, however, the formidable barrier it appears for it is broken by deep, if narrow, passes such as the Pass of Leny, the Pass of Killiecrankie and the Spittal of Glenshee. The rocks are chiefly schists and gneisses with some granite masses.

A mountain range in southwest central Victoria, Australia. is also called the Grampians. (T. HER.)

GRAMPUS (Grampus orca), a cetacean belonging to the *Delphinidae* or dolphin family! characterized by its rounded head without distinct beak, high dorsal fin and large conical teeth. The upper parts are nearly uniform glossy black, with a white eye-stripe and the under parts white. The animal is also known as the "killer," in allusion to its ferocity in attacking its prey, which consists of fishes: seals. porpoises and the smaller dolphins. It is very voracious. In the antarctic several will combine to break the ice in order to throw their prey (and, it is said, even men) into the water where they can kill it. These cetaceans sometimes hunt in packs and commit great havoc among the belugas (*q.v.*) and other whales. The grampus inhabits hoth northern and southern regions and is common in British waters. The number of species is doubtful, but only one is usually recognized. *Grampus* was formerly used as the generic name of Risso's dolphin. See WHALE.

GRANADA, LUIS DE (c. 1504–1588), Spanish Dominican preacher and spiritual writer, who made important contributions to teaching on Christian perfection, was born of poor parents at Granada, where he entered the order in 1524. He became prior at Cordoba (1544) and Badajoz (1554) and provincial of Portugal (1556–60). He was spiritual adviser to Queen Catherine of Portugal. He died at Lisbon on Dec. 31. 1588.

Luis' principal works, important also as Spanish prose: are: *Libro* de la oracidn y meditacidn (1554), on methodical prayer, akin to the systems of Ignatius Loyola and Garcia de Cisneros; *Guia* de pecadores ("Sinners' Guide," 1556), on practical Christian virtue (hoth proscribed by the Inquisition in 1559. when any vernacular devotional book was suspected of illuminism, but reinstated in 1564); *Memorial* de la *vida christiana* (1566) and *Adi*ciones to it (1574), on prayer. Spiritual classics that have enjoyed lasting popularity, they were translated during his lifetime into Latin, French, Italian and English (by R. Hopkins, 1582), and were esteemed by St. Teresa of Avila and St. Francis of Sales. Luis also published sermons. catechetical works, biographies and a translation of the *Imitation of* Christ. A critical edition of his works by J. Cuervo was published in 14 volumes (1906–08).

See biography *by* J. Cuervo (189;) ; E. A. Peers, *Studies* in *the Spanish Mystics*, vol. i, 2nd ed. (1951); M. H. Lavocat in A. Vacant, *Dictionnaire de théologie catholique* (1926), s. v. Louis. (S. BII.)

GRANADA, a department and city in Nicaragua. Central America. The department has an area of 541 sq.mi. and a population (1959 est.) of 70.257. It is bounded on the north by the department of Managua. on the west by Masaya and Carazo, Rivas on the south and Lake Nicaragua on the east. It is crossed by the Pan American highway and the Pacific railroad. The clustered islands on the lake near Granada called Las Isletas (the little islands) are famous for their beauty and are favourite excursion spots for the Granadinos.

Principal towns besides the capital city, are Nandaime and Diriomo. Main products are cattle and hides, cacao, sugar, cotton, rice and coffee.

GRANADA, the city, capital of the department and terminus of the Pacific railroad from the port of Corinto, is 36 mi. S.E. of Managua, the national capital. Pop. (1959 est.) 31.648. It lies at an altitude of 180 ft. above sea level near Mombacho volcano, on the northwest shores of Lake Nicaragua where steamers and launches connect it with the lake towns. Granada is remarkable for its churches, schools and institutions, including the Colegio Centro-América founded by the Jesuits. It is the seat of the bishop and as headquarters of the Conservative party has greatly influenced the political life of the country.

The city is typically Spanish and is laid out on a rectangular gridiron style. The houses are mostly one story, but include many fine mansions of the old families; the churches are massive and some are ornate.

Granada was founded in 1523 by Francisco Hernández de Córdoba and early became the hub of the Conservative life and trade of the region. From earliest times it has been a keen political and trade rival of Leon (*q.v.*), farther north, the centre of the Liberal party and now a more prosperous and populous business rival of Granada. Managua (*q.v.*) was founded between the two older cities as a political compromise. Granada was raided by pirates from the Caribbean many times in the 17th century. William Walker (*q.v.*) the U.S. filibuster: made Granada the centre of his attacks and his headquarters; he sacked and burned the city in 1857. (M. F.-G.)

GRANADA, a maritime province of southern Spain, formed in 1833 of districts belonging to Andalusia, and formerly centre of the ancient kingdom of Granada. Pop. (1960 est.) 828.525: area 4.838 sq.mi. Granada is bounded on the north by Córdova, Jaén and Albacete, east by Murcia and Almería, south by the Mediterranean sea and west by Málaga. It includes the western and loftier portion of the Sierra Nevada (*q.v.*), a vast ridge rising parallel to the sea and attaining its greatest altitudes in the Cerro de Mulhacén (11,411 ft.) and Picacho de la Veleta (11,128 ft.), which overlook the city of Granada. Lesser ranges, such as the sierras of Parapanda, Alhama, Almijara, Harana or Baeza, adjoin the main ridge. In this central watershed rise the three principal rivers of the province. Southward flows the Guadalféo to the Mediterranean, westward the Genil and northward the Guadiana Menor and its many tributaries draining the northeastern districts. Both the Genil and the Guadiana join the Guadalquivir outside the province. Summer drought predominates and only the mountain slopes are forested, mainly with pine trees. The soil of the high basins north of the Sierra is, however, fertile, that of the Vega of Granada being considered the richest in the whole peninsula, and from the days of the Moors it has been systematically irrigated. Sheep and goats are reared in the Sierra and esparto grass is obtained from the upland areas. Fine alabaster, jasper and other precious stones occur in the mountains behind Granada, but are little worked. The only important industry is sugar refining. This developed rapidly after the loss of the Spanish West Indies and the Philippine Islands in 1898, with the consequent decrease in competition, and there are now factories in many towns. especially in the Vega and along the coast.

See also ANDALUSIA and, for the history of the ancient kingdom, the city of GRANADA.

GRANADA, the capital of the province, and formerly of the kingdom of Granada, in southern Spain; on the Madrid-Granada-

Algeciras railway. Pop. (1950) 154,589. Granada is well situated, 2,195 ft. above the sea. on the northwestern slope of the Sierra Nevada. overlooking the fertile lowlands known as the Vega de Granada on the west and overshadowed by the peaks of Veleta (11.128 ft.) and Mulhacén (11,411 ft.) on the southeast. The southern limit of the city is the river Genil, the Roman *Singilis* and Moorish *Shenil,* a swift stream flowing westward from the Sierra Nevada, with a considerable volume of water in summer, when the snows have thawed. Its tributary, the Darro, the Roman *Salon* and Moorish *Hadarro,* enters Granada on the east. flows for more than a mile from east to west and then turns sharply southward to join the main river. which is spanned by a bridge just above the point of confluence. The waters of the Darro are much reduced by irrigation works along its lower course. and within the city it has been canalized and partly covered with a roof.

Granada comprises three main divisions, the Antequeruela, the Albaicin and Granada, properly so-called. The first division, founded by refugees from Antequera in 1410, consists of the districts enclosed by the Darro, besides a small area on its right, or western, bank. It is bounded on the east by the gardens and hill of the Alhambra (*q.v.*), the most celebrated of all the monuments left by the Moors. The Albaicin (Moorish *Rabad al Bayazin,* "Falconers' Quarter") lies northwest of the Antequeruela. Granada, properly so-called, is north of the Antequeruela, and west of the Albaicin. The origin of its name is obscure; it has been sometimes derived from *granada,* a "pomegranate," in allusion to the abundance of pomegranate trees in the neighbourhood. A pomegranate appears on the city arms. The Moors, however, callec! Granada *Karnattah,* or *Karnattah-al-Yahud,* and possibly the name is composed of the Arabic words *kurn,* "a hill," and *nattah,* "stranger" — the "city" or "hill of strangers."

Granada is the see of an archbishop. Its cathedral, begun in 1529 by Diego de Siloe, and finished only in 1703, is profusely ornamented with jasper and coloured marbles, and surmounted by a dome. The interior contains many paintings and sculptures by Alonso Cano (1601–67), the architect of the fine west façade, and other artists. In one of the numerous chapels, known as the Chapel Royal (*Capilla Real),* is the tomb of Ferdinand and Isabella, the first rulers of united Spain. The Cartuja, or Carthusian monastery, north of the city, was built in 1516 in memory of the great captain Gonzalo de Córdoba (1453–1515), whose tomb is in the convent of San Jeronimo.

After the Alhambra, and such adjacent buildings as the Generalife and Torres Bermejas, which are more fitly described in connection with it, the principal Moorish antiquities of Granada are the 13th-century villa known as the Cuarto Real de San Domingo, admirably preserved and surrounded by beautiful gardens; the Alcazar de Genil, built in the middle of the 14th century as a palace for the Moorish queens; and the Casa del Cabildo, a university of the same period, converted into a warehouse in the 19th century. Granada has an active trade in the agricultural produce of the Vega, and manufactures liqueurs, soap, paper and coarse linen and woollen fabrics.

History. — The identity of Granada with the Iberian city of *Iliberris,* or *Iliberri,* which afterward became a flourishing Roman colony, has never been fully established; but Roman tombs, coins, inscriptions, etc., have been discovered in the neighbourhood. Under the caliphs of Cordova the family of the Zeri, Ziri or Zeiri maintained itself as the ruling dynasty until 1090; it was then displaced by the Almorávides, who were in turn overthrown by the Almohades, in 1154. The dominion of the Almohades continued unbroken, save for an interval of one year (1160–61), until 1229. From 1229 to 1238 Granada formed part of the kingdom of Murcia; but in the last-named year it passed into the hands of Abu Abdullah Mohammed ibn Al Ahmar, prince of Jaen and founder of the dynasty of the Nasrides. Al Ahmar was deprived of Jaen in 1246, but united Granada, Almeria and Malaga under his sceptre, and made peace with Castile. Al Ahmar and his successors ruled over Granada until 1492, in an unbroken line of 2j sovereigns. Their encouragement of commerce — notably the silk trade with Italy — rendered Granada the wealthiest of Spanish cities; their patronage of art, literature and science attracted many learned Muslims such as the historian Ibn Rhaldun and the geographer Ibn Batuta, to their court, and resulted in a brilliant civilization, of which the Alhambra is the supreme monument.

The two noble families of the Zegri and the Beni Serraj, better known in history and legend as the *Abencerrages* (*q.v.*), encroached greatly upon the royal prerogatives during the middle years of the 15th century. A crisis arose in 1462, resulting in the dethronement of Abu Nasr Saad, and the accession of his son Muley Abu'l Hassan, whose name is preserved in that of Mulhacen, the loftiest peak of the Sierra Nevada. Muley Hassan weakened his position by resigning bfalaga to his brother Ez Zagal, and incurred the enmity of his first wife, Aisha, by marrying a beautiful Spanish slave, Isabella de Solis, who had adopted the creed of Islam and taken the name of Zorayah, "morning star." Aisha, or Ayesha, who thus saw her sons, Abu Abdullah Mohammed (Boabdil) and Yusuf, in danger of being supplanted, appealed to the Abencerrages. *(See* ALHAMBRA.) In 1482 Boabdil deposed his father, who fled to Malaga, but the Christians under Ferdinand and Isabella forced him to resign the task of defense into the more warlike hands of Muley Hassan and Ez Zagal (1483–86). In 1491 Boabdil signed away his kingdom; and on Jan. 2, 1492, the Spanish army entered Granada, and Moorish power in Spain ended. Nationalists captured Granada during the civil war of 1936–39.

GRANADOS, ENRIQUE (1867–1916), Spanish pianist and composer. was born at Lérida on July 27, 1867. After studying at Barcelona with Joan Pujol and Felipe Pedrell. he went to Paris in 1887, where he worked chiefly under Charles Wilfred de Bériot. In 1898 his first opera, *Maria del Carmen,* was produced in Madrid. Two years later he founded the Sociedad de Conciertos Clásicos and. in 1901, the Academia Granados. He had a brilliant career as a pianist, playing chiefly in France and Spain, but visiting the United States in 191j and 1916. when his opera *Goyescas* was performed in New York city. On his return he met his death in the English channel on board the "Sussex," which was sunk by a German submarine on March 24, 1916.

Granados' most characteristic writing is to be found in his piano music, which is full of the colour and rhythm of Spanish folk tunes. Especially in the *Goyescas*—two sets of pieces from which he took much of the material for his opera of that name—he produced melodies of great beauty, drawing inspiration from Francisco Goya's paintings and etchings, and the life of the period in Madrid. Among his other piano compositions are 12 Spanish dances, 3 sets of children's pieces, 6 pieces based on Spanish folksongs, *Romantic Scenes, Poetic Scenes, Book of Hours* and *Expressive Studies.* His remaining operas are *Petrnrca, Picarol, Follet, Gaziel* and *Liliana.* He also wrote a symphonic poem, *La cl del mort;* another on Dante's *Divina commedia;* and suites for orchestra; a suite, *Elisende,* for piano and orchestra; and three sets of songs. (E. W. BM.)

GRANARIES AND GRAIN ELEVATORS. Grain storage facilities range widely from simple provisions—in certain dry climates grain is sometimes stored in piles on the ground—to elaborate structures with equipment for mechanical filling and emptying, turning, blending, weighing. fumigating. drying or ventilating. Some buildings are for storing only a few bushels; others have capacity for several million bushels.

The character of a grain storage, as well as its size, depends upon the service required of it. On a livestock farm the granary usually has several separate bins for the various kinds of grain to be fed. Each bin may be filled or partly filled several times a year. Usually grain will not be stored for more than one season. The bins may be emptied a little at a time. and convenience of location for feeding and easy accessibility for removing grain are important.

On cash grain farms, from which most of the grain is sold, storage bins are for disposing of the grain at harvest time until it is sold later in the season. In this case ease of filling is most important. Larger grain storages on farms have built-in elevators but portable elevators or conveyors came to be used extensively.

Country elevators, located in smaller towns. serve to collect grain from farmers and ship it to terminals. Little grain is held for long periods. They are equipped with scales and with conveying equipment for filling, emptying and blending. They frequently also have driers.

Terminal elevators are the grain storages located at railroad centres. They collect grain from the producing areas and supply the processors and feed mixers and distributors in deficit areas. The terminal elevators have many separate bins and usually are of concrete construction. A typical bin may be 100 ft. deep and 20 ft. in diameter. Sloping floors are used so that the grain may drain out by gravity. Conveyor systems are installed so that grain may be moved into or out of the building or from any bin to any other.

In the United States during the 1930s the federal government entered into a program of grain price stabilization which resulted in government acquisition of large quantities of some grains to be held for relatively long periods. Other governments have taken more or less similar action. This results in the need for still another class of grain storage buildings where grain may be held for several years or at any rate for a longer period of time than had been the customary practice. Such storages are located on farms on government-owned bin sites or at grain elevators where they are operated in conjunction with storage and merchandising functions of the elevators.

In addition there are special storage facilities for segments of the grain industry. The storage of seed grains, for example, has special requirements. It is necessary in this case to avoid mixing of various lots since even a few kernels of the wrong variety may reduce the value of the lot.

Each kind of grain imposes its own requirements on storages and handling equipment. For example, rice is customarily harvested before it is dry enough to store; thus rice storages must have driers. Frequently rice is dried and stored in the same establishment where it is later milled.

Control of **Moisture** Content. — All grains contain water even when they are what is called dry. A bushel of wheat as ordinarily handled or stored contains about three quarts of water. Control of moisture content is important in successful storage of grains. Moulds develop and insects thrive in grain only if it has enough moisture for their needs. The safe limit of moisture is usually between 10% and 15%, depending on the kind of grain, the climate and the length of storage period. Since grains do not lose moisture readily when stored in bulk, it is important to accept for storage only grain that has been tested for moisture and found dry enough to keep.

One of the problems in storage of grains in large bins is the movement of moisture from one part of the bulk to another. This may occur even in grain that is initially dry enough for safe storage. The local increase in moisture results in caking or moulding and favourable conditions for insect breeding. The causes of the increase in moisture at the upper surface came to be understood only relatively recently.

The temperature of the interior grain in a large bin changes much more slowly than the atmospheric temperature. By late summer or fall the grain reaches its maximum temperature. The top surface and outer layers cool as winter approaches, but the centre stays relatively warm. About 40% of the space in a full bin is occupied by the air between the kernels, so there is a column of warm air in the centre of the bin surrounded by colder air near the walls. Since the warm air at the centre is light, it moves upward through the grain, being replaced by the colder heavier air near the walls which moves downward. This movement is very slow, but it continues as long as the temperature difference persists, which may be for several months. This continuous stream of warm air must pass through the grain at the top surface which, during the fall and winter. is cold. On coming in contact with the cold surface grain some of the moisture from the warm air is condensed or absorbed on the cold grain. The slow increase in grain moisture content at the surface continues for several months and may result in serious damage.

The damage from moisture migration usually is limited to the top foot or two, but it becomes a possible source of insect infestation. In elevators the grain can be turned, that is, moved from one bin to another.

If the grain is turned before serious increase in moisture has occurred, the surface grain will be mixed with the rest. At the same time the warm and cold grain will be mixed together so that convection air currents will be checked temporarily. Turning, however, affords only temporary relief. Repeated turning damages the grain by breaking kernels.

From the late 1940s onward mechanical ventilation was used to prevent damage from moisture migration in both elevators and storages of intermediate size when storing large quantities of grain for several years. A fan draws air downward through the grain during cooler months. This eventually cools the grain to near the atmospheric temperature, and at the same time the natural upward convection is reversed so that warm air cannot contact the cold grain at the surface. (W. V. Hl.)

GRANBY, JOHN MANNERS, Marquess of (1721–1770), British soldier. the eldest son of the third duke of Rutland, was born in 1721, educated at Eton and at Trinity college, Cambridge, and elected M.P. for Grantham in 1741. He received a commission as colonel of a regiment raised to assist in quelling the Highland revolt of 1745. This corps never got beyond Newcastle, but as a volunteer on the duke of Cumberland's staff Granby saw active service in the last stages of the insurrection. He was in the Flanders campaign of 1747, was promoted major-general in 1755, and three years later was appointed colonel of the Royal Horse Guards (Blues). He had married the daughter of the duke of Somerset, and in 1754 had begun his parliamentary connection with Cambridgeshire, for which county he sat until his death.

Dispatched to Germany in 1758 during the Seven Years' War, he was at the battle of Minden and succeeded to the command of the British contingent after Lord Sackville's disgrace. On July 31, 1760, Granby stormed Warburg at the head of the British cavalry, capturing 1,500 men and ten pieces of artillery. A year later (July 15, 1761) the British defended the heights of Vellinghausen with great bravery, and in the last campaign Granby's men bore the brunt of the fighting.

Returning to England in 1763 the marquess found himself the popular hero of the war. He was appointed to the Ordnance on July 1, 1763, and three years later he became commander in chief. In this position he was attacked by "Junius." He died at Scarborough on Oct. 18. 1770.

Two portraits of Granby were painted by Sir Joshua Reynolds, one of which is now in the National gallery, London. His contemporary popularity is indicated by the number of inns and public-houses which took his name and had his portrait as signboard.

See W. E. Manners, *Some Account of the Military, Political and Social Life of the . . . Marquis of Granby* (London, *1899).*

GRAN CHACO, an extensive region in the heart of South America belonging to the La Plata basin, stretching from 20° to 29° S. lat. Its area is estimated at 300.000 sq.mi. The greater part is covered with marshes, lagoons and dense tropical jungle and forest. and is still unexplored. On its southern and western borders there are extensive tracts of open woodland, intermingled with grassy plains, while on the northern side in Bolivia are large areas of open country subject to inundations in the rainy season. It is traversed by two great rivers, the Pilcomayo and Bermejo, the sluggish courses of which are not navigable. The greater part of its territory is occupied by nomadic tribes of Indians, some of whom are still unsubdued, while others like the Matacos, are sometimes found on neighbouring sugar estates and *estancias* as labourers during the busy season. The forest wealth of the Chaco region is incalculable, consisting of a great variety of palms and valuable cabinet woods, building timber, etc. Its extensive tracts of *quebracho colorado* (*Loxopterygium Lorentzii*) are of very great value because of its use in tanning leather. Both the wood and its extract are largely exported. Its possession was the cause of serious dispute and armed conflict between Bolivia and Paraguay between 1928 and 1935. (See Chaco.)

GRAND, SARAH (pseudonym of Frances Elizabeth [Clarke] M'Fall) (1855?–1943), British novelist and suffragist, was born in Ireland of English parents.

She travelled in the orient, visiting Japan and China. for five years and in 1888 published *Ideala*. She was best known for the novel The *Heavenly Twins* (1893), a best seller. Sarah Grand was a pioneer in the movement to gain suffrage for women in Great Britain and repeatedly served as mayor of Bath, Eng. She died at Calne, Wiltshire, on May 12. 1943

GRAND ALLIANCE, WAR OF THE, sometimes called the WAR OF THC LEAGUE OF AUGSBURG, a war fought by England. Holland the Holy Roman emperor and a number of other allies against France between 1689 and 1657. The uncertainty over its name is reflected in a similar misunderstanding about the mar's aims, character and results. To this misunderstanding the lack of skill of the military commanders and the ineffectiveness of their methods of making war have been held to have contributed. The French commanders have suffered by comparison with the great Condé and the maréchal de Turenne, who had disappeared from the scene. the one retired and the other killed, in 1675; and William III's reputation as a soldier has been eclipsed by that of Marlborough. Sieges rather than battles appear to have marked the progress of the war, with results obviously less striking to the modern eye Yet the deadlock which characterizes the war was not so much military as diplomatic. The Spanish succession (see SPAIN *History)*, on which the balance of poner betneen Bourbon and Habsburg in Europe depended was perhaps its main issue; and so long as Charles II of Spain remained alive (against every reasonable expectation), this question could not be settled. any war fought in the meantime being only an interlude in which the great powers sought to strengthen their bargaining position against the day when Charles should at last die If, then, rhere was for the time nothing important to fight about. it is not surprising that the generals found it difficult to achieve anything by fighting. But war could not easily be avoided since in its absence the circumstances of the rival powers might alter drastically Thus Louis XIV's ambitions depended upon the emperor Leopold I's being unable to exert full authority over the German princes and upon his entanglement with the Turks on his eastern frontier. Louis dared not allow his adversary a lengthy interval of peace in which he might extricate himself from his difficulties. In a sense then, Louis nas throughout his reign the aggressor. Yet from a major war he could hope for nothing, for. if Charles of Spain were to die while he was so engaged, his enemies mould allow him nothing from the Spanish inheritance. Thus it was that he began in 1688 the hostilities in the Palatinate which led to the general outbreak of war in the folloaing year He did so primarily to prevent Leopold from exacting a peace from the Turks. yet he was willing to surrender almost all his military gains to secure peace in 1697 nhen the crisis about the Spanish succession threatened at long last to come to a head. There is. therefore, little doubt as to the real issue at stake in the last quarter of the 17th century. It was the balance of power between Bourbon and Habsburg monarchies. as it had been since Henry IV became king of France, and the outcome of this struggle depended more upon diplomacy than upon war War was an adjunct to diplomacy, as important as. but no more important than, marriage alliances. So long as diplomacy nas stultified by the uncertain issue of the Spanish succession, so long would the wars be devoid of lasting consequences whatever the brilliance of the military commanders. The War of the Grand Alliance might not be north investigation were it not that the long-lasting diplomatic deadlock produced new factors in the situation, notably the accession of England as a European power of first importance, which were to prove decisive in the eventual settlement of the Spanish succession in the war of 1701–13.

Character of the War.—.Although their importance has been misunderstood some notice must be taken of the military developments which altered the character of war during the 17th century. Most obviously, the size of armies increased. The increasing wealth at the disposal of European governments allowed them to maintain larger armies, and improvements followed in military administration and supply. The effectiveness of infantry had been much increased during the previous wars of the 17th century not only by better regimental organization and drilling but also by improvements in the musket, which were to culminate in the introduction of the flintlock; and experiments were being made with the bayonet (instead of the pike). But infantry could move only slowly, and a large army of foot soldiers presented a considerable supply problem. This could be solved only by living off the country, and that involved dispersal over a fairly wide area. Only by occupying fortified places could an army in such a situation feel safe. During the vital weeks of a campaigning season the component parts of an army might be combined for offensive action, and it was necessary to collect supplies in advance for such an operation. This need called for large bases equally well fortified. So the capture or recapture of fortresses was frequently an indispensable prelude to more ambitious strategic operations. Such operations were not impossible, though until the development of the tactical possibilities of cavalry and artillery had caught up with those of infantry they were difficult. They were especially difficult where geographical obstacles lay between an army and its objective; and France, since the acquisition of the Franche-Comté and the occupation of Lorraine in the earlier wars of Louis XIV, was surrounded by natural barriers save for the southeastern coastal route from Italy and the northeastern frontier between the Moselle and the sea. Sébastien Le Prestre de Vauban (*q.v.*), the great builder of fortresses, provided for the northeastern frontier what nature had omitted. Flanders has always provided a natural gateway from Germany into France and vice versa, and it was there that the fiercest fighting of the war was to take place. In the event, the combination of a complicated river network and an elaborate defensive system of fortresses proved too much for the military commanders in the time available to them. Such a result, however, was not inevitable, but arose as much from the near balance of the forces engaged as it did from the intractability of the natural and man-made obstacles.

One other aspect of the character of the war needs to be considered. Since wars avowedly concerned the personal ambitions of princes. the clothing of religious controversy having been discarded, the civilian population ceased at ordinary times to be concerned directly in the struggle and came more and more to assume that role of neutral onlookers which Frederick the Great was later to regard as proper to them. The war began with a devastation of the Palatinate as harsh as any similar operation of the Thirty Years' War; but this proved to be exceptional as larger supplies of money and better methods of credit finance came to enable army commanders to purchase their supplies instead of seizing them by force. The burden of war thus became a financial one, borne by the countries responsible for the fighting rather than those fought over.

The Spanish Succession.——The problem of the Spanish inheritance, including territories in the Pietherlands, in Italy and in the Americas as well as Spain itself, began with the accession in 1665 of the epileptic Charles II, whose continual ill-health made it unlikely that he would have any direct male heirs. Inheritance through a female line would involve the rival Bourbon and Habsburg dynasties. Louis XIV had married the elder daughter of Philip IV and Leopold I the younger. and their fathers had similarly married daughters of Philip III. Whereas both the wives of the French kings had renounced their claims on the Spanish succession at the time of their marriages, Leopold's wife was named in the will of Philip IV as the direct line of succession. So far, however, no male heir had resulted from this line and the problem remained unsolved and full of danger, the more so since as early as 1662 Louis had suggested that his wife's renunciation, which was conditional, might have to be considered invalid. The possibility of securing at least a part of the Spanish inheritance was never far removed from Louis's calculations. After the treaties of Nijmegen (1678–79; see DUTCH WARS), he sought to anticipate as far as he could the death of Charles of Spain by laying claim to various fragments of territory on his borders on the grounds that they were dependencies of territories ceded him by the treaty of Münster (Westphalia). The French annexation of Strasbourg and of Casale in Sept. 1681, followed by the siege of Luxembourg in November, brought about fighting with Spain and Holland. A large-scale war was averted by the Turkish advance to Vienna in July 1683; but after relief of that city by John Sobieski, king of

Poland, in September fighting began again. A 20-year truce concluded at Regensburg in Aug. 1684 terminated this "War of the Reunions," leaving Louis in possession of Strasbourg. Luxembourg and Oudenarde He uas now perhaps at the summit of his power, and he showed his confidence nowhere more than in the revocation of the Edict of Nantes (168;). He could afford to stand by and watch the emperor embroiled in the war with Turkey. while he alone would be free to act when the testing time came in Spain. Meanwhile he had great hopes of pressing his son's claim to the Spanish throne (having by now definitely stated that his wife's renunciation was invalid) in Spain itself through the friendly offices of his niece Marie Louise of Orléans, who had been married to Charles II of Spain in 1679.

Leopold meanwhile had not himself been inactive. The infanta Margaret, his first wife, through whom the best claim of his family to the Spanish throne had arisen, had died in 1673 leaving only a daughter, Maria Antonia, born in 1669 and now of marriageable age. He agreed to her otherwise not very desirable marriage to the elector Maximilian Emmanuel of Bavaria, formerly an ally of France, on condition that she renounce all claims to the Spanish throne, thus in his opinion making the line of succession run through his own mother. Philip III's daughter. The candidate whom he had in mind for Spain was a second son of his own, the archduke Charles born in 1685 (the year of his daughter Maria Antonia's marriage) to his third wife Eleanor of Neuburg. Leopold's proposals brought no response from the Spanish government, which was beginning to seek a solution of its own. Moreover, Leopold was during these years fully occupied nith events in the war with Turkey. After the relief of Vienna in 1683, he had deliberately sacrificed nhat opportunity he had of uniting Germany in opposition to Louis XIV in order to concentrate upon an offensive against Turkey. This was his motive in agreeing to the truce of Regensburg. and his idea was that if Hungary could be recovered and the hereditary lands of the Habsburgs freed from the continuous burden of defense against the Turks, then he would be strong enough to challenge Louis XIV without depending upon the assistance of the German princes So the League of Augsburg concluded betneen himself, the kings of Sweden and of Spain (in their capacity of princes of the empire), the elector of Bavaria, the Ernestine house of Saxony and the circle of Franconia on July 9 (new style; old style, June 29), 1686, was not an important part of his policy. This alliance has been represented as the forerunner of the Grand Alliance by some historians nho have therefore given its name to the war of 1689–97. In fact it was quite ineffective, providing no machinery for combined military action; and the states which constituted the mainstay of the Grand Alliance were not parties to it. Leopold during these years was concerned as much with Turkey as with Germany; and a much more important alliance than the League of Augsburg was that already concluded with the elector Frederick William of Brandenburg. Frederick William, who had previously aligned himself with France, sent a contingent to help Leopold on the Danube in Jan. 1686 and entered into a secret understanding with him against France in March. Habsburg troops then advanced across Hungary in 1686 and in 168;; and on Sept. 6 (N.S), 1688, after the rejection of Turkish offers of peace in the previous year, Belgrade was taken. Turkey now prepared to make much more attractive offers of peace, and Louis XIV saw the control of the situation slipping from his grasp. He determined therefore on another military demonstration like those of 1681–84, hoping that this would keep the Turks fighting and restrain Germany from rushing into the Habsburg camp.

Cologne and the Palatinate. — Apart from the existence of the League of Augsburg and the emperor's refusal to perpetuate the truce of Regensburg, two disputes furnished Louis with pretexts for military intervention. The more immediate of the two was concerned with the archbishopric-electorate of Cologne The archbishop-elector Maximilian Henry had in Jan. 1688 appointed Wilhelm Egon Cardinal von Furstenberg to be his coadjutor; and when Maximilian Henry died in the following June, Fiirstenberg put himself foraard as a candidate for his succession. Fürstenberg, however, had all his life been a protégé of France, and his accession to Cologne was unacceptable both to the emperor and to the pope, who gave their support to the rival candidate Joseph Clement, brother of the elector of Bavaria and first cousin once removed of Maximilian Henry. Louis thereupon sent French troops to uphold Fiirstenberg. This move alarmed the German Protestant princes, who took measures to secure the Dutch against the possibility of a French attack; and the emperor, with papal encouragement, persisted in his recognition of Joseph Clement.

The other controversy in which Louis now decided to assert his claim mas about the succession to the Palatinate. Charles, the last elector Palatine of the Simmern line. had died without heirs in 1685 and had been succeeded by the head of the Zweibriicken line, Philip William of Neuburg, the emperor's father-in-law. It was possible, however, to claim that some part of the succession ought to have gone to the elector Charles's sister Elizabeth Charlotte (Liselotte), the second nife of Louis's brother Philip, duke of Orléans. Though the duchess of Orléans was herself disinclined to insist on this pretension, the fall of Belgrade determined Louis to enforce it. On Sept. 24 (N.S.), 1688, he issued a manifesto setting forth the French grievances. A French army under the command of the dauphin then advanced into the Palatinate.

The English Succession and the War in Ireland. — It is very doubtful whether France intended its action to lead to a major war. But at this point, in the autumn of 1688, other developments occurred which took the determination of events out of French hands. Both William of Orange and Louis XIV had sought to intervene in English politics since the restoration of the Stuart king Charles II in 1660, with the object of preventing hostile activity by the English on the continent. Since 1685 James II had lost the loyalty of nearly all of his subjects, and an important body of them looked to William of Orange, the husband of the heiress apparent Mary. as their only salvation from the tyranny of a Roman Catholic sovereign. William. for his part, being an inveterate opponent of Louis XIV, welcomed the prospect of securing England as an ally. The birth of a male heir to James in June 1688 brought matters to a state of crisis in England, and William agreed to land an army there to force James to act as his subjects wanted. Louis XIV was well aware of this intended invasion when he sent his troops into the Palatinate and in fact welcomed it as ensuring the absence of William from the continent so long as the expected civil war lasted in England.

When James was expelled from England without hostilities, Louis was able to restore his original plan by sending James to Ireland, which had remained loyal to him. Thus, although William succeeded in becoming king of England as William III and in involving his new kingdom in the continental war, he was for two years occupied in reducing Ireland. Almost the whole of Ireland was controlled by the Jacobite earl of Tyrconnel (Richard Talbot) with an army of 40,000 men of uncertain quality. In the north, however. the Protestant population declared in favour of William III and secured Enniskillen and Londonderry. On March 22 (N.S.; 12, O.S.), 1689, James II landed at Kinsale with a small French force and at once accompanied Tyrconnel to the north. The siege of Londonderry began on April 29 (N.S.; 19, O S.), but without a siege train no assault could be mounted. An English relieving force for Londonderry, sent by sea under Col. Percy Kirke at the end of May, was needlessly dilatory, but the blockade was eventually broken by Capt. John Leake's ships on Aug. 7 and the siege raised on Aug. 9–10 (N.S.; July 28 and 30–31, O.S.). At the same time a detachment of the Jacobite army was defeated by local forces organized by Col. William Wolseley, whereupon the siege of Enniskillen was likewise abandoned. The Williamite forces proceeded to overrun the whole of Ulster, and when the duke of Schomberg, sent with an army by William at the insistence of his English advisers, landed at Bangor near Belfast in August, he was able to advance southward immediately. He reached Dundalk, but there was held up. His army was small, much of it insufficiently trained. and rapidly being reduced by sickness. He was therefore unwilling to risk battle and eventually repaired to winter quarters in the north.

William at last became convinced of the necessity of making a serious effort in Ireland and in June 1690 went there himself with a considerable army, including Dutch and other foreign veteran troops. He advanced on Dublin with 40,000 men and came across James II entrenched behind the Boyne river with a slightly smaller force: including a French contingent landed under the comte (later duc) de Lauzun in March. James's army had some good cavalry, but it was the infantry which settled the day in favour of William on July 11 (N.S.; 1, O.S.), 1690. James fled once more to France, but his army made a good retreat, though abandoning all of Ireland save the west and southwest. William advanced in Ireland, but failed to take Limerick, which was defended by Patrick Sarsfield, in August; and after the earl (later duke) of Marlborough had taken Cork in September and Kinsale in October, fighting ended for the year with the war not yet completely over.

In 1691 Godart van Ginkel commanded for William in Ireland and the marquis de Saint-Ruth for James. Their armies met at Aughrim on July 22 (N.S.; 12, O.S.), where Saint-Ruth, after appearing to have the battle won, was killed and his army defeated. Even now, though the town of Galway surrendered and Athlone was already lost, Sarsfield held out in Limerick until Oct. 13 (N.S.; 3, O.S.) when a treaty was signed which brought the Irish war to a close. The war in Ireland had lasted for more than two years, and its outcome must not be allowed to disguise the fact that Louis XIV had succeeded in keeping William of Orange and 40,000 of his troops absent irom the continent for the important campaign of 1690. So far! indeed, William's inheritance of the English crown had proved a liability.

The Grand Alliance and the Continental War.—Louis had underestimated the reaction of Europe to his invasion of the Palatinate. True, Turkey was no longer milling to make peace with the emperor on acceptable terms and William of Orange had become involved in England. But William had been quickly and completely successful in accomplishing his mission to England, and the recent victories enabled the emperor to contain the Turks below Belgrade without much affecting the strength of his forces in the west. Moreover, the other German princes had been aroused rather than cowed by the French show of military strength; and France was already committed also against the Dutch and against Spain when the Dutch and the emperor concluded the treaty of Vienna on May 12 (N.S.), 1689. with the avowed aim of restoring the peace settlements of Westphalia (1648) and of the Pyrenees (1659). This treaty. to which England. Brandenburg, Hanover, Saxony, Bavaria. Savoy (see below) and Spain adhered in the course of the following 18 months. was the kernel of the Grand Alliance. The French found themselves faced at once by two strong armies: by the Dutch and the north German forces in Flanders and by the imperial and Bavarian troops on the Rhine. In these circumstances they were compelled to withdraw from the advanced positions occupied in 1688. Bonn and Mainz were evacuated on the Rhine. while in Flanders an English contingent under Marlborough assisted George Frederick, prince of Waldeck. in defeating the French at Walcourt on Aug. 25 (N.S.; 1j. O.S.), 1689.

Now. however. the situation in Ireland saved Louis from the consequences of his precipitate action. The allies had ambitious plans for a triple invasion of France, from Flanders. from the Rhine and irom Savoy. But with the death of Charles of Lorraine. who had been the leading figure in the south German opposition to France, on April 18 (N.S.), 1690. the Rhine offensive died away early In Flanders. with 40.000 allied troops away in Ireland, Waldeck's forces were outnumbered by those of the duc de Luxembourg; and while awaiting reinforcements preparatory to an advance upon Dinant. Waldeck was attacked and deieated at Fleurus (*q.v*) on July 1 (N.S.). Great hopes, honever. were still entertained by the allies of Savoy. The western irontiers of that country offered an easy route into Provence. and on the other side was the Spanish Milanese, giving easy access to the hereditary territories of the Habsburgs in Austria. This strategic position had compelled (or enabled) the dukes of Savoy to adopt a vacillating policy toward the Franco-Spanish conflicts of the 17th century. In 1689, though French garrisons in Pinerolo (Pignerol) and in Casale and the army under Nicholas Catinat on the Alpine frontier seemed to make France's influence over Savoy secure, the apparent strength of the Grand Alliance nevertheless caused the duke, Victor Amadeus II, to hesitate before committing himself to Louis XIV; and in 1690, when compelled by the French to choose. he joined the allied cause in the hope of securing Pinerolo and Casale. Catinat reacted at once and, advancing into Piedmont, defeated Victor Amadeus at Staffarda on Aug. 18 (N.S.), 1690. A further setback overtook the allies in October, when the Turks retook Belgrade and the hopes of a Turkish peace disappeared. The year 1690 had been one of continuous allied disaster on the continent.

Nor did 1691 bring much comfort. William III commanded in person in Flanders, but, operating from Brussels, failed to prevent Luxembourg from taking Mons (April 8 [N.S]). Without the support of the Brandenburg troops occupied in defending Cleves against a French diversion, he was unable to command favourable circumstances in which he could bring Luxembourg to battle, and the remainder of his campaign that year in Flanders was taken up with ineffective manoeuvring. After William's return to England in the autumn, Waldeck, while moving the army into winter quarters. was attacked and defeated by Luxembourg at Leuze (Sept. 20 [N.S.]). Meanwhile Catinat continued his progress into Piedmont, and the French army of Catalonia, under the duc de Noailles, took Urgel. Thus, for two years, France had more than countered all the threats of the Grand Alliance; the command of interior lines and great resources of manpower and of wealth had made it possible to defy the rest of Europe. This fact, and not the technicalities of the laws of inheritance, was to constitute the Bourbons' real claim to the Spanish succession.

What hopes remained to the allies lay in the contribution of England to the cause now that the war in Ireland was over. A French army led by the king himself, assisted by Vauban and covered by Luxembourg, began the campaign of 1692 by laying siege to Namur (May 25 [N S]). An unexpected period of heavy rain disrupted William's plans for relieving the city, and on June 5 (N S.) the town surrendered; the last stronghold, however. held out until July 1 (N S.). William then spent the rest of the summer endeavouring to bring Luxembourg to battle; he succeeded, but Luxembourg commanded a strong defensive position at Steenkirk (*q.v.*) In another battle of infantry (Aug. 3 [N.S.; July 24, O S.]), a determined attack by the British forces won some ground; but William's dispositions had been faulty, the success was not followed up, and at length his army was compelled to withdraw. Luxembourg, however. though left in possession of the field. had been sufficiently troubled to make him choose not to pursue the enemy. The year 1692 thus saw two considerable reverses sustained by the allied land forces.

William now recognized that the original aims of the Grand Alliance uere unattainable, but Louis was in no hurry to make peace. He spent the year 1693 instead in a series of disconnected offensives. Catinat once more defeated the duke of Savoy at Marsaglia (Oct. 4 [N S.]). the army of the Rhine captured Meidelberg, the army of Catalonia took Rosas and Luxembourg threatened Likge. William sent 20 000 men to relieve Likge and stood the rest of his army at Neerwinden. near Landen. to cover this force. There he was attacked by Luxembourg in superior force on July 29 (N.S.) and, despite an obstinate defense, was again defeated The campaign in Flanders closed with the French capture of Charleroi (Oct. 11 [N.S.]). while in the east the year's record was capped by the Austrian failure to recapture Belgrade.

The War **at** Sea.—Although the combination of English and Dutch sea power might have been expected to prove too much for France to contest. it was not until 1692 that the allies were able to secure a decisive naval supremacy in the English channel and not for a further tno years that they extended this to the Mediterranean. Colbert's achievements stood the French navy in good stead for a time (see COLBERT, JEAN BAPTISTE); but Colbert had died in 1683, and his work could not forever withstand Louis XIV's own indifference and neglect. On the other hand, the reforms in the English navy, in which James himself had shared after his appointment as lord high admiral on his brother Charles II's restoration. began to bear iruit as the political climate became more settled under William III. The first two years of the war, then, went in favour of France. Reinforcements on the way to James II in Ireland in 1689 were successiully covered by the Brest fleet under the marquis de Château-Renault, and the battle of Bantry Bay

(May 11 [N.S.; 1, O.S.]) which resulted when Adm. Arthur Herbert attacked it, though it won him the title of earl of Torrington, was reckoned a victory also by France. The next year the comte de Tourville was reinforced by the Toulon fleet and so enjoped a numerical superiority over Torrington, who, in reply, at first refused battle and subsequently, when worsted at the battle of Beachy Head (*q.v.*; July 10 [N.S.; June 30, O.S.], 1690), took the first opportunity of making a further withdrawal back to the Thames. Torrington maintained that so long as he avoided a decisive defeat and kept his "fleet in being" the French would not dare to invade England; and his phrase has been employed ever since to describe an important strategic concept. The French did not follow up their success but spent the next year, 1691, in making raids on shipping; and when in 1692 Tourville, acting upon orders from home, sought battle, he was heavily defeated by the English admirals Edward Russell and George Rooke at the battle of La Hogue (*q.v.*; May 29–June 3 [N.S.; May 19–24, O.S.]). The French never again during the war sought a general engagement at sea. and to some extent a permanent decline in France's naval fortunes may be dated from the battle of La Hogue.

For some time, however, the allies made little use of their victory, concentrating their strength on protecting their commerce and on defending the English channel and leaving the French still masters of the Mediterranean. Colonial rivalry in India, in North America and in the Caribbean brought sporadic fighting to those parts also; and though the English and the Dutch enjoped the better of their exchanges with the French, the distances involved prevented any concerted operations by either side. In 1693 the series of reverses that the allies sustained on land was accompanied by a serious naval setback when a convoy of 400 ships bound for Smyrna was attacked and dispersed by Tourville off Lagos on its way into the Mediterranean, and about 100 ships were lost (June 27–28 [N.S.; 17–18 O.S.]). The escorting warships, commanded by Rooke, were quite inadequate for their task, and the episode pointed out the desirability of taking more offensive and direct action against the French at sea.

William now abandoned the hope of achieving anything spectacular in Flanders. English hopes were centred instead upon the possibilities of combined military and naval operations against Brest and in the Mediterranean. In 1694, therefore, operations in Flanders were confined to attacking towns. William was again unsuccessful, but he could at least claim to have contributed to stopping the French advance. The reason the French were halted was partly that, thanks to a further effort on the part of England, the allies were at last enjoying a superiority in numbers there; and partly that the cost of the war was beginning to bear heavily upon France. Moreover the diplomatic situation relating to the Spanish succession called for caution. In Catalonia, however, Noailles crossed the Ter on May 28 (N.S.) and proceeded to take Palamos, Gerona, Ostalrich and Castel-Follit. In fact, the interior lines of communication enjoyed by the French armies enabled them to counter a check in one theatre of war by a successful offensive in another, and William resolved upon employing his fleet to offset this advantage. Russell left for the Mediterranean in June 1694 and stayed on the Catalan coast until well into the autumn when he withdrew to minter and refit—not in England but at Cádiz. Thus he was able to operate off Catalonia again early in the spring of 1695, and it was this almost continuous protection that saved Barcelona from a combined attack by Noailles and the Toulon fleet under Tourville. This experiment. which marks the beginning of the concept of a British Mediterranean fleet, was ended when Rooke, who had taken Russell's place in Sept. 1695, was recalled in the spring of 1696 on the reappearance of a French fieet under Château-Renault at Brest which, it was feared, might be the prelude to an invasion of England. The results produced by the experiment while it lasted did however indicate that the sea power of the allies might indeed prove to be the answer to the interior lines of communication enjoyed by France. The combined assault against Brest begun at the same time in 1694, however, turned out to be just one more allied disappointment, for the troops which were landed at Camaret bay (June 8 [N.S.; May 29, O.S.]) under Lieut. Gen. Thomas Talmash (Tolleinache) found the French prepared for them and had to be withdrawn almost at once.

The year 1695 saw the death of Luxembourg, whose replacement by the less able maréchal duc de Villeroi provided William with the opportunity of securing his one tangible success of the war. After a two months' siege of Namur, he compelled the maréchal duc de Boufflers to capitulate on Sept. 1 (N.S.; Aug. 22, O.S.).

The Peace of **Ryswick.**—By 1695 a number of reasons were inclining Louis XIV to investigate the possibilities of a general peace. His resources were stretched in maintaining armies upon four fronts; the value of the Turkish diversion had declined after the recapture of Belgrade, after which only desultory fighting occurred on that front; and William III became a less stubborn opponent as his continuous record of defeat and disappointment began to arouse serious opposition to his war policy in England.

But the most important motive for peace lay in new developments in the contest for the Spanish succession. A son, Joseph Ferdinand, had been born to Maria Antonia and the elector of Bavaria on Oct. 28 (N.S.), 1692, and in the mind of the Spanish government it was in this boy alone that there lay any prospect of maintaining the Spanish dominions intact on the death of Charles II. Neither Louis XIV nor the emperor Leopold was prepared to acquiesce in such a settlement?and for both of them the support of other European powers was vital. In 1695 Louis found himself still engaged in war and without an ally. His rival had succeeded in engaging his allies in the Grand Alliance to support his claims to the Spanish inheritance. Both Holland and England did this willingly since they hoped for commercial advantages from what they believed would be a continuation of the lax Spanish dominion over the American possessions. Moreover, Louis's main support at the Spanish court. Marie Louise of Orléans, the queen consort, had died on Feb. 12 (N.S.), 1689, and her successor was Maria Anna of Neuburg, sister to the empress. Despite his military successes, Louis's diplomatic position mas insecure. At this moment news came from Spain that Charles might really be dying at last. Louis began the task of making peace first with Savoy. Victor Amadeus had seen his troops twice defeated and was doubtful of the determination of some of his allies to continue the war. When, therefore, Louis offered surprising concessions, he agreed, as he had so often done before and was to do again. to change sides. The treaty of Turin, concluded in June 1696 after negotiations conducted with the utmost secrecy, not only restored all that France had conquered in the course of the war but also ceded Pinerolo and Casale to Savoy. Savoy then turned round on its allies and insisted that all fighting cease in Italy. The emperor could do nothing but agree. The fighting in Flanders in 1696 brought William III no successes, and he too began secret negotiations in the winter. The emperor still stood out, but further French successes in 1697, the naval raid on Cartagena in May and the capture of Barcelona in August, convinced him too. Official negotiations were conducted during the summer, at Ryswick near The Hague; and the treaty of Ryswick (*q.v.*), which ended the war, was signed by the powers concerned between Sept. 20 and Oct. 30 (N.S.), 1697. Once again, France agreed to restore all its military conquests and, in addition, made commercial concessions to Holland. Louis XIV also recognized William III as king of England and promised not to give any aid to his enemies (including, by implication, James II).

At first sight, Louis appears to have surrendered all that he had won in the war, and a closer examination of the terms of the peace supports that view. In any future war France could, in the military circumstances of the time, make a considerable military impression upon its enemies only if it began the war already in possession of the vital fortresses which ringed its frontiers. Yet, almost without exception, all such towns as had been captured were given up in 1697. Even so, it is misleading to conclude simply that France had been worsted in the War of the Grand Alliance. There is some truth in the suggestion that Louis had misjudged the reaction of Europe to his ambitions and overplayed his hand. In particular he had underestimated William of Orange, unsuccessful though that statesman was in war; for it was the advent of England into the affairs of the continent that both turned the balance of power against France and also, by involving the overseas world in the destinies of Europe, introduced forces which a predominantly continental power such as France could not control. In this last fact lies perhaps the worst mistake of Louis: his abandoning of the scheme of colonial and maritime expansion that had been advocated by Colbert in favour of the purely European policy followed by the marquis de Louvois. But the decisive role that England was to play lay still in the future. So far as the War of the Grand Alliance is concerned: Louis XIV's ambitions had not been seriously disturbed. His main objective was the Spanish succession. He had begun the war by invading the Palatinate in 1688 in order to prevent the emperor from making peace with the Turks and uniting Germany against him. In this he had to some extent succeeded; and his armies had succeeded also in preventing William from crowning his lifelong opposition to him with success. The war, in fact, was never more than an interlude in the diplomatic struggle for the Spanish succession and the century-old conflict between Bourbon and Habsburg. When the death of Charles II of Spain appeared imminent, Louis withdrew from the war without much difficulty. That to do so he surrendered most of his military gains was not important. They were insignificant beside the gains offered by the Spanish succession. In the event, Louis's timing proved sound. The Austrian advance against the Turks was resumed in 1697 and resulted in the victory of Zenta (Sept. 11 [N.S.]) under the young Prince Eugène of Savoy. The treaty of Karlowitz followed in Jan. 1699. whereby the sultan surrendered all of Hungary and Transylvania. In Spain, the crisis of the succession followed almost immediately upon the conclusion of peace, and it was the emperor, not Louis XIV, who was isolated and to a large extent ignored in the subsequent negotiations.

An appraisal of the significance of the War of the Grand Alliance must be related in the first place to its origins. Both Louis XIV and Leopold I sought predominance in Europe, the former through the medium of the Spanish inheritance, the latter in contesting Louis's claim by establishing his power in his hereditary territories. There is little doubt that on balance Louis was the more successful. So it may be concluded that his generals had successfully accomplished what had been asked of them. Leopold had had some success in defeating the Turkish menace and in building up an effective resistance to France. But the real credit for building up that resistance belongs to William III. It was he who had engaged England in the war and he who had made the most effective military effort. What he lacked was military success, and that might be remedied in the future. So. in the final analysis, the definite but necessarily indecisive achievements of Louis XIV and the potential consequences of the work of William III must be set against one another.

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GRAND BANKS. A portion of the continental shelf in the Atlantic ocean extending about 350 mi. off the southeast coast of Newfoundland; noted as an international fishing ground, the Grand Banks include a number of separate banks, chief of which are Grand bank, St. Pierre bank and Green bank. Depths on these banks average approximately 30 fathoms, but there are many places with depths reaching 100 fathoms. The vicinity of the Grand Bahks is the meeting place of the cold Labrador current and the relatively warm Gulf stream. Air masses passing over these contrasting water bodies produce fog frequently. The mingling of the cold and warm waters produces favourable conditions for plankton on which fish depend directly or indirectly for their food supply.

The fish of the Grand Banks have been looked upon as a great natural resource ever since John Cabot reported these riches more than four centuries ago. Among the species most plentiful are cod, haddock, rosefish, pollock, various flatfish, herring and mackerel. The trawler fleets of many nations, including Canada, the Cnited States, the United Kingdom, Portugal, Spain and France, fish the Grand Banks. An international commission was organized in 1949 to study fish populations and to guard against depletion.

See also Newfoundland. (C. N. F.)

GRAND CANARY (Gran Canaria), an island forming part of the Spanish archipelago of the Canary Islands (*q.v.*). Pop. (1950) 334,986; area, 592 sq.mi. Grand Canary, the most fertile island of the group, is nearly circular in shape, with a diameter of 24 mi. and a circumference of 75 mi. The highest peak, Los Pechos, is 6,398 ft. Large tracts are covered with native pine. Las Palmas (1950, [mun.] 153,856), the capital, is described in a separate article.

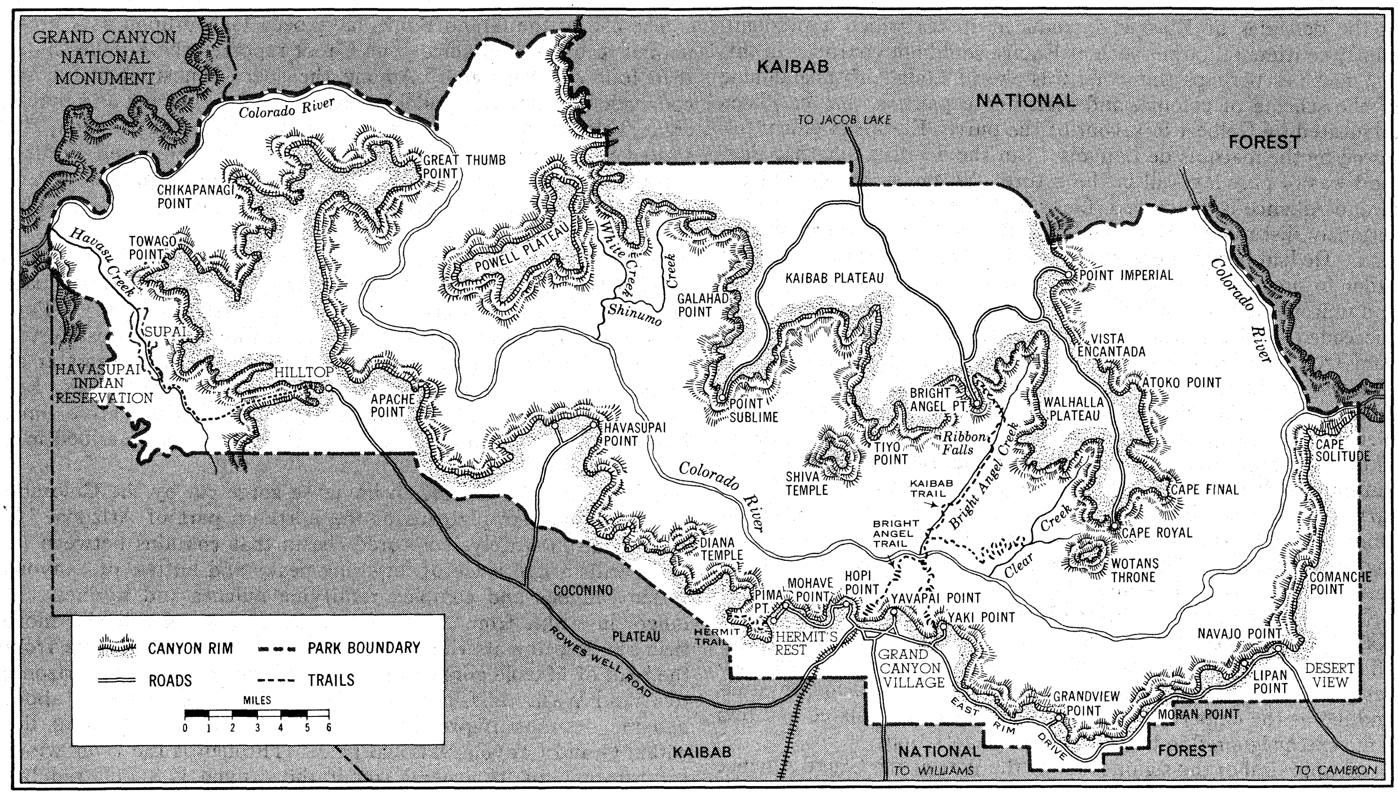
GRAND CANYON, an immense gorge cut by the Colorado river into the high plateaus of the northern part of Arizona. It is a broad, intricately-sculptured chasm that contains between its outer walls a multitude of imposing peaks and buttes, of canyons within canyons and complex ramifying gulches and ravines. It ranges in width from 4 to 18 mi., its greatest depths lie more than a mile below its rim and it extends in a winding course from the head of Marble gorge, near the northern boundary of Arizona, to Grand Wash cliffs, near the Nevada line, a distance of about 280 mi. Its most impressively beautiful section, j6 mi. long, lies within Grand Canyon National park. Through it the river winds for 105 mi. In its general colour the canyon is a dull red but each strata or group of strata has a distinctive hue—pale buff and gray, delicate green and pink and, in its depths, chocolate-brown, slate-gray, a violet and other sombre hues.

The impact of this scene was thus expressed by geologist F. E. Matthes: "The alpine mountain ranges of this country are equaled and exceeded in height, if not in spectacular beauty. by those of other lands, but though there are elsewhere deep canyons, some of even greater depth than the Grand Canyon of the Colorado, there is not one that can match its vastness, its majesty, its ornate sculpture, and its wealth of color. Whoever stands upon the brink of the Grand Canyon beholds a spectacle unrivaled on this earth."

History.—Discovery of Grand canyon is credited to members of the Coronado expedition of 1540. Two Spanish priests, Francisco Garcés and Silvestre Vélez de Escalante, rediscovered it in 1776. Beaver trappers examined it and members of government expeditions exploring the west looked it over. John Wesley Powell and companions descended the river in rowboats in 1869, and again in 1870 and published reports on the geography, geology and ethnology of the area. Prospectors in search of minerals explored its side canyons.

National Park.—Grand Canyon National park, containing 645,296 ac., was created in 1919. The north and south rims are connected by a paved road (217 mi.) and by a transcanyon trail (21 mi.) Scenic drives and trails lead to all important features. Campgrounds and a wide range of accommodations are available on both the north rim (8,200 ft.) and the south rim (7,000 ft.). There are more than 1,000,000 visitors annually. The famous mule ride into the canyon has increasing competition from the adventurous scenic rides down the river in motorboats, or inflatable rafts. Pueblo and cliff-dweller ruins, with accompanying artifacts, are numerous, indicating prehistoric occupation, and living on reservations nearby are five Indian tribes.

Geology.—From the rock record of the canyon a large part of geologic history is revealed more clearly than in any other place in the world. Two stories are superlatively presented: (1) the building of the earth's crust featuring the kind, origin and age of exposed rocks; and (2) the cutting of the canyon. a story of erosion. Furthermore. all the processes of earth building are exemplified: submergence, deposition, uplift, folding and faulting and erosion. Extending from the river to Bryce canyon to the north, there is exposed a 23.000 ft. cross section of sedimentary



MAP OF GRAND CANYON NATIONAL PARK. ARIZONA

rocks from old to recent in normal sequence. The "greatest single geological story" pertains to an unconformity where rocks of Algonkian, or Proterozoic (late Pre-Cambrian), Age have been eroded away completely, leaving only a line, where third era rocks rest upon first era rocks, indicating a missing record of 500,000,000 years of second era deposition.

The rock strata of the canyon's walls are mostly marine limestones. fresh-water shales and cemented sandstones of wind-blown origin (Paleozoic Age), the result of limey ooze, mud and sand laid down in water. later hardened into rock by the great neight of layers above. The crystalized. twisted and contorted unstratified rocks of the inner gorge are granite and schist (Archean or Early Pre-Cambrian Age) believed to be more than 4,000,000,000 years old. They constitute the roots of lofty mountains, their tops eroded away. Likewise, the superimposed Algonkian rocks are the roots of still another ancient mountain system planed down by prolonged erosion. O erlying the canyon rocks are butte remnants of Mesozoic Age and the vermillion, white and pink cliff terraces of southern Utah. which have been entirely eroded away to the south. Of recent origin are the sheets of black lava and the volcanic cones covering portions of the plateau tops, some estimated to have been active within the past 1,000 years.

An event of recent geologic history has been the cutting of the mile-deep Grand canyon by the Colorado river! a river with volume, speed and cutting tools in the form of mud, sand and gravel. Sediments carried by the Colorado have been measured and reported to average 500,000 tons per day. conditions favourable to vigorous erosion were brought about by the up warping of the region, which steepened the river's path and allowed deep entrenchment. The depth of the canyon is due to the cutting of the river but its ten-mile width is explained by rain, wind, temperature and chemical erosion. helped by the rapid wear of soft rocks, all of which steadily widens it.

Amazingly, the canyon was cut by a reverse process for the river remained in place and cut as the land moved slowly upward against it. Only thus can be explained the canyon's east to west course across a south facing slope and the presence of plateaus which stand across the river's course without having defected it. Minerals. mostly asbestos. copper. lead and some uranium exist but not in sufficient quantity and availability for profitable mining.

In the sedimentary rocks plant and animal fossils are abundant. ranging from primitive algae in the lower strata to trees in the upper strata and from seashells and trilobites to the remains of dinosaurs (both bones and footprints), and camels, horses, ground sloths and elephants. These fossils give a picture of evolving life through the ages.

Biology.—There are great ranges in soil. temperature and elevation and of the five life-zones, only that of tropical vegetation is absent. In the interior of the canyon vegetation is sparse and of desert type but on the plateaus grow forests of pine, fir. aspen and spruce. Animal life consists of about 100 varieties of birds. 60 mammals and 25 reptiles and amphibians. A half dozen kinds of fish live in the river and trout have been planted in tributary streams.

Plant and animal life on one rim differs somewhat from that on the other as shown in the Kaibab white-tailed squirrel of the north rim compared with the Abert grey-tailed squirrel of the south rim, which are regarded as varieties developing in a mutual isolation imposed by the barrier of the canyon.

Both the south rim (open year round) and the north rim (closed in winter) are accessible by automobile, railroad, bus and airplane.

See also COLORADO RIVER.

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GRAND DUKE, a title borne by princes ranking between king and duke (Fr. *grand-duc*, Ital. *granduca*, Ger. *Gross-herzog*). The dignity was first bestowed in 1567 by Pope Pius V on Duke Cosimo I of Florence, his son Francis obtaining the emperor's confirmation in 1576; and the predicate "royal highness" was added in 1699.

In 1806 Napoleon created his brother-in-law Joachim Murat, grand duke of Berg, and in the same year the title was assumed by the landgrave of Hesse-Darmstadt, the elector of Baden and the new ruler of the secularized bishopric of Würzburg (formerly Ferdinand III, grand duke of Tuscany) on joining the Confederation of the Rhine. According to the decision of the Congress of Vienna, the title was borne by the sovereigns of Luxemburg, Saxe-Weimar (grand duke of Saxony), Mecklenburg-Schwerin, Mecklenburg-Strelitz and Oldenburg (since 1829), as well as by those of Hesse-Darmstadt and Baden. The emperor of Austria included among his titles those of grand duke of Cracow and Tuscany, and the king of Prussia those of grand duke of the Lower Rhine and Posen.

The title is also retained by the dispossessed Habsburg-Lorraine dynasty of Tuscany.

Grand duke is also the conventional English equivalent of the Russian *velikiy knyaz,* more properly "grand prince" (Ger. *Grossfürst*), at one time the title of the rulers of Kussia, who, as the eldest born of the house of Rurik, exercised overlordship over the *udyelniye knyazi* or local princes. On the partition of the inheritance of Rurik, the eldest of each branch assumed the title of grand prince. Until 1886 this title grand duke or grand duchess, with the style "imperial highness," was borne by all descendants of the imperial house. It was then confined to the sons and daughters? brothers and sisters and male grandchildren of the emperor.. The other members of the imperial house bore the title of prince *(knyaz)* and princess (*knyaginya* if married, *knyazhna* if unmarried) with the style of "highness." The emperor of Austria, as king of Hungary, also bore this title as "grand duke'! of Transylvania, which was erected into a "grand princedom" (Grossfürstentum) in 176j by Maria Theresa.

GRANDEE, a title of honour borne by the highest class of the Spanish nobility (Span. *Grande*). It would appear to have been originally assumed by the most important nobles to distinguish them from the mass of the *ricos hombres,* or great barons of the realm. It was thus. as Selden points out, not a general term denoting a class, but "an additional dignity not only to all dukes, but to some marquesses and condes also" (*Titles* of *Honor,* ed. 1672, p. 478). It formerly implied certain privileges; notably that of sitting covered in the royal presence. Until the time of Ferdinand and Isabella, when the power of the territorial nobles was broken, the grandees had also certain more important rights; *e.g.,* freedom from taxation, immunity from arrest save at the king's express command, and even—in certain cases—the right to renounce their allegiance and make war on the king. Their number and privileges were further restricted by Charles I (the emperor Charles V), who reserved to the crown the right to bestow the title. The grandees of Spain were further divided into three classes: (1) those who spoke to the king and received his reply with their heads covered; (2) those who addressed him uncovered, but put on their hats to hear his answer; (3) those who awaited the permission of the king before covering themselves. All grandees were addressed by the king as "my cousin" (*mi primo*), whereas ordinary nobles were only qualified as "my kinsman" (*mi pariente*). The title of "grandee," abolished under King Joseph Bonaparte, was revived in 1834, when, by the *Estatudo real,* grandees were given precedence in the chamber of peers. The designation later, however, became purely titular, and implied neither privilege nor power.

GRAND FORKS, a town in the boundary district of British Columbia, Canada, at the junction of the north and south forks of the Kettle river, 2 mi. N. of the international boundary, on the Canadian Pacific and (for freight) Great Northern railways. Pop. (19) 1,995. It is in a good agricultural district. noted for fruit production by irrigation, but owes its importance largely to works for smelting gold. copper and silver ores. It is a trade centre, with sawmills. wood works. machine shops, etc.

GRAND FORKS, the second city in size in North Dakota. U.S.. and seat of the county of the same name. is situated at the confluence of the Red River of the North and the Red Lake river, 90 mi. S. of the Canadian border in the northeast corner of the state. The city is surrounded by prairies and is 350 mi. N.W. of Minneapolis, the nearest large U.S. city. It was originally the site of a North-West Fur company post in 1801, but Lord Selkirk, a Hudson's Bay company official, purchased the land for a colony of Scottish settlers, the Red River settlement (*q.v.*). However, only mixed-bloods settled about it.

Permanent settlement began in 1871 and from 1873 to 1875, the Hudson's Bay company operated a hotel and a retail store there. The town's future was assured when the Great Northern railway arrived in 1880 and established headquarters for its large Dakota division. There was a flood of settlers, many Norwegian or Canadian. and by 1910. 66% of its population were immigrants or the children of immigrants.

Primary dependence on retail merchandising and shipping of a large volume of spring wheat, potatoes and sugar beets ended with World War I. The large state-owned flour mill and elevator, a meat packing plant and a beet sugar refinery (in its twin city. East Grand Forks. Minn.) were opened. Despite the decline in the state's population, Grand Forks almost doubled in size from 1930 to 1955. (For comparative population figures *see* table in NORTH DAKOTA : *Population.*)

After World War II, manufacturing firms grew in size and number until they employed one-tenth of the labour force. but more than 1.000 retail and wholesale establishments were the chief employers. Much growth was stimulated by construction of an air force base 15 mi. W. Rail transportation by Northern Pacific and Great Northern railroads was supplemented by airlines using the municipal airport, an international port of entry.

In 1947 Grand Forks adopted the council-manager form of government. The University of North Dakota, under state control. n-as established there by territorial act in 1553. By the second half of the 20th century, it enrolled more than 3.500 full-time students. (R. P. WI.)

GRANDGENT, CHARLES HALL (1862–1939), U.S. philologist, an expert in phonetics and in the history of Romance languages. was born at Dorchester. Mass., on Nov. 14. 1862. He attended Roxbury Latin school and graduated from Harvard summa cum laude and head of his class in 1883. After three years' postgraduate study in Europe, he returned to Harvard as tutor in Romance languages (1886–89), then was director of modern language instruction in the Boston public school system for seven years. In 1886 he married Ethel \\'right Cushing, who predeceased him by five years.

From 1896 he was professnr of Romance languages and literatures at Harvard, becoming emeritus in 1932. He was acting dean of the faculty of arts and sciences in 1929, and exchange professor at Paris in 1915–1916 and again in 1930–31. The University of Chicago (1916). Michigan (19223. Oberlin (1927) and Harvard (1923) conferred honorary doctorates on him.

Grandgent's scholarly publications included grammars of French and Italian. Old Provençal, Vulgar Latin. and a work called *From Latin to Italian,* all of them distinguished by a skillful and highly selective presentation. His lectures showed this same power of selection. He lectured for many years on Dante as well as on Romance linguistics and phonetics. and produced an edition of Dante (1917). in addition to *The Ladies of Dante's Lyrics* (1917), *The Power of Dante* (1918), and *Discourses on Dante* (1923). He was decorated by the governments of France and of Italy; and he was a corresponding member of the Xccademia della Crusca. Grandgent's volumes of lighter essays give some idea of the man's humour and charm. He died on Sept. 11, 1939, at Cambridge, Mass. (J. WH.)

GRAND ISLAND, a city and the seat of Hall county, in southeastern central Nebraska. U.S., on the Platte river. is 85 mi. W. of Lincoln and 130 mi. S.W. of Omaha. The ton-n's name comes from the Grand island in the Platte. The island n-as a landmark for early travelers and of importance to the Oregon, California and Mormon trails.

German settlers established Grand Island in 1857, about 50 mi. W. of the then westernmost community in the area. A major factor in Grand Island's development was its strategic location for transportation. The Union Pacific and Burlington railroads crossed there, developing a railroad centre, and it became later the major highway centre in central Nebraska. An important supply point for the surrounding agricultural area: Grand Island also became an irrigation centre as the Platte valley turned to irrigation early in the 20th century.

Industrial activity, largely based on agricultural production. includes sugar beet processing, meat packing and grain storage.

A veterans hospital, a soldiers and sailors home, and an ordnance depot are among the federal institutions in the city. The present town was laid out in 1866 when the Union Pacific reached the settlement; it was incorporated in 1873. For comparative population figures *see* table in NEBRASKA: *Population.*

(W. D. A.)

GRAND JUNCTION, a city of western Colorado, U.S.. elevation 4,600 ft., at the confluence of the Colorado and Gunnison rivers, from which its name derives, is the seat of Mesa county. Immediately following expulsion of the Ute Indians, white settlers rushed in and founded the town in 1881. It was incorporated in 1882, and in 1922 adopted the council-manager form of government.

It is the centre of an extensive irrigated region (fruit, truck gardening and general farming) and industrial and jobbing centre of a large area. In the 1950s it became the business, administrative and milling headquarters of a large uranium-producing area. The lake-jeweled Grand Mesa is 30 mi. E., said to be the world's largest flat-topped mountain, and a favourite scenic and recreational area. Colorado national monument. 8 mi. W., contains spectacular specimens of erosion, and is threaded by famed Rimrock drive.

For comparative population figures *see* table in COLORADO: *Population.* (L. R. HA.)

GRAND'MERE, an industrial city in Laviolette county, Quebec, Canada, on the St. Maurice river, 21 mi. N. of Three Rivers, and on the Canadian National and Canadian Pacific railways. It is situated in a good farming district with excellent water-power facilities, which operate pulp and paper mills. Its industries include the manufacture of textiles, leather goods and electricity.

Population (1956) 14.023.

GRANDMONTINES, a religious order founded by St. Stephen of Thiers in Xuvergne toward the end of the 11th century. St. Stephen was so impressed by the lives of the hermits whom he saw in Calabria that he desired to introduce the same manner of life into his native country. He was ordained. and in 1073 obtained the pope's permission to establish an order. He went to Xuvergne, and in the desert of Muret, near Limoges, he made himself a hut of branches of trees and lived there for some time in complete solitude. A few disciples gathered around him, and a community was formed. The rule was not reduced to writing until after Stephen's death, 1124.

'The life was eremitical and very severe in regard to silence, diet and bodily austerities. It was modeled after the rule of the Camaldolese, but various regulations were adopted from the Augustinian canons.

About 11jo the hermits, being compelled to leave Muret. settled in the neighbouring desert of Grandmont, whence the order derived its name.

Louis VII founded a house at Vincennes near Paris, and the order had a great vogue in France, as many as 60 houses being established by 1170, but it seems never to have found favour out of France. Later centuries witnessed mitigations and reforms in the life. and at last the order came to an end just before the French Revolution.

See art. "Grandmont, order of" in the *Catholic Encyclopaedia;* Max Heimbuchcr, *Orden und Kongregationen* (1896), i, §31; and the art. in Wetzer and Welte, *Kirchenlexicon* (ed. 2), and in Herzog-Hauck, *Realencyklopädie.*

GRAND NATIONAL: *see* HORSE RACING AND BREEDING.

GRAND PRAIRIE, a city of central Texas, U.S., between Dallas and Fort Worth. Industries include aircraft and boat manufacture. Settled at the close of the American Civil War, Grand Prairie was originally called Alexander Deckman in honour of its founder. Principally an agricultural town during its early years, Grand Prairie boomed after the establishment of an aircraft factory in 1940–41. Incorporated in 1909, it has a council-manager form of government.

For comparative population figures *see* table in TEXAS: *Population.* (E. C. BE.)

GRAND PRIX: *see* HORSE RACING AND BREEDING.

GRAND RAPIDS, a city of Michigan, U.S., is in Kent county on the Grand river, 30 mi. from Lake Michigan and about 60 mi. W.N.W. of Lansing. It was founded in 1826 by the Frenchman Louis Campau as a trading post where several important Ottawa Indian trails (now diagonal streets) converged at the rapids. It was incorporated as a village in 1838 and as a city in 1850. Ample water power generated in the 18 ft. fall of the river, and the availability of valuable lumber from nearby pine and hardwood forests caused the establishment of many sawmills and woodworking industries. Following the display of Grand Rapids furniture at the Philadelphia centennial in 1876, the city gained a reputation as the furniture capital of America. Buyers the world over went to the furniture markets, first held in 1878. Diversification of industry began with the advent of World War I and the metal trades thereafter exceeded furniture in value and output. Nevertheless, Grand Rapids home, office, school and church furniture produced by skilled craftsmen in more than 70 factories maintained its supremacy in quality, style and design. Other important products are business machines, carpet sweepers, aircraft instruments, auto parts and accessories, hardware, tools, machinery, baked goods, paper boxes, gypsum products and refrigerator cabinets. More than 100 plants are engaged in the field of graphic arts. Grand Rapids is the principal trading centre of western Michigan. including a large area devoted to fruit farming and truck gardening, and serves a population of 1,600,000.

The elevation of Grand Rapids is 638 ft. above sea level. The average rainfall is 31.5 in. and the average temperature in summer is 69.3" F., and in winter, 24.9° F.

The city has a commission-manager form of government, adopted in 1916.

Higher education is provided by Calvin college, chartered in 1876 and affiliated with the Christian Reformed Church; Aquinas, a Roman Catholic coeducational college established in 1886; a University of Michigan extension centre for western Michigan and Michigan State university centre for continuing education. Kendall School of Design offers courses in iurniture and interior design and allied fields of art.

Cultural institutions include a municipal museum: the Public museum (founded in 1854) devoted to natural history and ethnology and including historical and contemporary furniture exhibits; the public library containing the country's most important collection of books on furniture design and manufacture; an art gallery; a symphony; and a civic theatre.

Grand Rapids has about 50 parks. playgrounds and park-school areas. Nearby are a number of Kent county parks, while 250 lakes and streams are within an hour's drive. Pop. (1960) city 177,313; standard metropolitan statistical area (Kent county) 363.187. For comparative population figures *see* table in MICHIGAN: *Population.* (F. L. D. M.)

GRAND RIVER, the name of several rivers in the central part of the United States.

Iowa-Missouri. — One of the more important branches of the Missouri river, the Grand rises in south-central Iowa near the city of Creston and flows almost due south into Missouri where it takes a southeasterly course! joining the Missouri near Brunsnick in north-central Missouri. The only city of importance in the Grand's drainage basin is Chillicothe. Mo., which lies near the confluence of the Grand and the Thompson.

Michigan. — Commercially the most important river in west-central Michigan, the Grand rises near Jackson and flows almost due north to Lansing where it turns west to Spring Lake. which empties into Lake Michigan through a short channel near Grand Haven. The major cities on the Grand are Lansing and Grand Rapids. Navigation is possible as far as Grand Rapids which owes its location to the development of water power from the river.

Missouri. — The Grand, sometimes known as the South Grand, rises in western Missouri about 30 mi. S. of Kansas City. It flows due east to join a west arm of the Lake of the Ozarks.

South Dakota. — Formed by the confluence of the North and South forks in Perkins county, S.D., the Grand flows eastward to join the Missouri near Mobridge, S.D. (R. R. D.)

GRANDSON (Ger. *Grandsee),* a town in the Swiss canton of Vaud, near the southwestern end of the Lake of Neuchâtel, and 20 mi. S.W. of Neuchâtel and 3 mi. N. of Yverdon by rail. Its population in 1950 was 1,800, mainly French-speaking and Protestant. The old church (once of a Benedictine monastery) contains Roman columns, etc., from Avenches and Yverdon. It has a tobacco factory. Its lords were vassals of Savoy, till in 1475 the castle was taken by the Swiss at the beginning of their war with Charles the Bold, duke of Burgundy, whose ally was the duchess of Savoy. It was retaken by Charles in Feb. 1476, and the garrison put to death.

The Swiss avenged this deed in a famous battle (March 2, 1476), defeating Charles with great loss. The battle was between Concise and Corcelles, at a place marked by several columns. *(See* SWITZERLAND: *History.)*

GRAND TETON NATIONAL PARK, established in 1929, is located in the Jackson Hole region of northwestern Wyoming. U.S., near the Idaho line and about 25 mi. S. of Yellowstone National park. Comprising 310,350 ac., or 484 sq.mi., it includes most of the former Jackson Hole national monument. The snow-covered peaks of its spectacular Teton range, sculptured from the sheerest rock, rise to a maximum height of 7,000 feet above the valley of the Snake river — itself nearly the same distance above sea level. Formed by a series of titanic upthrusts: this gigantic fault-block is traversed by great glaciers which have slowly crunched their way down the stream-cut canyons. Melting as they reached the bottom, they deposited their cargo of rock and debris into accumulations known as moraines. These are often beautifully forested with the sharp-pointed Engelmann spruce and pines so singularly straight and tall as to merit the designation of lodgepole.

These wooded deposits form the shores of frigid glacial lakes, which in varying size dot the region. Perhaps the most beautiful, and certainly the best known; is Jenny lake, but there are others with great individuality, such as Leigh, String, Bradley, etc.. fed from roaring torrents, exemplified by the unforgettable Hidden falls. On the other hand, the largest body of water. Jackson lake, is formed by a dam across the Snake river. The streams in the park abound in fish, while herds of buffalo, elk and antelope roam at ill, Throughout the summer season a succession of different varieties of wild flowers present ever-changing tapestries, even beginning their bloom underneath the snow.

The highest peak, Grand Teton (13,766 ft.), is one of the most difficult to climb in the United States. (R. R. MN.)

GRANDVILLE (professional name of JEAN IGNACE ISIDORE GÉRARD) (1803–1847). French caricaturist, whose works are characterized by a marvelous fertility of satirical humour, was born at Nancy on Sept. 13, 1803. He received his first instruction in drawing from his father, a painter of miniatures: and at the age of 21 went to Paris, where he soon afterward published a collection of lithographs entitled *Les Tribulations de la petite propriété.* He followed this by *Les Plaisirs de toutâge* and *La Sibylle des salons;* his success was made with *Métamorphoses* du *jour* (1828), a series of 70 scenes in which individuals with the bodies of men and faces of animals played the human comedy. Grandville contributed drawings to many periodicals, including *La Caricature* and *Le Charivari,* and his political caricatures came to enjoy a general popularity. He illustrated several classic works of literature. He died on March 17, 1847.

GRANET, FRANÇOIS MARIUS (1775–1849), French painter and the only landscapist of his day to emerge from the neo-classical school, was born at Aix-en-Provence on Dec. 17, 1775. He was the pupil first of J. A. L. Constantin, a local landscape painter, and later, in Paris, of J. L. David. With a number of other artists —Ingres, Bartolini, Gros, Girodet — he lived and worked in the Capuchin convent in the Boulevard des Capucines. There he found the subjects which are most characteristic of his work— cloisters, cells and large quiet sunlit rooms, with mild historical compositions in the same tranquil settings. In 1802 Granet went to Rome where he stayed for 17 years. On his return to Paris in 1819 he exhibited in the Salon his "Choeur de l'Église des Capucins," which was so successful that 16 replicas were commissioned. His paintings and water colours influenced the evolution of Corot's style. In 1826 Louis-Philippe made him curator of the pictures at Versailles. In 1848 he retired to Aix, where he died on Nov. 21 in the following year, leaving to his native town the greater part of his fortune and a collection of his works. (AA. B.)

GRANGE, THE, known officially as the National Grange, originally the National Grange of the Patrons of Husbandry, is a fraternal organization of farmers founded in Washington, D.C., in 1867 by Oliver Hudson Kelley and six associates. Growing slowly at first, the organization advanced rapidly during the agrarian discontent of the early 1870s, when its members, together with those of other groups, joined what was known as the "Granger" movement. Through political action centring in the middle west, an impetus was given to regulation of railways and grain elevators.

Local and state Granges in the same region also sought to circumvent monopolies by extensive co-operative business enterprises. Their general failure, coupled with internal dissensions, caused a heavy decline in the membership between 1875 and 1880, though the organization retained a strong influence. In 1875 the first Grange was organized in Canada, but the order never attained a dominant place there. After 1880 the Grange gradually increased its membership, and its centres of strength in the second half of the 20th century were found in Ohio, New York and Pennsylvania in the east and Washington, California and Oregon in the west.

The following definition of the Grange was selected in 1938 as the prize-winning entry in its national contest: "The Grange is a great farm fraternity: building character; developing leadership; encouraging education; promoting community betterment; instilling an appreciation of high ideals; teaching through work and play the value of co-operation and service in the attainment of happiness." There are seven degrees in the Grange, and the names of these, as well as the ritual of the order, carry agricultural connotations. Membership is open to all members of farm families 14 years old or over. Local subordinate Granges are usually organized on a community basis and often adopt the community name. Many local Granges own their own meeting halls and carry on a variety of social, educational and recreational programs. State Granges carry out policies agreed upon by the local and county Granges. Each state Grange sends two delegates, a man and his wife, to the annual meetings of the National Grange. These delegates are the policy forming body and elect the officers of the National Grange.

In the 1930s the National Grange supported the agricultural adjustment legislation. Its continued criticism of some features of it was an important factor in improvements in the parity formula and other price support legislation in the 1940s and 1950s. One of its major interests in the 1940s and early 1950s was the improvement of the co-operative farm credit agencies and their removal from direct government control. Beginning in the 1940s the Grange began taking a more active part in national legislative issues than at any time since the 1870s. A distinctive feature of the Grange program in the second half of the 20th century was its advocacy of using a commodity-by-commodity approach in dealing with farm problems. It supported domestic parity programs for wheat and other important export crops. *See* also AGRICULTURAL ORGANIZATIONS; UNITED STATES (OF AMERICA). THE: *History: From 1865 to 1910: Granger Movement.*

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(W. W. WX.)

GRANGEMOUTH, a small burgh and seaport of Stirlingshire, Scot., on the southern shore of the Forth estuary and at the mouths of the Carron and its former right-hand tributary, the

Grange Burn, 23 mi. W.N.W. of Edinburgh by road. Pop. (1951) 15,432. Its history begins in 1768 when digging was started for the Forth and Clyde canal. built by John Smeaton, which crosses the narrow "waist" of Scotland and enters the Clyde at Bowling. In 1777 the first foundation stone of Grangemouth was laid at the eastern end of the canal. which was opened in 1790. In 1843 the Old dock was opened and in 1859 the Junction dock was built to be followed by two wet timber basins for the Baltic trade. In Scotland Grangemouth is second in tonnage only to the port of Glasgow. Residential and industrial, it was early divided into two towns, an old and a new. Experiments in steam navigation were carried out on the canal in 1802 with the "Charlotte Dundas," which was built at Grangemouth. The chief industries are oil refining and the manufacture of its by-products, dyestuffs and other chemicals, timber importing and shipbuilding.

GRANGER, JAMES (1723–1776), English clergyman and print-collector, published a Biographical History *of* England (1769) "consisting of characters dispersed in different classes, and adapted to a methodical catalogue of engraved British heads." The work was supplemented in later editions by Granger, and still further editions were brought out by the Rev. Mark Noble, with additions from Granger's materials. Blank leaves were left for the filling in of engraved portraits for extra illustration of the text, and it became a favourite pursuit to discover such illustrations and insert them in a Granger, so that "grangerizing" became a term for such an extra-illustration of any work, especially with cuts taken from other books.

GRANICUS, BATTLE OF THE (May–June, 334 B.C.). In the spring of 334 Alexander the Great, having by various campaigns established a secure base of operations in Greece, set sail from Sestos to Abydos to carry out the invasion of Persia. His army consisted of about 30,000 foot and 5,000 horse, and it was accompanied by a siege train, a baggage train and a corps of engineers. Having visited Ilium to crown the tomb of his traditional ancestor Achilles, he moved northward through Lampsacus and came upon the Persian army on the Granicus river (Bigha-Chai), an army which, according to Arrian, numbered 20,000 Persian cavalry and 20.000 Greek mercenaries under Memnon. Memnon, an able general, had suggested to Arsites and Spithridates, who were in joint command. that they should withdraw and lay waste the country, and then land an army in Macedonia and attack Alexander's base. This they refused to do, and in place drew up their cavalry on the northern bank of the river with Memnon's infantry in the rear. Alexander, seeing this faulty distribution, determined on immediate attack, and deployed his army as shown in the diagram. From the accounts of this battle as given by the classical historians, it is obvious that Alexander's intention was to refuse his left wing, pivot his right wing on the phalanx, and rapidly moving this wing forward concentrate his main blow against the Persian left. In brief the action was as follows:—

The Battle.—The battle opened by a charge on the Persian left by the right wing light cavalry, who, after a severe engagement, were driven back. Under cover of this attack Alexander advanced at the head of the Companion cavalry and charged the left centre of the Persian horse, for it was here that their leaders had posted themselves. Little by little the Persians were pushed back until their left centre broke, whereupon both wings dispersed in flight. Alexander did not pursue them far; instead, he turned on the Greek mercenaries, and as Arrian says: "leading the phalanx against these, and ordering the cavalry to fall upon them from all sides," he soon completely surrounded them and cut them up. According to Diodorus, 12.000 Persians were killed, and 20.000 were made prisoners. Alexander is said to have lost less than 150; this figure is probably an understatement.

Tactics.—Though this battle was purely a cavalry action, it was not a blind charge of the Prince Rupert type, but an operation rendered possible only by the scientific organization of the Macedonian army which was the masterwork of Philip. Alexander's father. In the centre was the phalanx which possessed immense protective poner, and on its flanks were two wings which could, like the fists of a pugilist, punch out from it. Holding his left wing back, Alexander, under protection of the phalanx, which stood like

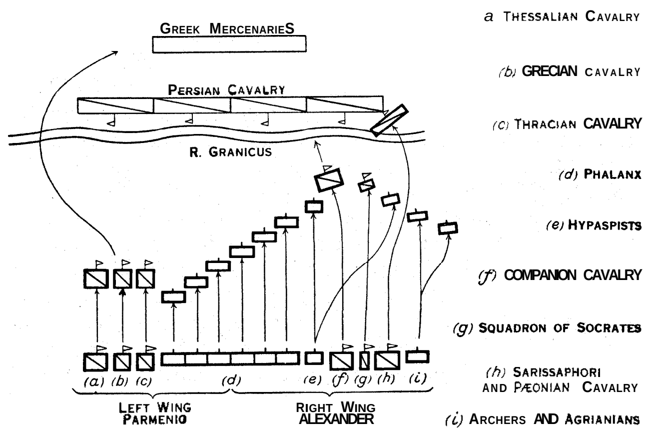

DIAGRAM SHOWING FORMATION OF TROOPS IN THE BATTLE OF THE GRANICUS. 334 B.C.

This, the first battle fought by Alexander the Great in his conquest of Asia, ended in victory for the Greeks. Alexander displayed the highest courage, first leading cavalry and then phalanx across the river in face of stubborn Persian resistance, and with his own hand slaying two Persian grandees

a wall on the left of his right wing, first sent forward his light cavalry, protected on their outer flank by light infantry, to hold the Persian left wing by engaging their cavalry and simultaneously disorganize them. Next he rapidly advanced the companion cavalry (the decisive attack); this advance drew the phalanx into an oblique order. This decisive attack was not directed on the Persian left flank (that is, it did not strike where the light cavalry had struck), but, instead, at the centre of the Persian left, for there the brains of the army (the generals) were assembled. This decisive attack moved down a protective funnel of men, for on its right were the light cavalry and light infantry, and on its left the hypaspists and the phalanx, both echeloned backward. While the Persian left flank was being pushed in confusion toward the centre. this centre was suddenly struck a terrific blow by a wedge of heavy cavalry followed closely by armoured infantry (the hypaspists), which worked into the enemy's shattered front and "ate" it away.

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GRANITE, a word apparently already used in the Renaissance to designate granular rocks, taken over almost in this very broad sense by early geologists, but in petrography, that is, the systematic classification and description of rocks, nearly always used in a much more restricted sense as referring to coarse or medium grained rocks rich in quartz and feldspar. The restricted usage was not only common among the early scientific petrographers but was also favoured by their precursors. naturalists such as A. F. Cronstedt and J. G. R'allerius. for instance.

Even in this restricted sense granite is by far the most common plutonic rock known or suspected to be of magmatic origin. So abundant is it that in the various earth models proposed by geophysicists and geologists a shell of granite is supposed to underlie the immediately visible portions of the lithosphere.

Because of its use both for paving block and as a building stone, the quarrying of granite was at one time a major industrial activity. The widespread introduction of macadam and concrete for roads together with the cessation of building in the depression of the 1930s produced a paralysis which lasted until well after World r 11 As the postwar building boom penetrated into the large cities the demand for structural stone and veneer led to a considerable revival of the industry. Except for tombstones, however, for which there is a continuing demand. the production of granite is geared to the fluctuating market for curbing in highway construction and veneer used in the facing of large industrial and commercial buildings (see also QUARRYING).

Composition and Occurrence.—Granite may occur in dikes or sills but more characteristically it forms irregular masses of extremely variable size. For the smaller of these—up to five miles or so in maximum dimension—a floor may sometimes be inferred on stratigraphic grounds but can rarely be proven beyond reasonable doubt. For the larger masses. known as batholiths, often hundreds or thousands of square miles in area, thicknesses cannot be estimated; such masses are often assumed to take their origin directly from the (hypothetical) underlying granite zone or shell of the lithosphere.

Intrusive rocks containing in excess of 40% (by volume) of quartz are virtually unknown. A lower limit to quartz content of granite is not so easily set, but rocks containing less than 20% of quartz are almost never named granite by those who describe them. Considerable evidence suggests that intrusive rocks of intermediate quartz content are less abundant than those rich in quartz (granite) or those in which quartz is scarce or lacking (gabbro).

The principal constituent of granite is feldspar (*q.v.*), both plagioclase and alkali-feldspar ordinarily being abundant. The relative abundance of the two kinds of feldspars has provided the basis for so many attempts at classification that even a brief review of the matter would turn this into an article about taxonomy rather than rocks. It is safe to say that in most rocks described as granite the ratio of dominant to subordinate feldspar is less than 2. In this category fall most of the granites of the eastern, central and southwestern United States, southwestern England (Cornwall, Devon), the Fennoscandian (Baltic shield) area, western and central France, Spain, etc. Indeed, examples are so numerous that it is difficult to select among them. Granites in which there is a great excess of plagioclase over alkali-feldspar are not at all rare, however. and in large regions of the western United States this is the common type; indeed, it is thought to be characteristic of the great series of batholiths stretching from Alaska and British Columbia southward through Idaho and California into Mexico. The least abundant granites appear to be those with a great excess of alkali-feldspar over plagioclase—the alkali granites. In the United States these are well known from Quincy and Cape Ann, Mass.! Conway, N.H., Mt. Dessert, Me. They occur in smaller bodies at numerous sites in rocks of the Tertiary period in Great Britain and in the Christiania region of Norway. but their most extensive development is in northern Nigeria. Like most alkaline rocks, they have received attention out of all proportion to their abundance. In New England. for instance. a region relatively rich in alkali-granites, they probably account for no more than a few per cent of the known outcropping of granite.

The relative abundance of the different kinds of granite is a bothersome matter because the roots of many granite classifications go back to a time when the plagioclase series was either unknown or poorly known. If a granite was to consist primarily of feldspar and quartz it was thus necessarily what we now call an alkali-granite, and in most classifications these, by all odds the rarest members of the class, are still the "true" granites.

The minor essential minerals of granite may include muscovite, biotite, amphibole, pyroxene or, rarely, iron-olivine (fayalite). Usually no more than two or three of these are present. Amphibole or pyroxene-bearing granites never carry muscovite in significant amount. Biotite may occur in granite of any type and is usually present, though sometimes in very small amount. The sodic-amphiboles and pyroxenes (riebeckite, arfvedsonite, aegirine) are characteristic of the alkali-granites. When plagioclase is in great excess over alkali-feldspar the ferromagnesians usually include hornblende, and augite may be present as well; the principal, and sometimes the only, potash bearing mineral in such rocks is biotite. If neither feldspar is in great excess of the other, neither amphibole nor pyroxene is likely to be an essential constituent; the dark minerals will then ordinarily be either or both biotite and muscovite. The maximum permissible dark mineral content varies from classification to classification, but rocks containing more than 20% (by volume) of dark minerals are rarely named granite, and in most granites the "colour index" is very much less than this. As with quartz. massive intrusives of intermediate colour index appear to be considerably less abundant than those either rich in heavy silicates (gabbro) or poor in them (granites).

Theories of Origins.—Controversy concerning the origin of granite has been alternately raging and simmering since the birth of scientific petrography, and there is as yet no general agreement on the subject; indeed, there are probably few areas of inquiry in which acknowledged specialists are in such unequivocal disagreement.

The principal contesting hypotheses may be classified as (1) magmatic or (2) transformist. The proponents of the former argue that granites are derived by intratelluric crystallization of a parent liquid or liquid-crystal mush (magma). The proponents of the latter argue that granites have formed without the intervention of magma. and sometimes even with no liquid at all, by the solid state metamorphism of pre-existing sedimentary rocks. A third group advances the metasomatic or hydrothermal hypothesis and regards granites as products of reaction between a dilute, largely aqueous fluid and previously consolidated sedimentary or metamorphic rocks. During the early 20th century the controversy was to a surprising extent regional or even national, the Scandinavians and French being devout metasomatists, the Germans and British equally devout magmatists. In the decade following World War I, however, a revival of transformism began almost simultaneously in France and Britain, and soon spread. By the middle of the century the controversy had lost all of its national and much of its scientific character. The theory of magmatic origin is perhaps strongest in the Soviet Union and the United States.

For further discussion of these hypotheses *see* GEOCHEMISTRY: *Geochemistry of the Lithosphere;* METAMORPHISM; METASOMATISM. *See* also PETROLOGY. (F. Cs.)

GRANITE CITY, an industrial city of Illinois, U.S.. is located in Madison county on the Mississippi river, 10 mi. N.E. of St. Louis. The land on which Granite City stands was countryside until 1891. when Frederick G. and William F. Niedringhaus, St. Louis manufacturers, acquired a site for the expansion of their graniteware industry. From the Niedringhaus plant Granite City has grown to impinge on the borders of older communities and blend into the heavily industrialized area extending north from East St. Louis. Xlore than a dozen railways help to feed Granite City's industries and distribute its manufactures. The production of steel. originally an auxiliary of the graniteware (enameled ironwear) industry, has assumed the premier place in the city's economic life. Graniteware. which gave the city its name, is no longer manufactured there. Granite City also manufactures metal containers. railway equipment, chemicals and stoves.

The city was founded in 1893 and incorporated in 1896. For comparative population figures *see* table in ILLINOIS: *Population.* (R. E. M.)

GRAN SASSO D'ITALIA ("Great Rock of Italy"), mountain of the Abruzzi e Molise provinces of Italy, culminating point of the Apennines, 9.560 ft. in height. It resembles the limestone Alps of Tirol and its elevated plateaus have a number of *doline* or funnel-shaped depressions into n-hich melted snow and rain sink. The summit is covered with snow for the greater part of the year. 'The Alpine region beneath its summit is still the home of the wild boar. and here and there are dense woods of beech and pine. The group has other lofty peaks. the Pizzo d'Intermesole (8.680 ft.). the Corno Piccolo (8,652 ft.), the Pizzo Cefalone (8,307 ft.) and the Monte della Portella (7,83j ft.). The most convenient starting point for the ascent is Assergi, 10 mi. N.E. of Aquila, at the south foot of the Gran Sasso with its interesting Romanesque church (Sta. Maria Assunta).

GRANT, DUNCAN JAMES CORROWR (1885–), Scottish painter and decorative artist, whose style, particularly influenced by Paul Cézanne and modern French painting, is marked by bold brushwork and bright colours, was born at Rothiemurchus, Inverness-shire on Jan. 21, 1885. Educated at St. Paul's school, London, he afterward studied at Westminster School of Art and visited Paris, Italy, Greece and Tunisia. He worked with Roger Fry at the Omega workshops, London, in 1913, designing fabrics and furniture, besides executing some highly individual paintings such as "The Lemon Gatherers" (1910, Tate gallery, London) and "The Tight-Rope Walkers" (1918, Ralph Partridge). His later easel pieces were often less well composed than the three large decorative panels originally intended for R.M.S. "Queen Mary" (1935).

Grant also designed stage décor and lithographs, holding his first one-man show at the Carfax gallery in 1920. Grant became a member of the London Group in 1919.

See *Duncan Grant,* with introduction by Roger Fry, new ed. (1930); Raymond Mortimer, *Duncan* Grant (1944); Retrospective Exhibition Catalogue, Tate Gallery (1959). (D. L. FR.)

GRANT, SIR FRANCIS (1803–1878), Scottish portrait painter, whose portraits generally have a superficial brilliance suited to their subject, was born at Edinburgh on Jan. 18, 1803. Educated at Harrow, he gave up law for painting in 1827, and exhibited at the Royal Academy in 1834. At first a painter of animals and hunting scenes like "The Melton Hunt, going to draw the Ram's Head Cover" (1839), he turned to portraiture, chiefly of society sitters. He painted many of the celebrities of his day, including Scott, Macaulay, Disraeli, Palmerston and Russell, his brother Sir J. Hope Grant and his friend Sir Edwin Landseer. Grant's works were not of the highest artistic rank, a distinguished exception being "The Duke of Portland" (1853). Grant was elected a member of the Royal Academy in 1851, and became president arid was knighted in 1856. He died at Melton Mowbray, Leicestershire, on Oct. 5, 1878. (D. L. FR.)

GRANT, GEORGE MONRO (1835–1902), Canadian educator, principal of Queen's university, Kingston, Ont., was born in Nova Scotia in 1835 and educated at Glasgow university, where he had a brilliant academic career. Entering the ministry of the Presbyterian Church, he obtained a pastoral charge in Halifax. N.S., which he held from 1863 to 1877. When Canada was federated in 1867 Nova Scotia was strongly opposed to federal union. Grant threw his influence in the federal scale, and his oratory played an important part in securing the success of the movement. When the consolidation of the dominion by means of railway construction was under discussion in 1872, Grant traveled from the Atlantic to the Pacific with the engineers who surveyed the route of the Canadian Pacific railway, and his book *Ocean to Ocean* (1873) helped to show Canadians the value of the heritage they enjoyed. In 1877 Grant was appointed principal of Queen's university at Kingston. A tour in 1888 to Australia, New Zealand and south Africa strengthened the imperialism that was the guiding principle of his political opinions. He died at Kingston on May 10, 1902.

GRANT, SIR JAMES HOPE (1808–1875), English general, son of Francis Grant of Kilgraston, Perthshire, and brother of Sir Francis Grant, president of the Royal Academy, was born on July 22, 1808. He entered the army in 1826, becoming captain in 1835. In 1842 he was brigade-major to Lord Saltoun in the Chinese War, and received the rank of major and the companion of the Bath for his services at the capture of Chin-Kiang. He fought in the first Sikh War of 1845–46 and in the Punjab campaign, winning further promotion. He took a leading part in the suppression of the Indian mutiny of 1857. After the recapture of Lucknow he was appointed to the command of the force employed for the final pacification of India. Before this task was quite completed he was created knight commander of the Bath. In 1859, in command of the British land forces in the French and British expedition against China, he accomplished the object of the campaign within three months of the landing at Pei-tang (Aug. 1, 1860), occupying Peking. For his conduct in this, which has been called the "most successful and the best carried out of England's little wars," he received the thanks of parliament and was gazetted knight grand cross of the Bath. In 1861, as lieutenant general, he was appointed commander in chief of the army of Madras; on his return to England in 1865 he n-as made quartermaster general at headquarters, and in 1870 was transferred to the command of the camp at Aldershot. He took part in the reform of educational and training plans of the forces after the Franco-German war, and was largely responsible for the introduction of annual army maneuvers. In 1872 he was gazetted general. He died in London on March 7, 1875.

Incidents in the Sepoy War of 1857–58, compiled from the Private Journal of General Sir Hope Grant, K.C.B., together with some explanatory chapters by Capt. H. Knollys, Royal Artillery, mas published in 1873, and *Incidents in the China War of 1860* appeared posthumously under the same editorship in 1875.

GRANT, SIR PATRICK (1804–1895), British field marshal, second son of Maj. John Grant. was born on Sept. 11, 1804, at Auchterblair, Inverness-shire. He entered the Bengal native infantry in 1820 and became captain in 1832. He served in Oudh from 1834–38 and raised the Hariana Light infantry. He became adjutant general in 1846. He served under Sir Hugh Gough and was present at the battles of Maharajpur (1843), Moodkee (1845), Ferozshah (1846) and Sobraon (1846), receiving the companion of the Bath and the brevet rank of lieutenant colonel. He was appointed aide-de-camp to the queen, and served in Kohat in 1851. From 1856 to 1861 he was commander in chief of the Madras army, was made knight commander of the Bath in 1857, and succeeded General Anson in command of the army in India. He directed operations from Calcutta until the arrival of Sir Colin Campbell. He left India in 1861, was promoted lieutenant general in 1862, and was governor of Malta from 1867 to 1872. He was promoted general in 1870, field marshal in 1883 and colonel of the Royal Horse guards and gold-stick-in-waiting to the queen in 1885. From 1874 he was governor of the Royal hospital, Chelsea, until his death there on March 28, 1895.

GRANT, ROBERT (1814–1892), British astronomer whose *History of Physical Astronomy* (1852) took a leading place in astronomical literature, was born at Grantown-on-Spey, Scot., on June 17, 1814. He became interested in astronomy at an early age and conceived the idea of his history while working in a counting house in London. In 1859 Grant succeeded J. P. Nichol as professor of astronomy in the University of Glasgow. His principal work at Glasgow consisted in determining the places of a large number of stars with the Ertel transit circle of the observatory. The results, extending over 21 years, are in the *Glasgow Catalogue of 6,415 Stars* (1883), which was followed by the *Second Glasgow Catalogue* of *2,156 Stars*, published a few weeks after Grant's death at Grantown-on-Spey, Oct. 24, 1892. (O. J. E.)

GRANT, ULYSSES SIMPSON (1822–1885), U.S. soldier and 18th president of the United States, was born at Point Pleasant, Ohio, on April 27, 1822. He was a descendant of Matthew Grant, a Scotsman, who settled in Dorchester, Mass., in 1630. His earlier years were spent in helping his father, Jesse R. Grant, upon his farm in Ohio. In 1839 he was appointed to the military academy at West Point, and it was then that his name assumed the form by which it is generally known. He had been christened Hiram, with Ulysses for a middle name. Since he was usually called by his middle name, the congressman who recommended him for West Point supposed it to be his first name, and added thereto the name of his mother's family, Simpson. Grant was the best horseman of his class, and took a respectable place in mathematics, but at his graduation in 1843 he ranked only 21st in a class of 39. In Sept. 1845 he went with his regiment to join the forces of Gen. Zachary Taylor in Mexico; there he took part in the battles of Palo Alto, Resaca de la Palma and Monterey, and, after his transfer to Gen. Winfield Scott's army, which he joined in March 1847, served at Vera Cruz. Cerro Gordo, Churubusco, Molino del Rey, and at the storming of Chapultepec. He was breveted 1st lieutenant for gallantry at Molino del Rey and captain for gallantry at Chapultepec. Three days later, Sept. 16, 1847, he was commissioned 1st lieutenant.

In Aug. 1848, after the close of the war, he married Julia T. Dent (1826–1902), and was for a while stationed in California and Oregon. In 1853 he was commissioned captain, but in 1854 he resigned his commission. His reputation had suffered from allegations of intemperate drinking which, whether well founded or not, certainly impaired his usefulness as a soldier. For the next six years he lived in St. Louis, Mo., earning a scanty subsistence by farming and dealings in real estate. In 1860 he removed to Galena, Ill., and became a clerk in his father's leather store. At that time his earning capacity seems not to have exceeded $800 a year, and he was regarded by his friends as a broken and disappointed man. He was living at Galena at the outbreak of hostilities between the North and South. (J. F.)

Grant's **Civil** War Career.—At the beginning of the war Grant offered his services as a colonel, but the war department ignored his application. He drilled the militia company organized in Galena and went to Springfield, where he worked in the office of the state's adjutant-general until he received appointment as colonel of the 21st Illinois infantry regiment. Shortly after, Lincoln appointed him a brigadier general. Assigned to command at Cairo, Grant won his first distinction by seizing, on his own responsibility, Paducah, Ky., at the confluence of the Tennessee and the Ohio rivers (Sept. 6, 1861). On Nov. 7 he led his troops to Belmont, Mo., won a momentary victory, and then was forced to retreat. Early in 1862 he persuaded Gen. Henry W. Halleck, commanding in St. Louis, to give him permission to advance on Fort Henry, located on the Tennessee river at the Tennessee-Kentucky border. Aided by a flotilla of gunboats, Grant easily took the fort, from which the Confederates fled to Fort Donelson on the Cumberland. Grant followed and launched an attack on the larger fort, which surrendered with its garrison of 15,000. After Donelson, the Confederates abandoned Nashville, and Grant occupied the Tennessee capital.

Failure of communications led Halleck to remove Grant from command temporarily, but he rejoined his army at Savannah, where it was preparing for a campaign against Corinth, Miss. On April 6, 1862, the Confederates attacked Grant's camp at Shiloh church, or Pittsburg Landing, and drove them back to the river bank. The next day, joined by the army of the Ohio under Gen. Don Carlos Buell, Grant drove the Confederates from the field. Immediately after Shiloh Halleck arrived to take command in person, and with Grant removed from all important duties and second in command, began to advance on Corinth. After the Confederates abandoned Corinth and federal forces occupied it, Halleck went to Washington as general in chief, and Grant resumed command of his army and of the army of the Mississippi under William S. Rosecrans. Two victories (Iuka and Corinth) by Rosecrans in the fall of 1862 enabled Grant to secure his position on the Mississippi, and late in the year he began an advance on Vicksburg, the last important Confederate stronghold on the river.

Slowly, with experience, Grant was gaining strategic concepts and displaying his particular qualities as a commander. He displayed a willingness to fight, the ability to make decisions, a bulldog determination and an absence of fear. He recognized the importance of cutting the Confederacy in two and in gaining control of the Mississippi and other rivers of the South. He was fortunate in being away from the political controversies and the interference which congress and the civil authorities in Washington exerted on the armies in Virginia, and he had the support of Lincoln, who admired his fighting qualities.

Through the winter of 1862–63 Grant maneuvered about Vicksburg, seeking an approach to the city. Much of the effort was expended in digging a canal into which he hoped to divert the river and thereby isolate Vicksburg. The effort proved futile, and late in the spring federal gunboats ran past the city's batteries and secured the banks south of the stronghold. Then Grant led his armies around the city, took Jackson, Miss.: and defeated the Confederates at the battle of Champion Hill (Baker's creek). As the Confederates retreated into Vicksburg, Grant besieged the city, and on July 4, 1863, the fortress surrendered with nearly 30,000 men. Lincoln promoted Grant to major general in the regular army.

The fall of Vicksburg cut the Confederacy in two, and Grant planned to follow his victory by an attack on Mobile and the rivers which flowed into the Gulf of Mexico. The defeat of Rosecrans at Chickamauga, however, forced a change of plans. Grant went to Chattanooga, where the federal army mas under siege. Joined there by troops under W. T. Sherman and Joseph Hooker, Grant launched an attack on the Confederates who surrounded him and drove them from the field.

Eastern Campaign.—Congress revived the rank of lieutenant general, and Lincoln promoted Grant to the new grade. In hlarch 1864 he went east and took up headquarters with George Gordon Meade's army of the Potomac and directed the campaign in Virginia. He advanced against R. E. Lee's armies in the Wilderness campaign and, although defeated. flanked the Confederates and renewed the attack. In a series of battles from the Wilderness to Cold Harbor: Grant suffered enormous casualties but succeeded in pushing Lee back toward Richmond. Although after Spottsylvania he wired Halleck. "I propose to fight it out on this line! if it takes all summer,'! he abandoned the approach across Virginia, shifted his base to the south and east of Richmond, and began a campaign against the Confederate capital and the nearby important railroad junction of Petersburg. The campaign of attrition lasted until Petershurg fell and Lee and the Confederate government abandoned Richmond in April, 186;. Grant pressed Lee's retreating armies until, on April 9, Lee surrendered to him at Appomattox Court House.

Although he gave his major attention to the Virginia campaign, Grant furnished general direction and supervision to the other armies advancing against the Confederates. He kept in close touch with Sherman, advancing against Atlanta and then moving to Savannah and turning northward across the Carolinas. and! with George H. Thomas, commanding in Nashville. An efficient command system, with Lincoln defining general objectives, Grant furnishing strategical advice and Halleck, as chief of staff, supervising technical details, evolved from experience and enabled the North to make effective use of its vastly greater resources of man power and industry.

At the close of the war Grant's superior military qualities received general recognition. His great opponent Robert E. Lee was clearly a better tactician, but Grant's concepts of strategy, though evolving slowly, surpassed that of any other commander on either side. He was less competent as an organizer than George B. McClellan, less brilliant than Rosecrans and less cautious than Thomas. But he displayed more capacity for growth than any of them. Decisiveness and persistence were the foundation stones of his success. For a fuller account of his role in the war, *see* AMERICAN CIVIL WAR.

Grant's Presidency (1869–77).—After Lincoln's assassination his successor, Andrew Johnson, at first showed a disposition to deal harshly with Confederate leaders and rumour had it that General Lee would be punished. Lee appealed to Grant, who protested to Johnson that the Confederate general was protected by the terms of his parole given at Appomattox. Johnson abandoned any intention oi bringing Coniederates to trial for treason. The president's plan for reconstructing the South brought him into conflict with radical Republicans in congress and both the president and the radical leaders angled for Grant's support. In 1866 congress created the grade of general and Johnson appointed Grant to the office. In that same year Grant accompanied Johnson and a number of other dignitaries on a "swing around the circle" to Chicago, which Johnson arranged in the hope of carrying his cause to the people. Radical tactics in creating disturbances at Johnson's appearances and the outcome of congressional elections in the fall convinced Grant that Johnson did not have popular support. The general avoided open commitment. however, until the following year, nhen he became involved in Johnson's attempt to remove Secretary of War Edwin M. Stanton from office. Grant took over the war department as ad interim secretary but nhen the senate, acting under the Tenure of Office act. refused to approve Johnson's act, Grant turned the office back to Stanton. Johnson had hoped to force Stanton to sue for his office in the courts and thus test the constitutionality of the Tenure of Office act and believed that Grant had deceived him and betrayed him. The bitter recriminations between the two drove Grant into the radical camp. After his quarrel with Johnson the Republicans rallied to him as a candidate and nominated him for the presidency. The Democrats chose Horatio Seymour. wartime governor of New York, to oppose him. Due to the Republican control of the Negro vote in the South. Grant had a majority of the popular votes and received 214 electoral votes to Seymour s 80.

Grant came into the presidency in 1569 without political experience and immediately began to make political mistakes. He selected able men for his cabinet, though few of them were prominent in political circles. Republican leaders. guided by Massachusetts senator Charles Sumner, forced Grant to withdraw the nomination of William T. Stewart, prominent merchant whom Grant had named secretary of the treasury, and accept George S. Boutwell, a Massachusetts politician instead. Thereafter the politicians were watchful lest Grant depart from party regularity. Soon a rift developed between such practical politicians as Benjamin F. Butler, Roscoe Conkling and Oliver P. Morton and such men as Sumner and Missouri's Carl Schurz, making claim to advocate reform. The division became sharper when Sumner defeated a treaty which Grant h'ad negotiated through his private secretary, by which Santo Domingo would be annexed to the United States. Thenceforth, those who sided with Sumner lost patronage and the support of the administration. The reforming element investigated the "Black Friday" episode—in which Jay Gould and James Fisk attempted to corner the New York gold market on Sept. 24, 1869—in hopes of implicating Grant in the scandal. They uncovered only the connections of Grant's brother-in-law with the speculators.

In 1872, a presidential election year, the disgruntled politicians combined with various types of reformers to launch a "Liberal Republican" party. Free traders, currency reformers and advocates of civil service assembled in convention in Cincinnati in May to select a candidate for the presidency in the almost certain belief that their candidate would receive the endorsement of the Democrats. Political ineptitude characterized the meeting and a clique of newspaper men dominated the proceedings which ended with the nomination of Horace Greeley, editor of the *New York Tribune*. The choice was unwise. Greeley had been an abolitionist, a high tariff protectionist and a lifelong opponent of the Democrats. Nevertheless the Democrats nominated him. In a campaign characterized by excessive mudslinging and the vicious lampooning of Greeley, Grant won an easy re-election—272 to 66 in the electoral college.

Scandals dominated public attention during Grant's second administration, 1873–77. Congressional investigation exposed the methods by which the Crédit Mobilier of America (*q.v.*) constructed the Union Pacific railroad and bribed congressmen, and newspapers turned upon congress to denounce a "salary grab" by which congressmen raised their own salaries. Investigators probed into the Sanborn contracts, uncovered a "whiskey ring" which defrauded the internal revenue bureau, and found that Secretary of War Belknap had received bribes. None of these involved Grant personally, but his private secretary was mixed up in the whiskey ring, and others close to the White House were involved in the corrupt activities of "Boss" Shepherd's board of public works in the city of Washington. One result of the scandals was a declining confidence in government which contributed to the panic of 1873 and to Democratic victory in the congressional and state elections of 1874. By 1876 it seemed that the Republican party's had odour would result in a Democrat's entering the White House. The era of scandals, however, was capped by the manipulations of the disputed presidential election of 1876 in which the votes of three Southern states were taken from the Democratic column and given to Republican Rutherford B. Hayes, who became Grant's successor in office (*see* UNITED STATES: *History*).

Three national problems moved closer to solution during Grant's administrations. One was the gradual disappearance of the problem of the reconstruction of the South. In 1870 the states ratified the 15th amendment to the constitution, forbidding the denial of suffrage because of race. Slowly, one by one, the Southern states were "redeemed" as conservative Democrats regained control and ousted corrupt carpetbagger and Negro governments. For the most part Grant refused to interfere in the South in support of Republican governments. He did, however, suspend the writ of habeas corpus in parts of South Carolina where the Ku Klux Klan was terrorizing Negro voters. A few weeks after Grant left the White House. in 1877, the last of the carpetbag governments disappeared from the South. The question of the public debts and currency inflation received Grant's attention. The secretary of the treasury slowly reduced the debt and retired greenbacks from circulation. In 1874 Grant vetoed a legal tender bill which would have inflated the currency. In 1875 congress passed and Grant approved a Resumption act providing for such resumption four years later. In foreign affairs, the outstanding event of Grant's administration was the settlement of the "Alabama claims" against England, nhich grew out of the Civil War. The British had allowed commerce destroyers, built for the Confederates, to slip away from England and destroy American shipping. By the treaty of Washington in 1871 the British agreed to submit these claims to an arbitration court—nhich awarded $15,500,000 damages to the United States. (W. B HE.)

Later Life.—After the close of his presidency in the spring of 1877 Grant started on a journey around the world, accompanied by his wife and one son. He was received with honours in England and on the continent. whence he made his way to India. China and Japan. After his return in Sept. 1880 he went back to his old home in Galena (Ill.). A faction among the managers of the Republican party attempted to secure his nomination for a third term as president, and in the convention at Chicago in June 1880 he received a vote exceeding 300 during 35 consecutive ballots. Nevertheless his opponents made such effective use of the popular prejudice against third terms that the scheme was defeated and Garfield was named in his stead. In Xug. 1881 General Grant bought a house in New York city. His income was insufficient for the proper support of his family, and accordingly he had become partner in a banking house, Grant and Ward. in nhich one of his sons nas interested. The ex-president invested in it all his available property, but paid no attention to the management of the business. His facility in giving his confidence to unworthy people nas now to be visited with dire calamity. In 1884 the firm became bankrupt, and it was discovered that two of the partners had been perpetrating systematic and gigantic frauds. This blow left General Grant penniless, just at the time when he was beginning to suifer acutely from the disease which finally caused his death. Up to that time Grant had never made any pretensions to literary talent, but on being approached by the *Century Magazine* with a request for some articles he undertook the work, which led to the writing of his *Personal Memoirs,* a frank, modest and charming book, which ranks among the best military biographies. The sales earned for the general and his family something like $500,000. The circumstances in which the book was written made it an act of heroism comparable with any that Grant ever showed as a soldier. During most of the time he was suffering from cancer of the throat, and it was only four days before his death that he finished the manuscript. In the spring of 1885 congress had passed a bill creating him a general on the retired list, and in the summer he mas removed to a cottage at Mt. M'Gregor, near Saratoga, where he passed the last five weeks of his life before his death on July 23, 1885. His body was placed in a tomb monument in Riverside drive, New York city, overlooking the Hudson river.

His misfortunes and the heroism he displayed when confronted with adversity did much to restore Grant in the affections of the American people. During his presidency, his opponents described the corruption and scandals as "Grantism" and dimmed the glory of his military achievements. As president he was conservative, suspicious of the motives of the reformers, and eager to restore both economic and political stability to the country. He did not conceive of himself as a parliamentary leader. "I shall have no policy to enforce against the will of the people," he said on accepting his nomination. Gradually, as he did during the Civil War, he learned from experience. Longer perspective, too, has thrown Grant's military accoinplishments into stronger relief, and ranked him among the great captains of history.

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See also Grant's personal biography, *Personal Memoirs,* 2 vol. (1885–86), new ed., 1 vol. (1952). (J. F.; W. B. HE.)

GRANT, in law, the transfer of property by an instrument in uriting, termed a deed of grant. According to the old rule of common law, the immediate freehold in corporeal hereditaments lay in livery (*see* FEOFFMENT), whereas incorporeal hereditaments, such as a reversion, remainder, advowson, etc., lay in grant, that is, passed by the delivery of the deed of conveyance or grant without further ceremony. The distinction between property lying in livery and in grant is now abolished, the Real Property Act 1845 providing that all corporeal tenements and hereditaments shall be transferable as well by grant as by livery. What in many other countries is termed a "concession" is in England usually called a "grant."

GRANTH, the sacred "book" of the Sikhs (*q.v.*). It is a notable compilation of later Indian protestant writings, inculcating monotheism, yet not excluding praise of the goddess Durga (*q.v.*), denouncing caste privileges, concremation of widows and female infanticide, the use of hemp and alcohol (though the latter prohibition is disregarded), and any indulgence in tobacco. It consists of two parts, the Adi Granth or "Original Book," and the Dasam Padshahi dā Granth, or "Book of the Tenth Reign," *i.e.*, of the 10th Gurū, Govind Singh. This latter is accepted by all Sikhs. Its difficulties of interpretation have hindered Sikh progress and expansion. Written in a special Sikh script (*Gurmukhi*) without separation of words in various dialects and even partly in Persian its earliest manuscripts have perished. It still awaits definitive exegesis.

See M. A. Macauliffe, ***The Sikh Religion; Its Gurus, Sacred Writings*** *and Authors*, 6 vol. (Oxford, 1909); Ernst Trumpp, *The Adi Granth* or *Holy Scriptures of the Sikhs* (London, 1877).

GRANTHAM, a municipal borough in the Grantham parliamentary division of the Parts of Kesteven, Lincolnshire, Eng., on the Witham river, 25 mi. S.S.W. of Lincoln by road. Pop. (1951) 23,555. Area 6 sq.mi. It is an important junction on the main railway line to Scotland. Of Saxon origin, the town (Grandham) is given in the Domesday survey as part of the royal demesne, the manor having belonged to Edith. queen of Edward the Confessor. It remained a royal possession until the time of William III, though often granted for a lifetime to such feudal families as the De Warennes. from whose famous checky shield the borough coat of arms is derived. The charter of incorporation was granted by Edward IV in 1463 and self-government of the town and soke was thereafter exercised through 13 "comburgesses," one of whom was annually elected alderman—the title retained by the town's chief citizen until the Municipal Corporations act of 1835. The town remained a parliamentary borough until 1918. The wool trade of the middle ages added to Grantham's prosperity. The parish church of St. Wulfram, mainly Early English and Decorated, is one of the finest mediaeval churches in England, the tower and spire (14th century) rising magnificently to a height of almost 280 ft. A small priest's room over the south porch houses a chained library which was presented to the church in 1598. Grantham was created a bishopric suffragan in the diocese of Lincoln in 1905. King's school, refounded early in the 16th century by Richard Fox, bishop of Winchester, still uses the old school building and headmaster's house of about that period. Edward VI granted the school's present name by charter of 1553. The greatest of its pupils was Sir Isaac Newton, who was born at Woolsthorpe, a few miles south of Grantham. The Angel hotel is said to be where Richard III signed the death warrant of the duke of Buckingham in 1483. The 18th-century George hotel is described in Charles Dickens' *Nicholas Nickleby* as one of the best inns in England. A market is held in Grantham's ancient market place on Saturdays.

The chief industries are concerned with mechanical engineering, including particularly oil engines and road rollers. A local firm invented the "caterpillar" track at the beginning of the 20th century, and it was so named by troops during a trial at Xldershot in 1908.

GRANTIA, a genus of the lesser calcareous sponges. It contains several species, of comparatively small size. common in the inshore waters of Great Britain and North America. (*See* SPONGES.)

GRANTOWN-ON-SPEY, a small burgh of Morayshire, Scot. Pop (1951) 1,541. Area .7 sq.mi. It lies in the Highlands near the boundary of Inverness-shire, on the left bank of the Spey, 34 mi. S.E. of Inverness by road. There are two railway stations. It was founded in 1776 by Sir James Grant of Grant, and became the chief seat of that ancient family, whose members had lived on their adjoining estate of Freuchie (Gaelic *froachach,* "heathery") since the beginning of the 15th century, and hence were usually described as the lairds of Freuchie. The town, built of gray granite and situated in the midst of beautiful woods, is known for its salmon fishing and is a holiday resort.

GRANTS, a town of Valencia county, N.M., U.S., 78 mi. W. of Albuquerque, is called the "uranium capital of the world" because of the extensive uranium mining and milling activities in the vicinity. The town dates from 1881 when the Grant brothers, contractors building the Atlantic and Pacific railroad, established a construction camp at what became known as Grants station. Originally a livestock shipping centre. Grants later was supported by lumber and vegetable growing industries. Uranium ore was first discovered near Grants in 1950 by Paddy Martinez, a Navaho Indian, and further exploration revealed that more than 70% of the world's known uranium reserves were located in the area. For population (which increased 282% between 1950 and 1960) *see* table in NEW MEXICO: *Population.* (H. T. B.)

GRANULITE. To German. Scandinavian and most English and North American petrologists a granulite (from Lat. *granulum,* "a little grain") is a crystalline schist or gneiss which contains certain mineral assemblages characteristic of high pressure and fairly high temperature; *i.e.,* granulite facies. The typical minerals in granulites are anhydrous, such as pyroxene. garnet, cordierite, sillimanite and kyanite (cyanite), together with feldspars and quartz. The hydrous minerals biotite and hornblende are not abundant in granulite. Muscovite is never present in a true granulite. The typical granulite is a quartzofeldspathic rock with magnesium-rich garnet (pyrope) and sillimanite or kyanite: the *Weisstein* of Saxony. Rutile is a common accessory.

Certain basic gneisses with diopside or hypersthene and a characteristic brown hornblende are also called granulites; *e.g.,* the norite granulite of Lapland in north Finland.

The alkali feldspar in granulites is often a microperthitic orthoclase or a feldspar with a triclinicity intermediate between orthoclase (which is monoclinic) and microcline (which is distinctly triclinic). Mesoperthites, *i.e.,* perthites with about 50% albite and 50% orthoclase. are much more common in granulites (and charnockites) than in other kinds of deep-seated rocks.

Antiperthitic plagioclase, *i.e.,* plagioclase with exsolved blebs of potash feldspar. is typical for granulites, as well as rocks belonging to the charnockite kindred.

Granulites may be fine grained or coarse grained; the texture is a sugary mosaic of irregular grains fitted together.

Occurrence.—Granulites occur chiefly in the pre-Cambrian basement complexes in various parts of the world, the areas in Saxony and Lapland perhaps being the best known. Such rocks have also been described from India. Ceylon. Madagascar, Norway, the United States, Canada, Greenland and Brazil. Granulites are intimately associated nith rocks of charnockitic affinity in the field. Some granulites are actually identical to rocks of the charnockite (*q.v.*), family.

Origin.—Although some petrologists consider granulites to be of magmatic origin (P. Eskola in his study of the Lapland granulites), most students believe that they are metamorphic rocks recrystallized under the high P,T (pressure, temperature) conditions of granuiite facies. *See* METAMORPHISM. (H. RG.)

GRANULOMA INGUINALE, a chronic, mildly contagious venereal disease initiated by an organism called the Donovan body. It is treated successfully with antibiotics. *See* VENEREAL DISEASES.

GRANVELLE, ANTOINE PERRENOT DE (1517–1586), French cardinal, a high-ranking member of the Spanish administration under Philip II, active in Brussels at the beginning of the Netherland revolt, was born at Besançon on Aug. 20, 1517, the son of Nicolas Perrenot de Granvelle. chancellor of Emperor Charles V. Granvelle was educated in Padua, Italy, and Louvain, Belg., ordained priest and, in 1540, consecrated bishop of Arras, France; in 1560 he was made archbishop of Malines, Belg, and the next year a cardinal. Together nith his brother Thomas Perrenot de Chantonay, Granvelle received thorough instruction in public affairs; he also derived from his father a high regard for the absolute, unrestricted authority of the monarch (as opposed to the ambitions of wealthy noblemen), which was to lead to a clash between him and the Netherland aristocrats.

In 1560 Philip appointed Cardinal de Granvelle, who was not a foreigner to the Netherlands (to the intellectual atmosphere of which he was also tied through his interest in painting and poetry and his somewhat epicurean outlook), chief counselor to Margaret of Austria, regent in the Netherlands. His political principles and possibly also his class consciousness (as a member of the lesser nobility) contributed to a gradual estrangement between him and the leaders of the Netherland magnates, William the Silent and the counts of Egmont and Horn. In his reports to Philip, Granvelle denied that any serious trouble was in the offing. The king himself was slow to discern the real character of the discontent and—owing perhaps to the influence of Margaret, who sided with the noblemen—regarded Granvelle's difficulties as a personal affair. On his order Granvelle left the Netherlands on March 12, 1564.

Later Philip concluded that the Netherlands revolution would have never developed had he supported Granvelle. After serving for some time in Italy, where he prepared the victory at Lepanto, Granvelle was appointed to the Spanish council of state, becoming the only non-Spanish member of that body. There his principles, hardened by experience, certainly did not make Philip's attitude to the Netherlands less intransigent. Granvelle died in Madrid on Sept. 21, 1586.

See also NETHERLANDS and biographies of William the Silent, Philip II, Margaret of Austria, etc.

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GRANVILLE, GRANVILLE GEORGE LEVESON-GOWER, 2ND EARL (1815–1891), English statesman, was foreign secretary in William Gladstone's first and second administrations. and succeeded him as leader of the Liberal party for a time. He was the grandson of the 1st marquess of Stafford (1721–1803). His father. the 1st earl (1773–1846), who married a daughter of the 5th duke of Devonshire, was, as Lord Granville Leveson-Gower, a member of parliament from 1795 to 1815, and a successful diplomat; he was a special ambassador to the tsar during 1804–07, and in 1824 his friend George Canning made him ambassador to Paris where he remained till 1841.

The 1st earl's eldest son was born in London on May 11, 1815, and educated at Eton and at Christ Church, Oxford. After a short spell as attaché to his father in Paris, he was elected Whig member of parliament for Morpeth in 1836 and 1837, and for Lichfield in 1841. In 1840 he married the widowed Lady Acton, heiress of the great Rhineland house of Dalberg, who died in 1860. Granville held various minor offices under Lord John Russell (*q.v.*) from 1846, and promoted the great exhibition of 1851 with such success that he was admitted to the cabinet while paymaster general. In Dec. 1851 he succeeded Lord Palmerston as foreign secretary for the remaining three months of the government's life. He was president of the council (1852–54) and chancellor of the duchy of Lancaster (1854–55) in Lord Aberdeen's coalition; he returned to the former office under Palmerston in 1855, and also became leader of the Liberal peers in the house of lords, a post he retained, save for an interval during 1865–68, until his death. In 1856, borrowing his cousin's gold plate from Chatsworth, he went on a special embassy to attend the coronation of the tsar. He was chancellor of the University of London, 1856–91, during which time he supported the admission of women.

In 1859 he attempted. without success, to form a government. He resumed the presidency of the council under Palmerston and Russell from 1859 to 1866. This post brought him into further contact with Queen Victoria, whose favourite Liberal minister he was henceforward. His most important political services were rendered as intermediary between her and Gladstone (*q.v.*). He was Gladstone's closest political friend from 1868, and served in three of his cabinets; he was secretary of state for the colonies in 1868–70 and in 1886, and for foreign affairs in 1870–74 and 1880–85.

Granville was an ideal negotiator, but as an initiator of policies Gladstone overshadowed him. The Franco-Prussian War, which broke out a few days after Lord Clarendon's death brought Granville to the foreign office, took both him and Gladstone by surprise. and brought on the only serious difference between them. Granville got the cabinet to override Gladstone's wish to protest at the annexation of Alsace-Lorraine. Otherwise they worked in close. constant and harmonious co-operation; and Gladstone found that. as he once wrote to Granville, "it is impossible for any man to talk over a difficulty with you and not to find himself nearer to a solution at the end than he was at the beginning." In the winter of 1870–71 Granville handled the Russian denunciation of the treaty of Paris with dexterity, and secured the point of form that future treaty denunciations would require in law the consent of all signatories; but had to concede the point of substance, a Russian fleet in the Black sea. The only other significant negotiation of these years was the settlement of the "Alabama" arbitration (*q.v.*). Granville became the official leader of the whole Liberal party when Gladstone first retired, and protested more mildly at Conservative policy in the great eastern crisis of 1876–78. He was again asked to form a government in 1880, but at once gave way to Gladstone. During his last spell at the foreign office Bismarck, in effect, dictated much of British foreign policy (*see* EUROPE. History), and Granville's own powers were clearly failing. He was one of the few Whig peers who stood by Gladstone in the Irish home rule crisis of 1886.

He died in London on March 31,1891, and was succeeded by the 3rd earl (1872–1939), the son of his second marriage, in 1865, to Castalia Campbell of Islay, Argyllshire.

See his *Life* by Lord Edmond Fitzmaurice, 2 vol. (London, 1905); *The Gladstone-Granville Political Correspondence, 1868–1876,* ed. by Agatha Ramm, 2 vol. (London, 1952). (M. R. D. F.)

GRANVILLE, JOHN CARTEBET, EARL (1690–1763), English statesman, known as Lord Carteret, was born on April 22, 1690, the son of George, 1st Lord Carteret, and great grandson of the Elizabethan admiral, Sir Richard Grenville. He succeeded his father in 1695 as 2nd baron Carteret. He was educated at Westminster, and at Christ Church, Oxford, and acquired a wide knowledge of modern languages and literatures, being almost the only Englishman of his time who knew German. He took his seat in the house of lords on May 25, 1711. An adherent of the Hanoverian dynasty, the friend of Stanhope and Sunderland, he took a share in defeating the Jacobite conspiracy of Bolingbroke on the death of Queen Anne and supported the Septennial act. His interests were, however, rather in foreign than in domestic policy. Early in 1719 he was appointed ambassador to Sweden, a post which he held for two years with great success. He gained an exceptional knowledge of European and, in particular, of German affairs.

Named secretary of state for the southern department on his return to London, he came into conflict with Townshend and Sir Robert Walpole. Walpole, who resented his ability to speak German with the king, arranged for him to succeed the duke of Grafton as lord lieutenant of Ireland, when the violent agitation in Ireland against Wood's halfpence (*see* SWIFT, JONATHAN) made a new appointment necessary. He was in Dublin from Oct. 23, 1724 until 1730. He had to deal with the opposition to Wood's halfpence, and to counteract the effect of Swift's *Drapier's Letters*. It is doubtful whether he could have reconciled his private friendship with Swift with his duty to the crown if Wood's patent had not been withdrawn. When he returned to London in 1730 Walpole was firmly established as master of the house of commons, and as the trusted minister of George II and he took no share in public affairs until the fall of Walpole in 1742. Carteret is credited with having paid the expenses of the first edition of Don *Quixote* to please Queen Caroline, but he lost her favour through becoming entangled in the scandalous family quarrel betaeen Frederick, prince of Wales, and his parents. His sympathies were with Maria Theresa in the War of the

Austrian Succession, on the ground that the fall of the house of Austria would increase the power of France. George II welcomed these views and made him secretary of state in 1742, a post which he held until 1744, accompanying the king to Germany in 1743. He succeeded in promoting an agreement between Maria Theresa and Frederick. His support of the king's policy was denounced as subservient to Hanover, but a few years later William Pitt adopted an identical policy and confessed that whatever he knew he had learned from Carteret. In 1751 he became president of the council and was still liked and trusted by the king but had little active share in the government.

In 1756 Newcastle asked him to become prime minister as the alternative to Pitt, but Granville, understanding why the offer was made, declined and supported Pitt. When in Oct. 1761 Pitt threatened to resign unless his advice to declare war on Spain was accepted, Granville replied that "the opinion of the majority (of the cabinetj must decide." He resisted Pitt's claim to be considered as a "sole minister," or in the modern phrase, "prime minister." Granville remained in office as president until his death in London on Jan. 22, 1763.

The title descended to his son Robert, who died without issue in 1776, when the earldom became extinct.

A somewhat partisan life of Granville was published by A. Ballantyne, *Lord Carteret, a Political Biography* (1887). His correspondence is in the British Museum.

GRANVILLE, at one time a town in New South Wales, Australia: 13 mi. W. of Sydney by rail near the head of the so-called Parramatta river, a salt-water extension of Sydney harbour. It became a municipality in 1885, but from 1949 was incorporated as part of the city of Parramatta. It was an important railway junction and manufacturing town, producing agricultural implements, locomotives, motor bodies, asbestos sheeting, aluminum ware, cream of tartar, tires. kalsomine, pipes, tiles and bricks; there are tanneries, flour mills and oil refineries.

GRANVILLE, a fortified seaport and bathing resort of northwestern France, in the *département* of Manche, at the mouth of the Bosq, 85 mi. S.W. of Cherbourg by rail. Pop. (1954) 9,858. The upper town stands on a promontory and is surrounded by ramparts; the lower town, with the bathing beaches and promenade, and the harbour lie below it. The barracks and the church of Notre Dame are in the upper town. The port consists of a large tidal harbour and a floating basin and is the port of Normandy for British goods. Its principal exports are eggs, vegetables, fish, lard and butter, and it imports mainly coal, timber and raw materials. Granville is a great centre for yachtsmen and tourists and for visitors to the Channel Islands. Deep-sea fishing is carried on, and the industries include shipbuilding, the preserving of vegetables, metal founding, ropemaking, the manufacture of chemical manures, shoes and biscuits.

GRANVILLE-BARKER, HARLEY (1877–1946), British dramatist, producer and critic, who profoundly influenced the 20th-century theatre and the presentation of Shakespeare's plays, was born in London on Nov. 25, 1877. He began his stage training at 13, and at 1j Charles Hawtrey gave him a London part. He preferred work uith William Poel s Elizabethan Stage society and Ben Greet's Shakespeare repertory company to a West End career, however, and in 1900 joined the experimental Stage society. In 1904 he undertook management of the Court theatre with J E. Vedrenne and made theatrical history by introducing the public to Ibsen. Maeterlinck, Galsworthy, John Masefield, Gilbert Murray's translations from Greek, new plays by Shaw and many other works. His wife Lillah McCarthy played most of the leading roles. The Court became an authors' theatre, and among new plays produced there were several of his own: *The Voysey Inheritance* (1905), the most famous, showing Shaw's influence; *Prunella* (1906), a charming fantasy written with Laurence Housman; *Waste* (1907); and *The Madras House* (1910).

Also revolutionary was his treatment of Shakespeare. Instead of traditional scenic décor and declamatory elocution, Barker successfuliy introduced, in the Savoy productions of *Tlze Winter's Tale* and *Twelfth Night,* continuous action on an open stage and rapid. lightly stressed speech. He was active in promoting a national theatre and by 1914 had every prospect of a brilliant dramatic career.

After World War I, however, during which he served with the Red Cross, he found the mood of the postwar theatre alien and contented himself with work behind the scenes, as president of the British Drama league, for instance. He settled in Paris with his second wife, Helen, an American, collaborating with her in translating Spanish plays, and writing his five series of brilliant *Prefaces to Shakespeare* (1927–48), an important contribution to Shakespearian criticism, which threw fresh light on the plays by analyzing them from the standpoint of a practical playwright with firsthand stage experience.

In 1937 Barker became director of the British institute of the University of Paris. He fled to Spain in 1940 and then went to the United States, uhere he worked for British information services and lectured at Harvard university. He returned to Paris in 1946 and died there the same year, on Aug. 31.

See W. Bridge-Adams, *The Lost Leader* (1954); C. B. Purdom, *Harley Granville-Barker* (1955). (W. A. DN.)

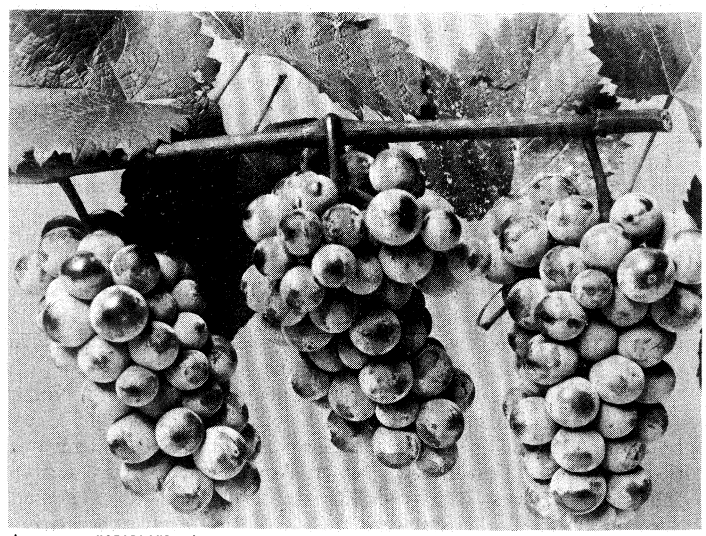
GRAPE. The grape genus *Vitis* of the family Vitaceae comprises about 50 species native to the north temperate zone, especially North America. Fossilized grape leaves, stem pieces and seeds unearthed from Miocene and Tertiary deposits in the northern hemisphere—the European continent, Korth America, England, Iceland—indicate the long existence and wide distribution of the vine. Certain of the present species closely resemble the fossil forms.

This article is divided into (1) a general viticultural and botanical discussion and (2) a detailed discussion of cultivation.

VITICULTURE

History.--Old world viticulture dates far back. Seeds found in the remains of the Swiss lake dwellings of the Bronze Age and entombed with mummies in Egypt closely resemble seeds of the oldest and most extensively cultivated species of today. Viticulture's tradition is nearly as old as man; details for grape and wine production figured in the hieroglyphics of the 4th (2400 B.C.), 17th and 18th dynasties of Egypt. According to the Bible, Noah planted a vineyard. In Homer's time wine uas a regular commodity among the Greeks. Pliny described 91 varieties of grapes, distinguished 50 kinds of wines and described vine-training methods.

Viticulture probably had its beginnings in the area around the Caspian sea, generally recognized as the place of origin of *V. vinifera,* the best known grape. From there grape growing in the old world spread to other parts of Asia Minor, then to Greece and from there to Sicily. The Phoenicians carried the grape into France about 600 B.C.; the Romans planted grapes on the Rhine not later than the 2nd century A.D.; and there is evidence that they introduced them into England. Coinciding with the westward



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GRAPE CLUSTERS. LEAVES AND VINE

spread of grape culture, grapes were moved into the orient by way of India. As new lands were colonized the grape mas taken along, so that today it is cultivated on all continents and islands where the climate is favourable.

Kinds **of** Grapes.—On the basis of use, grapes are grouped as wine grapes, raisin grapes, table grapes. sweet juice grapes and canning grapes. The mature fruit of all varieties—about 8,000—will ferment into a kind of wine when crushed, and most of them can be dried or eaten fresh. But only a limited number of varieties produce standard or higher quality wines; three varieties account for most of the raisins of commerce; only 1j to 20 varieties are grown extensively as table grapes; a single variety yields the bulk of sweet juice produced in America; and only a few varieties are used for canning.

A wine grape may be defined as a variety known to be capable in some locality of producing an acceptable wine. Table (dry) wines require grapes of high acidity and moderate sugar content, while dessert (sweet) wines are the product of grapes that are high in sugar and moderately low in acidity. In addition, high quality wines—those of outstanding bouquet, flavour and general balance—require grapes that possess individuality. Examples of such grapes are the White Riesling. Semillon, Cabernet Sauvignon, Tinta Madeira and similar varieties when they are grown under favourable climatic conditions.

Raisin grapes are those varieties that produce an acceptable dried product: soft in texture, of little tendency to stickiness, pleasing in flavour. large or very small and seedless. Only the Thompson Seedless, Muscat of Alexandria and Black Corinth varieties meet most of these requirements (see RAISIY).

Grapes used fresh, either as food or for decoration. are called table grapes. They must be pleasing to the eye and to the palate. Large size, brilliant colour and unusual form are appreciated. When grapes must be shipped long distances to markets or stored for a considerable period, important qualities are firmness of pulp, toughness of skin, adherence to the stem (pedicel) and resistance of the stems to desiccation or browning. These qualities are possessed to a degree by the Tokay, Emperor, Malaga, Red Malaga, Almeria and Ribier (Xlphonse Lavallee), all of which are grown in California, South Africa, Australia, Chile, Argentina and elsewhere. The raisin grape Thompson Seedless (Sultanina) is also, because of its seedlessness, a popular table grape.

Sweet juice grapes are those varieties that produce a juice acceptable as a beverage when preserved by pasteurization, germproof filtration or freezing. The juice must retain the natural, fresh-grape flavour. In America, grape juice has generally been preserved by pasteurization. When vinifera varieties, including the strong-flavoured Muscats, are pasteurized by the usual methods they lose their fresh flavour and acquire an unpleasant, cooked taste. The taste of strong-flavoured American varieties, particularly the Concord, is less affected by pasteurization, which largely accounts for the general use of Concords for juice in the United States. In central Europe a sweet juice of renown is made of certain vinifera varieties. Preservation is effected by germproof filtration or storing under carbon dioxide pressure. Freezing is a valued technique in grape juice preservation.

Grapes are largely canned in combination with other fruits as fruit salad and fruit cocktail. Only seedless types are used. Grapes are also prepared as jams, jellies and conserves.

Species.—For centuries, one species, V. vinifera, supplied all of the grapes grown by civilized man. It is the grape mentioned in the Bible, the grape of myths and poets, the grape that provides the wines and raisins of commerce and most of the world's table grapes. It is the old world grape, the European grape and, more recently in America, the California grape.

There was no real need for other species until eastern North America was colonized. But there *V.* vinifera was destroyed by phylloxera (the plant louse Dactylosphaera vitifoliae) and several other diseases. Fortunately, North America had many native species of Vitis that had lived with these enemies and developed resistance. The colonists were then able to turn to the native V. *labrusca* and hybrids of it with vinifera and other American species, to create a new and different grape industry in that part of America. Varieties with a preponderance of V. labrusca blood, the so-called slip skins, have a pronounced aromatic, or foxy, flavour.

In the southeastern part of the United States, varieties of V. rotundifolia are cultivated. These are muscadines not true grapes. The berries are borne in very small clusters, mature irregularly and drop when ripe. In all but the most recently created self-fruitingvarieties, the flowers are pistillate, making it necessary to interplant a limited number of male vines. These varieties are nevertheless important, since they and their fruit are very hardy under hot and humid conditions.

Europeans introduced American grapes when these became available. The early importations, in mid-18th century, were grown without mishap. However, in 1845 powdery mildew (*Uncinula necator*) was discovered on grapes in a hothouse in England. Two years later it was observed in France, where in the space of ten years, until a control measure could be found, it reduced production 70%. Downy mildew (*Plasmopara* viticola) and black rot (Guignardia bidwellii), two other diseases of American origin, were identified in the south of France in 1878 and 1885, respectively. While powdery mildew was ravaging the French vineyards additional American grapes resistant to it were imported, 1858–1862, and with them phylloxera. Phylloxera took little more than two decades to destroy most of the vineyards of France, and in the early 1870s resistant rootstocks were sought out in America by French viticulturists. The magnitude of this effort is indicated by the fact that by 1890 2,400,000 acres of vineyard were again flourishing, this time on rootstocks of American species or hybrids. Among widely used rootstocks are selections of V. *rupestris, V. riparia* and *V. Champinii;* hybrids of these, and V. cinerea, V. *Berlandieri*, V. candicans, V. *solonis* and V. monticola; or hybrids of vinifera varieties with certain American species.

The fight against phylloxera also involved attempts to develop resistant vines, by hybridizing V. *vinifera* varieties with American species. Resistance to both phylloxera and various diseases was sought. Because of their resistance to fungus diseases, some of these hybrids are grown extensively in certain parts of Europe. They are grafted on phylloxera-resistant stocks.

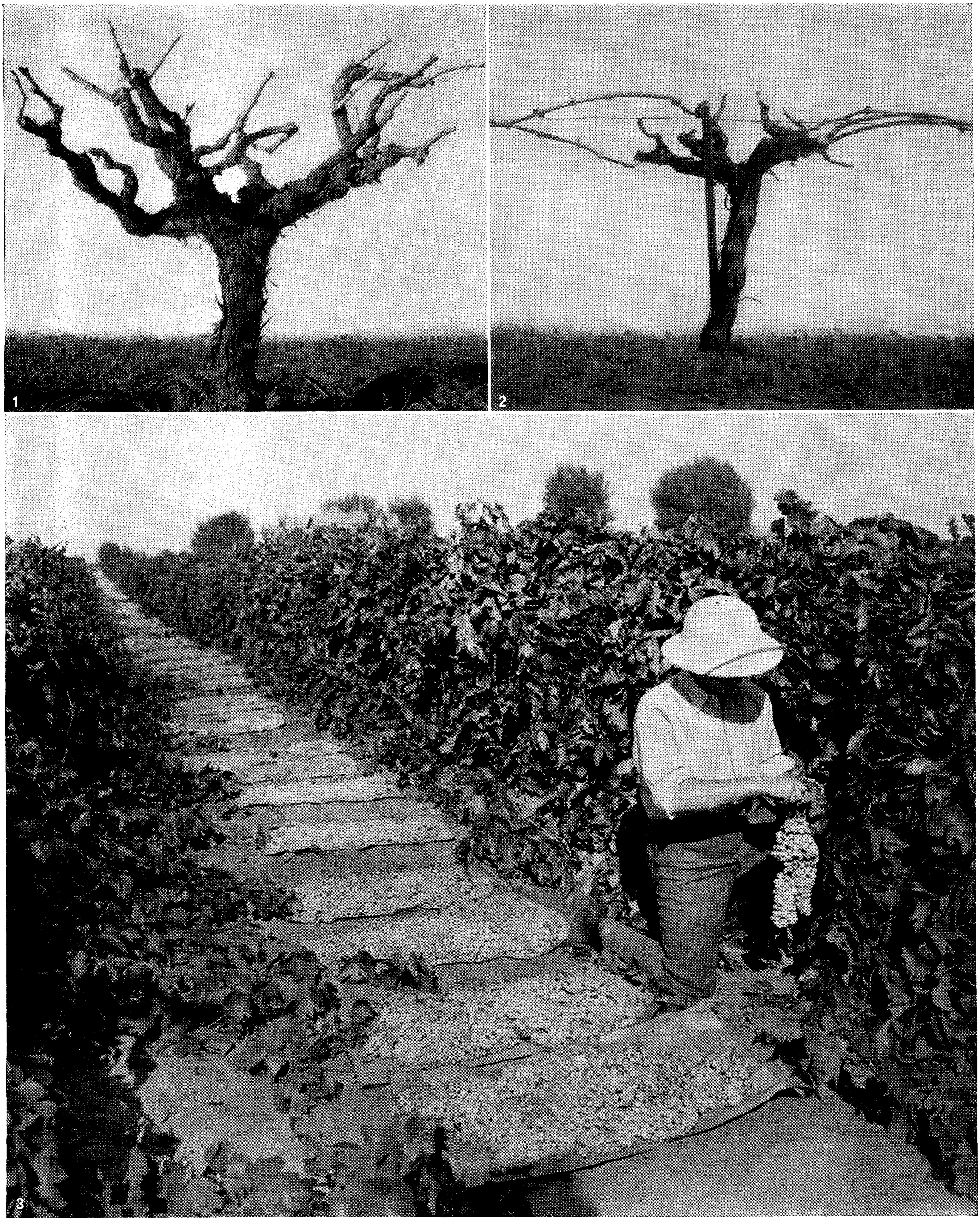
Influence **of** Climate.—Vinifera grapes require long, dry, warm-to-hot summers and cool winters for their best development. Humid summers favour the development of diseases that attack the fruit. while severe winter conditions (0° F. or below) will destroy unprotected vines. Spring frosts occurring after the vines start growth will kill the shoots and clusters. Winter rains are needed for soil moisture; summer rains make disease control more difficult; rains during the ripening and harvest periods may cause rotting of the fruit if they are of considerable duration. Where raisins are produced by natural sun-drying, as in California, a month of clear, warm, rainless weather is essential after the grapes are mature.

Varieties possessing the characteristics of V. labrusca will withstand humid summers and cold winters better than will the vinifera. They may in fact do better where summer rains of short duration are the rule. Varieties of V. rotundifolia thrive in the very warm, humid regions of the southeastern states of the U.S.

Just as climate broadly limits grape growing to the temperate zone, it further limits the highest development of individual varieties to specific localities within this zone. For example, the table grape Tokay fulfills itself only in a ten-square-mile area of central California—the warm, dry vineyards at Lodi. In certain areas of Europe individual climate is so subtly suited to the needs of the White Riesling, Pinot Noir, Cabernet Sauvignon, and Chardonnay varieties that only highly localized areas produce some of the greatest table wines of the world.

Temperature is by far the most important climate factor, affecting maturity date and palatability. Time of maturity is established by the total summation of heat, between full bloom and a given degree of maturity. Palatability, however, is influenced more by the summation of heat during the ripening period. Cool weather will mean higher acid content and a sour taste; hot weather will mean lower acid content and a sweet taste.

Vineyard Soils.—Grapes are adapted to a wide range of soils.



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METHODS OF PRUNING AND HARVESTING GRAPES

1. A mature head-trained, spur-pruned vine
2. 4 mature head-trained, cane-pruned vine
3. Harvesting Thompson Seedless grapes for raisins. The fruit is placed on paper trays between the vine rows for drying

Although growers often express a preference for certain soil types, surveys of soils used successfully in grape production in many different localities show a great variety of types. ranging from blow sands to clay loams, from shallow to very deep soils. from highly calcareous to noncalcareous soils and from very low to high fertility.

Extremes are not generally desirable, however, and poor drainage or excess salts are to be avoided. The highest tbnnages are produced on the deeper and more fertile soils. They are especially preferred for raisins and common wine grapes.

Extent and Distribution of the Industry. — Acreage devoted to cultivation of grapes averaged more than 3.350.000 in the second half of the 20th century in France. Italy. Spain: more than 1.000.000 in Hungary, Turkey and the U.S.S.R.; and more than 500,000 in Algeria, Argentina, Greece, Portugal, Rumania, Yugoslavia and the United States.

Other principal grape-producing countries. with more than 100,-000 ac. of vines. included Australia, Bulgaria, Chile, Germany, Syria and the Union of South Africa.

The larger areas of grape production in eastern North America border on the Great Lakes around Ontario. Can., and in the U.S. in New York, Pennsylvania. Ohio and Michigan. Districts of less importance are in Missouri, Arkansas. Iowa and Washington with scattered plantings in almost every other state. The Concord is the variety most extensively grown.

California, the principal grape-growing state of the U.S., produced about 3% of the wines of the world, and led all countries in the production of table grapes (20%) and raisins (40%).

CULTIVATION

Establishing the Vineyard. — Commercial grape varieties are propagated with cuttings, segments of canes or grafts. These are usually grown for one year in a nursery to develop roots. The use of clean soil permits the use of cuttings of fruiting varieties, but the presence of either phylloxera or nematodes (round worms) requires the use of grafts or rootstocks. The grafts consist of a segment of a stem of a fruiting variety placed on a rootstock cutting. Both grafts and rooted rootstock cuttings are employed. The latter are field budded to the desired fruiting variety in late summer after being planted in the vineyard. The union of grafted or budded vines must be above the soil, to prevent the production of scion roots.

Planting distances may vary widely. In European and most other countries the planting distances range from 3 ft. to 4 ft. in either direction; in California. where cultivation is largely mechanized, the widest vine spacing, 6 ft. by 12 ft. and 8 ft. by 12 ft., is generally employed. Similar distances are used in Australia.

Training is necessary to develop a vine of desirable form. It is accomplished by pruning the young vine and then tying it and its growth to a support. Two vine forms are generally used; headed vines and cordon vines. In the headed vine there is a straight, vertical trunk or stem of desired height, with arms radiating out from its top to form the head. The most widely used cordon is the bilateral, in which the trunk rises vertically to the desired height, where it is divided into two branches extending horizontally in opposite directions along the row. Arms rise from the horizontal parts of the divided trunk. Headed vines are common for wine and raisin grapes and some table varieties. The bilateral cordon is useful for large-clustered grapes. These are the common commercial systems. but minor variations occur in some producing areas. and in addition the vine can be readily trained to walls. pergolas and arbours.

Stakes are standard supports for all head-trained and spur-pruned vines, while trellises are usual for vines that are cordon-trained and spur-pruned or head-trained and cane-pruned. Stake lengths vary with country and variety of grape — from 4 to 8 ft. The stakes used in California are usually 2 in. by 2 in. split redwood. The trellis most generally used has two wires, placed 34 and 48 in. from the ground. while a flat or sloping top trellis with two or three additional wires is widely used for table grapes.

Pruning. — Pruning is the most important single vineyard operation. With wine and raisin varieties, it is usually the sole means of regulating crop, largely determining not only the quality of the fruit but also the quality of the wood for the next year. At the annual pruning, from 90% to 95% or more of the year's growth is removed, leaving the spurs or fruit canes. or both. Spurs may be used on varieties whose basal buds (near the point of origin of the canes) are fruitful; and fruit canes are necessary when the buds near the basal end of the cane are unfruitful or when the variety produces such small clusters that many are required for a full crop.

Shoots and Flowers. — Grapevines have climbing stems. which late in the spring start a rapid growth that reaches a peak in early summer, then slowing. with little further shoot elongation after the fruit begins to ripen. The leaves continue to function until the end of the season.

The leaves. tendrils, flowers and lateral shoots arise from the nodes The flowers are borne in a cluster. The primordium of the flower cluster is formed during the year preceding its bloom, differentiation into a fruitful bud beginning with the accumulation of carbohydrates in the shoots soon after their growth slows down, in early summer. By leaf fall, the cluster primordia have developed into initial points for individual flowers. Thus, the number of flowers and the shape of the clusters are determined in the year prior to that in which the fruit is produced. The formation of the flower parts (calyx. corolla, stamen and pistil) follows leafing out in spring, requiring six to eight weeks, depending on weather and variety, before the complete flower has developed to the point of blooming.

Set of the Berries. — In normal setting (development) of the fruit, pollination is folloned by fertilization, and this in turn by seed development. But normal fruit setting may fail in a number of varieties, either partially or nearly completely. As a result these varieties typically show a wide variation in berry size and shape. Four definite types of fruiting or fruit setting occur among varieties. Although all these types are found in many varieties, the proportion of types within an individual variety is relatively constant. The most common type of setting is that in which normal seed development occurs. Each carpel (see FLOWER) has one, two or more seeds. and the berries are relatively uniform in size and shape. According to variety. they are round, oval or fusiform (tapering at ends). Some varieties of this type are not perfect in set and produce at most only one or two seeds to a berry. With much elongated berries. the presence of a single or two adjacent seeds may cause the berries to be falciform (gherkinlike) in shape.

In a second type most of the seeds produced are empty. Empty seeds result from embryo abortion after the seed is well advanced in its development. Some varieties produce less than 3% of viable seeds. The berries of such varieties are nonuniform in both size and shape.

Two other types of setting produce seedless fruit. In one, fertilization takes place, but early abortion prevents seed development (stenospermocarpy). producing a fruit setting common to a number of important varieties, such as Thompson Seedless. In the other seedless type, fruit setting is by stimulative parthenocarpy (see PLANTS AND PLANT SCIENCE: Plant Physiology: *Growth*). Here the berries are very small and round. with no trace of seeds. Seedlessness and small size. however, have made the Black Corinth (representative of this type) of commercial importance. It supplies the dried currants of commerce.

Thinning Table Grapes. — Three methods of thinning have been developed as an aid in correcting fruit setting in certain table grapes, for not all varieties set equally well. Some set clusters that are too compact; the clusters of others are well filled; those of others are loose to the point of being straggly; and still others set shot berries (of parthenocarpic origin) along nith the normal berries. Berry thinning will improve quality when an overabundance of berries makes the clusters too compact, or overlarge clusters interfere with proper colouring and maturing. In California. berry thinning consists in cutting the rachis to leave only the desired number of berries; in other areas individual berries are removed. Thinning soon after fruit set gives a marked increase in the size of seeded berries. Thinning flower clusters soon after they emerge is another method. It improves the carbohydrate nutrition of the flowers retained, giving a better set of normal berries. Flower-cluster thinning is useful on varieties that have loose or straggly clusters or tend to set shot berries with standard pruning methods.

A third method, cluster thinning, involves removal of entire clusters soon after the berries have set. By leaving enough fruiting wood at pruning to produce a full crop in poor years and then reducing the overload by cluster thinning in good years, larger crops of high-quality fruit can be produced every year. Cluster thinning improves the nutrition of the fruit that is retained, enhancing seeded berry size and colour.

Girdling. — This operation (also called ringing) involves the removal of a complete ring of bark, $\frac{3}{16}$ to $\frac{1}{4}$ in. wide, from the trunk or from a cane below the fruit that is to be influenced. The girdle prevents downxvard movement of carbohydrates (through the phloem) improving the nutrition of the fruit. For best results the girdle must be open to be effective. During bloom it increases the set of seedless berries; during the period of rapid growth of seedless berries it increases berry size; during the early ripening period of seeded varieties it may accelerate colouring and ripening. These effectsof girdling in seedless grape varieties can be produced by spraying with the proper concentration of plant growth regulators, such as 4-chlorophenoxyacetic acid and gibberellin.

Cultivation and Irrigation. — In areas of rainless summers and where periods of drought are a common occurrence, meeds are destroyed to prevent their robbing the vines of soil moisture. A winter cover crop or growth of native plants is usually encouraged. On rolling soils and hillsides it is of great value in checking erosion. The minter cover is destroyed at the end of the rainy season or at the spring cleanup. Cultivation is repeated only often enough to destroy or prevent weed growth. This conserves soil moisture only by eliminating weeds and not by virtue of loosening or pulverizing the soil.

In irrigated vineyards the matter of weed competition is of less importance. Such vineyards are usually cleaned up in spring and kept free of weeds during the period of rapid vine growth. When ample soil moisture is available weed growth after mid-summer is controlled only to prevent undue interference with the various vineyard operations.

Vinifera grapes do best in dry, warm-to-hot summers. Irrigation is required where the rainfall is insufficient or the soil too shallow to store sufficient water to meet the moisture requirements of the vine. The soil must be wetted as deep as the roots penetrate during the late fall, winter or early spring. After growth starts, irrigation is not needed until the vines have almost exhausted the available water in the soil area containing most of the roots. Irrigation should be repeated as often as this point is reached. The amount and frequency of the applications of water are determined by the texture and depth of the soil, climatic conditions and type of grapes grown.

Insects and Diseases. — The grapevine and its fruit are seriously attacked by a number of insects and diseases. In California and other arid regions there are fener pests. The principal insects attacking the vine are the phylloxera *(Dactylosphaera vitifoliae)* and the root knot nematode *(Meloidogyne javanica)*. They are combatted by using resistant rootstocks. The grape leafhopper *(Erythroneura elegantula)* is controlled with DDT or Malathion; the grape root worm (*Adoxus obscurus*) and the grape leafroller *(Desmia funeralis)* are controlled with arsenicals or cryolite; and the red spiders (*Tetranychus pacificus* and *Tetranychus Wilmetti*) can be controlled by some of the new organic phosphate miticides, either as dusts or sprays. In more humid regions there are in addition the berry moths (*Polychrosis botrana* and *Clysia ambiguella*) and various beetles and caterpillars. They may be controlled with DDT or arsenicals.

Diseases affecting the grape under arid conditions are powdery mildew (*Uncinula necator)*, prevented by dusting elemental sulfur on all green parts of the vine; and black measles, whose cause is unknonn but which can be controlled by sodium arsenite spray while the vines are completely dormant. Under humid conditions the grape is also attacked by black rot (*Guignardia bidwellii*), anthracnose *(Gloeosporium ampelophagum*) and downy mildew (*Plasmopara viticola*), which are controlled with Bordeaux sprays; *Cryptosporella viticola Reddick*, which is controlled with sodium arsenite; and numerous minor diseases.

A number of viruses infect the vine. Fanleaf (infectious degeneration), Yellow Mosaic, Pierce's disease and White Emperor do extensive damage in many grape areas. There is no cure. Much can be done to prevent spread by the careful selection of buds and cuttings. Selection of vines for cuttings is most effective when the vines are observed in late spring and again when the crop is almost mature. An important project in the University of California's college of agriculture, at Davis, is the production of virus free planting stock of all grapes. At present such planting stock is available in limited quantity of some 22 fruiting sorts and five rootstocks.

Harvesting. — A grape is ripe when it has reached the stage best suited for the use to which it is to be put. The containers in which table grapes are moved to market and the methods of packing the fruit in the containers vary greatly from country to country. The least amount of handling that is consistent with thorough trimming and efficient packing is imperative. The sooner the grapes are cooled after picking, the better will be their quality when they reach the market. When grapes are to be shipped long distances or held in storage (at 31° F.) for prolonged periods, it is advisable to treat them with sulfur dioxide. In shipment, the sulfur dioxide is applied by displacing the air of the standard refrigerator car with sulfur dioxide diluted with air to a concentration of approximately 1.5% by volume. Grapes in cold storage are treated at given intervals by releasing .2% sulfur dioxide into the air as it enters the storage room.

To make raisins by the natural sun-drying process, as in California, grapes are picked from the vines and spread evenly on wooden or paper trays without pretreatment of any kind. When the berries on the upper side of the clusters have shriveled and turned brown, the bunches are turned over onto another tray. The slow oxidation that takes place within the berries during sun-drying is instrumental in the development of the typical raisin flavour. Wooden trays are stacked, and paper trays rolled, when the raisins are three-fourths dry. Grapes to be dehydrated are usually dipped in a caustic solution, to facilitate water loss, and treated with sulfur dioxide to produce a translucent, golden-coloured product. Dehydrated grapes do not possess a raisin flavour. See also WINE; FRUIT; FRUIT FARMING; HORTICULTURE.

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GRAPEFRUIT (*Citrus paradisi*), also known as pomelo, a tree and its citrus fruit, belonging to the family Rutaceae. It is probably an offshoot of the pummelo or shaddock (*q.v.*). Certainly the grapefruit and pummelo are closely related, and some students consider it probable that the grapefruit originated from the pummelo as a mutation. In 1814, John Lunan in his *Hortus Jamaicensis* mentioned that there was a small variety of the shaddock resembling the grape in flavour. The place of origin of the grapefruit is not certain. but it probably originated in Jamaica, for, in spite of careful search, it has not been found native in southeastern Asia or in the East Indian archipelago, where the parent species, C. *grandis*, is widely grown, or in any other region where any other *Citrus* species is native.

The grapefruit tree grows to be as large and vigorous as an orange tree; a mature tree may be from 1j to 20 ft. high. The foliage is very dense, leaves dark shiny green, larger than those of sweet orange but smaller than those of the pummelo, nearly glabrous, with petioles broadly winged. Flowers are large, white, borne singly, or in clusters in the axils of the leaves; petals are similar to those of sweet orange but usually larger. The fruit, which is lemon yellow when ripe, ranges from 4 to 6 in. in diameter and averages twice as large as a medium-sized orange, the size depending upon the variety and upon cultural conditions; the pulp is usually of a light yellowish colour, somewhat intermediate between that of the orange and that of the lemon, tender and usually very full of juice, with a distinctive, mildly acid, very pleasing flavour. Several varieties, originated by bud mutations, have pink or red pulp of varying intensity of colour; some of these varieties have a slightly pinkish cheek overlying the normal yellow colour of the peel.

At least 23 varieties of grapefruit with normal-coloured pulp and 4 varieties with pink or reddish pulp, have been propagated in the United States. Most of the fruit produced in the U.S. is of either the Marsh or Duncan, yellowish-pulp varieties. The Ruby and Webb are the principal varieties having red pulp; the actual quality of these varieties is comparable to that of the normal-coloured varieties, and they have become increasingly popular in the fresh fruit market because of their attractive appearance, for use at banquets and other social functions.

The grapefruit hybridizes readily with other species of Citrus. The tangelo, an intrageneric hybrid, is the result of a cross between the mandarin orange (some varieties of which are known as tangerines) and the grapefruit (also known as pomelo). One of the most promising of these hybrids, the Sampson tangelo, was produced in 1897, in Florida, by W. T. Swingle, an investigator employed at the time by the United States department of agriculture. This fruit has considerable merit as a juice fruit and as a source of seed for rootstock purposes.

As a fruit for home consumption, grapefruit became well established in the islands of the West Indies before its culture spread to the mainland. By the late 1950s, 90% of world production was in the United States, concentrated in Florida, Texas, Arizona and California. Grapefruit has become popular as a breakfast fruit in various parts of the world and production has expanded to other citrus-growing countries, notably Israel and Jordan, South Africa and Brazil.

Grapefruit trees thrive and produce the best quality fruit on sandy but relatively fertile soils. Supplementary fertilization is necessary in practically all the producing areas in the U.S.

In addition to the usual nitrogen, phosphorus and potassium, the fertilizers or sprays should contain supplementary nutrients or microelements in the form of copper, manganese, zinc, iron and boron. In Florida the area of greatest grapefruit production is on the light sandy soils which require additional micronutrients applied as a fertilizer to the soil or as a spray to the foliage. The trees come into bearing early and may be expected to produce commercially profitable crops by the fourth to sixth year after being planted in the orchard. Mature trees may produce remarkably large crops — 1,300 to 1,500 lb. of fruit per tree. Culture and pest-control problems of grapefruit are comparable to those of other citrus crops (see LEMON and ORANGE).

The rapid expansion of grapefruit acreage in the U.S. caused serious problems in the sale and distribution of the fruit. Fresh fruit from Florida and Texas is not available throughout the entire year. The season of shipment is primarily from late fall to early spring, with the peak of the marketing season in midwinter. To avoid an overproduction at one period, and a shortage of grapefruit at another, the preservation of the fruit by canning developed into an important industry. The two products which have taken most of the fruit off the fresh-fruit market are the juice and the prepared segments. The latter product is very frequently used as a basis for salad making. The segments may be packed in a 40° Brix sugar syrup.. The increase in these two methods of processing grapefruit has been very rapid. After 1941 at least 50 per cent of the crop produced in the United States was marketed in the processed form. This makes grapefruit available to the general public the year round and is an important service to both the consumer and the producer of this popular fruit. The processing of grapefruit juice is comparable to that of orange juice. It is sometimes advisable to add cane or beet sugar to grapefruit juice as it is canned. The yield of grapefruit juice under factory conditions will approximate 70 to 90 gal. per 2,000 lb. of fruit.

The total soluble solids of the juice (principally sugars) increases during fruit growth and development and at maturity usually varies from 8 to 12 per cent (fresh-weight basis). The concentration of the total acidity of the juice gradually decreases during fruit growth and, at maturity, the fruit may contain from 1 to 1.4 per cent total acids (fresh-weight basis). The grapefruit is richer as a source of vitamin C than most of the fruits and vegetables normally consumed by man; it is exceeded only by the orange and the lemon. The vitamin C content of grapefruit juice depends upon the variety, soil fertility and the season of the year when the fruit is picked; it may average from 39 to 47 mg. per 100 gr. Early in the season of maturity, the vitamin C content is higher than it is later.

See also FRUIT FARMING.

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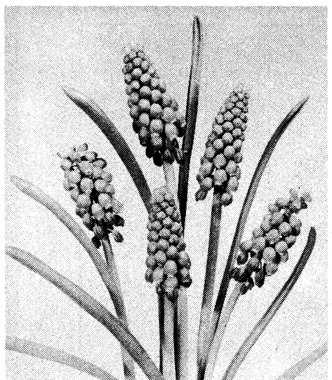
GRAPE HYACINTH, the name given to any species of Muscari, a genus of the lily family (Liliaceae, *q.v.*), comprising about 50 species, natives chiefly of the Mediterranean region and southwest Asia. They are small bulbous plants with narrow fleshy basal leaves and small usually blue urn-shaped or globose flowers, nodding or pendulous, in a more or less dense cluster terminating a single flowering stalk.

The common grape hyacinth (M. botryoides), called also grape-flower, babies'-breath and bluebell, widely cultivated in gardens, is native to southern Europe and western Asia and has run wild in meadows and thickets in the eastern United States. It has narrow erect leaves about as long as the flower stalk, which usually grows from 4 in. to 12 in. high, bearing at the top about 12 globose blue, or in some varieties white, or pink, faintly scented flowers, about $\frac{1}{8}$ in. long, crowded in a cluster. The starch grape hyacinth (*M.* racemosum), native to Europe and found in sandy fields in England and Scotland, has become naturalized in the eastern United States. It grows about a foot high. and bears very narrow, almost cylindrical, recurved leaves and numerous starchy-scented, urn-shaped blue flowers in a dense raceme. About a dozen other species are cultivated, notably the musk hyacinth (M. *moschatum*), the tassel hyacinth (M. comosum) and the beautiful feather hyacinth (M. *comosum monstrosum*). The latter two produce mostly sterile flowers. All make sheets of colour when naturalized en masse in the lawn.



ROCHE

GRAPE HYACINTH (MUSCARI BOTRYOIDES)

(N. TR.)

GRAPE SUGAR: see CARBOHYDRATES; SUGAR.

GRAPHIC METHODS IN MATHEMATICS. It is often found helpful to devise some scheme to show to the eye the relations between the different quantities involved in certain mathematical and statistical problems. In the simplest cases, the purpose of such "graphic methods" is merely to present the results of mathematical or statistical analysis. For instance, in the Statistical Atlas of the United States, the census statisticians use various graphic devices to make readily available to others important results such as the average number of persons per square mile in various states or counties.

The selection from a mass of statistical work of the results that are to be shown graphically, and the determination of the best statistical device for each case, are tasks which require both close familiarity with the details of the aork and a broad view of the problems in which the results may be significant and of the mental attitude of those who will use the results.

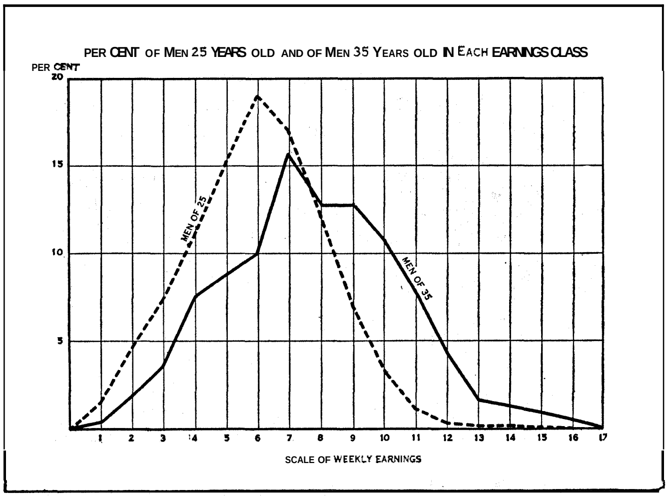
Graphic presentation, if it is attempted at all, should be regarded as the culmination of a statistical study and not as an incidental diversion.

Graphic Methods As an Aid to Thinking. — In some cases graphic methods are much more than a vehicle for conveying information. Without their aid it is difficult to formulate the ideas which underlie many investigations of complicated quantitative relations, or to carry through the various steps of the investigation. The ordinary graph, obtained by plotting on co-ordinate paper various values of one quantity against corresponding values of another quantity, has become so familiar that we sometimes use it without realizing it.

For instance, consider the following (hypothetical) description of the relation between average wages and term of service in a certain company:

"On the average, wages rise, though at a decreasing rate, until about the 10th or 12th year of service, and then flatten out. except for workmen appointed to supervisory positions. Salaries, on the other hand, continue to rise at a pretty uniform rate until the 20th or 25th year of service, after which the averages are based on too few cases to establish a trend."

While no graph is mentioned specifically, this statement would hardly be made except with the graph of earnings as a function of years of service definitely pictured in the mind of the writer, and would not be understood except with the same graph pictured in the mind of the reader.



AN EXAMPLE OF GRAPHICAL METHODS SHOWING HOW STATISTICAL DATA ARE SO REPRESENCED THAT THE COMPARISON BETWEEN TWO RELATED VALUES CAN BE SEEN AT A GLANCE

As a second illustration of the use of graphic devices as an aid to thought, consider the graphs cf frequency distributions, as constructed by statisticians. The accompanying diagram, for instance. compares the percentage distribution according to weekly earnings of male nage earners 25 years old and of those 35 years old, in a certain factory.

After inspection of these two frequency polygons, statements like the following may be made:

(1) The earnings of different individuals of the same age differ considerably; therefore an average for any group is of little value as an indication of the number below any particular standard of pecuniary well-being.

(2) Relatively high earnings are more common among men of 35 than among men of 25; therefore a single distribution by earnings of men of all ages is-inadequate to measure the extent to which earnings are large enough for all needs, which obviously vary with age.

(3) The earnings of men of 35 more frequently vary considerably from the most typical amount than do those of men of 25. There is no point on the scale at which as large a percentage of 35 year old men are concentrated as of 25 year old men at "6" or "7" on the scale.

PERCENTAGE DISTRIBUTION

Earnings scale	Men of 25	Men of 35	Earnings scale	Men of 25	Men of 35
1	1.5	0.4	9	6.9	12.7
2	4.6	1.8	10	3.2	10.7
3	7.4	3.6	11	1.1	7.7
4	11.1	7.5	12	0.3	4.3
5	15.3	8.8	13	0.2	1.6
6	19.0	10.0	14	0.2	1.2
7	17.0	15.6	15	0.1	0.9
8	12.1	12.7	16		0.5

As these statements show, a diagram of this type provides a basis for beginning to think about the problems of variation which are the subject matter of statistical science. In such cases the graph is an instrument whereby a real idea can be definitely formulated, made clear to others, and used for guidance in the solution of problems.

Securing Approximate Numerical Results Rapidly. — On the basis of a limited number of paired values of the quantities x and y, obtained either by substitution in a formula or by observation of phenomena, a graph may be constructed by drawing a smooth curve through the points representing these paired values. From the graph me may then read other pairs of values, thus avoiding additional observations or substitutions in the formula. In many cases this process of graphic interpolation is much shorter than the processes which it replaces, although it is usually not as accurate.

A variation of this scheme is to construct a scale on the basis of the given pairs of values. Distances on this scale from an indicated starting point are measured off proportional to the various values of y, and each such point on the scale is labeled with the value of x corresponding to the value of y. This scale can then be used in further calculations, by estimating the values of x corresponding to points between those labeled. If, for instance, y is the logarithm of x, the well-known properties of logarithms make it possible to perform multiplication or division by mechanical addition or subtraction on the logarithmic scale or on two such scales that are combined in a slide rule. (See COMPUTING MACHINES, ELECTRONIC.)

To show graphically a relationship among three quantities, as, for instance, that connecting the pressure, volume and temperature of a gas, me assign a series of values to one of the three quantities and plot on the same sheet the graphs of the resulting formulas connecting the other two quantities, each such graph being labeled to indicate the value of the first quantity to which it corresponds. This method may be varied by using logarithmic or other scales in constructing the field on which the graphs are plotted. The purpose in such cases is to facilitate plotting by reducing the graphs to straight lines or at least to simple curves.

When a three-variable relationship has thus been plotted in a series of "contour lines," it is a simple and rapid process to read off approximately the value of one quantity corresponding to any specified values of the other two. The process is often more simple and rapid if a nomographic or alinement chart is constructed (see NOMOGRAPHY) and that method can also take care of relationships involving four or more variables.

While in general the aim of graphic methods of this type is merely to do simply and rapidly what could otherwise be done at the cost of more time and labour by arithmetic, algebra or measurement, in some cases the alternatives are so laborious as to be prohibitive. For instance, graphic analysis makes clear the nature of the solution of certain differential equations which cannot be solved in terms of elementary functions. In certain cases, moreover, mechanical methods whose basis is mainly graphic provide many of the numerical results which are the real reason for desiring to solve the differential equation.

Limitations of Graphic Methods. — The unquestionable value of graphic methods if properly handled has been sometimes obscured by cases in which they have not accomplished the purpose intended as well as other methods, or more skilful use of graphic methods, would have done. If a proposed method of presenting the results of a statistical investigation does not make the results clearer to the audience than if the results had been presented merely in words or in a table, the method should be discarded or improved. If a proposed scheme for graphic computation is less accurate than is necessary or less rapid in actual use than other methods, the true friend of graphic methods will be the first to turn to some other mode of computation.

A serious difficulty with graphic computations is the existence in most charts of regions in which the results have a larger margin of error than is acceptable. If, for instance, a point is to be located by tbe intersection of two arcs, the location is accurate if the arcs are nearly perpendicular. but if they run in about the same direction, a slight error in one of the radii or one of the centres will shift the point of intersection to a much greater extent. This difficulty can sometimes be avoided by using a second chart modified by change of scale or otherwise in order to shift the region of inaccuracy.

The careful maker and user of charts always bears in mind this possibility of serious error, and determines the probable size of such errors, either by experiment or by analysis of his methods and formulas.

See PROBABILITY AND STATISTICAL THEORY; STATISTICS.

(R. W. B.)

GRAPHITE, a mineral consisting of the element carbon, crystallizing in the hexagonal system. in contrast to the same element crystallizing in the cubic system as diamond. Usually such dimorphous pairs are rather similar in their physical properties, but not so in this case. Graphite is black, opaque and very soft (hardness = 1); diamond may be colourless and transparent, and is the hardest naturally occurring subs'tance known. Graphite is a good conductor of electricity; diamond is a poor conductor. The specific gravity of graphite is 2.2, and for diamond, 3 5. Diamond has a perfect octahedral cleavage. while graphite has basal cleavage. Graphite crystals are rare, and only occasionally are six-sided plates found. The plates or cleavage flakes are flexible but not elastic. Graphite has a greasy feel and rubs off on anything it touches, leaving a black mark, thus the name from the Greek verb *graphein,* "to write." The lustre is bright metallic and the colour dark gray to iron black; the streak on glazed porcelain is dark gray. Graphite, also known as plumbago or black lead. bears a striking resemblance in many physical properties to molybdenite (*q.v.*), consisting of molybdenum disulfide, which also has a greasy feel and is soft enough to write on paper.

Although differing so markedly from diamond in physical properties, graphite has a closely related structure. In both minerals each carbon atom is bonded to four adjacent carbon atoms. In diamond these four strong bonds are arranged tetrahedrally, giving great strength in three dimensions. In graphite, three equal bonds lie nearly in the horizontal plane. while the fourth is weaker and is in a vertical position. Thus while there is good bonding in two dimensions, it is lacking in the third, and allows easy separation into thin sheets.

Graphite occurs mainly in the older crystalline rocks, gneiss, schist, quartzite and marble; sometimes in granite and pegmatites; and is found as isolated scales embedded in these rocks, or as large masses or vein fillings. It has also been observed as a product of contact metamorphism in carbonaceous clay slates near their contact nith granite, and where igneous rocks have been intruded into beds of coal; in these cases the mineral has clearly been derived from organic matter. The graphite found in granite and in veins in gneiss. as well as that contained in meteoric irons, cannot have had such an origin. As an artificial product, graphite is nell known as scales in gray pig iron, and in the graphitic ponder. or "kish," that forms in iron furnaces; it is also produced artificially on a large scale in electric furnaces (see *L'ses* below). The graphite veins in the older crystalline rocks are probably akin to metalliferous veins and the material derived from deep-seated sources The decomposition of metallic carbides and the reduction of hydrocarbon vapours have been suggested as possible modes of origin. Graphite veins often reach a thickness of several feet, and sometimes possess a columnar structure perpendicular to the enclosing walls. These are found in the crystalline limestones and other Laurentian rocks of New York and Canada, in the gneisses of the Austrian Alps and of Ceylon. Other localities which have yielded large amounts are the Alibert mine in Irkutsk, Sib.. the Borrowdale mine in Cumberland and the Santa Maria mines of Sonora, Mex. (L. S. RL.)

Natural Graphite Production. — Most natural graphite, both flake and amorphous, is recovered from shallow open-pit mines by stripping the overburden, and removing the graphite-bearing rock with power shovels and trucks. In Ceylon, Mexico and North Korea, however, where the graphite veins are folded or dip steeply, underground mining is required. Because of the nature of its occurrence, graphite must be subject to a refining process. The character of the graphite in a particular deposit and its intended use determine the extent of refining. Flake graphite is processed by net and dry grinding to remove the larger impurities, and flotation removes the remaining impurities. The flotation product is filtered, dried and passed over an air table to obtain a uniform product. Amorphous graphite is processed by grinding and air separation except in Ceylon, where there is a preliminary hand sorting at the mine and later grading by combined manual and machine methods. Refined natural graphite contains at best 90% to 98% carbon. with the major part containing 90% to 94%.

Manufactured Graphite Production. — The original discovery that graphite could be manufactured was made by Edward G. Acheson (*q.v.*) while experimenting with the effect of high temperatures on carborundum or silicon carbide (*q.v.*). It was found that carborundum decomposed at about 7,500° F., the silicon being vaporized and the carbon being left behind in the graphitic form. In 1896, Acheson was granted a patent for the manufacture of graphite and commercial production began in 1897. Petroleum coke, anthracite culm (hard coal dust), or mixtures of carbon, quartz, sand and sawdust were used as late as 1918 to produce manufactured graphite. Since 1918, however. petroleum coke. which consists of small imperfect crystals of graphite surrounded by organic compounds, has been almost the only raw material utilized. After heating until all the volatile material has been driven off the remaining product. graphite. with a carbon content of 99% to 99.5% or better, is cooled, pulverized and graded to uniform sizes.

Uses. — The value of graphite to industry is based upon suitable application of one or more of its inherent qualities, such as unctuousness, or plastic qualities; refractoriness, or ability to withstand high temperatures; conductivity of heat and electricity; inertness to a large range of reagents; and miscibility with other materials and liquids. The most important uses of natural graphite are in lubricants. crucibles, foundry facings, shoe and stove polishes, brake linings, pencils, packings, steelmaking, batteries and carbon brushes.

Manufactured graphite competes with natural graphite in some uses; among which are lubricants, foundry facings, pencils, polishes, batteries and carbon brushes.

Only manufactured graphite of a purity of better than 99.5% is suitable for use as a reactor moderator. for which it is used more extensively than any other material, and as structural material in atomic energy plants. Other major uses are in electrodes. electrolytic cells, bushings, disks, electrical contacts and furnace linings.

See ATOMIC ENERGY: *Achievement* of *a Chain Reaction; Furnace.* ELECTRIC; PENCIL. *See* also CARBON.

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(G. R. G.)

GRAPHOLOGY: see HANDWRITING.

GRAPHS: see STATISTICS: Graphs; GRAPHIC METHODS IN MATHEMATICS.

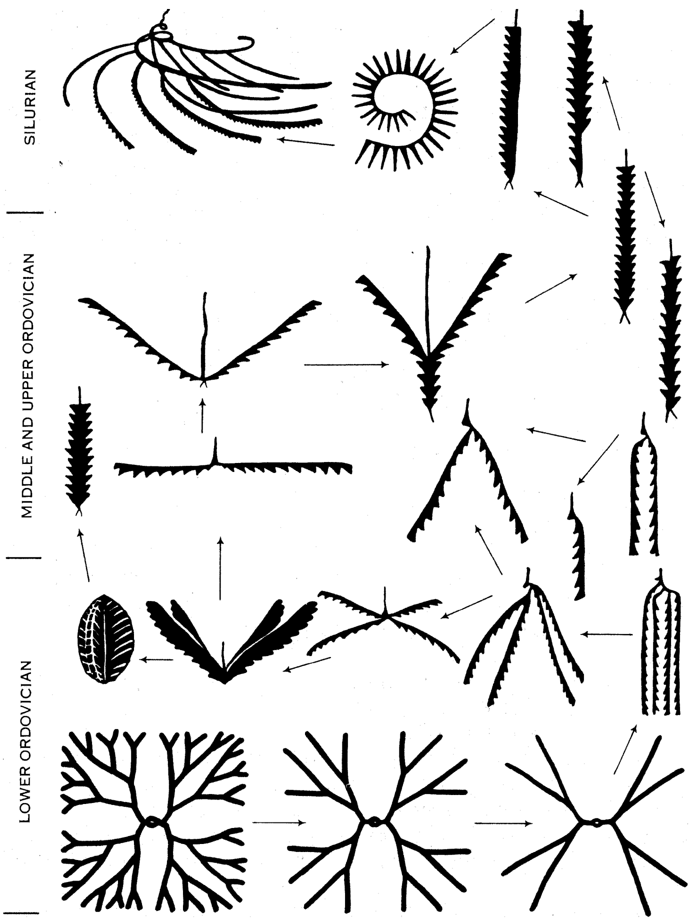
GRAPPA, MONTE, a mountain or rather mountainous group. 17 mi. long and 10 mi. wide. lies between the Brenta and the Piave rivers in Italy. The highest peak, 10 mi. N. of Bassano, rises to 5,827 ft.

The area was the scene of extremely heavy fighting during World War I (*q.v.*) between Nov. 1917 and Oct. 1918.

GRAPTOLITE, a class, Graptozoa or Graptolithina. of extinct colonial marine animals of uncertain relationship. They are preserved most commonly on bedding planes of black shale as flattened. leaflike. twiglike or weblike films of carbon that resemble pencil marks (graptos, "write"; lithos, "rock"). Their remains are restricted to the lower half of the Paleozoic era with greatest abundance in the Ordovician and Silurian periods during the interval from about 500,000,000 to 350,000,000 years ago.

Uncrushed examples shoning fine details of structure, *e.g.*, impressions of muscle attachment are occasionally found in limestone and flint, and may be recovered by acid dissolution of the rock matrix surrounding the remarkably resistant chitinous skeletal material

Many groups of graptolites show marked evolutionary changes in time. and many species are diagnostic of restricted time units. They, therefore, are important as indicators of geologic age Four



FROM MOORE, LALICKER AND FISCHER, "INVERTEBRATE FOSSILS," REPRODUCED BY PERMISSION OF MCGRAW-HILL EOOK CO , INC.

EVOLUTIONARY TRENDS OF GRAPTOLITE COLONIES DURING THE ORDOVICIAN AND SILURIAN PERIODS SHOWING CHANGES IN NUMBER AND POSITION OF BRANCHES

successive graptolite faunas are recognized over the world. each in characteristic stages of evolutionary development. From older to younger, these are: Xnisograptid. Dichograptid. Diplograptid and Monograptid faunas. The first three occur in the Ordovician, the last in the Silurian. They are further subdivided by O M. B. Bulman into nine chronological subfaunas and many zones of local extent.

The first individual of a graptolite colony is the conical sicula, which was attached to the sea bottom by a flexible stalk or was suspended by a chitinous thread (the nema) to a floating object. One or more series of successive cuplike buds (thecae) comprise the branches (stipesj whose growth direction is characteristic of particular genera and species. One or both edges of each stipe may be saw-toothed.

Evolution of graptolites was characterized by persistent tendencies or trends that affected independent groups (fig. 1). These tendencies include progressive reduction in the number of stipes from many to one during the Ordovician; gradual changes in the direction of stipe growth from downward (pendent) to upward along the nema (scandent) ; and elaboration of the apertures of the thecae.

Most of the primitive graptolites, the tiny bushlike Dendroidea, with thickened stems and expanded attachment bases. apparently were attached to the sea floor. Their weblike remains usually are associated with bottom-dwelling organisms of shallow waters and are restricted in geographic distribution; but Dictyonema *flabelliforme,* one of the most advanced and most widely distributed species of the group, probably lived suspended from floating objects which carried it throughout the world.

It is believed that the more advanced graptolites of the order Graptoloidea also were attached to floating seaweeds, the decomposition of which supplied carbonaceous material to the fine-grained black shales in which graptolites are so characteristically found.

The biological affinities of the graptolites are in doubt. The chitinous exoskeleton reflects little of the original anatomy. leaving as evidence only the form and mode of colony development. Graptolites have been considered members of such divergent groups as sponges. corals, plants, bryozoans, cephalopods, coelenterates and pterobranchs; however, only the last two groups deserve serious consideration as possible graptolite relatives.

The comprehensive work of R. Kozlowski in 1948 pointed to pterobranch (protochordate) affinity, since the wall structure characteristic of graptolites is also found in a living pterobranch (Rhabdopleura).

However, B. Bohlin and. earlier, C. E. Decker, impressed by a discovery of supposed nematothecae (cups bearing nematocysts or stinging cells) in Cambrian graptolites, tended to regard them as specialized coelenterates.

BIBLIOGRAPHY.—Birger Bohlin, "The Affinities of the Graptolites," Bull. *geol. Instn. Univ. Uppsala,* vol. 34 (1950); O. M. B. Bulman, "Graptolithina," pt. v, *Treatise on Invertebrate Paleontology* (1955) and "The Sequence of Graptolite Faunas," *Palaeontology,* vol. 1 (1958); **R. R.** Shrock and W. H. Twenhofel, *Principles of Invertebrate Paleontology* (1953). (N. D. N.)

GRASMERE, a village and lake of Westmorland, England, in the heart of the English Lake district which, in 1951, was made a national park (see LAKE DISTRICT). Pop. (1951) 1,043. The village lies near the head of the lake, into which the Rothay river flows, 13 mi. S.S.E. of Keswick and 4 mi. N.W. of Ambleside by road.

The scenery is very beautiful; the valley of Grasmere and Rydal Water is well wooded. and on its eastern flank there rises boldly the range of hills which includes Rydal Fell and Fairfield (to the north). On the south is Loughrigg Fell and on the west Silver How.

The village, though a favourite tourist centre, preserves its picturesque and sequestered appearance. In Dove cottage, still standing, lived William and Dorothy Wordsworth at intervals from 1799 to 1808 and, later, Thomas de Quincey. Dove cottage is now the Wordsworth museum, and his tomb, with that of Coleridge, is in the churchyard of the ancient church of St. Oswald. The church contains a memorial to Wordsworth with an inscription by John Keble and also one to A. H. Clough.

The Rushbearing festival, held on the Saturday nearest Aug. 5 and including a procession and general holiday, is of ancient origin.

The lake of Grasmere is 1 mi. in length and about $\frac{1}{2}$ mi. in breadth.

A ridge divides the basin from north to south and forms an island about the middle.

GRASSE, FRANÇOIS JOSEPH PAUL, MARQUIS DE GRASSETILLY, COMTE DE (1722–1788), French naval commander who engaged British forces during the American Revolutionary War, was born at Bar (Alpes Maritimes). In 1734 he took service on the galleys of the order of Malta, and in 1740 entered the French service.

Shortly after France and the United States joined forces in the Revolutionary War, he was dispatched to America as commander of a squadron.

In 1779–80 De Grasse fought the English off the West Indies. In 1781 he was promoted to the rank of admiral and was successful in defeating Adm. Samuel Hood and in taking Tobago. When Washington and Rochambeau determined to march to Virginia to join forces with Lafayette's army against Cornwallis, Washington requested the co-operation of De Grasse's fleet. De Grasse therefore sailed from the Indies to the Chesapeake river, where he was joined by a fleet under Count de Barras.

A British force under Adm. Thomas Graves attempted to prevent this juncture by engaging De Grasse's fleet when it arrived at the Chesapeake but was unsuccessful. French naval supremacy in the waters off Yorktown was instrumental in the success of the siege of that city.

After Cornwallis' surrender, De Grasse returned to the West Indies, where he captured the island of St Kitts in Jan. 1782. In April, however, he was defeated by Admiral Rodney and taken prisoner.

On his return to France, he published a Mdmoire *justificatif* and was acquitted by a court-martial in 1784. He died in Paris, Jan. 11, 1788.

See Alexandre de Grasse, Notice bibliographique *sur* l'amiral comte de Grasse *d'après les* documents intdits (1840); Georges Lacour-Gayet, La *Marine* militaire de la France *sous* le *règne* de Louis *XV* (1902).

GRASSE, capital of an arrondissement, ddpartement of Alpes Maritimes (until 1860 in that of Var), France, 12½ mi. by rail N.N.W. of Cannes. Pop. (1954) 14,078. From 1244 (when the see was transferred there from Antibes) to 1790 it was an episcopal see, but was then included in the diocese of Fréjus until 1860, when the region was annexed to the newly formed *département* of the Alpes Maritimes. It has a 12th-century cathedral. now a simple parish church; and an ancient tower, of uncertain date, near the town hall. formerly the bishop's palace (13 century). The library contains the muniments of the abbey of Lérins, on the island of St. Honorat opposite Cannes. In the chapel of the old hospital are three pictures by Rubens.

Grasse is built in an amphitheatre at a height of 1.066 ft., on a south slope facing the Mediterranean. It possesses a mild and salubrious climate, and is well supplied with water. That used for the purpose of the factories comes from the fine spring of Foux. But the drinking water used in the higher portions of the town flows, by a conduit. from the Foulon stream. Grasse is particularly celebrated for its perfumery. Oranges and roses are cultivated abundantly in the neighbourhood. It is stated that the preparation of attar of roses (which costs nearly £100 per 2 pounds) requires alone nearly 7,000,000 roses a year. It manufactures nax, soap and the finest quality olive oil. There are a sub-prefecture and a tribunal of commerce

GRASSES, a group of plants possessing certain characters in common and all members of a single monocotyledonous family (Gramineae or Poaceae). No other family of flowering plants is of as great importance to man, or more widespread; and only a few comprise a greater number of species. Although only those plants which belong to the Gramineae may properly be called grasses, the term grass is commonly used for many other plants of widely different affinities nhich superficially resemble true grasses in their foliage; *e.g.,* knotgrass (*Polygonum*), cotton grass (*Eriophorum*), rib grass (Plantago). blue-eyed grass (*Sisyrinchium*), yellow-eyed grass (*Xyris*), star grass (*Hypoxis*), bear grass (*Xerophyllum*) and eelgrass (Zostera). The grass tree of Australia (Xanthorrhoea), a desert plant allied to the lilies and rushes. has a tall. unbranched. soft-woody, palmlike trunk which bears a cronn of long, narrow, grasslike leaves and stalked heads of small densely crowded flowers. In agriculture the word "grass" has an extended significance in that it may include the various forage plants, especially the legumes.

Grasses were recognized as a natural group long before there was a science of botany or a system of classification. Common lawn, pasture and meadow grasses such as bluegrass, bent grass, timothy and fescue are the best known and the wild prairie grasses and such weeds as crab grass and quack grass also are familiar. The grains or cereals, such as wheat, rice, oats, barley and maize, are also true grasses, as are sugar cane, sorghum and millet, and even the giant woody-stemmed bamboos.

In early attempts at a scientific classification of plants a group of Gramina was recognized, and this, though bounded by nothing more definite than habit and general appearance, contained the Gramineae of modern botanists. The early systematists, however, often included also in the group the Cyperaceae (sedge family), Juncaceae (rush family) and some other monocotyledonous plants with inconspicuous flowers. The sexual system of classification developed by Linnaeus (1753), which was based on the numbers of stamens and pistils, served to separate the true grasses more distinctly; most of them fell under the order Digynia of his class Triandria, whereas the allied plants, with few exceptions, were distributed under other classes and orders.

Geographic Distribution. — The Gramineae are the world's most universally distributed flowering plants. R. Pool estimated in 1948 that perhaps 30% of the land vegetation of the globe is dominated by grasses. or at least may be classified as potential grassland. Probably the best-kno n and most extensive of these areas are the steppes of the U.S.S.R. and the prairies and plains of North America. Other regions in which grasses are dominant, although sometimes mixed with scattered trees, are to be found in South America, Africa and Australia. In number of species the Gramineae are far exceeded by the Compositae. Orchidaceae and Leguminosae, but with respect to numbers of individuals, grasses hold undisputed first place. Numerous species, moreover, have such wide ranges that the proportion of grasses to other families in the various floras of the world is much higher than the number of species would indicate.

Species of grasses are most numerous in the savannas of the tropics, while the number of individuals is greatest in temperate and cold regions of the world. As the colder latitudes are approached. grasses become relatively more numerous, and in arctic and antarctic regions they comprise about one-fourth of all the species. They reach the limits of vegetation, except for some lichens and algae, in the polar regions and on mountain tops. Indeed. on all the great mountain systems of the world, grasses are the dominant plants above timber line. They are dominant also in arid regions, as aell as on sand dunes, in salt marshes and in other places where conditions for plant life are exceedingly severe. Grasses are essentially plants of the open and are rarely seen in dense forests. A few broad-leaved species grow on the forest floor in the tropics, and in temperate regions, also, there are a few woodland grasses.

Some species of grasses are almost cosmopolitan. such as the common reed, *Phragmites communis.* A number of others are found throughout the warm regions of the earth: e *g.,* Hackelochloa *granularis, Eleusine* indica, Cynodon *dactylon* and such weeds as Echinochloa and *Setaria.* In contrast to these aide-ranging grasses are the relatively few genera nith extremely limited distribution. Examples of such endemics are Anomochloa of Brazil, *Opizia* of Mexico and Buergersiochloa of New Guinea.

Structure. — Grasses, even when not in flower, may be recognized and readily distinguished from members of other plant families by the following structural features: the stems are jointed. hollow as in nheat or oats or pithy as in maize. sugar cane and sorghum. The leaves are alternate in two ranks. and consist of two parts, the sheath and the blade. The sheath surrounds the stem like a tube but is usually open along one side. nhile the blade is more or less divergent. At the junction of the sheath and blade there is usually a small membranous organ (sometimes represented only by hairs. or missing) known as the ligule. Members of the closely related sedge family are often confused with grasses, but for the most part they have solid triangular stems on which the leaves are borne in three ranks. The leaf sheath, moreover, is always closed and the ligule is lacking.

Root.—In grasses the roots are fibrous and are often much branched and widely spreading. These, in combination with underground and creeping aerial stems, serve to anchor the plants firmly in the soil. Roots of many grasses are extensive, and in some species the roots of a single plant, if dug up and placed end to end, would total a length of several miles. These extensive root systems enable grasses to hold the soil in position against the forces of water and wind, thus rendering them of great value in the prevention of erosion and floods and in the reclamation of devastated areas.

The cord grasses (species of *Spartina*) are important soil builders, and many square miles of salt marshes have been reclaimed due to their presence. One species, S. townsendii, has been planted extensively along the coast of the Netherlands, where it is adding to the usable land area at a spectacular rate.

Stem.—In perennial grasses underground stems or rootstocks (rhizomes) are often well developed; they may be long and creeping as in quack grass (Agropyron) and marram grass (Ammophila). That rhizomes are stems and not roots is evident from the fact that they have distinct joints (nodes) and sheathing scales (leaves). features which are lacking in roots. Rhizomes are always solid and the internal structure is that of the usual monocotyledonous stem. Some grasses produce, instead of rhizomes. extensive horizontal stems which creep along the surface of the soil (stolons). An example of a stoloniferous species is buffalo grass (*Buchloë*) of the North American plains. Both rhizomes and stolons, being stems, give off branches from their nodes, and adventitious roots are also formed. Thus each node is potentially capable of giving rise to a new plant. Grasses possessing these structures, and especially rhizomes, are able to form dense sod, and for this reason bluegrass (Poa pratensis) and bent grass (Agrostis) are valuable for lawns and golf greens. In the formation of rhizomes and stolons, which are really branches from the main shoot, these break directly through the sheath in the axil of which they originate. In other cases, the branches grow upward inside the sheath, which is ultimately pulled away from the parent culm. This latter mode of growth is seen in the tillering of cereals, and results in a tufted plant with many erect branches from the lower nodes of the young stem. It is also the manner of growth of the bunch grasses so common in arid grasslands.

The upright stems (culms) of grasses are usually cylindrical (rarely flattened) and conspicuously jointed. The nodes are always solid, whereas the internodes (fig. 1) are commonly hollow but occasionally solid as in maize and sugar cane. At the base of each internode there is an actively growing (meristematic) region in which the cells continue to divide for a considerable period, and this causes the stem to elongate. When the culms are forced into a horizontal position, due to the action of rain, wind, animals or other agents. they tend to rise again by bending at the nodes. This is accomplished by the action of a growth hormone (auxin), which, under the influence of gravity, tends to accumulate on the lower side of the stem, causing increased multiplication and enlargement of the cells. Auxin is present even when the culm is erect, but it is evenly distributed around the stem with the result that growth is uniform and no bending occurs.

The exterior of the culm, which is more or less concealed by the leaf sheaths, is usually smooth and often highly polished, the epidermal cells containing an amount of silica sufficient to leave after burning a distinct skeleton. A white siliceous material (tabasheer), found in the joints of several bamboos, was once thought to have medicinal properties. In some grasses a few of the lower nodes become swollen and subglobular. these functioning as storage organs. Examples of such bulbous grasses are timothy (*Phleum*) and tall oat grass (*Arrhenatherum*).

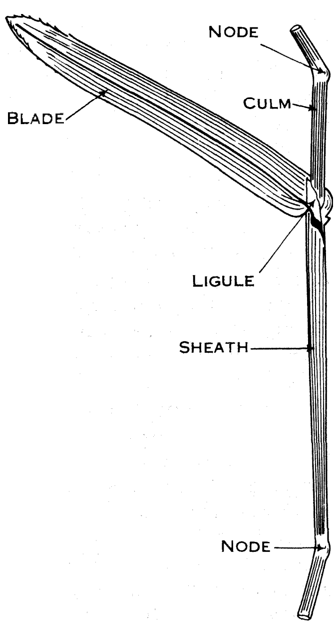


FIG. 1.—INTERNODE OF A GRASS CULM WITH ITS LEAF

Although many grasses produce only simple culms, branching from the upper nodes is not uncommon. Branches originate in the axils of sheaths and at the point of origin there is produced, on the side next to the parent culm, a characteristic two-keeled organ (prophyllum), which is the first leaf of the branch. Many tropical grasses are much branched. particularly the bamboos. *Dinochloa,* a Malaysian genus, is scandent and climbs over trees as much as 100 ft. in height. Among grasses other than bamboos, Olyra and *Lasiacis* are also woody climbers, and their culms and branches often attain a length of many metres.

Grass culms grow with great rapidity. In bamboos a height of 25 ft. may be attained in a single month, and some species have been known to grow 2 or 3 ft. in a period of 24 hours.

Leaves.—These are borne singly at each node and are two-ranked. the leaf at each succeeding node being turned 180° from that immediately below. The leaf consists of two distinct portions, the sheath and the blade. The sheath encircles the stem and may be shorter or longer than the internode. It forms a firm protection for the internode, and particularly for the younger basal portion (growing zone or meristem), which remains delicate and fragile for a considerable period. As a rule the sheath is split down its entire length. but in a few grasses (species of Poa, *Bromus*, etc) the margins are united. Occasionally the sheaths are much dilated, and in Hygroryza, a Malaysian aquatic, they actually serve as floats. At the summit of the sheath, at its junction with the blade, there is usually a small membranous appendage (sometimes an inch or more in length) called the ligule. In some species this organ is represented only by a tuft of hairs. while in others it is lacking altogether. In certain grasses (species of Muhlenbergia and others) in addition to the ligule there is a green, erect. tongue-like process extending upward from each margin of the sheath.

The blade is borne at the summit of the sheath and diverges from the culm at a more or less acute angle. In some cases there are produced. one on either side at the base of the blade. small outgrowths which tend to clasp the culm. These appendages, known as auricles, are most frequently seen among members of the tribe Hordeae. The usual form of the blade is familiar—sessile. more or less ribbon shaped, tapering to a point and entire at the edge. In a few grasses, such as Pharus, Pariana, *Zeugites* and bamboos. there is a short petiole between the sheath and the blade. In most bamboos. moreover, the blade is articulated with the sheath from which it is deciduous. Although most grasses have narrow linear leaves, there are some (*e.g.,* Streptochaeta, Olyra, Pharus) in which the blade may be two inches or more wide and not more than twice this dimension in length. In all grass leaves, however. the venation is strictly parallel, although in a number with broad blades (including the bamboos) there are connecting cross veins as well. The tissue is often raised above the veins. forming longitudinal ridges, usually on the upper face; the stomata are in lines in the intervening furrows.

The blades of many grasses, particularly those of arid regions, are capable of rolling up or folding along the midrib. This is accomplished by means of large thin-walled cells (bulliform or motor cells) situated between the veins. As the humidity decreases, these cells lose water and the blade folds or rolls toward the face on which they occur. This rolling or folding serves to protect the plant against excessive desiccation, since the majority of the stomata occur on the protected surface.

Epidermal appendages of various sorts commonly occur on blades and sheaths. Frequently the leaf has a rough (scabrous) texture, due to the presence of numerous sharp-pointed siliceous spicules These may occur on all surfaces, and are sometimes of sufficient size and frequency to impart a serrate appearance to the leaf margin. Epidermal hairs are also common, and these may be weak or stiff, long or short and sparse or dense. Sometimes the base of the hair is enlarged and bulbous or papillalike. Examples of extreme hairiness are found in the common velvet grass (Holcus lanatus) and *Alopecurus lanatus* of Asia Minor.

Inflorescence.— In grasses the unit of the inflorescence is the spikelet and not a single flower as is the case with most other plants.

Spikelets, discussed below, almost never occur singly on a plant, but a number of them are aggregated to form an inflorescence. Familiar grass inflorescences are the tassel of maize, the head of wheat and the panicle of oats. The simplest type of inflorescence is the spike, as seen in wheat or rye, in which the spikelets are sessile along the main axis. A raceme differs from a spike in that the spikelets are pedicelled. Simple racemes are rare in grasses, an example being semaphore grass (Pleuropogon). The commonest type of inflorescence found among grasses is the panicle, characterized by having pedicelled spikelets borne on a branching axis. Strictly defined, a panicle is a compound raceme, but in the Gramineae the term is applied to any branching inflorescence! even though some of the spikelets in the group may be quite sessile. Panicles may be open and diffuse. as in bluegrass. or much contracted and spikelike. as in timothy. Sometimes the panicle branches are directed to one side. as in orchard grass or cocksfoot (Dactylis) and dog's tail (*Cynosurus*). Spikes or racemes also may be asymmetrical. with spikelets borne on one side of the axis only. as in crab grass (*Digitaria*), cord grass (Spartina), and grama (Bouteloua).

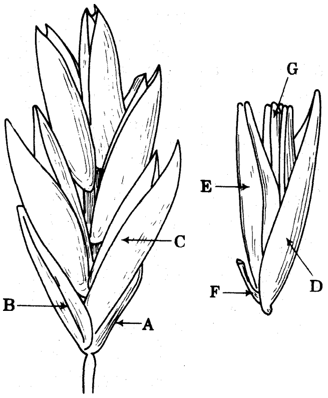


FIG. 2.— FIVE-FLOWERED SPIKELET OF FESTUCA, WITH A PARTIALLY OPENED FLORET AT THE RIGHT: (A) FIRST GLUME; (B) SECOND GLUME; (C) FLORET; (D) LEMMA; (E) PALEA; (F) RACHILLA JOINT; (G) STAMENS

The spikelet, as the name suggests, is itself a miniature inflorescence—a spike (fig. 2. 3). A generalized spikelet consists of a short axis (rachilla) bearing, in two-ranked arrangement. a series of modified leaves (bracts), some of which produce flowers in their axils. The two lowermost bracts. which are empty. are called glumes. These are not borne at precisely the same level, but one (lower or first glume) is slightly below the other (upper or second glume). The bracts above the glumes are designated lemmas (formerly called flowering glumes). Facing each lemma and partially enclosed by it. is a second bract (palea) which bears the flower. The lemma and palea with the enclosed flower are termed the floret (fig. 2). The lemma bears an odd number of nerves or veins (1. 3, 5, *j*. etc.), while the palea is two-nerved and somewhat flattened on the back, which is next to the rachilla.

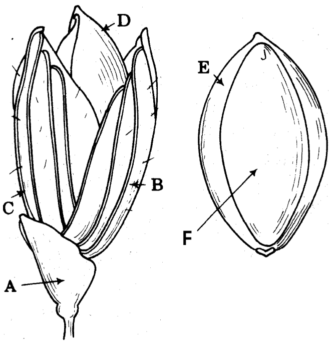


FIG. 3.—LEFT. SPIKELET OF PANICUM SHOWING THE VARIOUS PARTS: (A) FIRST GLUME; (B) SECOND GLUME: (C) LOWER FLORET. WHICH IS STERILE OR STAMINATE AND OF THE SAME TEXTURE AS THE GLUMES; (D) UPPER OR FERTILE FLORET. WHICH IS INDURATED AND OFTEN SHINY RIGHT FERTILE FLORET SEEN FROM THE PALEA SIDE: (E) LEMMA; (F) PALEA

The flower in grasses is much reduced, consisting typically of a single pistil bearing two feathery stigmas. and three stamens. At the base of the pistil there are two small scales (lodicules), which are thought to represent the perianth. At flowering time (anthesis) the lodicules become much swollen. and this causes the lemma and palea to separate, exposing the stamens and stigmas (fig. 4). In the flowers of some bamboos there are three lodicules, six stamens and three stigmas. Such flowers are considered to resemble most closely the ancestral type. In the flowers of some other grasses (*e.g., Oryza* and *Ehrharta*) six stamens also are found occasionally, and three lodicules rarely occur in flowers of genera other than bamboos (*e.g.*, Stipa). Infrequently in the flowers of of some bamboos and in those of Pariana and Luziola (which are unisexual), more than six stamens occur; up to roo have been counted.

When the typical flower of Gramineae is compared with that of the general monocotyledono'us type, as represented by Liliaceae, it is found to differ in the following ways: (1) the outer perianth whorl (sepals) is missing entirely; (2) the inner whorl (petals) has one member missing, the remaining two being represented by lodicules; (3) the inner whorl of stamens is lacking; (4) one stigma is no longer present, and only one carpel of the ovary is functional. As indicated above, however, each of the usually missing organs can be found normally, or as an occasional development, in some genera.

The flowers of grasses are so reduced and exhibit such uniformity in their structure that they are of minor importance in classification. The spikelets, on the other hand. show great variability, and their modifications and arrangements are very useful in identification and in suggesting relationships. Glumes are almost universally present, although occasionally one (*e.g., Lolium, Paspalum*) or even both (*e.g.*, Leersia, *Reimarochloa*) may be wanting. Usually they are similar in shape and texture. but the first is often smaller and with fewer nerves. Sometimes the midnerve is extended as a bristle (awn), and the glumes may be reduced entirely to bristles as in some species of Elymus. Among members of the tribe Andropogoneae, the first glume is usually indurate, sometimes strongly so, and may be sculptured (Hackelochloa'). In the more primitive grasses, lemmas are similar to the glumes, but many modifications occur. In certain genera (*Panicum, Phalaris*, Olyra) the lemma is hard and shining. while the glumes are of the usual membranous texture. In most members of the Andropogoneae, on the other hand, the lemmas are very thin and may be hyaline. The firm lemmas of Stipa and *Aristida* have a sharp-pointed base (callus). which is formed where they break away obliquely from the rachilla. Awns are very common on lemmas, and these may be straight or bent one or more times. When they are bent (geniculate) the basal segment is often more or less twisted. In addition to the median awn. there may be additional ones formed by the extension of the lateral nerves (e g, *Pappophorum*). The palea. which is considered to be homologous with the prophyllum, is two-nerved and usually two-keeled, although the two nerves may be so close together that they appear as one (*Cinna*). The keels may be broadly winged (*Distichlis*) and are sometimes ciliate (*Eragrostis*). or bearded (Triplasis). Occasionally the palea is much reduced or completely lacking. as in some species of *Agrostis*. Ordinarily the palea falls from the plant attached to its lemma. but in numerous species of Eragrostis it persists upon the rachilla after the lemma has fallen.

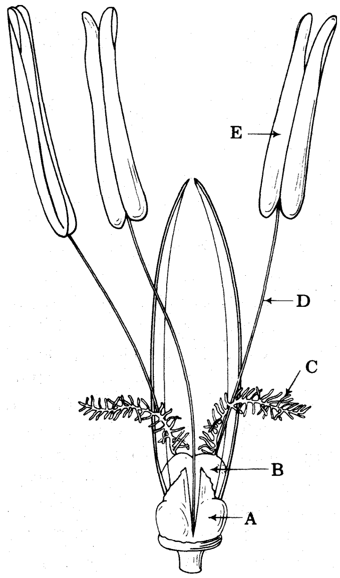


FIG. 4.— FLOWER OF LOLIUM PERENNE ATTACHED TO ITS PALEA: (A) LODICULE (B) OVARY, (C) STIGMA: (D) FILAMENT OF THE STAMEN. (E) ANTHER OF THE STAMEN

The number of florets per spikelet varies from one {Agrostideae) to nearly 60 in some species of *Eragrostis*. In grasses which have their spikelets composed of several florets. these are usually similar in size and shape. but those toward the summit may be somewhat smaller. sterile or may lack paleas. Occasionally reduced or sterile florets occur at the base of the spikelet just above the glumes (*Uniola*). Sterile florets also occur below the fertile one in some apparently one-flowered spikelets. Thus in the Phalarideae a pair of staminate or neuter florets subtend the single perfect one. Spikelets of the Paniceae and Andropogoneae also have one functional floret, and below this is a sterile one which may be reduced to the lemma. Spikelets may be strcngly flattened either from the side or from the back, or plump and even circular in cross section. In outline, too. they exhibit a wide range of variation, from those of Eragrostis or Distichlis, often narrow in proportion to their length and with the margins nearly parallel, to those of Paspalunt, which are sometimes almost circular. Another important characteristic of spikelets is the manner in which they break apart. thus freeing the seed from the parent plant. In some cases (*e.g., Panicum*) the spikelet falls as a unit, in certain other cases, such as the Festuceae. the rachilla breaks up above the glumes and between the florets. each of the latter falling separately and with an internode of the rachilla attached.

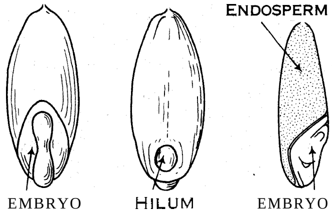


FIG. 5.— CARYOPSIS OF DIGITARIA SANGUINALIS IN FRONT AND BACK VIEWS. AND IN LONGITUDINAL SECTION

True involucres. consisting of subtending bracts, are rare in the Gramineae, although involucrelike structures do occur. being formed in various ways. In *Setaria, Pennisetum*, etc.. the one or more whorls of simple or feathery bristles which occur below the spikelet represent abortive branches of the inflorescence. In *Cenchrus* these become fused and more or less indurated. forming a sort of bur which encloses the spikelets. In Job's-tears (*Coix*) the hard and shining beadlike structure is a much-modified bract or leaf sheath.

FLOWERING, GERMINATION AND DISPERSAL

Flowering. — Most grasses are chasmogamous—*i.e.,* their florets open to expose the stamens and pistil — but some are cleistogamous, the pollination taking place within the closed spikelets. There are a few species (*e.g., Amphicarpum* and *Chloris chloridea*), moreover, which in addition to the usual inflorescence bear cleistogamous spikelets on special underground stems, while still others (*e.g., Danthonia*) produce them within the lower sheaths. Cross-pollination is affected by wind, and the pollen is well adapted to this means of transport, being very light and with a perfectly smooth surface. Most annual grasses are self-fertile, but many perennials and some annuals are self-sterile: being unable to set seed without cross-pollination, These latter species usually have large anthers which become fully exserted from the floret. The self-fertile annuals. in contrast, often have very small anthers, which may protrude from the open floret slightly, if at all.

The process of flowering in a typical grass proceeds somewhat as follows: The first noticeable sign is that the inflorescence becomes much more open, the branches spreading from the axis. This is accomplished by means of the swelling of a pad of spongy tissue (pulvinus) located in the axil of each branch. When this has occurred, and if conditions are favourable, the lodicules become greatly swollen and exert sufficient pressure at the base of the floret to force the lemma and palea apart. The filaments of the stamens next elongate rapidly, pushing the anthers from the floret. where they hang in the air. At the same time the feathery stigmas spread and project laterally. one on each side of the open floret. The anthers next split longitudinally, releasing the pollen, which is scattered by the slightest breeze. At the completion of flowering, the lodicules lose their turgidity, and the floret gradually closes.

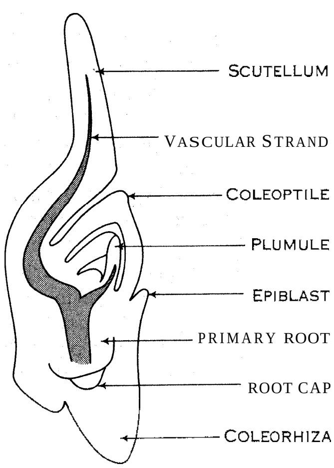


FIG. 6.—EMBRYO OF BECKMANNIA SHOWING THE VARIOUS PARTS

A few species of grasses are dioecious. the spikelets of an individual plant bearing either stamens or pistils but not both. Others are monoecious. unisexual flowers occurring on the same plant. in which case entire spikelets may be either staminate or pistillate, or some of the florets within the same spikelet may bear only stamens while others have only pistils. A somewhat comparable condition (polygamy), in which both perfect and unisexual flowers occur on one individual and often within the same spikelet. is also common among grasses, especially among members of the Paniceae and Andropogoneae. When unisexual flowers of both sexes. or unisexual flowers along with perfect ones, occur on the same plant, it is usual for these to bloom at slightly different times. thus promoting cross-pollination. Even when the flowers are all perfect, often the stamens shed their pollen either before or after the stigmas are mature, and this also decreases the possibility of self-fertilization.

Fruit and Seed. — The fruit. which develops from the ovary of the pistil, is usually small: ovoid or rounded, and furrowed along one side. It is entirely occupied by the single seed, from which it is not to be distinguished, the thin pericarp of the fruit being completely united with the testa of the seed. This characteristic fruit is properly termed a caryopsis (fig. 5), although it is often referred to as a grain. This latter term, however, is less precise, since it is often applied to fruits of a quite different nature, such as those of buckwheat and seeds of some species of Amaranthus.

Although the caryopsis is of almost universal occurrence among grasses, other types of fruits rarely occur. In *Sporobolus,* Eleusine and some other genera, the fruit is a utricle, the pericarp being quite free from the seed. Among the Bambuseae, the pericarp is sometimes hard: forming a nut. and in others it becomes thick and fleshy, forming a berry which is often as large as an apple. In *Melocanna*, one of the bamboos, the berry is edible, somewhat pear shaped and may attain a length of three or four inches. The small seed germinates within the fruit. the shoots often attaining a length of six inches or more before the fruit falls from the parent plant.

Ordinarily the pericarp and testa are thin and the outline of the embryo is clearly visible. It occupies a position at the base of the caryopsis on the side facing the lemma. Often the embryo is small, but in some cases (*e.g., Echinochloa* and *Spartina*) it is nearly as long as the seed. Opposite the embryo, on the other side. is a more or less evident dot or line (the hilum) which marks the point of attachment of the ovule to the ovary wall. The space inside the seed coat which is not occupied by the embryo is filled with endosperm. starchy material which. when the seed germinates, serves to nourish the developing plantlet. The outermost layer of endosperm, the aleurone, consists of regular cells filled with small protein granules. The remainder is made up of large polygonal cells containing numerous starch grains in a matrix of protein.

The structure of the embryo (fig. 6) and its position within the seed is unique and quite different from that in the Cyperaceae or other monocotyledons. On the side next to the endosperm is the single cotyledon or scutellum. This platelike organ bears, on the surface in contact with the endosperm, an epithelial layer containing enzymes which aid in the digestion of the starchy tissue during germination. On the side opposite the scutellum, and inserted at about the same level, there may be a small organ (epiblast) which some authors have considered to be a reduced second cotyledon. In some grasses the epiblast is large and conspicuous. in others it is small, and in many it is altogether lacking. The primary root is enclosed in a sheath (coleorhiza). The epicotyl or plumule is also enclosed in a sheath (coleoptile), which typically has two vascular bundles, one on either side. Vascular tissue extends from the root into the shoot with a side branch to the scutellum. Neither the coleorhiza nor the epiblast develops vascular tissue. Although there has been a certain amount of disagreement with respect to the homologies of the parts of the grass embryo, it has come to be generally agreed that the scutellum is the cotyledon and that the coleoptile represents the first leaf of the plant.

Germination. — When a seed germinates, the coleorhiza expands, lengthens and ruptures the pericarp. The coleoptile, with its enclosed epicotyl, next appears. Soon afterward the primary root breaks through the coleorhiza, as do also secondary roots in those cases in which they are formed in the embryo. Filaments closely resembling root hairs often develop on the coleorhiza, and these probably serve as absorbing organs. At the same time that these external changes are taking place, the scutellum is elongating and pushing deeper into the endosperm, which is being digested slowly to feed the developing plantlet. In the meantime the coleoptile is pushing vertically upward through the soil. Finally the first leaf appears, emerging through the tip of the coleoptile. The primary root persists for only a short time, the function of absorption being assumed by adventitious roots which arise from the nodes at the base of the primary shoot.

Dispersal and Migration. — In grasses the seed rarely falls free, and among wild species even the grain seldom separates from the parent plant devoid of its lemma and palea. Often whole spikelets serve as propagules, and these may have parts of the inflorescence attached to them. In some cases short spikes fall from the parent plant; in others the axis of the inflorescence breaks up at the joints, each spikelet falling attached to an internode of the rachis. In grasses with several-flowered spikelets, the rachilla usually breaks apart between the florets, each of these falling with a short rachilla joint attached. The persistent lemma and palea, and other parts when present, serve to decrease the specific gravity, and the grain is thus more readily carried by the wind. Lemmas and paleas may also afford a certain amount of protection in that they prevent excessive desiccation or too rapid wetting of the embryo. Among cultivated cereals there has been a conscious selection for those in which the grains fall free from their enveloping scales, as this greatly facilitates their harvest. In some cases. however, the combination of easily separating caryopses and high yield has not been achieved, and such grains as oats and barley, when harvested, are tightly enclosed between their lemmas and paleas.

The awn, which frequently occurs on the lemma, is often a very efficient agent in the dispersal of fruits. It may catch in the fur of animals or in the plumage of birds, or. when long and feathery (species of *Stipa*) may act as a sort of parachute. The awn, moreover, may serve to bury the fruit in the soil, thus hastening germination and the establishment of a new plant. The florets of *Stipa* and species of *Avena,* and the spikelets of *Heteropogon* and others, often have a sharp callus which easily penetrates the soil and also short stiff hairs which oppose its withdrawal. The bent and twisted awn, which is hygroscopic, serves as a driving organ. twisting and untwisting with changes in humidity. When the upper part of such an awn is caught in the ground or in vegetation, the repeated twisting causes the fruit to be driven deeper and deeper into the soil. Grass fruits of this type sometimes cause injury to sheep when they catch in the wool and burrow through the skin. A very efficient means of seed dispersal is seen in those grasses in uhich the large open panicles break off at maturity and are blown long distances by the wind, scattering their fruits as they go.

Examples of such tumbleueeds are *Eragrostis spectabilis* and *Panicum capillare.*

Vivipary, or the germination of seeds within the fruit upon the parent plant, was mentioned above as occurring in *Melocanna.* The condition has also been observed in some other bamboos and is occasionally seen in other grasses. The conversion of the spikelet, above the glumes, into a leafy shoot (proliferation) is often confused with vivipary. Proliferated spikelets are occasionally found among many genera of grasses, and these are often the result of particular environmental conditions. In some grasses, however, this peculiarity is genetically determined; there are races known in which it occurs regardless of the conditions of the environment.

At one time it was believed that proliferated spikelets were of considerable importance in reproduction. but it has been found that under natural conditions these seldom grow into new plants.

CLASSIFICATION

There are about 500 genera and perhaps 5,000 species of grasses known, and each year more are discovered and described. Although it is relatively easy to recognize members of the family, their great complexity, as well as the extreme reduction and uniformity of the flowers, renders classification very difficult. Since the flowers themselves offer few clues as to relationships, reliance must be placed upon other characters; hence the classification of grasses has been built up largely from a study of vegetative structures. Thus glumes, lemmas and paleas, while associated with flowers, are in reality all more or less modified leaves. The difficulty of classification is further increased by the realization that much parallel evolution has occurred, with the result that superficial similarity does not necessarily indicate close phyletic relationship. A classification system on which all botanists can agree has not been formulated.

Grasses may be separated rather readily into two great groups or subfamilies. Robert Brown (1814) was apparently the first author to record the observation that in one group (Panicoideae) there is a tendency for aborted flowers to be borne at the base of the spikelet, while in the other (Festucoideae) aborted or rudimentary flowers occur above the fertile ones. It was pointed out later by George Bentham (1882) that in the Panicoideae the spikelet usually breaks away below the glumes, thus falling as a unit, while in the Festucoideae the spikelets disarticulate above the glumes and between the florets, these falling individually. Further, in the Panicoideae the spikelets are flattened from the back (dorsally). while in the Festucoideae the compression is from the sides (laterally), and the glumes and lemmas are often somewhat keeled. Not only are these groups recognizable on morphological grounds, but they have been found to differ also with respect to chromosome size and number, leaf epidermis and anatomy, embryo and seedling and in some other characters.

In his monograph on the Gramineae. E. Hackel (1887) further divided the family into 13 tribes. This system, often with some slight modifications, has been used widely through the world and is probably the best-known classification of the grasses. The principal change made in Hackel's system was to reverse the order of the tribes. The classification outlined below, a modified Hackel system. is essentially that used in A S. Hitchcock's *Manual of Grasses of the United States,* the standard work on the family for America. The first nine tribes are treated as members of the subfamily Festucoideae, while the remaining four fall under the Panicoideae.

Tribe I: **Bambuseae.**—This is a group—the bamboos — of usually tall grasses with woody stems. The blades are often broad and articulated to the sheath, to which they are attached by a short petiole. The spikelets bear from two to several florets which are usually awnless, and these are arranged in panicles. racemes, fascicles or compact heads. The tribe numbers about 60 genera, most of ahich are tropical; one genus. *Arundznaria,* is native to the United States. In those parts of the world where bamboos are abundant. they are of great economic importance. The woody culms are used in all kinds of construction. for vessels, and water pipes. and also furnish fibre from nhich an excellent quality of paper is manufactured. Bamboo shoots are an article of food in the orient, and the grains are also eaten, especially in time of famine.

Tribe II: **Festuceae.**—In this tribe — the fescues — the spikelets are also tao- to several-flowered and are borne in open. contracted or spikelike panicles, or sometimes in racemes. The glumes are usually shorter than the lowest floret. The lemmas are awnless or awned, the ann straight or flexuous and borne on the tip or from between the teeth of a minutely bifid apex. When mature. the spikelets disarticulate above the glumes and between the florets As circumscribed here, the tribe includes about 12j genera, most of which are characteristic of temperate or cool regions Many common meadow grasses belong in this tribe. such as bluegrass brome grass, fescue and orchard grass or cocksfoot.

Tribe III: **Hordeae.**—Spikelets in members of the Hordeae—the barley tribe — are often similar to those of the Festuceae (sometimes they are reduced to one flower), but the inflorescence is always a symmetrical spike, the spikelets borne on both sides of the rachis. which may be continuous or break apart at the joints when mature. Often the glumes are reduced to bristles or awns, or one may be lacking (Lolium). This tribe comprises only about 25 genera, but although small it is very important economically. Some of the most valuable cereals, wheat (Triticum), barley (*Hordeum*) and rye (*Secale*) are members of the Hordeae.

Tribe **IV: Aveneae.**—As in the preceding tribes, the spikelets in this group — the oat tribe — are also two- to several-flowered. They are borne in open or contracted panicles or occasionally in racemes. The glumes are longer than the lowest floret, and may be as long as the spikelet, more or less obscuring the florets within. The lemmas are usually awned from the back (dorsally), the awn commonly bent and twisted. The rachilla and callus of the florets are often hairy, and frequently the inflorescence has a shiny or silvery appearance. There are about 45 genera in this tribe, among them velvet grass (Holcus), tall oat grass (Arrhenatherum) and the cultivated oat (*Avena*).

Tribe **V: Agrostideae.**—This—the bent tribe — is somewhat unnatural. containing a number of unrelated genera. The characters which these share in common and which delimit the tribe are one-flowered spikelets borne in open, contracted or spikelike panicles. The inflorescence is never a true spike or a one-sided raceme. The lemma may be awnless or awned. and the awn may be straight or bent and twisted, and borne either terminally or dorsally. The floret usually disarticulates above the glumes, falling free from them, but in some cases the spikelet falls as a unit. The Agrostideae comprises about 65 genera, most of which are found in temperate and cool regions. Timothy (Phleum), bent grass (Agrostis), and marram grass (*Ammophila*) are members of this tribe.

Tribe **VI: Phalarideae.**—In this — the canary grass tribe — the spikelets have one perfect terminal floret; below this are two others which are staminate or neuter, sometimes reduced to small scales. The inflorescence'is an open or contracted panicle. As treated by Hackel and many subsequent authors. the tribe consists of six genera, among them sweet grass (Hierochloe) and canary grass (*Phalaris*).

Tribe **VII: Chlorideae.**—The form of the inflorescence is the most characteristic feature among members of the Chlorideae, the grama tribe. The spikelets may be one- or several-flowered, awned or awnless. sessile or pedicellate, but they are always borne in two rows on one side of a continuous rachis. These spikes or racemes may be solitary, digitate or arranged as branches of an elongated axis. In some cases only the lowest floret of the spikelet is fertile, the others being sterile and often much reduced or rudimentary. There are perhaps 40 genera in this tribe. most of them inhabiting warm regions. Included are such important forage grasses as buffalo grass (Buchloe), and the grama grass (*Bouteloua*) of the southwestern United States and northern Mexico.

Tribe **VIII: Zoysieae.**—As in the preceding tribe, the form of the inflorescence is of prime importance in delimiting this group, the tobosa grass tribe. The spikelets are usually one-flowered, sessile or subsessile in short spikes of two to five (single in Zoysia), each spike falling entire from the continuous rachis. All the spikelets may be perfect, or perfect and staminate ones may occur together in the same inflorescence. Often three are found together, the central one being perfect while the two laterals are staminate. This tribe comprises about 17 genera of tropical distribution, particularly in dry regions and on seashores. Mesquite grass (Hilaria) is a member of the tribe, as is also Zoysia, the genus from which the tribal name is derived.

Tribe **IX: Oryzeae.**—In this — the rice tribe — the spikelets, which are borne in open panicles, are one-flowered and perfect or unisexual. The glumes are occasionally well developed, but usually they are small or may be completely lacking. The stamens are often six in number. As defined by Hackel, the tribe includes about 16 genera. but some of these are of doubtful affinities. The best-known member, cultivated rice (Oryza sativa), is one of the most important food plants in the world.

Tribe **X: Melinideae.**—Members of this group have well-developed glumes and two-flowered spikelets. The upper floret is perfect, the lower being staminate or neuter and often represented only by a lemma. There are seven or eight genera in this tribe, all occurring in tropical regions. Most are unimportant, but Thysanolaena, a native of Asia, is often a troublesome weed. Melinis, with a single species, found in both South America and Africa, is prized for forage and is sometimes cultivated.

Tribe **XI: Paniceae.**—The spikelets in the Paniceae — the *Panicum* tribe — are distinctive, being dorsally compressed and two-flowered. although appearing one-flowered until examined carefully. The glumes are membranous in texture, the first often shorter than the second. Occasionally the first glume is completely lacking. The upper floret is perfect, the lemma and palea indurated or firmer than the glumes, often hard and shiny. The lower floret is staminate or neuter, sometimes reduced to the lemma, this of the same texture as the glumes. Awns occasionally occur on the glumes or on the lower lemma, but almost never on the fertile one, and when present on this latter organ, the awn is usually short. The Paniceae comprises 80 or more genera, most of them found in tropical and warm regions. Many are troublesome weeds, such as crab grass (Digitaria), foxtail (Setaria) and witch grass (Panicum capillare). A few are grown for the grains—*e.g.*, millets (Panicum miliaceum and *Setaria italica*)—and some are used for forage.

Tribe **XII: Andropogoneae.**—The spikelets of the Andropogoneae — the sorghum tribe — are also two-flowered, with the upper floret perfect and the lower staminate or neuter. The glumes, however, are firmer than the lemmas, and the latter are commonly auned, the awn often well developed, bent and twisted. The spikelets usually occur in pairs on the inflorescence axis or its branches, the usual arrangement being that one of the pair is sessile and fertile, while the other is pedicellate and staminate or neuter. Rarely the upper spikelet is wanting. The axis usually disarticulates at the joints, and the pair of spikelets fall attached to a short internode. This tribe comprises 50 or more genera, most of which are tropical. Some are important forage grasses, and the group also includes sugar cane (*Saccharum*), Sorghum and oil grasses (*Cymbopogon*), this latter group furnishing citronella oil. an important source of perfume.

Tribe **XIII: Maydeae.**—In this tribe (also called Tripsaceae)—the Indian corn tribe — the plants are monoecious, the spikelets being unisexual. The staminate spikelets are borne in pairs, or occasionally in threes. The pistillate spikelets are more or less embedded in a thickened axis or enclosed within a thickened sheath. The glumes and lemmas are awnless. This small tribe of seven genera is closely allied to the Andropogoneae, the chief distinction being that in the Maydeae the staminate and pistillate spikelets are borne in different inflorescences or in different parts of the same inflorescence. Maize (Zea mays) is a member of this tribe, as is also Job's-tears (Coix *lachryma-jobi*).

Other Classifications. — The classification outlined above, although quite unnatural in many respects, is perhaps the most satisfactory available. Other systems have been suggested, the most notable, perhaps, being that of C. Hubbard (1934), in which 27 tribes were recognized. many of which previously had been designated as subtribes. In several respects this system is more natural than Hackel's, although it is someuhat less satisfactory for the nonspecialist because of the large number of tribes, often based on minor characters.

R. Pilger presented in 1954 an even more detailed system, in which he recognized 9 subfamilies and 35 tribes. Although he indicated that it was based on the latest information from all disciplines, his system is far from natural in many respects and, because of the large number of subfamilies and tribes, is unwieldy and difficult to use.

Even though a natural classification for the Gramineae acceptable to all botanists has not been worked out, data bearing on the subject are accumulating as the result of researches along various lines. Perhaps the most useful information has come from the study of the epidermis of the leaf and its anatomy, the structure of the embryo, and chromosome size and number, although root-hair development, starch-grain structure and other studies also prove helpful in some cases. Using the newer techniques, the subfamily Panicoideae, as classically treated, proves to be quite natural, but this is not true of the other subfamily. The tribes Chlorideae and Zoysieae, for example, are misplaced in the Festucoideae, even though this is not evident from a study of the gross external features alone. These are the only complete tribes for which a shiit to the other subfamily is indicated. Among several of the other tribes, however, there are genera which prove to be unrelated to the majority with which they have been associated. This is especially true with respect to the tribes Festuceae and Agrostideae, in which numerous genera have been found to have panicoid affinities, even though most of the genera are festucoid.

See also articles on the various tribes and genera of grasses, as BAMBOO; BARLEY; FESCCE; MILLET; RICE; WHEAT; etc.; and GRASSLAND.

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GRASSHOPPER, a name applied to insects of the families Tettigoniidae and Acrididae (see ORTHOPTERA). They are strong leapers with enlarged hind femora; the males are often loud stridulators, while the females are mostly silent. The Acrididae or short-

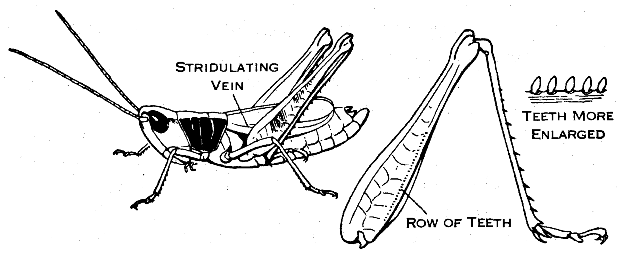

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FIG. I.— A MALE SHORT-HORNED GRASSHOPPER (CHLOEALTIS) SHOWING THE STRIDULATORY APPARATUS (AFTER ALLARD). SOMEWHAT ENLARGED

horned grasshoppers have short, rather stout antennae, three-jointed tarsi and a short four-valved ovipositor. They stridulate by scraping a toothed ridge on the hind femur against sharp-edged veins on the closed tegmen. Some make buzzing or crackling noises in flight. Auditory organs are present on the base of the abdomen Eggs are usually laid in soil in masses of 30 to 100 or more, enclosed in a capsule of hardened secretion. Acrididae include most of the common grasshoppers, and also the locusts. The name locust is often used for any member of the family, but refers properly to the destructive swarming and migratory species (see LOCUST). The Tettigoniidae (katydids [*q.v.*] or long-horned grasshoppers), formerly termed Locustidae, have long threadlike antennae four-jointed tarsi and a prominent ovipositor. They stridulate by rasping a filelike vein on the base of the left fore wing across a scraper vein on the right wing, causing taut drum areas on these tegmina to vibrate. Auditory organs are present on the fore tibiae. Mostly herbivorous like Acrididae, many Tettigoniidae are omnivorous or partly carnivorous. Eggs are laid singly in soil. or in rows in plant stems or on leaves. Many terrestrial species are wingless or short-winged; the winged forms mainly frequent bushes or trees.

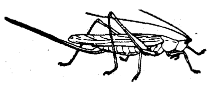

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FIG 2 —A FEMALE LONG-HORNED GRASSHOPPER OR KATYDID (NEOCONOCEPHALUS) SHOWING THE LONG OVIPOSITOR SOMEWHAT REDUCED

The green Phaneropterinae of North America and the large green Phasgonura viridissima of southern England are noteworthy stridulators. (T. H. HL.)

GRASSI, GIOVANNI BATTISTA (1854–1925), Italian zoologist who investigated the life cycle of protozoa, intestinal worms and insects: was born on March 27, 1854, at Rovellasca, and died in Rome on May 4, 192j. He graduated in medicine at the University of Pavia. and after studying zoology at the universities of Heidelberg and Würzburg, was appointed professor of zoology at the University of Catania in 1883, and of comparative anatomy at the University of Rome in 1895. Grassi's researches concerned the life history of eels, the Chaetognatha, the social life of the termites; the sporozoan malarial parasite of the mosquito and the transmission of malaria in man.

GRASSLAND may be considered as any area devoted to the production of forage grasses, legumes, or combinations oi grasses and legumes with other herbage plants, used for grazing, hay. grass silage or green feeding. Green feeding, soiling, zero pasture, green chop and other terms are used to describe the process of harvesting and feeding green pasture crops mechanically, instead of grazing directly by livestock.

Grassland agriculture is as old as the domestication of animals, which n-as achieved about 10,000 B.C. Dairying in Europe based upon feed from grassland was under way by 4000 B.C. In some areas dairying has changed little since its beginning between 4000 B.C. and 2000 B.C., nor has the culture of grassland which supplies the feed for livestock, including the improvement of the forage plants themselves.

This article deals with the role of grassland in agriculture, the various kinds of grassland and their improvement and uses and the improvement of forage grasses and legumes. For specific information about the occurrence and agricultural uses of grassland, the reader is reierred to the articles on individual countries, *e.g.,* ARGENTINA; AUSTRALIA, and especially to the sections of those articles dealing with physical geography and agriculture. Botanical characteristics are discussed in the article GRASSES and there are separate articles appearing under the common names of the more important species of grasses and legumes. See also AGRICULTCRE; RANGE (IN AGRICULTURE).

Following are the main divisions of this article:

I. IMPORTANCE OF GRASSLAND

Grassland produces the world's most extensively grown crop. Its acreage exceeds the combined acreage of wheat, corn (maize), cotton, oats, barley. rye. soybeans. sugar beets, rice, flax, peanuts, potatoes and tobacco. In terms of the livestock feed supply. grassland furnishes over half of the total in many countries and as much as 85% to 90% of the total in others.

Grassland and the grass crop dominate the nonforested agricultural land area of every continent. Over 200 major grass and legume species and thousands of species of limited distribution adapted to various soil and climatic conditions are grown on the world's grassland. One or several of the many kinds of grasses and legumes grow in each of the numerous grassland habitats from the tropics to the permafrost of the arctic region, and from regions oi high rainfall (over 100 in. a year) to semiarid regions that receive less than 10 in, of precipitation a year. The annual production of grassland varies from a few pounds to several tons to the acre. depending upon the climate, soil productivity and management of the crop. Land that will grow any crop can be made into grassland, but much grassland is not suitable for the economic production of any other crop.

Livestock feed for domesticated animals is the major contribution of grassland. but not its only one. In certain situations the soil and water conserving attributes may be more important than the feed produced, since a grass or grass-legume cover retards water runoff, increases the rate of infiltration into the soil and reduces or prevents soil erosion by wind or water. As a rotation crop, well-managed grassland restores productivity that is lost by growing cultivated crops (see ROTATION OF CROPS).

Grassland also supplies the major portion of the feed for many kinds of game animals and especially big game. More specialized uses of grassland are to maintain highway shoulders, separation strips and embankments; to provide a suitable surface of pleasing appearance for recreational areas, such as golf courses, playing fields, parks and lawns; and to provide protective cover on roadways of limited use, firelanes, waterways, airstrips, around buildings and on other normally turfed areas.

II. KINDS OF GRASSLAND

1. Sown or Seeded Grassland. — This is the largest and by far the most productive supplier of nutritious forage; it includes tame pasture, tame hay, ley. meadow, rotation hay or pasture, temporary pasture and annual forage crops. Generally these are found in areas of moderate to heavy rainfall on land once occupied by natural forest. Soils in these areas are well supplied with moisture during much of the year, with some leaching occurring due to the percolation of excess water. They are the grasslands that support the intensive, highly developed livestock industry in New Zealand, western Europe, the United Kingdom, humid regions of North America and other parts of the world. Smaller acreages of sown grassland have been established on submerged areas reclaimed from the sea, and on irrigated deserts. During most of the growing season, and when properly managed, herbage from these grasslands constitutes an adequate diet for sheep and cattle. Dairy cattle produce nearly as much milk when their entire ration comes from well-managed pastures as they produce with any other feed or combination of feeds. Beef cattle make optimum growth and may be fattened satisfactorily on forage alone. Sheep seldom receive anything but feed from grassland whether kept on somn or natural grassland Horses that have access to ample amounts of good quality hay or pasturage may receive no other feed except during periods of heavy work. Swine and poultry obtain less, but often an important fraction, of their rations from grassland (see also FEEDS, ANIMAL).

Annual yields, on a dry forage basis, of 12,000 lb. to the acre are not uncommon from sown pastures or meadows. This amount of high-quality forage is sufficient to meet the feed requirement of one high-producing dairy cow for one year. Occasionally, acre yields of 20,000 lb. or more have been obtained with alfalfa (*Medicago sativa*). Tropical and subtropical grasses have given yields of dry matter in excess of 40,000 lb. to the acre. These high yields more closely approach the maximum potentials than the average yields of somn meadows and pastures, but can be realized over substantial areas with good management.

While the term sown implies the establishment of grassland by planting seed, which is usually the case, it is used here to include grassland established by planting stolons or budded shoots or other plant parts that root to produce new plants.

Sown grassland may be used as a temporary crop grown in rotation with other cultivated crops or it may be nearly permanent. Within these extremes will be found pastures and hay fields ranging from a few months to several years of age. The permanence and productivity of sown grassland depend upon intended use as well as good management, soil and climatic factors. These, in turn, usually determine the life span of a permanent pasture. The improvement of forage plants through selection and breeding, and improved establishment methods, have encouraged short-term stands (two to four years) of forage grass or legume, interspersed nith small grain and other cultivated crops. On productive cropland or irrigated land, the grass crop may be grown only one year out of ten or more (*see* ROTATION OF CROP;

Hilly land too steep to plow without serious danger of erosion is seldom cropped and should remain in grass most of the time. if farmed at all. Such areas may be seeded, limed and fertilized with aircraft adapted for such uses. Thus treated, and properly grazed, hill land not suitable for the production of other crops becomes an efficient producer of livestock feed.

Species of the following grasses and legumes are those often used to establish sown grasslands:

Grasses

Bermuda grass (*Cynodon*)
Bluegrasses (*Foa*)
Bluestems (*Andropogon*)
Brome grasses (annual and perennial) (*Bromus*)
Buffalo grass (*Buchloë*)
Canary grasses (*Phalaris*)
Carpet grass (*Axonopus*)
Cocksfoot, orchard grass (*Dactylis*)
Dallis, Bahia, etc. (*Paspalum*)
Dropseeds (*Sporobolus*)
Fescue grasses (*Festuca*)
Grama grasses (*Bouteloua*)
Kikupu, napier grass, etc. (*Pennisetum*)
Love grasses (*Eragrostis*)
Meadow foxtail (*Alopecurus*)
Millets and bristle grasses (*Setaria*)
Molasses grass (*Melinis*)
Needle grass (*Stipa*)
Oat grasses (*Arrhenatherum*)
Pangola grass (*Digitaria*)
Pará grass, guinea, switch grass, etc. (*Panicum*)
Redtop (*Agrostis*)
Rhodes grass (*Chloris*)
Rye grass (*Lolium*)
Smilo and rice grass (*Oryzopsis*)
Sudan, Johnson, etc. (*Sorghum*)
Timothy (*Phleum*)
Veldt grass (*Ehrharta*)
Wheat grasses (*Agropyron*)
Wild rye (*Elymus*)

Legumes

Bird'sfoot trefoil (*Lotus*)
Bur clover, alfalfa, etc. (*Medicago*)
Chick-pea (*Cicer*)
Clover (*Trifolium*)
Crotalaria (*Crotalaria*)
Fenugreek (*Trigonella*)
Hyacinth bean (*Dolichos*)
Kaimi and Spanish clover (*Desmodium*)
Koa haole (*Leucmna*)
Kudzu (*Pueraria*)
Lespedeza (*Lespedeza*)
Lupines (*Lupinus*)
Milk vetch (*Astragalus*)
Pigeon pea (*Cajanus*)
Sainfoin (*Onobrychis*)
Soybean (*Glycine*)
Sweet clover (*Melilotus*)
Vetch (*Vicia*)

2. Natural Grassland. — This group embraces a wide array of types ranging from desert grass-shrub combinations to the tall grass prairie. Unlike the sown grasslands that occupy areas cleared of forest vegetation, natural grasslands are themselves the end product of natural forces that favoured grass and other plant growth more than that of trees. When undisturbed by man's activities or by fire, natural grasslands are not easily invaded by trees or other scrub growth, but when subjected to overgrazing or plowing for crop production, brush or scrub may invade rapidly. The scattered tree growth that is found in typical savanna grassland thickens if the surrounding grass is damaged by overgrazing or fire.

Natural grasslands generally occupy those areas between the climatic extremes of humid woodlands and dry desert shrub. The transition belts, therefore, between typical grass prairie and either of these extremes contain more or less tree growth on the one hand, or desert shrub on the other. Soil moisture, rather than total rainfall. usually determines the extent of natural grassland. If the upper layers of soil are moist during part of the year, but the deeper layers remain dry. tree growth cannot compete with grass. The savannas of the tropics annually receive substantial total rainfall, but a prolonged dry period each year, combined with high temperatures and evaporation, prevents the development of forests.

Temperature or soil moisture may limit the effective growing season in natural grasslands to a few weeks of the year. Thus, tender grass feed of high nutritive quality is available for relatively short periods compared with the season of lush growth in sown grasslands. However, the absence of a long season of green forage growth is supplemented by naturally cured, leafy forage of acceptable feed value for several weeks after growth has stopped, particularly in arid regions. Generally, those species found in arid regions tend to exceed those of the wet tropics in feed value after maturity. Associated browse plants, including some species of sagebrush, also reinforce the feed supply of natural grasslands in semiarid regions. especially between growing seasons. In addition to carbohydrate and protein, some of them supply exceptionally high quantities of vitamin A. The productivity of natural grassland varies widely but averages much less than that of sown grassland. Forage production may range from a few pounds to several hundred pounds to the acre.

Some of the more important grasses found in natural grasslands include one or more species of the following:

Big bluegrass, etc. *(Poa)*
Bluestems *(Andropogon)*
Bristle grass, etc. *(Setaria)*
Brome grasses *(Bromus)*
Buffalo grass *(Buchloe)*
Cogon grass *(Imperata)*
Cord grasses *(Spartina)*
Danthonia, etc. *(Danthonia)*
Dropseed *(Sporobolus)*
Grama grasses *(Bouteloua)*
Jaragua grass, etc. *(Hyparrhenia)*
Kangaroo grass *(Thenzeda)*
Love grasses *(Eragrostis)*
Muhly grasses *(Muhlenbergia)*
Needle grass *(Stipa)*
Oil grass *(Cynzbopogon)*
Panic grass, switch grass, etc. *(Panicum)*
Reed grass *(Calamagrostis)*
Sand paspalum *(Paspalum)*
Sickle grass *(Ctenium)*
Three-awn grasses *(Aristida)*
Tobosa, etc. *(Hilaria)*
Wheat grass *(Agropyron)*
Wild rye grass *(Elynzus)*

III. GRASSLAND IMPROVEMENT

Previous to about 1930 little research attention had been given to the improvement of grasslands, compared with the work on such crops as wheat, cotton, rice, maize and many others. Thus, the grass crop, too often, has been less profitable than it should have been. Moreover, a profitable return from the grass crop (since three-fourths or more of it is harvested by grazing) is as dependent upon proper utilization by livestock as it is upon the successful growing of the crop. Wise animal husbandry, therefore, is an essential ingredient of successful and profitable grassland agriculture.

Grassland improvement research must take into account the end use of the crop. Higher feed value, better seasonal distribution of production or greater palatability are often more important objectives than higher forage yields, per se, since the final measure of profit from grassland is milk. beef. mutton or other products from forage-consuming animals. Increased use of applied fertilizers, especially nitrogen, phosphorus, calcium, magnesium, potassium and sometimes molybdenum, cobalt and other trace elements. has improved both yield and quality of humid area grasslands. Conservation and the return of animal manures are essential unless heavy applications of chemical fertilizers are made. With few exceptions, larger applications of fertilizer nutrients on sown grasslands have been profitable. Forage yields in humid areas are often doubled or tripled by good soil fertility practices alone.

Reseeding is sometimes essential to obtain the maximum output from grassland. Natural grassland that has deteriorated from misuse may require reseeding after the destruction of brush and weeds. Sown grassland may require occasional cultivation or plowing and reseeding to re-establish a good legume-grass balance for maximum production of nutritious forage. Also, as superior varieties of forage grasses and legumes are developed by plant breeders, reseeding is required to utilize them promptly. Occasionally, top seeding without any land preparation is possible, but successful establishment of grassland by this method is the exception rather than the rule. Immediate seeding in the ash following burns is, perhaps. the most noteworthy exception.

Improvement by proper grazing management is difficult to achieve. Yet this is the principal method of economically maintaining and improving the natural grassland of subhumid and semiarid regions around the world. The vegetative cover is usually sparse, yet surface protection is essential to increase water intake and to reduce erosion by wind and water. To provide adequate cover with living or dead vegetation, as much as 50% of the grass growth should remain on the land. Continuous overgrazing reduces the vigour of the grass. invites encroachment of weeds and brush and brings on general deterioration. These grassland areas are often too extensive in size and too low in yield to justify large-scale, costly renovation treatments that may be profitable in humid grasslands. Improvement may be accomplished by (1) reseeding selected sites of higher yield potential; (2) by construction of water-spreading systems that divert runoff and aid in the more uniform infiltration of water; and (3) adjusted grazing practices that allow natural reseeding and the accumulation of desirable vegetative cover. On areas of more abundant moisture, fertilization may be profitable when coupled with grazing management systems designed to relieve the pressure on overgrazed areas. With all these improvement measures, however, success is dependent upon proper grazing management.

IV. UTILIZATION OF GRASSLAND

Pasturage, hay and grass silage are derived from grassland, in that order of importance. Because the grazing animal is the most economical harvester yet developed for most grassland conditions, three-fourths or more of the world's grass crop is grazed off. However, grazing is not always available throughout the year, or the feed value of the crop available for grazing during part of the year is so low that other high-quality forage is essential. Such forage is provided by hay or grass silage that is harvested when the grass or grass-legume combination is at a nutritious stage of growth.

1. Pasturage.—At the same time. good-management practices and forage crop sequences that provide high-quality pasture during most of the growing season can minimize the need for other feeds. The value of legumes in grassland agriculture is best realized in this connection. As a supplier of nitrogen to the associated grass, as well as to itself, the nitrogen-fixing legume helps maintain a satisfactory protein level in the legume-grass mixture during much of the growing season. In addition, for reasons not yet fully understood, the animal performance on grass-legume pastures is often superior to that on grass alone, even on grass nitrogen-fertilized to maintain the same protein level. Although the higher content of phosphorus and calcium in legumes is sometimes beneficial, properly fertilized grass supplies most animal requirements for these minerals. The high-digestible energy content of lush-growing clover or growth-regulating substances found in some legumes may partially explain this phenomenon.

To provide such pasturage, no other group of legumes has been utilized as extensively as several species of *Trifolium*. Grass-legume combinations that include these species comprise some of the best grazing lands in the world. Rye grass and white clover, Ladino clover and orchard grass (cocksfoot) and crimson clover and rye grass are examples. Where adapted. these pasture combinations produce large yields of top-quality forage that satisfies the needs of high-producing grazing animals. At the same time. these grass-legume associations thrive under properly managed continuous or rotational grazing systems (see also LEGUMINOSAE).

To supplement permanent pastures, temporary grazing, including feeding on root crops, is provided. Crops for temporary grazing are planned to be at their peaks of production during periods of low production from the permanent pasture. Such annuals as Sudan grass, pearl millet and lupine may be planted especially for this purpose. Winter grazing may be provided by reseeding crimson clover in a sequence of Bermuda grass and crimson clover. The same field produces Bermuda grass abundantly throughout the warm and hot periods of the year after the crimson clover has matured and died. Winter grains also are used for grazing, either for brief periods in advance of heading to permit the harvest of a grain crop later, or for grazing off completely.

On natural grasslands in many areas, plant growth is permitted to cure "on the stump" for grazing during periods when there is no growth. Often such feed is supplemented with a protein concentrate, such as cottonseed cake or soybean oil meal. Considerable grazing may be obtained also from adjacent grain stubble or recently planted winter grains if the natural grassland borders cropped areas. Over vast areas, however, the green and cured forage alone, which may or may not include browse plants, comprise the feed supply. When concentrates or high-quality preserved forage (hay or silage) are not available to balance low-grade roughages, the grazing animals lose weight, may fail to produce offspring or even die of starvation. Nevertheless, many flocks and herds go through this seasonal cycle and make phenomenal gains when the season of good pasturage returns.

2. Hay.—The making of hay is the most general means of preserving high-quality forage for later use. The same grasses and legumes grown for pasture may also be used for hay, although certain legumes, particularly alfalfa (lucerne), and a number of grasses, are better suited for hay production than for pasturing. The protein content and digestibility of forage grasses and legumes decrease as the growing plants advance in maturity. Total yield continues to increase as protein content declines. Since there is a correlation between protein content and digestibility, the crop should be cut for hay well in advance of maturity to produce feed of highest quality. The protein content at this time may be 20% or higher To obtain maximum hay yields from a meadow on a sustained basis. including the maximum protein, the crop must be permitted to advance in maturity beyond the point of optimum feed quality. The most satisfactory compromise is to cut the crop for hay during the early bloom stage while the protein content (dry basis) is 14% to 18%. (Young legume growth may contain over 30% protein and mature grass less than 4% on a dry basis.)

For good hay, the crop must be cut at the proper stage of maturity, handled so as to retain the leaves, and cured to prevent spoilage or discoloration. Under field conditions, during periods of rainy weather, losses may exceed 50%. To avoid such losses, hay may be mow cured in the barn with forced air either heated or not heated. The cost of special machinery and equipment for this purpose has limited this procedure. Or, the hay may be placed in small piles or stacks in the field until it is dry enough for storage in large stacks or in the barn. Properly cured hay with 20% or less moisture may be stored for months without danger of spoilage (*see* CROP DRYING AND PROCESSING).

3. Silage. — Where weather conditions preclude the possibility of making high-quality hay. making silage has become important as a forage preservation measure. Compared nith corn silage, grass silage is low in total energy. but in other respects it is equal to or better than corn silage. when properly made. Grass-legume combinations can be made into good silage easier than protein-rich legumes alone. The green material should be chopped fine enough to assure good packing and the exclusion of air from the mass of chopped material, whether placed in a tower silo, stack, trench or pit. The crop should be cut at the same or slightly earlier stage of maturity as is required to make high-quality hay. A high-moisture content in the ensiled material facilitates compaction and the exclusion of air. However, excess moisture (above 70%) seeps away and carries valuable nutrients with it. Excess moisture in the silo may also interfere with the fermentation processes that produce the best quality silage. Since freshly harvested forage contains from 75% to 80% moisture, it is difficult to adjust the moisture content of the forage precisely throughout the ensiling period. It is considered good practice to fill the bottom half or two-thirds of the silo with forage as near the optimum moisture content as possible (68% to 70%), and the remainder with material known to contain excess moisture. The heavy wet material on top helps to pack the entire mass and seals the exposed top surface better than drier material. Airtight covers properly installed practically eliminate the danger of loss due to spoilage. Though it is possible to make and preserve silage in a trench, pit or stack, losses may approach or exceed 50% unless precautions are taken to protect all exposed surfaces from air. Lightweight covers have been developed for this purpose. Such covers also protect the stack from outside moisture due to rain or snow. Good silage has a clean, acid odour and taste, no mold or sliminess, and a pH (acidity) of 3.5 to 4.j.

See also ENSILAGE.

4. Green Feeding. — In addition to pasture. hay and silage, the grass crop may be cut and fed fresh. This practice of green feeding (soiling) is not new, but has been revived for a number of reasons. Some of these reasons are associated with special problems, such as the inaccessibility to adequate pasturage of large, commercial dairy herds or cattle-feeding establishments. Other reasons include: (1) reduction of the danger of bloat that may occur when grazing animals are given unlimited access to pasture legumes; (2) unsuitability of the herbage species for grazing, but adaptability to mechanical harvest at regular intervals; (3) higher net feed recovery per unit area; and (4), higher net financial returns from the enterprise. The latter two reasons are not generally valid. They depend upon several conditions and alternatives such as topography and soil-moisture conditions, cost of machinery. labour and fencing. and the skill of the operator in managing grazing animals. Though green feeding is practiced with justification and profit under some conditions, its disadvantages have limited its use (*see* also FEEDS, ANIMAL).

V. BREEDING AND IMPROVEMENT OF FORAGE GRASSES AND LEGUMES

Although significant advances have been made in the development of superior forage grasses and legumes in the second half of the 20th century, the major effort to improve the forage plants grown in many parts of the world continues to be through the introduction and testing of species and strains in new environments, rather than through the breeding and improvement of the plants themselves.

The scope of forage plant improvement work is enormous because so many different species are involved. Reduction in the number of species may be attained by improvements that extend the use of certain species into new areas, and thus remove the need for some other species. Nevertheless, a great many species are needed to meet the climatic, soil and use requirements throughout the world, or even within a single country.

The forage plant breeder has many objectives, depending upon the species and the problems recognized as most pressing in his area. Disease resistance, greater seed size and seedling vigour that aid in establishment, insect resistance, tolerance to specific weather hazards. leafiness. persistence under grazing and higher yield may be sought. Elimination of or reduction in toxic or growth-retarding substances in the plant may be desired. Improved palatability is a worthy objective with productive grasses or legumes otherwise well adapted. To accomplish these and other objectives, the application of many basic sciences is required including genetics, physiology, chemistry, nutrition, pathology, entomology, mathematics, microbiology and taxonomy.

Interspecific and intergeneric hybridization may be used to transfer desirable germ plasm from one species to another or to produce new combinations of characteristics that possess the advantages of both parental species. This crossing technique is used also to produce segregating populations of plants in normally apomictic (egg not fertilized) species. Chromosome doubling has been used to create new varieties, to facilitate the crossing of species with different chromosome numbers and to restore fertility in sterile hybrids. Seeds or other plant parts may be irradiated to produce desired characteristics not found in the species. Segregating plant populations produced by these and other methods are then selected and tested for one or more of the desired characteristics listed in the foregoing objectives.

Occasionally it is possible to select superior plants for a new variety within an existing variety or plant population without resorting to more involved methods. Regardless of the procedure followed, the desired end product is a variety better in one or more important characteristics than the one it replaces.

A few examples of new or improved varieties are cited to illustrate the past accomplishments of forage plant breeders in various parts of the world:

Borre sweet blue lupine.—A vigorous, high-yielding sweet blue variety palatable to livestock.

Climax *timothy*.—A leafy variety of medium late maturity better suited to delayed hay harvesting in its area of adaptation than ordinary timothy.

Coastal Bernzuda *grass*.—A high-yielding, tall-growing hay type that produces no seed (a sterile hybrid) is resistant to root-knot nematode and is of good forage quality.

Dixie crimson clover.—Developed and released for its wide adaptation and reseeding characteristic.

Du Puits *alfalfa*.—Noted for vigour of establishment, early season production and high yield.

H-I rye *grass*.—A leafy, vigorous, high-yielding variety that produces more forage in short-term leys than longer-lived perennials.

Kenland red clover.—Southern anthracnose-resistant, superior yielding variety with greater persistence in its area of adaptation.

Lahontan alfalfa.—Developed for resistance to stem nematode, this high-yielding variety is also resistant to bacterial wilt and the spotted alfalfa aphid.

Madrid sweet clover.—A frost-resistant, high-yielding variety with outstanding seedling vigour and high seed yielding capacity.

Merkeron Napier grass.—Developed and released for high yield and resistance to eyespot disease.

Mt. Barker subclover.—A widely adapted, superior reseeding, high-yielding variety.

Sew *Zealand* white clover.—A persistent, higher yielding, more uniform variety in its area of adaptation.

Nordan crested wheat grass.—Developed with large seed size, seedling vigour and high seed quality to facilitate establishment of crested wheat grass under suboptimum soil moisture and seeding conditions.

Piper Sudan grass.—A high-yielding, heavy tillering variety low in prussic acid potential developed and released to reduce the danger of prussic acid poisoning in animals that graze on Sudan grass

Potomac orchard grass.—A hay and pasture type with some resistance to foliage diseases, particularly rust.

Ranger alfalfa.—A winter-hardy variety developed and released for its resistance to bacterial wilt, a disease that has destroyed alfalfa crops within two or three years after establishment. Wilt-resistant Ranger has persisted and remained productive in wilt-infested areas for ten or more years.

Rowan Korean lespedeza.—Root-knot nematode-resistant variety with high yield.

S23 rye grass.—A leafy type especially adapted for grazing and with greater persistence in its adapted area.

S100 white clover.—Released for its higher yield and wider range of adaptation.

S143 orchard grass.—A late maturing, leafy pasture variety better suited for grazing than the taller growing, early maturing hay types.

Starr pearl millet.—A late-maturing, leafy, high-yielding variety superior for grazing.

Sweet Sudan grass.—A widely adapted, sweet, juicy variety.

Tetra alsike.—A tetraploid variety of high yield and nutritive value.

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GRASSMANN, HERMANN GÜNTHER (1809–1877), German mathematician chiefly remembered for his major work, Die Ausdehnungslehre or calculus of extension. was born at Stettin, Ger. (now Szczecin. Pol.) on April 15, 1809, where he taught until his death on Sept. 26, 1877. In Die *Ausdehnungslehre* (1844), he developed the idea, due to Leibnitz, of an algebra in which symbols representing geometric entities (points, lines, planes . . .) are manipulated according to certain rules. In suitable circumstances this calculus proves far more powerful than earlier methods of co-ordinate geometry. To Grassmann is due also the notion of representing subspaces of a given space (*e.g.,* the lines in three-dimensional space) by co-ordinates; this leads to a mapping by points of an algebraic manifold, called the Grassmannian.

Somewhat similar ideas were propounded independently and contemporaneously by W. R. Hamilton in his quaternion theory; indeed Grassmann, Hamilton (and also G. Boole) were the pioneers in the field of modern algebra. Although Grassmann's methods were only slowly adopted, because of his obscure exposition, they eventually inspired the continental school of vector analysts Later, through the work of E Cartan, they have shonn their utility in the study of differential forms, with its important applications to analysis and geometry.

For an introduction to Grassmann's work *see* H G. Forder, *The Calculus of Extension* (1941). (L R.)

GRASS-OF-PARNASSUS, any herbaceous plant of the genus Parnassia (family Saxifragaceae; *q.v.*), found throughout the north temperate zone.

GRASS-OF-PARNASSUS

At left is flower with front sepals, etc., removed to show pistil, nectaries and two of stamens, one of which has lost its anther and the other is in a position ready to shed pollen as the stigma is touched by a visiting insect. On right is honey-bearing scale

The white regular flower is rendered attractive by a circlet of scales. opposite the petals, each of which bears a fringe of delicate filaments ending in a yellow knob. These glisten in the sunshine and look like a drop of honey. Honey is secreted by the base of each of the scales.

There are about 40–45 species of Parnassia, of which the commonest is P. *palustris.* About 13 other species occur in North America, mostly in the northern United States and Canada. (N. Tr.)

GRASS PINK, one of the common names for Dianthus *plumarius,* a low-growing garden perennial with small, fragrant flowers of white, pink or shades of red and purple (some variegated). It is also called garden pink and cottage pink (see Pink; Caryophyllaceae).

The grass-pink orchid is an American swamp plant, Calopogon *pulchellus* (see Orchid).

GRASSQUIT, any small finch of the genera Sporophila and Tiaris common in tropical and subtropical America and the West Indies. One species, S. torqueola *sharpei,* Sharpe's seedeater, ranges into the Rio Grande valley of Texas; and two others, T. bicolor, the Bahama or black-faced grassquit, and T. *canora,* the Cuban melodious grassquit, occur as stragglers in Florida. The birds, about 4 in. long, dull coloured, with poor song, feed on seeds.

GRASS TREE (Xanthorrhoea hastilis), a well-known Australian plant represented by five species and belonging to the family Liliaceae. One of the species (X. *preissii*) is commonly known as blackboy. The plants have the habit of an aloe, with a long spike of flowers resembling that of the bulrush. A resin is obtained from the bases of the old leaves.

GRATIAN (Flavius Gratianus Augustus), Roman emperor 375–383, son of Valentinian I by Severa, was born at Sirmium in Pannonia on April 18 or May 23, 359. On Aug. 24. 367, he received from his father the title of Augustus. On the death of Valentinian (Nov. 17, 375) the troops in Pannonia proclaimed his infant son (by a second wife Justina) emperor under the title of Valentinian II (*q.v.*). Gratian acquiesced in their choice; reserving for himself the administration of the Gallic provinces. he handed over Italy, Illyria and Africa to Valentinian and his mother, who fixed their residence at Milan. The division. however, was merely nominal, and the real authority remained in the hands of Gratian. The eastern portion of the empire was under the rule of his uncle Valens. In May 378 Gratian completely defeated the Lentienses, the southernmost branch of the Alamanni, at Argentaria, near the site of the modern Colmar.

When Valens met his death fighting against the Goths near Adrianople on Aug. g in the same year, the government of the eastern empire devolved upon Gratian, but feeling himself unable to resist unaided the incursions of the barbarians, he ceded it to Theodosius (Jan. 379). With Theodosius he cleared the Balkans of barbarians. Gratian governed at first with energy and success, but gradually he sank into indolence, occupied himself chiefly with hunting, and became a tool in the hands of the Frankish general Merobaudes and bishop Ambrose. By taking into his personal service a body of Alani, and appearing in public in the dress of a Scythian warrior, he aroused the contempt and resentment of his Roman troops. A Roman named Maximus raised the standard of revolt in Britain, and invaded Gaul with a large army, upon which Gratian. who was then in Paris, being deserted by his troops, fled to Lyons, where, through the treachery of the governor, he mas delivered over to one of the rebel generals and assassinated on Aug. 25, 383.

During the reign of Gratian orthodox Christianity for the first time became dominant throughout the empire. In dealing with pagans and heretics Gratian, who during his later years was greatly influenced by Ambrose. bishop of Milan, exhibited severity and injustice at variance with his usual character. He prohibited heathen worship at Rome; refused to wear the insignia of the pontifex maximus as unbefitting a Christian; removed the altar of Victory from the senate house at Rome, in spite of the remonstrance of the pagan members of the senate and confiscated its revenues; forbade legacies of real property to the Vestals; and abolished other privileges belonging to them and to the pontiffs.

For Gratian's treatment of the heretics the church histories of the period should be consulted.

See Ammianus Marcellinus xxvii–xxxi; Aurelius Victor, *Epit.* 47; Zosimus iv, vi; Ausonius (Gratian's tutor) especially the *Gratiarum actio pro consulatu;* Symmachus x, epp. 2 and 61; Xmbrose, *De fide,* prolegomena to *Epistolae* 11, 17, 21 *Consolatio de obitu Valentiniani;*

H. Richter, Das westromische Reich, besonders unter den Kaisern *Gratian, Valentinian II* und *Maximus* (1865); A. de Broglie, *L'Église* et *l'empire romain* au *IVe siècle,* 4th ed. (1882); H. Schiller, Geschichte der *römischen Kaiserzeit*, iii, iv, 31–33 (1883–86); Gibbon, Decline and Fall, ch. 27; R. Gumpoltsberger, Kaiser Gratian (1879); T. Hodgkin, Italy and her *Invaders,* vol. i (1892); J. Wordsworth in Smith's Dictionary of Christian Biography.

GRATIAN (GRATIANUS, MAGISTER GRATIANUS) (fl. *c.* 1140) has been called the father of the science of canon law, because his writing and teaching initiated a new branch of learning in the 12th century. the study of church law as a discipline distinct from theology. By confusing him with later personalities, bibliographers have sometimes given his name wrongly as Johannes Gratianus or Franciscus Gratianus. Yery little is known about Gratian's life. He was born. presumably in the late 11th century, in central Italy somewhere between Orvieto and Chiusi, perhaps at the hamlet of Carraria-Ficulle. Professed as a monk in the Camaldolese congregation of the Benedictine order, he became lecturer (magistcr) at the monastery of Sts. Felix and Nabor in Bologna, the city which just then began to acquire fame as centre of the revived study of Roman law and a new civil jurisprudence. There he completed, in 1140 or shortly thereafter, his Concordia discordantium canonum, a collection of nearly 3.800 texts touching upon all fields of church discipline, which he presented in the framework of a treatise designed to resolve into harmony (concordia) all the contradictions and inconsistencies existing in the millenary tradition of rules accumulated from divers sources (discordantes *canones*). Gratian is once mentioned in 1143 as consultant to a papal judge, and there is evidence that he was dead before 1159.

Later generations of chroniclers tacked several legends onto this meagre record of his life, pretending that he was a half-brother of the celebrated theologian Peter Lombard, or that he became a bishop or even a cardinal. Actually his person is entirely effaced by his work. Although by no means the first systematic compilation of canon law. it proved to be the right book at the right time because of its completeness and because of its superior method in combining the juristic with the scholastic approach. For the former, Gratian was indebted to the Bolognese doctors of civil law; for the latter, some directives had already been given by earlier canonists—*e.g.*, Yves de Chartres — but a more direct influence came from the trends of contemporary theology in France.

The *Concordia* discordantium canonurn, soon to be cited for short as *Decreta* or *Decretum Gratiani,* became the basic text on which the masters of canon law lectured and commented in the schools, first at Bologna. soon also at Paris. Oxford and other centres of learning. What is more, without ever receiving formal approbation, it was used as a book of authorities for the "old" law in the practice of the papal Curia. Even after much of its contents had become obsolete by later papal legislation, it remained the first part of the traditional corpus of canon law of the Roman Catholic Church until the codification of 1917 See also CANON LAW.

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GRATRY, AUGUSTE JOSEPH ALPHONSE (1805–1872), French author and theologian, was born at Lille. March 10, 1805. Educated at the École Polytechnique in Paris, he was ordained a priest in 1832. After being a professor of the Petit Séminaire at Strassburg, he was appointed director of the College Stanislas in Paris in 1842 and in 1847 chaplain of the École Normale Supérieure. He became vicar-general of Orleans in 1861. professor of ethics at the Sorbonne (1862) and in 186; a member of the French academy where he occupied the seat formerly held by Voltaire. Together with M. Pététot, curé of Saint Roch, he reconstituted the Oratory of the Immaculate Conception, a society of priests mainly devoted tb education. Gratry was one of the principal opponents of the definition of the dogma of papal infallibility, but in this respect he submitted to the authority of the Vatican council.

His chief works were De la connaissance de Dieu (1855), opposing Positivism; La *Logique* (1856); *Les Sources*, *conseils* pour la conduite de *l'esprit* (1861–1862); La Philosophie du credo (1861); Commentaire *sur l'évangile* de Saznt *Matthieu* (1863); *Jésus-Christ,* lettres *à M.* Renan (1864); Les Sophistes et la critique (in controversy with E. Yacherot) (1864); La *Morale* et la loi de l'histoire, setting forth his social views (1868); Mgr. *l'évêque d'Orléans* et Mgr. *l'archevêque* de *Malines* (1869), containing a clear exposition of the historical arguments against the doctrine of papal infallibility.

Gratry died at Montreux, Switz., Feb. 6, 1872.

GRATTAN, HENRY (1746–1820), Irish statesman, son of James Grattan, for many years recorder of Dublin, was born in Dublin on July 3, 1746. At Trinity college, Dublin, he began a lifelong devotion to classical literature and especially to the great orators of antiquity. He was called to the Irish bar in 1772, but never seriously practised. Like Flood he cultivated his natural genius for eloquence by study of good models, including Bolingbroke and Junius. Flood influenced Grattan's political aims; and it was through no design on Grattan's part that when Lord Charlemont brought him into the Irish parliament in 1775, in the very session in which Flood damaged his popularity by accepting office, Grattan quickly superseded his friend in the leadership of the national party. His speeches were packed with epigram, and expressed with rare felicity of phrase; his terse and telling sentences were richer in profound aphorisms and maxims of political philosophy than those of any other statesman save Burke; he possessed the orator's incomparable gift of conveying his own enthusiasm to his audience and convincing them of the loftiness of his aims.

The principal object of the national party was to set the Irish parliament free from constitutional bondage to the English privy council. The menacing attitude of the Volunteer Convention at Dungannon greatly influenced the decision of the government in 1782 to resist the agitation no longer. It was through ranks of volunteers drawn up outside the parliament house in Dublin that Grattan passed on April 16, 1782, to move a declaration of the independence of the Irish parliament. "I found Ireland on her knees," Grattan exclaimed, "I watched over her with a paternal solicitude; I have traced her progress from injuries to arms, and from arms to liberty. Spirit of Swift, spirit of Molyneux, your genius has prevailed! Ireland is now a nation!" After a month of negotiation the claims of Ireland were conceded. The gratitude of his countrymen to Grattan found expression in a parliamentary grant of £100,000, which had to be reduced by one half before he would consent to accept it.

One of the first acts of "Grattan's parliament" was to prove its loyalty to England by passing a vote for the support of 20.000 sailors for the navy. Grattan himself never failed in loyalty to the crown and the English connection. He desired moderate parliamentary reform, and, unlike Flood, he favoured Catholic emancipation. The Irish House of Commons was still subject to the influence of corruption, which the English government had wielded through the Irish borough owners, known as the "undertakers," or more directly through the great executive officers. "Grattan's parliament" had no control over the Irish executive. The great majority of the people were excluded as Roman Catholics frdm the franchise; two-thirds of the members of the House of Commons were returned by small boroughs at the absolute disposal of single patrons. It was to give stability and true independence to the new constitution that Grattan pressed for reform. Having quarrelled with Flood over "simple repeal" Grattan also differed from him on the question of maintaining the Volunteer Convention. He opposed the policy of protective duties, but supported Pitt's commercial propositions in 1785 for establishing free trade between Great Britain and Ireland, which, however, had to be abandoned.

In general Grattan supported the government for a time after 1782, and in particular spoke and voted for the stringent coercive legislation rendered necessary by the Whiteboy outrages in 1785; but as the years passed without Pitt's personal favour towards parliamentary reform bearing fruit in legislation, he gravitated towards the opposition, agitated for commutation of tithes in Ireland, and supported the Whigs on the regency question in 1788. In 1792 he succeeded in carrying an Act conferring the franchise on the Roman Catholics; in 1794 in conjunction with William Ponsonby he introduced a reform bill which was even less democratic than Flood's bill of 1783. The defeat of Grattan's mild proposals helped to promote more extreme opinions, which, under French revolutionary influence, were now becoming heard in Ireland.

In 1794 Lord Fitzwilliam became lord-lieutenant of Ireland. It was arranged that Grattan should bring in a Roman Catholic emancipation bill, and that it should then receive government support. But finally it appeared that the viceroy had either misunderstood or exceeded his instructions; and on Feb. 19, 1795, Fitzwilliam was recalled. The English cabinet was now determined firmly to resist the Catholic demands, with the result that Ireland rapidly drifted towards rebellion. Grattan warned the Government in a series of masterly speeches of the lawless condition to which Ireland had been driven, but his words were unheeded. He retired from parliament in May 1797, and departed from his customary moderation by attacking the government in an inflammatory "Letter to the citizens of Dublin." The rebellion of 1798 was sternly and cruelly repressed. The project of a legislative union between the British and Irish parliaments was taken up in earnest by Pitt's government. Grattan from the first denounced the scheme with implacable hostility.

When in 1799 the government brought forward their bill it was defeated in the Irish House of Commons. Grattan was still in retirement. His popularity had temporarily declined, and the fact that his proposals for parliamentary reform and Catholic emancipation had become the watchwords of the rebellious United Irishmen had brought upon him the bitter hostility of the governing classes. He was dismissed from the privy council; his portrait was removed from the hall of Trinity College; the Merchant Guild of Dublin struck his name off their rolls. But the threatened destruction of the constitution of 1782 quickly restored its author in the affections of the Irish people. On Jan. 15, 1800 the Irish parliament met for its last session; on the same day Grattan secured by purchase a seat for Wicklow; and at a late hour, while the debate was proceeding, he appeared to take his seat. "There was a moment's pause, an electric thrill passed through the House, and a long, wild cheer burst from the galleries." (Lecky, *Leaders* of *Public Opinion in Ireland.)* Grattan's strength gave way when he rose to speak and he obtained leave to address the House sitting. For more than two hours he kept his audience spellbound by a flood of epigram, of sustained reasoning, of eloquent appeal. After prolonged debates Grattan, on May 26, spoke finally against the committal of the bill, ending with an impassioned peroration in which he declared, "I will remain anchored here with fidelity to the fortunes of my country, faithful to her freedom, faithful to her fall." (Grattan's Speeches, iv. 23). These were the last words spoken by Grattan in the Irish parliament.

For the next five years Grattan took no active part in public affairs; in 1805 he became a member of the parliament of the United Kingdom. He modestly took his seat on one of the back benches, till Fox brought him forward to a seat near his own, exclaiming, "This is no place for the Irish Demosthenes!" When Fox and Grenville came into power in 1806 Grattan was offered, but refused to accept, an office in the government. In the following year he showed the strength of his judgment and character by supporting, in spite of consequent unpopularity in Ireland, a measure for increasing the powers of the executive to deal with Irish disorder. Roman Catholic emancipation, which he continued to advocate with unflagging energy though now advanced in age, became complicated after 1808 by the question whether a veto on the appointment of Roman Catholic bishops should rest with the crown.

Grattan supported the veto, but a more extreme Catholic party was now arising in Ireland under the leadership of Daniel O'Connell and Grattan's influence gradually declined. He seldom spoke in parliament after 1810, the most notable exception being in 181j, when he separated himself from the Whigs and supported the final struggle against Napoleon. His last speech of all, in 1819, contained a passage referring to the union he had so passionately resisted, which exhibits the statesmanship and at the same time the equable quality of Grattan's character. His sentiments with regard to the policy of the union remained, he said, unchanged; but "the marriage having taken place it is now the duty, as it ought to be the inclination, of every individual to render it as fruitful, as profitable and as advantageous as possible." He died on June 6, 1820, and was buried in Westminster Abbey close to the tombs of Pitt and Fox. His statue is in the outer lobby of the Houses of Parliament at Westminster. Grattan had married in 1782 Henrietta Fitzgerald, a lady descended from the ancient family of Desmond, by whom he had two sons and two daughters.

The most searching scrutiny of his private life only increases the respect due to the memory of Grattan as a statesman and the greatest of Irish orators. Sydney Smith said with truth of Grattan soon after his death: "No government ever dismayed him. The world could not bribe him. He thought only of Ireland; lived for no other object; dedicated to her his beautiful fancy, his elegant wit, his manly courage, and all the splendour of his astonishing eloquence." (Sidney Smith's *Works*, ii, 166–167.)

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(C.)

GRATZ, HEINRICH (1817–1891), German-Jewish historian. was born at Xions. Posen, Oct. 31. 1817. He spent three years at Oldenburg as assistant and pupil of S. R. Hirsch. He matriculated in 1832 at Breslau. headquarters of Abraham Geiger, leader of Jewish reform. whose attitude repelled him. Gratz remained a conservative, in spite of the radical views on the Bible and tradition which made him an opponent of Hirsch. He fought for freedom of thought. but not of ritual practice. In 1853 he became famous by the publication of the fourth volume of his history of the Jews, in which he dealt with the Talmud. In 1869 he became a professor of Breslau university. His *Geschichte der Juden* (11 vol., 1853–1875, Eng. trans. 5 vol., 1889–95) is a work of genius, in spite of his biased judgments and lack of sympathy with mysticism.

Gratz died at Munich on Sept. 7, 1891.

A full bibliography of Gratz's works and a memoir are in the *Jewish Quarterly Review,* iv, 194. A memoir was prefixed to the "index" volume of the *History* in the U.S. reissue of the Eng. trans., 6 vol. (1898).

GRAUBÜNDEN (Fr. GRISONS; It., GRIGIONI), most easterly of the Swiss cantons and the largest, though relatively sparsely populated. Pop. (1950) 137,100, giving a density per sq.mi. of 49.9. Its area is 2,745 sq.mi., of which more than a half is classed as productive (forests covering about one-fifth of the total), but it has 138.6 sq.mi. of glaciers, ranking in this respect next after the Valais and before Bern. The whole canton is mountainous; the principal glacier groups are those of the Tödi, N. (11,876 ft.), of Medels, S.W. (10,531 ft.), of the Adula Alps, S.W. (Rheinwaldhorn, 11,161 ft.), with the chief source of the Rhine. of the Bernina, S.E. (13,284 ft.), the most extensive of the Albula, E. (Piz Kesch, 11,214 ft.), and of the Silvretta, N.E. (Piz Linard, 11.191 ft.).

The principal valleys are those of the upper Rhine and of the upper Inn (or Engadine, *q.v.*). The three main sources of the Rhine are in the canton. The valley of the Vorder Rhine is called the Biindner Oberland, that of the Mittel Rhein the Val Medels and that of the Hinter Rhein (the principal), in different parts of its course, the Rheinwald, the Schams valley and the Domleschg valley; the upper valley of the Julia is named the Oberhalbstein. Other streams join the Ticino and so the Po, the Adda and the Adige. The inner valleys are the highest in Central Europe; among the loftiest villages are Juf, 6.998 ft. (the highest permanently inhabited village in the Alps)! at the head of the Avers glen, and St. Moritz, 6,037 ft., in the upper Engadine.

Below Chur, near Malans, good wine is produced, while in the Val Mesocco, etc.. maize and chestnuts flourish. Forests and the mountain pasturages are the chief source of wealth. There are many mineral springs. The climate, except on the southern slope of the Alps, is severe. Many tourists visit different spots in the canton, especially Davos (*q.v.*), Arosa and the Engadine. A railway runs from Maienfeld to Chur (*q.v.*), the cantonal capital, with a branch line from Landquart to Davos. From Chur the line bears west to Reichenau whence one branch runs beneath the Albula pass to St. Moritz, and another up the Vorder Rhine valley to Disentis. There are roads across the passes leading toward Italy.

The German-speaking part of the population live mainly around Chur and Davos, the Italian-speaking in the Val Mesocco, Val Bregaglia and the valley of the Poschiavo. The characteristic tongue of Graubunden is a survival of an ancient Romance language which has a scanty printed literature, but is still widely spoken. It is distinguished into two dialects: Romansh, which prevails in the Bundner Oberland and in the Hinter Rhein valley, and Ladin, which survives in the Engadine and in the neighbouring valleys of Bergun, Oberhalbstein and Munster. There are; however, in these regions German-speaking people, mostly as a result of immigration from the upper Valais in the 13th century. Much of the population is engaged in catering to tourists, but there is a considerable trade with Italy, particularly in the wines of the Valtellina. Some lead and silver mines were formerly worked, but are now abandoned.

The canton is divided into 14 administrative districts and includes 224 communes. It sends members to the federal *Standerat* and to the federal *Nationalrat.* The cantonal constitution has created a legislature (*Grossrat*—no numbers fixed by the constitution) elected by universal suffrage. The "obligatory referendum" obtains in the case of all lams and important matters of expenditure and revisions of the constitution.

History. — The greater part (excluding the three Italian speaking valleys) of the modern canton of Graubunden formed the southern part of the province of Raetia (*q.v.;* probably the aboriginal inhabitants, the Raeti, were Celts rather than, as was formerly believed, Etruscans), set up by the Romans after their conquest of the region in 1j B.C. The Romanized inhabitants were to a certain extent Teutonized under the Ostrogoths (A.D. 493–537) and under the Franks (from 537 on). Governors called *Praesides* are mentioned in the 7th and 8th centuries, while members of the same family occupied the episcopal see of Coire (founded 4th to 5th centuries).

About 806 Charles the Great made this region into a county, but in 831 the bishop procured for his dominions exemption ("immunity") from the jurisdiction of the counts, while before 847 his see was transferred from the Italian province of Milan to the German province of Mainz (Mayence) and was thus cut off from Italy to be joined to Germany. The bishop became a prince of the empire in 1170 and later allied himself with the rising power (in the region) of the Habsburgers. This led in 1367 to the foundation of the League of God's House or the *Gotteshausbund,* chiefly in order to stem his rising power, the bishop entering it in 1392. In 139j the abbot of Disentis, the men of the Lugnetz valley and the great feudal lords of Razuns and Sax, joined in 1399 by the counts of Werdenberg, formed another league, called the *Oberbund* (as comprising the highlands in the Vorder Rhine valley) and also wrongly the Grey league (as the word interpreted "grey" is simply a misreading of *graven* or counts, though the false view has given rise to the name of Graubiinden or Grisons for the whole canton.

Finally, in 1436, the third Raetian league was founded by the former subjects of the count of Toggenburg, whose dynasty then became extinct; they include the inhabitants of the Prattigau, Davos, Maienfeld, the Schanfigg valley, Churwalden and the lordship of Belfort (*i.e.,* the region round Alvaneu), and formed ten bailiwicks: whence the name of the league—*Zehngerichtenbund* or league of ten jurisdictions. In 1450 the *Zehngerichtenbund* concluded an alliance with the *Gotteshausbund* and in 1471 with the *Oberbund;* but of the so-called perpetual alliance at Vazerol, near Tiefenkastels, there exists no authentic evidence in the oldest chronicles. though diets were held there. In 1496 the possessions of the extinct counts of Toggenburg passed to the elder Habsburgers, the head of whom, Maximilian, was already emperor-elect, and desired to maintain the rights of his family there and in the Lower Engadine. Hence in 1497 the *Ober Bund* and in 1498 the *Gotteshausbund* became allies of the Swiss confederation.

War broke out in 1499, but was ended by the great Swiss victory (May 22, 1499) at the battle of the Calven gorge (above Mals) which, added to another Swiss victory at Dornach (near Basel), compelled the emperor to recognize the *practical* independence of the Swiss and their allies of the empire. In 1526, by the articles of Ilanz, the last remaining traces of the temporal jurisdiction of the bishop of Coire was abolished. In 1512 the three leagues had conquered from Milan the rich and fertile Valtellina, with Bormio and Chiavenna, and held these districts as subject lands until in 1797 they were annexed to the Cisalpine Republic. After the emperor had formally recognized, by the treaty of Westphalia (1648), the independence of the Swiss confederation, the rights of the Habsburgers in the Prattigau and the Lower Engadine were bought up (1649 and 1652). In 1803, after a brief inclusion in the Helvetic republic, it entered, under the name of canton of the Graubünden or Grisons, the reconstituted Swiss confederation.

See also ENGADINE; JENATSCH, GEORG; VALTELLINA.

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GRAUDENZ: *see* GRUDZIADZ.

GRAUN, KARL HEINRICH (1701–1759), German composer, the youngest of three brothers, all musicians, was born on

May 7, 1701, at Wahrenbrück, Saxony. Graun's beautiful soprano voice secured him an appointment in the choir at Dresden. At an early age he composed a number of sacred cantatas and other pieces for the church service. He completed his studies under Johann Christoph Schmidt (1664–1728), and profited much by the Italian operas which were performed at Dresden under the composer Antonio Lotti. He made his début as a tenor in opera at Brunswick, in a work by Schürmann, an inferior composer of the day; but not being satisfied with the arias assigned him he rewrote them, and in the result was commissioned to write a complete opera for the next season. This work, *Polydorus* (1726), and five other operas, together with two settings of the Passion, belong to the Brunswick period. In 1735 Frederick the Great, at that time crown prince of Prussia, engaged Graun for his private chapel at Rheinsberg. There he remained for five years, and wrote a number of cantatas, mostly to words written by Frederick himself in French, and translated into Italian by Boltarelli. On his accession to the throne in 1740, Frederick sent Graun to Italy to engage singers for a new opera to be established at Berlin. Graun remained a year on his travels singing in the chief cities of Italy. After his return to Berlin he was appointed conductor of the royal orchestra (*Kapellmeister*) and in this capacity he wrote 28 operas, all to Italian words, of which the last, *Merope* (1756), is perhaps the best. It was, however, in his oratorio *Der Tod Jesu* (1755) that he revealed to the full his powers and produced a work which gained for him the highest applause. In Germany, indeed, *Der Tod Jesu* long held a place similar to that occupied by *The Messiah* in England, being regularly performed in Holy Week for a century and a half after the composer's death. The *Te Deum* written to celebrate the victory of Prague (1757) was another of Graun's sacred choral works which found great favour and showed him at his best.

Graun died on Aug. 8,1759, at Berlin, in the same house in which, 32 years later. Giacomo Meyerbeer was born.

See K. Mennicke, *Hasse und die Brüder Graun als Sinfoniker* (1906), in which a thematic catalogue of Graun's works will be found

GRAU SAN MARTÍN, RAMON (188;–), Cuban statesman, was born Sept. 13, 1887, in Pinar del Río, Cuba, the son of a wealthy tobacco merchant. He was educated at the University of Havana, receiving his M D. degree in 1908, and continued medical studies at several European schools. Grau San Martin, who became titular professor of physiology at the University of Havana in 1921, resigned in 1927 in protest against the dictatorship of Gerardo Machado. Two years later he was imprisoned by the police for revolutionary activities.

After Machado was ousted in the revolution led by Col. Fulgencio Batista y Zaldívar in 1933, Grau San Martin became president and held office for four months, resigning in Jan. 1934. As head of a Centrist political group, he announced in 1940 that he would run as opposition candidate to Batista for the presidency. He declared the Centrists were committed to a policy of economic and political co-operation with the United States and denounced the Batista followers as "Reds." He was defeated by Batista in the election of July 1940.

Grau San Martin again became a presidential candidate in 1944, this time successfully; his opponent was Carlos Saladrigas Zayas, a Cuban attorney who had Batista's support but lacked the dynamism and popularity of his mentor.

Assuming the presidency on Oct. 10, 1944, Grau San Martin pledged democratic rule. The first two years of his tenure were marked by rumblings of revolutionary plottings against his regime. While his personal popularity remained high, he was attacked by Cuban conservatives.

He was also accused of being too lenient with the Cuban Communists. Grau San Martín, however, maintained that the influence of the Communist party in Cuba was negligible.

In 1945 and 1946, Grau San Martin's government put down two short-lited revolts. He was succeeded in the presidency by Carlos Prío Socarrás in 1948.

GRAVAMEN, a complaint or grievance, the ground of a legal action and particularly the more serious part of a charge against an accused person. In English the term is used chiefly in ecclesiastical cases, being the technical designation of a memorial presented from the lower to the upper house of convocation, setting forth grievances to be redressed, or calling attention to breaches in church discipline.

GRAVE. (1) A place dug out of the earth in which a body is laid for burial (see CEMETERY). The verb "to grave," is used of the making of incisions in a hard surface (see ENGRAVING, LINE). (2) A title, now obsolete, of a local administrative official for a township in certain parts of Yorkshire and Lincolnshire; it also appears in the form "grieve," which in Scotland and Northumberland is used for sheriff (*q.v.*), and for a bailiff or understeward. It is probably connected with the German *graf,* count, and thus appears as the second part of many Teutonic titles, such as landgrave, burgrave and margrave. "Grieve," on the other hand, seems to be a form of O.E. *gerefa,* reeve. (3) To grave a ship's bottom is to clean it in a specially constructed dock, called a "graving dock."

GRAVE CREEK MOUND, a prehistoric earthwork, near Moundsville, Marshall county, West Virginia, known since 1734, as appears from the date cut in a tree growing from its summit. It is the largest of the conical type of mounds in the United States, having a basal diameter of 320 ft., a height of 70 ft. and about 1,870,000 cu.ft. of solid contents. It is symmetrical in form and has a depression in the top. In 1838 excavation disclosed a burial vault at the base and another 30 ft. above, each built of logs and covered with stones. The lower contained two human skeletons, the upper vault one; and with each were thousands of shell beads, mica ornaments, copper bracelets and several stone articles, including it was said, one with an inscription which gave rise to much discussion. Subsequent investigation, however, failed to establish the authenticity of the stone or to prove that it came from the mound.

GRAVEL, an aggregate of more or less rounded rock fragments coarser than sand, technically more than two millimetres in diameter. Gravel beds in some places contain accumulations of heavy minerals, such as metallic ores, as cassiterite, a major source of tin, or native metals in nugget form. A notable example of the latter is the extensive auriferous gravel of Tertiary age in California, goal of much hydraulic mining. Gravels also are widely used building materials (see CONCRETE; FOUNDATIONS).

The rounding of gravel results from abrasion in the course of stream transport or milling by the sea. Gravel deposits accumulate in parts of stream channels or on beaches where the water action is too rapid to permit sand to remain. Because of changing conditions, gravel formations are generally more limited and more variable in coarseness, thickness and configuration than are sand or clay deposits. .Persistent accumulation of gravel or pebble beds may take place along an inner breaker zone, on a beach otherwise sandy. Cobble and pebble beaches (shingle beaches) often take their origin from the points of rocky cliffs.

In many regions there are marine gravels wholly resembling those of the seashore, at levels tens of hundreds of feet above tide level. Such gravel terraces (or raised beaches) may extend great distances and indicate that the sea at one time stood relatively higher. River gravels occur mostly in the middle and upper parts of streams where the currents are most active. Ancient terraces of gravel are found at levels much above those of the present rivers. They mark a former greater activity of streams or are evidence of uplift of the land or lowering of the sea, whereby the rivers have been able to cut their beds to a lower level. The Lafayette and related terrace gravel formations of the Atlantic and Gulf coastal plains of North America are products of both fluvial and marine action.

Fragments in gravels range from pebble to boulder size. Prolonged weathering and extended transport by long rivers on continental masses result in more complete rounding and selection as to size and physically and chemically durable rock materials. Gravels on smaller land masses, and where siliceous rocks are missing, are less well selected and less recognizable as definite rock formations. Conglomerates (*q.v.*) are cemented gravels. See also ALLUVIUM; BEACH; SEDIMENTARY ROCKS. (C. K. WE.)

GRAVELINES, (Flem. Gravelinghe), a seaport town of northern France, in the *département* of Nord and arrondissement of Dunkirk, near the mouth of the Aa, 15 mi. S.W. of Dunkirk on the railway to Calais. Pop. (1954) 2,078.

The canalization of the Aa by a count of Flanders (about mid-12th century) led to the foundation of Gravelines (grave-linghe, meaning "count's canal"). It finally passed from the Spaniards to the French by the treaty of the Pyrénées in 1659. It is fortified by a double circuit of ramparts and by a tidal moat.

The river is canalized and opens out beneath the fortifications into a floating basin. Its trade has suffered because of the nearness of Calais and Dunkirk and the silting-up of the channel to the sea. It is a centre for the cod and herring fisheries. Imports consist of timber from northern Europe and coal from England, to which eggs and fruit are exported. Gravelines has paper manufactories, sugarworks, fish-curing works, salt refineries, chicory-roasting factories, a cannery for preserved peas and vegetables and an important timberyard.

The greater part of the population of Gravelines dwells in the maritime quarter of Petit-Fort-Philippe at the mouth of the Aa, and in the village of Les Huttes (to the east of the town), which is inhabited by the fisherfolk.

GRAVES, ROBERT RANKE (1895–), English poet and author, the son of A. P. Graves, the Irish song writer, author of "Father O'Flynn." Robert Graves was educated at Charterhouse, and at St. John's college, Cambridge. During World War I he served in France with the royal Welsh fusiliers, and was seriously wounded at the Somme.

After 1915 Graves published several volumes of poetry, and critical essays. His Collected *Poems* were published in 1927, 1938 and 1948. His prose works include: The Meaning of Dreams (1924); *Contemporary* Technique of Poetry (1925); Goodbye to *All That* (1929); *I,* Claudius (1934); The Island of *Unwisdom* (1949).

GRAVES, THOMAS GRAVES, 1st Baron (1725?–1802), British naval officer, commander of the British forces in the battle of the Virginia Capes, during the American Revolution, was the son of Adm. Thomas Graves of Cornwall. Graves met De Grasse's fleet, which had sailed from the West Indies to aid the American and French land forces, off the entrance to Chesapeake bay on Sept. 5, 1781, and was decisively defeated. De Grasse then drew Graves to the south for three days so as to permit a squadron from Newport to enter the Chesapeake. Although the battle cost the British only one ship, it sealed the fate of Lord Cornwallis, who was penned in on the Yorktown peninsula and expecting rescue by the Royal Navy. Cornwallis surrendered on Oct. 19. Graves became a vice-admiral and then admiral, and was made a baron for his share in the battle of June 1, 1794, during the war with France. A severe wound in the right arm, received during this battle, caused him to resign his command. He died in Feb. 1802.

(J. B. Hn.)

GRAVESEND, a municipal borough and river port in the Gravesend parliamentary division of Kent, Eng., on the right bank of the Thames, 22 mi. E.S.E. of London by road. Pop. (1951) 44,560. Area 6.3 sq.mi. At Swanscombe, about 2 mi. W., parts of the skull of Smanscombe man were found during quarrying (1935–55). They date from the Great Interglacial Age. Nearby was situated the Roman settlement of Vagniacae. Gravesend is mentioned in Domesday Book as Gravesham, possessing a landing place, or hithe, on the river. Although the town was originally concerned with agriculture, Richard II granted sole ferry rights for conveying passengers to London. Arising out of these ferry rights, for more than four centuries many illustrious persons were received in the borough on their way to and from the capital. The borough was incorporated by charter in 1562, the present charter dating from 1632. Pocahontas, the American Indian princess, died at Gravesend in 1617, and was buried in St. George's church, now known as St. George's Chapel of Gnity (Pocahontas memorial).

For a variety of reasons, not least of them the ferry rights mentioned above, the town for centuries has been closely associated with administrative duties in relation to shipping on London's river. From the 16th century onward it became increasingly active in the handling of Britain's expanding maritime trade. Today Gravesend is the centre for customs, the Port of London Health authority and the Trinity House pilots. There is a passenger and vehicle ferry across the Thames to Tilbury.

The town's prosperity increased greatly during the first half of the 19th century when, as a result of the coming of the steamboat, Gravesend became well known as a health resort and watering place. This period saw rapid growth, the building of the Town pier and the Royal Terrace pier, and the purchasing and layout of many parks and public gardens.

There followed a process of transition to its present state as a modern industrial, commercial and maritime centre. Jetties of paper mills, cement factories, engineering works, tire and rubber works, printing works, shipbuilding and repair slipways flank the river frontage opposite Tilbury docks. Today Gravesend is the shopping, commercial, educational and entertainment centre for a prosperous industrial belt stretching along several miles of the south bank of the Thames. To the south and east on rising ground lie the residential areas of the town, which are bounded by agricultural land.

GRAVES WINES are made from grapes grown in the vineyards of the Graves district of the Gironde, France. This district, which owes its name to its gravel soil, begins just outside Bordeaux and extends about 5½ mi. west of that city and 13 mi. to the south, along the left bank of the Garonne. It produces about 1,000,000 gal. of white wine (which is 3½% of the average annual production of white wine within the whole Bordeaux area) and just under one-third of this quantity of red wine. Generally the red Graves are inferior to those from the Médoc although there are important exceptions such as Château Haut-Brion, Château La Mission Haut-Brion and Château Pape Clément, but for dry white wines the Graves cannot be excelled.

The best white Graves — Domaine de Chevalier, Château La Tour Martillac and Château Carbonnieux among them — are dry or medium dry and possess a full subtle flavour; they are crisp but lack all sharpness. They have a low percentage of acidity and this causes them to age or mellow considerably, after four or five years in bottle. The bouquet becomes pronounced and the wine turns deep yellow: generally they are preferred when drunk young and fresh. The best red Graves have great quality and will improve and keep in bottle for many years; they can sometimes be distinguished from the wines of other districts in Bordeaux by a special flavour that seems to derive from the high proportion of gravel in the soil.

Château Haut-Brion is the best-known château of the whole district and it produces fine red and white wines, the red being classed as a "first growth," together with three from the Médoc, in the classification of 1855. Appellation *contrôlée* has been permitted to Graves wines which fulfil the legal standard since the beginning of the 20th century ("Graves Supérieures" being wines which possess a little more alcohol than "Graves"). An attempt was made to classify the individual chbteaux in 1953, but the result has been impartially criticized in France and cannot be considered definitive.

For the red wines the same grapes are used as in the Médoc (*q.v.*), while for the white wines a mixture of the Sémillon and Sauvignon is customarily used in the same vineyards.

The name "Graves" is often applied to white wines from other countries; although they never rival true Graves, they may approach its style.

See A. Lichine and W. E. Massee, Wines of France (1951); J. R. Roger, "Vignoble Girondin" in ***Revue*** du ***Vin*** de *France,* no. 168 and 172 (1957).

(C. C. H. F.)

GRAVIES. A gravy is a sauce made from the juices and fats extracted from meats in cooking. The term is also applied to the thickened liquid of stews. Ordinary meat gravies are distinguished from sauces by their predominating element (osmazome), which gives them their characteristic meat flavour. **A** plain meat gravy is the diluted juices of meat. It may be made: (a) by pouring hot water over a dripping pan, adding salt and pepper and boiling until the sediment in the pan has coloured to a brown colour; where a plain gravy is not well coloured, extra colouring may be added in the form of browned flour or of an artificial colouring made for the purpose; (b) by stewing shank-ends of legs of mutton or other bones, gravy beef, etc., to form a stock; (c) by artificial means; *i.e.*, gravy powders sold for the purpose. Meat gravies are often thickened with flour, and milk is sometimes added. Gravy is used with roast meat, game and poultry, but where meat is stuffed with forcemeat it is usual to serve a thickened gravy. In certain cases it is advisable to have extra flavouring added to the gravy, such as garlic, spices, walnut or mushroom ketchup, lemon juice, etc. Generally speaking, these are used for stews and inferior meats, etc., to give extra flavour. For varnishing galantines, savoury rolls, etc., glaze is used. This is made by reducing a good brown gravy (generally made from brown stock) until it is of sticky, glazelike consistency. (J. A. SI.)

GRAVINA, a town and episcopal see of Apulia, Italy, in the province of Bari, 36 mi. S.W. from Bari by rail (29 mi. direct), 1,148 ft. above sea level. Pop. (1936) 21,909 (town), 23,208 (commune). The town perhaps occupies the site of the ancient Blera, a post station on the Via Appia. The cathedral is mainly of the 15th century. The town is surrounded with walls and towers, and a castle of the emperor Frederick II rises above the town, which later belonged to the Orsini, dukes of Gravina; just outside it are dwellings and a church (S. Michele), all of which have been hewn in the rock.

GRAVING DOCK, a narrow basin, closed by gates or by a caisson, in which a vessel may be placed and from which the water may be pumped or let out, leaving the vessel supported on blocks. In this way the ship is left dry and accessible for the purposes of examination, cleaning and repairs of the under-water parts of the hull. In British ports the term "dry dock" is more often used than graving dock. The word "graving" was originally used to denote the cleaning of a ship's bottom by means of scraping or burning and coating with tar. (*See* DOCKS.) (N. G. B.)

GRAVITATION. Few physical phenomena are roughly as well known to everybody as gravitation. The common fact that any unsupported body falls to the ground was certainly known even to primitive man. The attempt to understand the laws of, and the reasons for, this very ordinary observation has given occasion to several fundamental advances in scientific thought, It is the purpose of this article to sketch briefly the main developments of the theory of gravitation.

The first to unravel the law of motion of a falling body was Galileo Galilei, one of the founders of the scientific method. He not only showed that the acceleration of any falling body is constant and has the same value for all bodies, but brought together, perhaps for the first time, mathematical analysis and experiment. This combination of analysis and experiment is a true landmark in the history of science, and is easily the most fruitful innovation that has ever been introduced for the purpose of discovering scientific truth.

The next to add a fundamental discovery to our knowledge of gravitation was Sir Isaac Newton. He found out the inverse-square law, according to which any two bodies in the universe attract each other in proportion to the product of their masses and inversely as the square of their distance apart. He worked this into a self-consistent scheme of dynamics and formulated completely the fundamental laws of mechanics. His work is another landmark in the history of science.

The task of developing Newton's ideas from the mathematical point of view fell to the great French mathematicians of the early 19th century, mainly Siméon Poisson, Pierre Simon Laplace, Joseph Lagrange and Jean d'Alembert. In their hands the Newtonian theory of gravitation reached its highest perfection, and became what is known in our day as the classical theory of gravitation. This is sketched briefly in the first of the following sections.

Almost a century elapsed before any significant progress was made towards understanding gravitation. In the first quarter of the 20th century, however, Albert Einstein made a number of revolutionary discoveries. First he showed that the Newtonian assumption that time is a universal parameter independent of the reference system, is not correct. As a consequence the fundamental Newtonian equations of motion must be revised. Next he set up his famous equivalence principle and proved the equality of inertial and gravitational mass. Following in the footsteps of Hermann Minkowski he built up the concept of four-dimensional space-time and suggested that matter determines the geometry of space-time. According to him gravitation is a consequence of the fact that the space-time around matter is not flat, but curved. This is discussed briefly in the second section below.

The development of Einstein's ideas is accompanied by huge mathematical complications, the root of which lies in the use of arbitrary variables to describe events in space-time. To these must be added the difficulty of ascribing clear-cut physical meaning to such arbitrary variables. These complications and difficulties more recently led George David Birkhoff to see how far one could build up a self-consistent theory of gravitation by using a flat space-time and Lorentz variables alone. He thus gave up the connection between matter and geometry of space-time, but, by way of compensation, achieved a very considerable simplification of the mathematical machinery required to develop the theory of gravitation. Experiment alone can decide whether the Einstein or the Birkhoff theory is closer to the facts, although from the point of view of philosophical depth and beauty the advantage is unquestionably on the side of the former. Birkhoff's theory forms the subject of the third section below.

Another significant attempt to depart from Einstein's formulation of the theory of gravitation and to simplify the concepts used, is due to E. A. Milne. His theory has led to a reformulation of the fundamental law of gravitation, in which the Newtonian law appears as a first approximation. He has shown that an observer may at will describe events in terms of either one of two times, "kinematical time" or "dynamical time," but that his choice of time also determines his choice of the geometry of space-time. In the hands of Milne and his collaborators this theory has led to far-reaching results. It forms the substance of the fourth section in this article.

Part II of this article is concerned with the measurement of gravitational forces.

PART I. THEORIES OF GRAVITATION

Classical Newtonian Theory.—The classical formulation of the well-known Newtonian theory, expressed by the inverse-square law of attraction, and due mainly to Laplace and Poisson. may be briefly sketched as follows: there is a scalar gravitational potential, φ, which obeys Poisson's equation,

$$\nabla^2\varphi = -4\pi\rho \qquad (1.1)$$

where p is a function of position, *i.e.*, a function of the space variables (x, y, z), defining the distribution of matter in space. This function thus expresses essentially the density of matter (mass per unit volume) in space. For example, in a region where matter is uniformly distributed, $\rho=$ const.; in a region where the density varies exponentially, $\rho = e^{-kr} (r = \sqrt{x^2+y^2+z^2})$, etc. In empty space $(\rho = 0)$ this reduces to Laplace's equation

$$\nabla^2\varphi = 0. \qquad (1.2)$$

If a solution of (1.1) or (1.2) can be found, the force is given by

$$F = -\rho\nabla\varphi \qquad (1.3)$$

and the equation of motion of matter is, by Newton's second law of motion

$$\frac{d}{dt}(\rho v) = F \qquad (1.4)$$

where v is the velocity of p. The latter expresses the mass density.

Example.—Suppose it is desired to find the motion of a particle of mass m in the gravitational field of a large spherical body of mass M. In the space outside the latter, the solution of (1.2) satisfying the condition of spherical symmetry, regular everywhere ($r=0$ excluded) and vanishing at infinity is

$$\varphi = A/r$$

where A is an integration constant. From the condition that at the surface of the sphere of mass M, the potential is M/r, it is seen that $-A=M$, and

$$\varphi=-M/r.$$

From (1.3) the force is

$$F=-m\frac{\partial}{\partial r}\left(-\frac{M}{r}\right)=-\frac{mM}{r^2}$$

and from (1.4) the equation of motion is,

$$\frac{d}{dt}\left(m\frac{ds}{dt}\right)=m\frac{d^2s}{dt^2}=-\frac{mM}{r^2}$$

where r is the distance from the centre of the sphere generating the gravitational field and s is the path described by the mass particle.

In order that equations (1.1) to (1.4) may have a meaning, it is necessary to introduce a reference system. It is shown without difficulty that (1.1) and (1.3) are invariant with respect to changes of the space co-ordinates. With regard to (1.4) the situation is more complex. For $\rho=$const. (1.4) can be written

$$\rho\frac{d^2s}{dt^2}=F. \qquad (1.5)$$

Let us now investigate for what transformations (1.5) is invariant. In Newtonian mechanics it is assumed that the time is independent of the reference system, and hence also independent of the observer. Let us consider two cartesian reference systems moving with respect to each other with uniform velocity. Without loss of generality we may assume that the velocity is parallel to one of the axes, say the x-axis. Then, according to classical mechanics the transformation from the first co-ordinate system, S_1, to the second, S_2, is:

$$\begin{aligned} x_2&=x_1-vt_1\\ y_2&=y_1\\ z_2&=z_1\\ t_2&=t_1 \end{aligned} \qquad (1.6)$$

For a particle moving in any way whatever, the equations of motion in S_1 are

$$F_x=m\frac{d^2x_1}{dt_1^2},\ F_y=m\frac{d^2y_1}{dt_1^2},\ F_z=m\frac{d^2z_1}{dt_1^2}. \qquad (1.7)$$

In S_2 we have, from (1.6):

$$\frac{dx_2}{dt_2}=\frac{dx_1}{dt_2}-v\frac{dt_1}{dt_2},\ \frac{dy_2}{dt_2}=\frac{dy_1}{dt_2},\ \frac{dz_2}{dt_2}=\frac{dz_1}{dt_2},\ 1=\frac{dt_1}{dt_2}$$

and therefore

$$\frac{d^2x_2}{dt_2^2}=\frac{d^2x_1}{dt_1^2},\ \frac{d^2y_2}{dt_2^2}=\frac{d^2y_1}{dt_1^2},\ \frac{d^2z_2}{dt_2^2}=\frac{d^2z_1}{dt_1^2};$$

hence the equations of motion in S_2 are, from (1.7)

$$F_x=m\frac{d^2x_2}{dt_2^2},\ F_y=m\frac{d^2y_2}{dt_2^2},\ F_z=m\frac{d^2z_2}{dt_2^2} \qquad (1.8)$$

bearing in mind that m is assumed to be independent of the reference system. Hence the equations of motion are *invariant* with respect to the transformation (1.6). It may also be readily shown that they are invariant under rigid rotations.

The transformation (1.6) is known as a Galilean transformation. It can be easily shown that the Galilean transformations form a group (*see* GROUPS), which is known as the Galilean group. The theorem may therefore be stated: The Newtonian equations of motion are invariant with respect to the transformations of the Galilean group.

A number of interesting conclusions may be drawn from this theorem. In the first place it is clear that if *one* reference system exists in which the Newtonian equations of motion hold, then they also hold in an infinite number of reference systems obtained by applying to the first the transformations of the Galilean group. Reference systems in which the equations of motion hold are known as *inertial systems*. The theorem above may therefore be restated as follows: If an inertial system exists, then all other reference systems obtained from it by applying transformations of the Galilean group are also inertial. This is known as Mach's principle. The fundamental question in classical mechanics, therefore, is the discovery of a fundamental inertial system of reference. Without it, the formulation of the Newtonian theory of gravitation has no meaning. Since Mach's analysis it is known that this problem is essentially insoluble, and that the existence of a fundamental inertial system is a *postulate* of classical Newtonian mechanics and therefore also of the classical theory of gravitation. From this point of view, the latter may therefore be characterized as follows: (1) The time of an event is independent of the reference system. (2) There exists a fundamental inertial reference system. (3) In the fundamental reference system the Newtonian equations of motion hold.

Einstein's Relativistic Theory.—In 1905 Einstein formulated his special theory of relativity. Among other fundamental contributions, he first recognized clearly that to compare the time which holds in different reference systems one must make use of a physical experiment; *i.e.*, one must send a signal from the observer anchored to one reference system to the observer anchored to another. Since the only kind of signal which can be sent in general between two reference systems in motion with respect to each other is a light signal, and because the speed of propagation of light in space is finite, Einstein showed that, as a consequence, time depends on the co-ordinate system. Hence he reached the following essential conclusion:

(a) The time of an event is one of its co-ordinates, and depends on the reference system.

In place of the postulates of classical gravitational theory stated at the end of the preceding section, the Einstein theory of gravitation begins with the following postulates: (1) All systems of reference are equivalent for the description of natural laws, in particular for the laws of gravitation. (2) Gravitation is a consequence of the geometry of physical space. (3) Matter determines the geometry of physical space.

Since, according to the results of Karl Gauss and Georg Riemann, the geometry of any space is determined by its metric fundamental from,

$$ds^2=g_{\mu\nu}dx^\mu dx^\nu \qquad (2.1)$$

and since according to conclusion (a) the three space co-ordinates (x_1, x_2, x_3) and the time co-ordinate (x_4) are all of the same kind, it follows that physical space is four dimensional, and the indices μ, ν in (2.1) have the values 1,2,3,4. In accordance with well-known conventions, repeated indices, as in (2.1) are summed over all values of these indices.

In accordance with postulate (2), the law of gravitation must be expressed in terms of the tensor $g_{\mu\nu}$. Since this tensor is symmetrical, ($g_{\mu\nu}=g_{\nu\mu}$) there are ten different components of $g_{\mu\nu}$ which play the role of the gravitational potential of classical theory. Since $g_{\mu\nu}$ is a tensor, its use as a gravitational potential also satisfies the requirements of postulate (1).

It now remains to satisfy the requirements of postulate (3); *i.e.*, to determine $g_{\mu\nu}$ in such a way that, just as in classical theory, the distribution of matter (and energy) determines the gravitational potential $g_{\mu\nu}$. The inclusion of energy is essential because, from the restricted theory of relativity it follows that to an energy E corresponds an amount of matter E/c^2, where c is the velocity of light in vacuum. Further, since classical theory correctly describes gravitational phenomena, at least in the first approximation, it is necessary to require that the new equation determining the potential should reduce for weak fields to Poisson's equation (1.1) and that the new equation of motion should also reduce, for the same case, to the classical Newtonian equation (1.3).

The above considerations limit considerably the choice of the law of gravitation. Since Poisson's equation (1.1) is of the second order the new law should involve at most second-order derivatives in the components of $g_{\mu\nu}$. There is only one fundamental geometrical tensor satisfying this requirement, *i.e.*, the Riemann-Christoffel tensor $R^{\alpha}_{\mu\nu\beta}$ or its contracted form for $\alpha=\beta$, $R_{\mu\nu}$. Guided by such considerations, Einstein chose for his law of gravitation in empty space

$$R_{\mu\nu}=0 \qquad (2.2)$$

which reduces to Laplace's equation (1.2) for weak fields outside of matter. In the presence of matter, one must generalize the function ρ expressing its distribution in the classical static case: one builds up the energy-momentum tensor $T_{\mu\nu}$ which expresses the distribution of matter and its motion. In order to obtain Poisson's equation as a limiting case, as described above, and to satisfy the conservation of energy and momentum, one must write,

$$R_{\mu\nu}-\frac{1}{2}Rg_{\mu\nu}=-8\pi T_{\mu\nu} \tag{2.3}$$

where R is the scalar R^{α}_{α}. It is important to notice that the divergence

$$T^{\nu}_{\mu;\nu}=0 \tag{2.4}$$

because of the conservation of energy and momentum. The semicolon indicates covariant differentiation (see TENSOR ANALYSIS). But, because of Ricci's theorem, the divergence $(R^{\nu}_{\mu}-\frac{1}{2}Rg)^{\nu}_{\mu;\nu}$ vanishes identically.

It now remains to determine the equation of motion. In the absence of gravitation the motion of a particle is a straight line, *i.e.*, a geodesic in the Minkowski space characterized by

$$ds^2=dx_1^2+dx_2^2+dx_3^2-dx_4^2 \tag{2.5}$$

since in this case $g_{11}=g_{22}=g_{33}=1$, $g_{44}=-1$, $g_{\mu\nu}=0(\mu\neq\nu)$. This geodesic, as is well known, satisfies the condition $\delta\int ds=0$. Einstein then showed that acceleration of the reference system is equivalent to the appearance of a gravitational field in the accelerated reference system (principle of equivalence) and inferred that the path of an exploring particle in any gravitational field must be a geodesic satisfying the condition

$$\delta\int ds=0 \tag{2.6}$$

with respect to the ds^2 (2.1), where the tensor $g_{\mu\nu}$ is found from (2.3) (or [2.2]). He later showed that (2.6) reduces to (1.3) for the case of weak fields.

The principle of equivalence can be more accurately stated as follows: In any infinitesimal region of any gravitational field it is always possible to find a local reference system with respect to which $d^2x\mu/ds^2=0$ for all world-lines through a point.

From the above it is seen that the language adequate for the expression of Einstein's theory of gravitation is that of tensors. The fundamental group of transformations is that of the arbitrary transformations of four independent variables,

$$x_1'=x_1(x_1, x_2, x_3, x_4),\ x_2'=x_2(x_1, x_2, x_3, x_4),\ \text{etc.} \tag{2.7}$$

This is an extremely complicated group and its complete structure has not yet been worked out. As a result the Einstein theory of gravitation is also very complicated and its consequences have only been worked out in a limited number of cases. Of the cases where the field equations (2.2) or (2.3) have been solved, perhaps the most important is the solution of $R_{\mu\nu}=0$ for the static field having spherical symmetry (Schwarzschild's solution). It is

$$ds^2=\frac{dr^2}{1-2m/r}+r^2d\theta^2+r^2sin^2\theta d\varphi^2-(1-2m/r)dt^2 \tag{2.8}$$

where r is the distance from the origin and m is the mass of the particle at the origin, which generates the gravitational field. From (2.8) and (2.6) when applied to the motion of a planet in the gravitational field of the sun, follows the formula for the advance of the perihelion

$$\frac{6\pi m}{a(1-e^2)}\quad \text{seconds per revolution} \tag{2.9}$$

where a is the semimajor axis of the elliptical path and e is the eccentricity. The path itself may be described as an ellipse in which the major axis revolves slowly with sun as axis, in the way described by (2.9). For Mercury the advance of the perihelion is 42 sec. per century, in good agreement with observation.

For light the path is a geodesic, subject from (2.5) to the condition that $ds=0$. Applied to the sun, there follows for the deflection of a light ray going by the limb of the sun,

$$4m/p \tag{2.10}$$

which amounts to 1.78 sec. for the case in question, in fairly good agreement with experiment.

Lastly, for a stationary atom placed on the surface of a heavy body $dr=d\theta=d\varphi=0$. Hence, if one compares the radiation emitted by two identical atoms, one on the surface of a star and the other on the surface of the earth, and assumes that the proper time (ds) for both is the same, one obtains for the ratio of the frequencies emitted by the two atoms

$$\frac{\nu_e}{\nu_s}=\frac{1-2m_s/r_s}{1-2m_e/r_e} \tag{2.11}$$

m_s, m_e, mass of the star and earth, respectively; r_s, r_e, radius of the star and earth, respectively. Hence, a spectral line emitted by the atom on the star has a greater frequency than the same spectral line emitted by a similar atom on the earth. The spectral line emitted by the atom on the star is shifted towards the red (red shift). It is to be noted that in this derivation of the red shift no mention is made of the light signal which conveys the information from the star to the earth. Formula (2.11) is in fairly good agreement with experiment.

It should be noted that the space described by Schwarzschild's form (2.8) is curved. The distance r from the origin is therefore not to be confused with the Euclidean distance, nor the variables θ, φ with the Euclidean angles. Nor is the time the same as the local time of restricted relativity. As a consequence it is impossible to compare the results obtained from (2.8) with experiments using local time and Euclidean distances and angles.

Cosmological Consequences.—Since the field equations (2.3) claim general validity, they may be applied to the study of the universe as a whole. However, analysis shows that they, just like the classical equation of Poisson (1.1), are incapable of being so applied as they stand. If one makes the simplest possible assumption, *i.e.*, that the distribution of matter in the large is homogeneous and isotropic, and space is unbounded, it follows from (1.1) (1.3) that F is undefined at a point. If one attempts the same analysis using (2.3) it turns out that the $g_{\mu\nu}$ are still undefined at any point, or else it is impossible to satisfy the proper regularity conditions. In the classical case it was proposed by Carl Neumann to use in place of (1.1) the equation

$$\nabla^2\varphi+\lambda\varphi=-4\pi\rho \tag{2.12}$$

whose fundamental solution is $e^{-\lambda r}/r$ instead of $1/r$ and gives a definite force at any point. In analogy with this, Einstein suggested that for cosmological applications one should write in place of (2.3) (λ=cosmological constant)

$$R_{\mu\nu}-\frac{1}{2}Rg_{\mu\nu}+\lambda g_{\mu\nu}=-8\pi T_{\mu\nu} \tag{2.13}$$

which reduces to (2.12) for weak fields. Einstein, W. De Sitter, N. F. Friedmann and Georges Lemaitre have found solutions of (2.13); of these, Einstein's solution corresponds to an unstable universe, De Sitter's to an empty one. The only solution of real physical interest is that due to Friedmann and, independently, to Lemaitre. This leads to an expanding universe in which the velocity of any point from any other chosen arbitrarily as origin is proportional to the distance. This has important applications to the recession of extragalactic nebulae discovered by E. C. Slipher and studied by Edwin Hubble, which show a red shift (Doppler effect) corresponding to a radial velocity of recession proportional to their distance from the earth. However, according to Hubble the experimental distribution, after all relativistic and other corrections have been applied, is not uniform. Rather the density of nebulae seems to increase as the distance increases. This contradicts the initial assumption and is a serious difficulty in relativistic cosmology.

Birkhoff's Theory of Gravitation.— The inherent complication of Einstein's theory and the difficulty about assigning definite physical meaning to the arbitrary variables employed to describe physical phenomena led G. D. Birkhoff (about 1941) to try a new theory of gravitation using a flat space-time ($R^{\alpha}_{\mu\nu\beta}=0$) and the Minkowski line element (2.5) ("electromagnetic space-time," as he calls it) as a basis. The variables used are thus the local space co-ordinates and the local time of restricted relativity, and have perfectly definite physical meanings, as made clear by Einstein himself. In place of Einstein's postulate (1), Birkhoff assumes that for the description of physical laws there is a fundamental Lorentz frame of reference, from which all others are obtained by applying a Lorentz transformation. The laws of physics, in particular of gravitation, are thus expressed invariantly or covariantly with respect to such transformation. The fundamental group of transformations is now the 10-parameter Lorentz group and thus much simpler than Einstein's group. From this point of view Birkhoff's theory is closer to classical Newtonian theory than Einstein's. As a consequence, the language adequate to express Birkhoff's theory is that of vectors in Minkowski's space-time. Birkhoff gives up the connection between matter and geometry and does not assume that gravitation is connected with the geometry of space-time.

The fundamental equation determining the gravitational potential is now, according to Birkhoff

$$\Box h_{ij} = -8\pi T_{ij} \tag{3.1}$$

where $\Box$ is D'Alembert's operator, h_{ij} is the gravitational potential and T_{ij} is the momentum-energy tensor. (3.1) clearly reduces to (1.1) for static distributions of matter and static gravitational fields. Thus the velocity of propagation of the gravitational potential and field is always that of light.

By generalizing (1.3) Birkhoff sets for the force equation

$$f_i = \left(\frac{\partial h_{ij}}{\partial x^k} - \frac{\partial h_{jk}}{\partial x^i}\right) u^j u^k \tag{3.2}$$

where u^j is the velocity. The equation of motion is obtained similarly, *i.e.*,

$$f^i = \frac{d}{ds}\left(m\frac{dx^i}{ds}\right). \tag{3.3}$$

Example: Field of a particle.

Let us try to find the field outside a single particle of mass m at rest at the origin. In empty space, (3.1) reduces to

$$\Box h_{ij} = 0; \tag{3.4}$$

h_{ij} can have singularities only at the points of world-lines where the mass-particle is. The asymptotic form of h_{ij} in the vicinity of m, and in a reference system where m is at rest is,

$$h_{11} = h_{22} = h_{33} = h_{44} = m/r,\ h_{ij} = 0 (i \neq j). \tag{3.5}$$

Further, $h_{ij} \to 0$ as $r \to \infty$ and of course all the components h_{ij} satisfy D'Alembert's equation. The conditions mentioned determine h_{ij} uniquely and (3.5) is therefore the only solution of the problem. Knowing the potential, the field of force is determined using (3.2).

It is worth noticing carefully that, as a consequence of the fact that (3.1) is linear, Birkhoff's theory is linear in the potential and the field, that is, the potentials and fields of several particles simply add together just as in classical theory. In contrast, Einstein's theory is not linear, and the field of several particles is not the sum of the separate fields of each particle.

It is apparent that Birkhoff's theory of gravitation is inherently much simpler than Einstein's. While very few problems of any physical interest have been solved with the help of the latter, the former may be used to attack certain questions of great physical and astronomical interest, among which may be mentioned the two-body, three-body and n-body problems. In Einstein's theory the first has already proved to be attended by very serious difficulties, and its solution can be obtained (T. Levi-Civita, Einstein and Leopold Infeld, Banesh Hoffmann) only by making approximations, the meaning of which is not entirely clear. In Birkhoff's theory, as shown by C. Graef (1943), the solution of this problem is fairly simple and direct. The orbit of each body may be described as an ellipse of which the apsidal line of the system advances at the rate of

$$\frac{3m_1^2 + 7m_1m_2 + 3m_2^2}{m_1 + m_2} \frac{2\pi}{a(1-e^2)} \tag{3.6}$$

seconds per revolution. Here m_1 and m_2 are the masses of the two bodies, a is the semimajor axis and e the eccentricity. For $m_2 = 0$ this reduces to Einstein's formula. The immediate suggestion is to compare this with observations made on binary stars. Unfortunately the test, which would be crucial if sufficiently accurate measurements could be made, is not easy because the components of most known double stars are so close together that important tidal forces come into consideration which also produce an advance of the apsidal line and mask the effect sought. Where conditions are most favourable, as in the white dwarf binary discovered by Willem Luyten, the time of a single revolution is of the order of centuries, so that no check is possible for the present.

Important applications of Birkhoff's theory to the cosmological problem have also been made by Graef, and the comparison with observational material has been made by L. E. Erro. The cosmological constant is not introduced ad *hoc*, but now appears simply as an integration constant. Again the velocity of recession of extragalactic nebulae is proportional to the distance. The theory, moreover, indicates a way out of Hubble's dilemma by showing that an additional correction to the observational data must be applied. This correction, known as the simultaneity correction, is needed because the density of matter in the universe should be determined, not when light was emitted from distant nebulae, but at the place where such nebulae are now. Using Lorentz variables, and a frame of reference attached to the earth, as done in Birkhoff's theory, this correction acquires a perfectly definite meaning.

A. Barajas has pointed out that Birkhoff's and Einstein's theories predict different relativistic corrections even for the case of weak fields (except for the advance of the perihelion) and further that in the former the trajectory of a particle is not a geodesic in any curved four-dimensional space. He has shown that the principle of equivalence holds in Birkhoff's theory just as in Einstein's, *i.e.*, that it is possible to introduce in a gravitational field a local reference system in which the trajectories of mass particle are straight lines and the field vanishes.

The comparison between Einstein's and Birkhoff's theories is most readily seen in the following table:

EINSTEIN

Four arbitrary Gaussian variables.
Fundamental group: Transformations of four arbitrary functions of four arbitrary variables.
Doubtful physical meaning of variables employed.
Curved Riemann space.
Restricted relativity valid in infinitesimal region of space-time.
No fundamental reference system.
Matter determines geometry of physical space.
Inertial mass proportional to gravitational mass.
Principle of equivalence valid.
Nonlinear gravitational equations.
Mechanical equations of motion are a consequence of field equations.

BIRKHOFF

Four Lorentz variables.
Fundamental group: Lorentz group with ten arbitrary parameters.
Local co-ordinates and local time of restricted relativity.
Flat Minkowski space.
Restricted relativity valid everywhere.
Fundamental Lorentz reference system.
Matter does not determine geometry of physical space.
Principle of equivalence valid.
Linear gravitational equations.
Mechanical equations of motion are not a consequence of field equations.

Finally, in Birkhoff's theory gravitational waves propagate with speed of light everywhere. The question of gravitational waves is difficult to discuss in Einstein's theory as a consequence of the introduction of arbitrary variables.

Milne's Theory of Gravitation. — Milne has also tried to get rid of the difficulties which accompany the use of arbitrary variables to describe gravitational phenomena and has built up a theory of gravitation where the variables employed are Lorentz variables.

Milne starts from the following postulates: (1) observers attached to different reference frames can signal to one another by means of light; (2) the speed of light in any reference frame is constant; (3) any set of particles presents the same appearance to all observers.

From these postulates he deduces that, if observers attached to a galaxy use Euclidean space, they will conclude that all galaxies are receding from one another, as they do if the red shift of spectral lines is to be interpreted as a Doppler effect. If, on the other hand, they prefer to regard one another as at rest, they must use a different time scale and hyperbolic, not Euclidean, space. Further, if a particle moves under forces which depend only on its distance from other particles, and if every observer has to give the same description of these forces, the only possible law of force is,

$$\frac{\Gamma m_1 m_2}{ct_0^2 \sin h^2(r/ct_0)} = \frac{\Gamma m_1 m_2}{r^2(1+r^2/6c^2t_0^2+r^4/120c^4t_0^4+\ldots)} \quad (4.1)$$

where m_1, m_2 are the masses of any two particles, Γ is a constant, c is the constant speed of light, t_0 is the "present" and r is the distance between the two particles. The present time t_0 is 2×10^9 years$=6.3\times10^{16}$ sec. as inferred from the red shift of distant nebulae, and is not very accurately known. ct_0 is thus of the order of two billion (2,000,000,000) light-years, so that for all distances less than millions of light-years the law of force is the classical Newtonian law $\Gamma m_1 m_2/r^2$. The constant of gravitation Γ is calculated from the mean density of matter in the universe.

According to Milne's theory an observer can choose any time scale he likes, but the choice of his time scale fixes his geometry. However there are two kinds of time scales which give the simplest results. The so-called kinematical time scale gives the simplest account of radiation, and of a minority of the properties of matter. Using this time scale, the past is finite.

The second kind of time scale gives the so-called dynamical time, which is related to the kinematical time t by a logarithmic transformation.

$$\tau = t_0(\log t/t_0+1). \quad (4.2)$$

The past is infinite (negative) and the time is the same for all observers.

On this scale all observers in the universe would assign the same instant to the appearance of a nova, just as in classical Newtonian theory. But the geometry now is hyperbolic, not Euclidean. The galaxies are not receding from one another, and neither stellar nor planetary systems are expanding. Energy and angular momentum are constant and dynamics is very nearly Newtonian.

The logarithmic transformation connecting kinematical and dynamical time thus transforms a one-way infinite time scale (kinematical) into a two-way infinite scale (dynamical). We may choose for our calculations either scale, at will, and the results will be the same. But it appears that, roughly, kinematical time is most appropriate for calculations having to do with radiation while dynamical is best fitted for those relating to matter. The present is so chosen that at present the two scales coincide. It is clear, however, that if they coincide now they did not in the past and will not in the future. Thus the wave length of the red line of cadmium, say, measured in terms of a material standard, will shrink about 5×10^{-8} per century. The disagreement between the scales of time of matter and radiation of course becomes most important when dealing with huge intervals of time such as occurring in astronomy and geology.

Milne's cosmology thus solves the old problem as to whether the age of the universe is finite or infinite. According to him the answer depends on which time scale is used, *i.e.,* on whether one depends on radiation or matter to assign an age to the universe.

(M. S. V.)

PART II. THE MEASUREMENT OF GRAVITATIONAL FORCES

General Considerations.— The law of gravitation of classical mechanics first deduced by Newton (1665) from a study of Johann Kepler's empirical laws of motion of the planets states that: mutual action exists between masses of matter such that each mass is attracted toward every other mass with a force varying directly as the product of the masses and inversely as the square of the distance between them. This law is formulated as:

$$F=G\frac{M_1M_2}{d^2}, \quad (5.1)$$

where: F is the force between the two particles of mass M_1 and M_2, d is the distance between them, and G is a constant for all kinds of matter—the *gravitational constant.* This constant has the dimensions $L^3M^{-1}T^{-2}$ and a numerical value depending on the units used.

Although this law was first formulated rigorously by Newton, the existence of the gravitational action was seen more or less clearly by others. Even Ptolemy (A.D. 150) had a vague conception of a force tending toward the centre of the earth which not only kept bodies on its surface but in some way upheld the order of the universe. Kepler (1609) inferred that the planets move in their orbits under some influence or force exerted by the sun; but the laws of motion were not then sufficiently developed, nor were Kepler's ideas of force sufficiently clear to permit a precise statement of the nature of the force. C. Huggens and R. Hooke, contemporaries of Newton, saw that Kepler's third law implied a force tending toward the sun which, acting on the several planets, varied inversely as the square of the distance. But two requirements necessary to generalize the law were missing. One was to show that the law of the inverse square not only represented Kepler's third law but his first two laws also. The other was to show that the gravitation of the earth extended to the moon. Newton's researches showed that the attraction of the earth on the moon was the same as that for bodies at the earth's surface, only reduced in the inverse square of the moon's distance from the earth's centre. He also showed that the total gravitation of the earth, assumed as spherical. would be the same on external bodies as if the earth's mass were concentrated at its centre. This led at once to the statement of the law in its general form (equation [5.1]).

The existence of the gravitational phenomenon is exhibited in the simple observation that any body on the surface of the earth is attracted to the earth by a force proportional to its mass. This force we commonly term the *weight* of the body. Thus, from equation 5.1, the force acting on a body of mass M_1, due to the attraction of the whole earth, whose mass M_2 may be considered as concentrated at its centre, would be

$$F=W=GM_1M_2/r^2 \quad (5.2)$$

where r is the radius of the earth.

The force *per unit mass* is therefore F/M_1, or:

$$F_0=GM_2/r^2. \quad (5.3)$$

The force acting on the body M_1 also may be considered as defined by Newton's second law of motion; *i.e.,* $F=M_1a$, where a is the acceleration that would be caused by the gravitational attraction of the earth if the body were allowed to fall freely. Thus the force on the body is exactly the same as if it were being accelerated at a rate $a=F/M_1$ which is given by equation 5.3. And, when the attraction of the earth is expressed as a force per unit mass, it is exactly equivalent to an acceleration. Therefore, we often speak of the *acceleration* of *gravity* synonomously with the *intensity of gravity, g,* of the earth.

The gravitational constant G of the foregoing equations is one of the fundamental constants of nature. It can not be determined, however, by astronomical data such as led Newton to the formulation of the general law as expressed in equation (5.1). But. if all other quantities in equation (5.1) can be measured experimentally, then G can be calculated. Thus, in view of its fundamental importance, the experimental determination of the numerical value of the gravitational constant became an important problem to physicists immediately the gravitational law was formulated.

On the other hand, in reviewing the efforts of the earliest workers in this field, it might appear that they were primarily interested in determining A, the density of the earth rather than the gravitational constant G. However, these two problems are so closely related that the determination of one leads quite directly to the evaluation of the other. This circumstance arises as follows:

If we assume the earth to be a nonrotating sphere of mass M, density Δ and radius r, the intensity of gravity g at its surface (from equation [5.3]) is

$$g=\frac{GM}{r^2}=\frac{G}{r^2}\left(\frac{4}{3}\pi r^3\Delta\right)=\frac{4}{3}\pi r(G\Delta) \qquad (5.4)$$

$$G\Delta=\frac{3g}{4\pi r}. \qquad (5.41)$$

Thus, if g and r are known, the determination of G and Δ are equivalent problems since the measurement of either determines the other within the limits of accuracy of the known quantities.

The Determination of the Gravitational Constant.—In view of the above statement formulated in equation (5.41), we see that the determination of the gravitational constant G, the really fundamental problem, may be regarded either as the determination of the mass of the earth in grams, most conveniently expressed as its mean density Δ (mass/volume), or the determination of the gravitational constant G. Corresponding to these two aspects of the problem there are two modes of attack.

(1) Suppose that a body of mass m is suspended at the earth's surface where it is pulled vertically downward with a force w, its weight. At the same time let it be pulled laterally with a force p by a measurable mass M which may be a mountain, or an artificially prepared mass brought very near to m, and let d be the distance between the centres of mass m and M whether M be the mountain or the artificial mass. The earth pull may be regarded as the same as if its mass were concentrated at its centre, distant r.

Then $$w=G\frac{4}{3}\pi r^3\Delta m/r^2=\frac{4}{3}m\pi r(G\Delta) \qquad (6.1)$$

and $$p=GMm/d^2. \qquad (6.2)$$

By division $$\Delta=\frac{3M}{4\pi rd^2}\left(\frac{w}{p}\right) \qquad (6.3)$$

and we can obtain the mean density of the earth if the ratio $\frac{w}{p}$ can be observed experimentally.

But the same observations permit the evaluation of G, the gravitational constant. For, putting $m=\frac{w}{g}$ in equation (6.2), we get

$$G=\frac{d^2}{M}\left(\frac{p}{w}\right)g \qquad (6.4)$$

and g, the acceleration of gravity, is known from, say, measurements of the acceleration of a falling body or from pendulum measurements.

(2) In the second method of attack the pull p between two artificially prepared measured masses M_1 and M_2, is determined when they are a distance d apart. From the measured value of the pull p, we obtain directly from equation (5.1),

$$G=pd^2/M_1M_2. \qquad (6.5)$$

But again, having determined G, we can determine the mean density of the earth, Δ, for $m=\frac{w}{g}$ put in equation (6.1) gives immediately

$$\Delta=3g/4\pi rG. \qquad (6.6)$$

Experiments of the first type in which the pull of a known mass is compared with the pull of the earth may properly be termed experiments on the mean density of the earth, while experiments of the second class in which the pull between two known masses is measured directly may be termed experiments on the gravitational constant. However, for purposes of describing such experiments, a slightly different classification is desirable, viz.:

(1) Comparison of the earth's vertical pull on a body with the lateral pull of a natural mass such as a mountain or other massive natural feature.

(2) Comparison of the earth's pull on a body with the vertical pull of an artificial mass as in experiments with the common balance.

(3) Determination of the attraction between two artificial masses as in the Cavendish experiment.

It is interesting to note that the possibility of gravitational experiments of this kind was first considered by Newton in both of the forms (1) and (3). In the Systems of the World (3rd edition, p. 40, 1737) he calculates that the lateral pull of a hemispherical mountain of radius 3 mi. and of the earth's density will cause a plumb line at its side to be deviated less than 2 minutes of arc. He also calculates (though with an error in his arithmetic) the acceleration towards each other of two spheres each a foot in diameter and of the earth's density, and comes to the conclusion that in either the case of the deviation of the plumb line or the attraction of the spheres, the effect is too small for measurement. In the *Principia,* Book iii, Prop. x, he makes the celebrated estimate that the earth's mean density is five or six times that of water. Adopting this estimate, the deviation by an actual mountain or the attraction of two terrestrial spheres would be of the orders calculated, and regarded by Newton as immeasurably small.

Whatever method is adopted, the force to be measured is indeed very minute. This may be realized if we here anticipate the results of the experiments which show that when the masses are in grams and the distances in centimetres, the values are approximately $\Delta=5.5$ and $G=1/15{,}000{,}000$. The latter may be expressed as $G=6.6\times10^{-8}$ (c.g.s. units).

Comparison of the Earth's Pull with That of a Natural Mass—*Bouguer's* Experiments.—The earliest experiments were made by Pierre Bouguer about 1740 and they are recorded in his Figure de la Terre (1749). They were of two kinds. In the first he determined the length of the seconds pendulum and thus g at different elevations. Thus at Quito, Peru, which may be regarded as on a tableland with an elevation of about 9,400 ft., and again on the Isle of Inca at sea level, he determined g with pendulum apparatus. From the known difference in elevation of the two points of observation the measured value at sea level was projected to the elevation of the plateau by the inverse r^2 law, assuming that only free air occupied the intervening space. Actually his observed value of g at the elevated station was $\frac{1}{6{,}983}$ greater than this calculated value, which difference he immediately assigned to the attraction of the 9,400 ft. of plateau material actually underlying the elevated station. Thus the experiment indicated that the attraction of the whole earth was 6,983 times that of the plateau. Since the attraction of the plateau could be calculated on the assumption that it was effectively an infinite slab of known thickness Bouguer concluded that the density of the earth was 4.7 times that of the plateau. This result is obviously much too large.

In the second type of experiment he attempted to measure the horizontal pull of a 20,000 ft. mountain by suitable observations on the deflection of a plumb line. Because of experimental difficulties his results are not of interest but the importance of the experiment was in indicating the possibilities of the method.

Maskelyne's Experiment.—In 1774 Nevil Maskelyne (*Phil. Trans.*, p. 495, 1775) made an experiment on the deflection of the plumb line by a mountain, Schiehallion, in Perthshire, Scotland. It has a short east-west ridge with steeply sloping north and south flanks. He selected two stations on the same meridian, one on the north and the other on the south slope and by means of a zenith sector, a telescope provided with a plumb bob, he determined at each station the meridian zenith distances of a number of stars. From a survey of the district made in the years 1774–76, the geographical difference of latitude between the two stations was found to be 42.94 sec. The difference in meridian zenith distances of the same star at the two stations would have been this value if the mountains were absent and the plumb line thus maintained a true vertical. But at the north station the plumb bob was pulled south and the apparent zenith deflected northward, while at the south station the effect was reversed. The observed zenith distances of the same star at the two stations was 54.2 sec. as against the surveyed difference of 42.94 sec. Thus the difference representing the double deflection of the plumb line was 11.26 sec. From the results of this survey, Charles Hutton *(Phil. Trans.*, p. 689, 1778) computed the relative density of the earth and mountain as 9/5. Assuming the mountain density as 2.5, the mean density of the earth, A, would be 4.5.

Airy's Experiment.—A modification of Bouguer's experiment was carried out by Sir G. B. Airy (Phil. *Trans.*, p. 297, 1856) in 1854 at Harton mine near South Shields. This consisted in comparing gravity at the top and bottom of a mine by the swings of the same pendulum and thus finding the ratio of the pull of the intervening strata to the pull of the whole earth. The principle of the method may be understood by assuming that the earth comprises concentric homogeneous spherical shells, the last being of thickness h equal to the depth of the mine. Let the radius of the earth to the bottom of the mine be r and the mean density up to that point be Δ. This will not differ appreciably from the mean density of the whole. Let the density of the strata of depth h be 6. Denoting the values of gravity above and below by g_a and g_b we have

$$g_b = G\frac{4}{3}\frac{\pi r^3\Delta}{r^2} = G\frac{4}{3}\pi r\Delta \qquad (6.7)$$

and

$$g_a = G\cdot\frac{4}{3}\frac{\pi r^3\Delta}{(r+h)^2} + G\cdot 4\pi h, \qquad (6.71)$$

the added term being the attraction of a shell h thick observed at a point on its outer surface. The ratio of equation (6.7) and (6.71) may be reduced to

$$\frac{g_a}{g_b} = 1 - \frac{2h}{r} + \frac{3h\delta}{r\Delta} \text{ (approx.)} \qquad (6.8)$$

or

$$\frac{\Delta}{\delta} = \frac{3h}{r}\Big/\left(-1+\frac{2h}{r}+\frac{g_a}{g_b}\right). \qquad (6.81)$$

Stations were chosen in the same vertical, one near the head of the shaft and the other 1,250 ft. below in an abandoned working. Two *invariable* seconds pendulums were swung and timed by a comparison clock at each station. The seconds pendulums were interchanged at intervals. The final result taking into account the ellipticity and rotation of the earth is $\Delta = 6.565$, a value about 20% higher than currently accepted values.

Von Sterneck's Experiment.—(*Mitth. des K.V.K.* **Mil.** *Geog. Inst. zer Wien*, ii, p. 77, 1882; p. 59, 1883; vi, p. 97, 1886.) R. von Sterneck repeated the mine experiment in 1882–83 at the Adalbert shaft at Pribram in Bohemia, and in 1885 at the Abraham shaft near Freiberg. He swung two invariable half-seconds pendulums simultaneously, one at the surface and the other below, interchanging them at intervals. Von Sterneck introduced an important improvement by comparing the swings of the two pendulums with the same clock using an electrical connection between stations. This method eliminates the clock rates from the final calculations of the relative gravity values and begins a new era in the determination of local variations of gravity.

The values of **A** obtained by Von Sterneck were not consistent but increased with the depth of the second station. All such experiments to determine *A* by the attraction of natural masses are open to the serious objection that the distribution of density in the neighbourhood can not be determined with sufficient accuracy.

Comparison of the Earth's **Pull** on a **Body** with the Vertical Pull of an Artificial Mass by Means of the Common Balance.—The principle of the method is as follows: Suppose a sphere of mass m and weight w to be hung by a wire from one arm of an ordinary balance. Let the mass of the earth be E and its radius be r. Then

$$w = GEm/r^2.$$

Now introduce beneath m, a sphere of mass M and let d be the distance between the centres of the two masses. Its pull increases the apparent weight of m by, say, δw. Then

$$\delta w = GMm/d^2.$$

Dividing, we obtain

$$\delta w/w = Mr^2/Ed^2, \text{ whence}$$

$$E = M\left(\frac{w}{\delta w}\right)\left(\frac{r^2}{d^2}\right).$$

Hence the mass of the earth is obtained in terms of the known mass M. Indirectly the gravitational constant G may then be determined from the relation

$$g = GE/r^2;\ G = gr^2/E$$

and the known value of g as measured by pendulum or falling-body experiments.

Von Jolly's Experiment.—*(Abhand. der K. bayer. Akad. der Wiss.* 2 Cl. xiii, Bd. 1, Abt. p. 1j7 and xiv. Bd. 2 Abt. p. 3.) About 1878–81, Philipp von Jolly performed experiments using a common balance. Some of these experiments involved measurements of the change in weight of a mass due to change of elevation of the mass above the earth's surface. Coupled with these experiments he built up a lead sphere about 1 metre in diameter beneath one of the lower pans of the balance. He found that the weight of a 5 kg. mass was increased by 0.589 mg. when it was placed on the lower pan of the balance directly over the lead sphere as compared with its weight on the upper pan so remote from the lead sphere as to be influenced a negligible amount by the artificial mass.

He obtained as a result,

$$G = 6.465\times 10^{-8}; \qquad A = 5.692.$$

Experiments of Richarz and Krigar-Menzel.—(*Anhang zuden Abhand. der k. preuss. Akad. der Wiss. zu Berlin 1898.)* In 1884 A. Koenig and F. Richarz proposed a similar experiment which was ultimately carried out by Richarz and 0. Krigar-Menzel. In this experiment a balance mas supported about 2 metres above the floor and with scale pans above and below as in Von Jolly's experiment. Weights 1 kg. each were placed say in the top right pan and the bottom left pan. Then they were shifted to the bottom right and top left, the result being, after corrections for the change in density of air displaced through pressure and temperature changes at the two elevations, a gain in weight on the right of 1.2453 mg. due to the change in level of 2.2628 metres. Then a rectangular column of lead 210 cm. square cross-section and 200 cm. high was built up under the balance between the pairs of pans. On repeating the weighings there was now a decrease on the right when a kg. weight was moved on that side from top to bottom while another was moved on the left from bottom to top. This decrease was 0.1211 mg., showing a total change due to the lead mass of $1.2453+0.1211=1.3664$ mg. and this is obviously four times the attraction of the lead mass on 1 kg. The changes in the weights were made automatically, the results gave

$$G = 6.685\times 10^{-8};\ A = 5.505.$$

Poynting's Experiment.—*(Phil. Trans.*, vol. 182, *A*, p. 565, 1891.) In 1878, J. H. Poynting published an account of a preliminary experiment of the type of Von Jolly's but on a smaller scale with the view to demonstrate that the common balance could be adapted to gravimetric work. In 1891 he gave an account of the full experiment carried out with a large balance and with much greater care. The balance had a 4 ft. beam. The scale pans were removed and from the two arms were hung lead spheres, each weighing about 20 kg. at a level about 120 cm. below the beam. The balance was supported in a case above a horizontal turntable, the axis of which was vertically below the central knife-edge of the balance. On this turntable was mounted the attracting mass, a lead sphere weighing 150 kg. The centre of the large sphere was 30 cm. below the level of the centres of the hanging weights. The turntable could be rotated between stops so that the attracting mass was first directly below one of the hanging weights and then directly below the other. It was found necessary to add a second balancing mass to the turntable at twice the radius of the large mass in order to eliminate a spurious tilting of the balance support due to the shifting weight of the turntable.

The balance beam was equipped with a special mirror arrangement which magnified the tilt of the beam about 150 times. About 5 metres from this mirror was a telescope and scale for observing the tilt of the mirror. The experiment indicated that in moving the attracting mass from under one weight to a position under the opposite weight the balance beam changed deflection a little more than 1 second of arc—equivalent to a change in weight of about 0.4 mg.

Poynting's results were

$$G=6.698\times10^{-8};\ \Delta=5.493.$$

Determination of the Attraction between Two Artificial Masses, Cavendish's Experiment.—(Phil. Trans., p. 469, 1798.) This celebrated experiment was planned by the Rev.

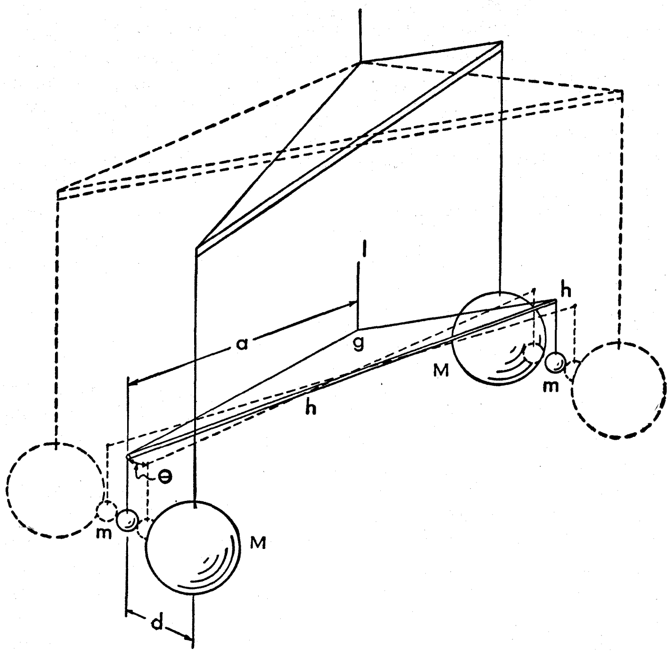


FIG. 1.—CAVENDISH BALANCE

John Michell. He completed an apparatus but did not live to begin the work on the experiment. After Michell's death the apparatus came into the possession of Henry Cavendish, who largely reconstructed it and in 1797–98 carried out the experiment.

The essential feature of the experiment consisted in the determination of the attraction of a lead sphere 12 in. in diameter on another lead sphere 2 in. in diameter, the force measurement being made with a torsion balance. Fig. 1 shows the essential features of the apparatus. A horizontal beam *hh*, 6 ft. long, was suspended at its centre by a torsion wire *lg*. Two lead balls, m, m, each 2 in. in diameter, were suspended at the ends of the beam. One end of the beam carried a suitable index whereby its angular position with respect to a horizontal scale could be determined very accurately by viewing through a distant telescope. The torsion balance mas enclosed in a case to shield it from convection currents. Outside the case, two 12 in. diameter lead spheres, *M, M,* were hung from an arm which could be turned on a vertical axis colinear with the suspension *lg* of the torsion balance.

Suppose that first the spheres are so placed that one is a distance d in front of the left-hand ball m and the other is the same distance behind the right-hand ball m. The gravitational attraction of the two pairs of balls will be additive in tending to turn the torsion balance counterclockwise as viewed from above. If the big spheres are then moved around so as to be on the opposite sides of their adjacent small balls m, *m*, the torque on the torsion arm will be reversed and it will turn clockwise. The angle 2θ between the two rest positions of the balance arm is four times as great as the deflection that would result due to the approach of one sphere to one ball. (We have neglected the cross-attraction of the right sphere on the left ball and the left sphere on the right ball.)

By operating the torsion balance as a torsion pendulum and determining its period, or by other means, it is obvious that the torsion constant of the suspension may be determined. Thus the force acting at lever arm length a to produce the observed deflection 2θ may be calculated, and with the values of *M, m* and d known, equation (5.1) in principle gives directly the value of the gravitational constant G.

The work of Cavendish was undoubtedly very accurate for a pioneer experiment; in fact, it was not really improved upon until nearly a century later. After making various corrections, Cavendish's results were:

$$G=6.754\times10^{-8}\ \text{(c.g.s. units), and}\ \Delta=5.448.$$

These results are within about 1.2% of currently accepted values.

Reich's Experiments.—In 1838 F. Reich published an account of a repetition of the Cavendish experiment carried out in the same manner but with somewhat smaller apparatus. (Versuche *über* die Mittlere Dichtigkeit der Erde *mittelst* der Drehwage, Frieberg, 1838; "Neue Versuche mit der Drehwage," *Leipzig* Abh. Math. Phys., i, p. 383, 1852.) The principal differences were in the methods of measuring the times of vibration and the deflection, and the changes were hardly improvements. His result after revision was $\Delta=5.49$. In 1852 he published an account of further work giving as a result $\Delta=5.58$.

Baily's Experiment.—In 1841–42 Francis Baily made a long series of determinations by the Cavendish method and with apparatus of almost the same dimensions. (Memoirs of the Royal Astron. *Soc.,* XIV.) The attracting masses were 12 in. lead spheres and as the attracted balls he used various materials, lead, zinc, brass, glass, etc. The suspension was also varied, sometimes consisting of a single wire, sometimes being bifilar. There were systematic errors in the work difficult to explain. His final result, $\Delta=5.6747$, is not of value compared with later results.

Boys' Experiment.—(Phil. Trans., **A.,** pt, i, p. 1, 1895.) Professor C. V. Boys, having found that it is possible to draw quartz fibres of practically any degree of fineness, of great strength and very constant elastic properties, determined to repeat the Cavendish experiment. He first investigated the question of optimum dimensions for the apparatus and concluded that the dimensions should be reduced until the determination of the linear dimensions became the limit of accuracy. These conclusions were based on the fact that smaller dimensions would reduce temperature variations and resultant air disturbances and in other ways would make the experiment more manageable.

Fig. 2 shows diagrammatically his arrangement of the apparatus. The horizontal beam was a small rectangular mirror about 2.4 cm. long. From the sides of this mirror gold balls of about 2.6 gm. mass each were hung by quartz fibres at levels differing by 1 j cm. The attracting masses were lead spheres, about 11 cm. in diameter and weighing about 7.4 kg. each, so arranged that the torque resulting from the attraction was a maximum. The vertical displacement of the spheres and balls served to minimize the attraction of opposite pairs and permitted the use of the very short beam. The horizontal mirror comprising the beam reflected a scale 700 cm. distant by which the deflection could be read. The result of this experiment, as given by Boys, was $G=6\ 6576\times10^{-8}$; $\Delta=5.5270$. However, the last figure is not significant since

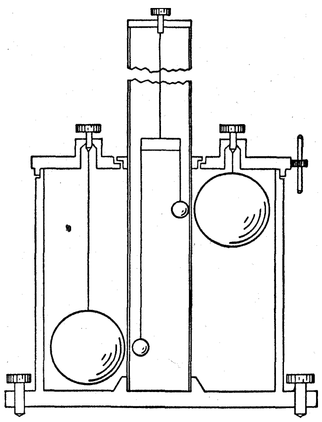


FIG. ,?.—BOYS' CAVENDISH BALANCE

the individual observations ranged from 6.653 to 6.671.

Braun's Experiment.—(*Denkschr. Akad. Wiss. Wien. Math. Naturw.*, Cl. 64, p. 187, 1896.) In 1896 Dr. K. Braun, S.J., gave an account of a very careful and excellent repetition of the Cavendish experiment with apparatus much smaller than that used in the older experiments, yet much larger than that used by Boys. A notable feature of the work consisted in the suspension of the torsion apparatus in a receiver exhausted to about 4 mm. of mercury, a pressure at which convection currents almost disappear while radiometer forces have hardly begun. The attracted balls weighed 54 gm. each and were 25 cm. apart. The attracting masses were spheres of mercury, each weighing 9 kg. and brought into position outside the receiver. Braun used both the deflection method and the time of vibration method suggested by Reich and John Forbes. The methods gave almost identical results and his final values were:

$$G=6.6579\times 10^{-8};\ \Delta=5.5275.$$

Ignoring the 5th figure, which is not significant, the results agree with Boys' values. Braun reported 46 separate experiments, 26 by the time-of-swing method and 20 by the method of direct deflection, the individual results being weighted from 1 to 4. The individual results vary as much as 4 units of the third significant figure.

G. K. Burgess' Experiment.—(*Thèses présentées à la faculté des sciences de Paris pour obtanir le titre de docteur de l'université' de Paris*, 1901.) This was a Cavendish experiment in which the torsion system was buoyed up by a float in a mercury bath. The attracted masses could thus be made large (2 kg.) and yet the torsion fibre could be kept fine. From the centre of the beam depended a vertical steel rod with a varnished copper float at its end, entirely immersed in mercury covered with dilute sulphuric acid to remove disturbances due to varying surface tension acting on the steel rod. The size of the float was such that the quartz torsion fibre 35 cm. long supported a weight of only j to 10 gm. The results gave:

$$G=6.64\times 10^{-8};\ \Delta=5.55.$$

Eötvös' Experiment. — (*Ann. der Physik und Chemie*, 59, p. 354, 1896.) In the course of investigations on local variations of gravity by means of the torsion balance, R. Eotvos devised a method for determining G somewhat like that used by Reich and Braun. Two pillars 30 cm. × 30 cm. × 60 cm. high were built up of lead blocks, the pillars being 30 cm. apart. The torsion balance consisted of a platinum wire suspension about 150 cm. long supporting a beam somewhat less than 30 cm. long with small weights at the ends and enclosed in a shallow double-walled brass case with the view to minimize convection currents. The balance beam was first set in the line joining the centres of the pillars and its time of vibration determined. It was then set with its length perpendicular to the line joining the centres of the pillars and the period of oscillation again measured. From these periods Eötvös was able to determine the provisional value,

$$G=6.65\times 10^{-8},\ \text{whence } A=5.53.$$

Heyl's Experiment.—(*U.S. Bureau* of *Standards Journal of Research*, vol. 5, p. 1243, 1930.) After a careful review of the work of Boys and Braun, Paul R. Hey! concluded that increased precision in the determination of G could hardly be expected of the direct deflection method, whereas, as stated by Braun, the possibilities of the time-of-swing method had not been fully utilized. In his repetition of the Cavendish experiment, Heyl therefore decided to use only the time-of-swing method. The apparatus was designed after the general pattern of Braun's but with a considerable increase in the attracting masses.

The torsion pendulum consisted of two small spheres, 50 gm. each, hung from the ends of a very light separator rod about 20 cm. long which in turn was supported from its ends by truss wires attached to a fine tungsten filament about 1 metre long which comprised the torsion suspension. A small mirror attached at the point of suspension in conjunction with a telescope and scale 3.5 metres distant permitted observations of the angular motion of the moving system. A motion of one minute of arc of the moving system was exhibited as a shift of about 2 mm. of the scale in the field of the telescope. The timing of the torsion pendulum was accomplished by manually keying the observed transits of the pendulum and thus recording them on a chronograph which also carried seconds signals derived from a Riefler clock rated daily against Naval observatory signals. By well-known methods the chronograph record was then used for accurate calculation of the timing of the torsion pendulum, reduced to zero-amplitude time.

The attracting masses used by Heyl were two 66 kg. steel cylinders mounted with axes vertical and suspended from a rotatable support such that the line forming their mass centres could be made coincident with the line of centres of the masses on the torsion pendulum or at right angles thereto (as in Eotvos' experiment). Clearly in the former position the gravitational forces add to the restoring force of the torsion wire and the period of the pendulum is a minimum. With the large masses at right angles to the axis of the pendulum the period is at a maximum. As might be anticipated, particularly in the "near" position, the attracting masses produce a nonuniform gravitational field and the pendulum oscillations are not strictly sinusoidal (nonisochronous), a detail which must be considered in timing the pendulum. It is of interest to note that as stated by Heyl, "the time of swing in the 'near' position was usually about 1,754 seconds and in the 'far' position about 2.081 seconds, and each could be measured to about 0.1 seconds. The difference, 327 seconds, formed the critical quantity of the whole measurement and may be presumed accurate to about 1 part in 3.300." The original intent was to time the pendulum photographically but because of optical difficulties reliance was placed on the manual observations.

Precautions were taken that all mass and length measurements were well within the tolerance required to assure that such quantities could not introduce errors in the derived value of G within say 1/10,000. The use of steel cylinders rather than the usual lead spheres was with the view to assure accuracy of measurement, uniform density and permanency of measured values at the cost of some inconvenience and mathematical labour.

Heyl used as masses on the moving system, gold, platinum and glass balls, but not with the idea of obtaining any different value of G due to difference in material. The original gold balls were found to absorb mercury from the trap used in the evacuating system, such that in a period of five months their weights increased from 49.1067 gm. by 0.1379 gm. To avoid this difficulty the platinum balls were coated thinly with lacquer. The glass balls were made of high-quality optical glass ground truly spherical. This material was selected because it would permit visual examination to insure perfect homogeniety of the mass.

The moving system was housed in an air-tight container exhausted to a pressure of about 2 mm. of mercury to decrease the damping and minimize convection disturbances. The lower portion of the housing containing the beam system was of soft iron material to shield the pendulum magnetically. This was required because the massive steel cylinders when moved from one to another of the two observation positions altered the earth's magnetic field. And while the small masses used on the beam were not of ferromagnetic material, they were either paramagnetic or diamagnetic and the resultant magnetic effect would be appreciable. The effectiveness of the magnetic shielding was tested by artificial magnetic fields before gravimetric observations were made.

In order to start the pendulum swinging for an observation, bottles of mercury served as portable masses which were moved manually and in resonance with the gravitationally induced swings of the pendulum until the desired amplitude of oscillation had been attained. Thereafter these masses were removed from the vicinity and because of the low damping, adequate amplitude remained for the duration of the observation.

The following data mere obtained by Heyl, the results using the gold balls having been corrected for an assumed steady rate of absorption of mercury.

Heyl preferred to weight the results with the gold balls at $\frac{1}{3}$ the neight given to the platinum and glass results and gives as a final value:

$$G=6.670\times10^{-8}\pm0.005.$$

Heyl and Peter *Chrzanowski Experiment.*—(*Jour.* of Research, *Nat'l. Bur. of Stds.*, vol. 29, RP 1480, p. 1, July 1942.) In view of the unexplainable inconsistencies in the several experiments of Heyl's 1930 work, it was repeated mith such improvements as were suggested by careful reconsideration of the details of the earlier experiment. Two improvements were found worthy of adoption: photographic recording, and a change in the position of the large attracting masses.

In the 1930 experiments the 66 kg. steel cylinders were arranged nith their axes vertical. In the later work the axes of these cylinders were laid horizontally. This simplified the measurement of distances and also eliminated some difficulties with slight departures from isochronism caused by the nonuniform field encountered by the pendulum when swinging with appreciable amplitude. In all other respects the general arrangement of the apparatus mas the same as in the 1930 experiments. The balls used on the torsion pendulum were of platinum and weighed about 87 gm. each. The suspensions used were of two kinds: ordinary commercial hard-drawn tungsten lamp filament, 0.0012-in. diam. of 288 gm. tensile strength, and a specially straight-drawn and annealed filament of 0.0014-in. dia. and 284 gm. tensile strength. As will be evidenced in the results, the hard-drawn filament was superior for this work. This may be explained by the statement taken from the paper, "The times of swing with the annealed filament were about 1,880 and 1,640 seconds in the 'far' and 'near' positions respectively, with a difference of 240 seconds. With the hard-drawn filament (smaller diameter), the times of sning were increased to 2,920 and 2,200 seconds, with a difference of 720 seconds. This three-fold increase in sensitivity nith the hard-drawn filament apparently overbalanced any slight advantage of stability on the part of the annealed filament."

The time standard used was derived from the bureau of standards' 100 kc. quartz oscillator precision standard and comprised light flashes at 5 sec. intervals obtained from a suitably slotted disk driven from the time source by a synchronous motor. By a suitable lens system the image of the signalling slit, after reflection from the mirror on the torsion pendulum, was focused on a photographic plate. As the pendulum swung an image was recorded on the plate every 5 sec. The distance from the mirror to plate was 490 cm. and a deflection of 1° at the mirror corresponded to a distance of 17 cm. at the plate. The sharpness of the lines recorded was such that 3 lines per mm. could be resolved by a low-power microscope.

The results of the observations were:

	Hard-drawn Filament	*Annealed Filament*
	$G=6\ 6739\times10^{-8}$	$G=6\ 6670\times10^{-8}$
	56	667
	69	703
	62	707
	51	680
Mean,	$G=6.6755\times10^{-8}$	$G=6.6685\times10^{-8}$

These data indicate that the results for the hard-drawn filament give a precision twice that obtained with the annealed filament. Weighting the results in proportion, the weighted mean is given:

$$G=6.6732\pm0.0031\times10^{-8}$$

and in view of the average departure from the mean appearing in the third decimal place, the final result:

$$G=6.673\pm0.003\times10^{-8}(\text{cm.}^3\ \text{gm.}^{-1}\ \text{sec.}^2)$$

The final result in the 1930 experiments was:

$$G=6.670\pm0.005\times10^{-8}(\text{cm.}^3\ \text{gm.}^{-1}\ \text{sec.}^3).$$

The authors conclude with the statement that "a carefully planned and executed attempt to increase the precision of the 1930 results has met with but slight success. The conclusion may be drawn that the limit of the possibilities of the torsion balance has been reached."

Zahradnicek's Resonance *Method.*—(*Phys. Zeits.*, vol. 34. p. 126, 1933.) In 1932 J. Zahradnicek introduced a modification of the torsion balance methods which shows considerable promise. His apparatus comprises two coaxial torsion balances. The outer or primary balance is a U-shaped beam supported at its midpoint by a steel suspension wire. At the lower terminals of the inverted U-beam, heavy lead weights are attached. The inner secondary balance is smaller and its axis is vertically below that of the primary balance. Its beam is a light horizontal bar mith small equal lead spheres at the ends and is supported at its centre by a fine torsion wire. The suspensions of the balances each carry a small mirror so that oscillations may be recorded photographically on a drum camera. The rest positions of the two balances are adjusted to be in the same vertical plane and each balance when displaced and released executes damped harmonic oscillations about the rest position. The balances are protected from air currents by a housing and, in addition, the secondary balance is shielded from air currents induced by oscillations of the primary balance by an inner housing of its own.

It will be evident that the two balances are coupled by gravitational forces and, in particular, the small secondary balance mill be markedly affected by the much larger primary balance. The experiment comprises the adjustment of the period of the primary balance until resonance occurs; that is, when the amplitude of the secondary compared with the primary is a maximum. The amplitudes and the logarithmic decrement of the secondary as determined by observing a number of turning points on the photographic record of the oscillations, together with measurable dimensions including the moment of inertia of the secondary balance and its period in the absence of the primary, permit calculation of G. The theory involves the complexities of coupled oscillators and may be obtained from the reference publication. The method appears to be capable of accurate results. Zahradnicek gives

$$G=6.659\pm.02\times10^{-8}.$$

Summary of Experimental Determinations of the Gravitational Constant *G*.—It is to be noted that in any experiment of class (1) or (2) as described above and involving a comparison of the earth's pull with the attraction of an artificial mass. the significant measurement involves a very small force superposed on the total attractive force of the earth. The experiment is therefore handicapped, so to speak, in the ratio of the radius of the earth to that of the artificial mass. That is, the apparatus must have a very high sensitivity indeed if the significant portion of the measurement is to have any reasonable degree of precision. Thus, while a modern spring gravity meter may be constructed to measure relative g within 10^{-8}, if used in an experiment of the type described by Poynting, the value of G could scarcely be determined within two significant figures. And while the use of natural rather than artificial masses may appear to offer possibilities, actually such determinations can hardly compete due to spurious effects caused by undeterminable nonhomogeneities in density distribution within the earth's crust.

Experiments in class (3), therefore. appear to offer the only promise of precision in determinations of G. Heyl and Chrzanowski made a serious attempt to push the precision of the Cavendish experiment beyond that of previous attempts and concluded that the gain was inappreciable. Perhaps Zahradnicek's resonance method is worthy of further careful instrumentation. The most significant experiments up to 1945 and their results were:

(1)	Boys—1895	$G=6.658$
(2)	Braun—1896	6.658
(3)	Heyl—1930	$6.670\pm.005$
(4)	Zahradnicek—1932	$6.659\pm.02$
(5)	Heyl and Chrzanowski—1942	$6.673\pm.003$

Since (3) and (5) showed the lowest probable error and selecting the latter as probably the best determination to date, we have

$$G=6.673\pm0.003\times10^{-8}\ (\text{cm.}^3\ \text{gm.}^{-1}\ \text{sec.}^{-2}).$$

Variations in *G*.—While theoretical considerations (Part I) show that the gravitational constant G is independent of the nature of material composing the mass, experiments have been made to test the universal applicability of the constant. Eotvos and others working with the torsion balance showed that when the nature of the attracting masses was varied over a wide range of substances, it was independent of the nature of the masses within the experimental error of $10^{-9}G$. The same work showed G to be independent of the chemical combination of the elements in the masses. Various experimenters have investigated the effect of anisotropic bodies, *i.e.*, the value of *G* remains independent of the direction of the crystallographic axes to within 10^{-9} G, the limit of experimental error. Herman Shaw has shown that within experimental error, any variation in *G* with temperature must be less than 2×10^{-6} G per degree C. Q. Majorana and L. W. Austin, and Thwing have investigated the effect of shielding layers of different media and obtained negative results. Thus in one case 5 cm. of lead interposed between the attractive masses produced no change exceeding 2×10^{-11} G. Accordingly, G may be considered a universal constant independent of the state or nature of the mass body (not to be confused with the relativistic change of mass with velocity).

MEASUREMENT OF THE INTENSITY OF GRAVITY

General **Considerations.**—Measurements of the intensity of gravity or synonymously, the acceleration of gravity, g, of the earth comprise a class of measurements of more practical significance perhaps than determinations of the gravitational constant G by methods already described. While equation (5.4) gives the theoretical intensity, g, at the surface of a homogeneous, nonrotating, spherical earth, the actual intensity at any point on the earth's surface departs considerably from the value so derived. Actually the value of g observed at any point at or near the earth's surface is the resultant of the earth's attractive force and the oppositely directed centrifugal force due to the earth's rotation. Therefore the value of g at the poles where centrifugal force is zero will be greater than at the equator where the rotational effect is a maximum. Moreover, g is modified by the shape of the earth and related factors. In particular, the earth's figure of equilibrium under the influence of gravitation and its own rotation is closely an ellipsoid of revolution, its minor axis through the poles being some 42.95 km. or 26.69 mi. shorter than the equatorial diameter. Normal gravity at sea level according to the formula of Cassinis, accepted as standard by the 1930 meeting of the International Union for Geodesy and Geophysics, is given by:

$$g_o=978.049\ (1+0.0052884\ \sin^2\phi-0.0000059\ \sin^2 2\phi)\ \text{cm./sec./sec.} \qquad (7.1)$$

where ϕ is the latitude of the sea-level station and the rotational and polar flattening effects are properly considered.

If, however, the station is at a height h metres above the sea-level datum because of the increased distance from the centre of the earth, normal g is given approximately by:

$$g_h=g_o-0.0003086\ h\ (\text{cm./sec./sec.}).$$

In geophysical literature unit g has been named the "gal" (after Galileo); 1 gal= 1 cm./sec./sec., or, 1 milligal (abbreviated mg.) =0.001 gal= 0.001 cm./sec./sec. It represents about 1×10^{-7} *g* and the notation mg. will be used in the remainder of this discussion. Thus the above elevation correction has a value of -0.3086 mg. metre or -0.09406 mg./ft. approximately.

However, the above simple formula or "free-air" elevation correction assumes that only free air occupies the space between the point of observation and sea level, the attraction of the mass of earth between the observation point and sea level being ignored. The additional correction for the attraction of this material is commonly called the "Bouguer" correction and, if the topography is fairly flat, is given quite closely by the attraction of an infinite slab of thickness h and density σ. The attraction of such a slab is

$$+0.04185\ \sigma h\ (\text{mg./metre})\ \text{or}\ +0.01276\ \sigma h\ (\text{mg./ft.})$$

and is to be added algebraically to the "free-air" correction. If the topography is irregular, additional "terrain" corrections are required which are too complicated for consideration here.

Now it will be evident that in calculating normal g on the basis of an ellipsoidal rotating earth with corrections for the effects of elevation above sea level and topography, it has been tacitly assumed that any density variations in the material below the selected sea-level datum are uniformly distributed as concentric shells comprising the earth's crust. Actually this is not the case and studies in isostasy (see GEODESY) indicate that significant lateral variations in the density of the crustal material persist to a depth, called the "depth of isostatic compensation" some 114 km. below the sea-level datum. Thus measurements of g at points on the earth's surface may differ by varying amounts from the value as calculated above for the idealized earth, and these differences or anomalies reflect the nonhomogeneous density distribution in the crustal material. If such nonhomogeneities did not exist, an equigravity surface would everywhere be parallel to the sea-level datum. Hence in modern geodetic studies involving gravity observations covering large areas, the observed values are compared with theoretical values only after suitable isostatic corrections have been made in addition to the more obvious elevation and topographic corrections. (William Bowie, *Effect of Topography and* Isostatic Compensation *upon the Intensity* of Gravity, U.S. Coast and Geodetic Survey, Special Publ. No. 12, 1912.) When such complete corrections are included, the residual anomalies are relatively small as illustrated by the fact that out of 122 scattered stations in the United States the *maximum* residual anomalies are about ±60 mg. with a very localized area near Seattle, Wash., having the unusual residual of -95 mg. Doubtless such values may be considered representative of the order of magnitude that may be observed generally over the entire earth. And since with few exceptions these maximum residuals amount to say ±50 parts per million of total *g* and in general are far less, a high degree of isostatic adjustment within the earth's crust is indicated. Indeed, as stated in the above reference, gravity observations in the United States "indicate that the excesses or deficiencies of mass represented by the residual gravity anomalies correspond to a mass excess or deficiency averaging about 630 ft." However, it is to be noted that these conclusions refer to averages. Actually individual areas may show anomalies far in excess of these figures and it has been shown conclusively that some regional anomalies are closely related to regions of abnormal tectonic activity in the earth's crust and that local anomalies are definitely related to local density variations associated with geological features.

Evidently the intensity of gravity varies in anomalous fashion over the surface of the earth. The anomalies of a regional nature are associated with broad-scale isostatic, tectonic and geological factors and even possible departures from the assumed ideal shape of the earth. Herein lies the interest of geophysicists and geodesists (see GEODESY) in regional and world-wide gravity data. On the other hand, in addition to this somewhat academic value, a very practical interest exists in the local gravity anomalies resulting from the perturbations superposed on the regional gravity field as a result of density variations associated with the more superficial geologic features. It is the relation of such local gravitational anomalies to structural geology that has given rise to an important application of gravity measurements in the field of exploration geophysics, particularly as applied to petroleum exploration. The very considerable economic importance attached to the latter has resulted in the expenditure of great effort and vast sums in the development of gravimetric methods and in extensive and detailed surveys in known and potential petroliferous areas. Indeed, it may be said that the most significant advances in instrumentation have been made in this field since such methods were first applied on a large scale for exploration purposes about 1923.

Methods of Gravity Measurement. — Measurements of the intensity of gravity may be divided into two classes: (1) absolute, and (2) relative gravity. As will be evident later, and in common mith all absolute measurements of forces or similar quantities, the precision attainable in absolute gravity measurements is considerably less than in the case of relative measurements. Fortunately, from a practical viewpoint the relative method is adequate for the purposes desired and moreover its precision increases somewhat in proportion as the areal extent of the desired survey decreases. Thus while a precision of say 2×10^{-6} g may be adequate to define semiregional anomalies, for exploration purposes involving very local and hence very minute variations, relative measurements within 10^{-7} or even 5×10^{-8} g are required.

Absolute Gravity Measurements. — Measurements of the intensity of gravity have long been made by means of the pendulum and prior to the middle of the 18th century a small weight suspended by a thin thread was usually employed. The length was adjusted so that the pendulum oscillated a little faster or slower than the escapement of a chronometer-type clock and accurate comparisons of the period of the pendulum with the gravity-independent timing of the clock were made by the method of coincidences. Assuming the pendulum bob to be a point mass and its support a weightless thread, the relation between its period T and the intensity of gravity g, when oscillating with an infinitesimally small amplitude, is given by

$$T=2\pi\sqrt{l/g} \text{ or, } g=4\pi^2 l/T^2. \quad (8.1)$$

However, any practical pendulum comprises some form of rigid rod carrying a supporting axis, usually a knife-edge, at one end and perhaps a mass or bob at the other end. For such a compound pendulum equation (8.1) becomes:

$$T=2\pi[(K^2+l^2)/lg]^{\frac{1}{2}} \quad (8.2)$$

where K is the radius of gyration of the whole pendulum about its centre of gravity, and l is the distance from the knife-edge to the centre of gravity of the pendulum.

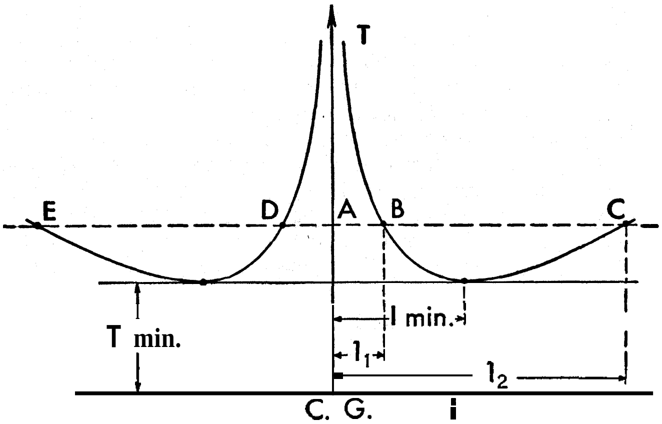


FIG. 3.— CHARACTERISTICS OF COMPOUND PENDULUM. PRINCIPLE OF "MINIMUM" PENDULUM (EFFECTIVE LENGTH=RADIUS OF GYRATION)

In the design of pendulums for gravity measurements it is important to look further into the properties of the compound pendulum. If a rigid rod be equipped so that the length l between the centre of gravity of the rod and the knife-edge may be varied over a wide range, the period T of the pendulum will be related to l as shown in fig. 3. Thus it will be found that there are two values of 1 when the point of support is on the same side of the centre of gravity, for which the period of oscillation is the same: points B and C at l_1 and l_2 respectively. The period of such a pendulum is given by

$$T=2\pi[(l_1+l_2)/g]^{\frac{1}{2}}. \quad (8.3)$$

On the other side of the centre of gravity there are two other points D and E for which the period is the same. $AD=AB=l_1$, and $AE=AC=l_2$. Also $CD=BE=(l_1+l_2)$. Thus C and D are two points, unsymmetrically placed with respect to the centre of gravity, whose distance apart is equal to the length of a simple pendulum whose period of oscillation is the same as that of the compound pendulum. This relation holds even though the pendulum is not a uniform bar.

Kater's *Pendulum* for *Measurements* of *Absolute g*.—The best method known for absolute determinations of g involves the above properties of a compound pendulum. This was suggested by Gaspard de Prony (1800), by J. G. von Bohnenberger (1811) and by Capt. Henry Kater (1817). Kater was probably the first to make pendulums to which equation (8.3) could be applied precisely.

About the year 1818 Kater employed the invariable pendulum for determining the variation in g at the principal stations of the Trigonometric Survey of Great Britain. (Phil. Trans., p. 337, 1819.) The pendulum comprised essentially a rod fitted with two knife-edges at opposite sides of the mid-point and so adjusted that the period of oscillation was the same about both of them. When this adjustment had been made the distance between the knife-edges was equal to the length of a simple pendulum of the same period (equation [8.3]). Thus the absolute value of g could be determined from the period of oscillation and measurements of the distance between the knife-edges.

Kater's pendulum still remains the best method of measuring the absolute value of g, since the measurement of the distance between its knife-edges is a relatively simple problem. In a later form Kater's pendulum comprises a metal bar carrying two fixed knife-edges. These are set facing each other on opposite sides of the centre of gravity of the bar and serve as axes of oscillation. On the bar are also mounted two masses, one of which is much larger than the other. By adjusting the position of the larger mass the period of oscillation about the two knife-edges is easily made approximately equal. The small mass can then be adjusted until the difference of the two periods is arbitrarily small. With this form of pendulum equation (8.3) still applies and the distance between the fixed knife-edges is the only measurement, other than the period of oscillation, required to determine g. There are, however, certain corrections required if very accurate determinations are to be expected and since similar corrections are required in all types of pendulum measurements the factors involved are given here.

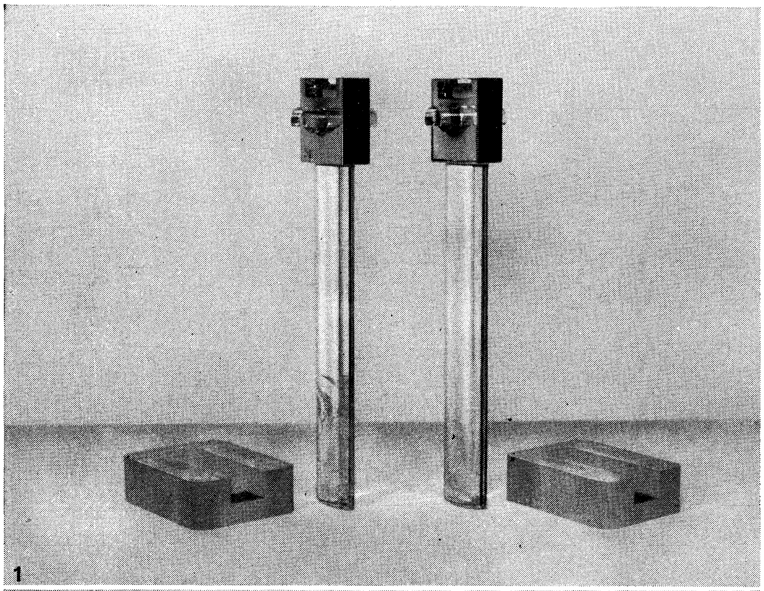
(1) *Amplitude.*—The amplitude of the actual oscillations are not infinitely small as required of the simple pendulum theory and the period T must be corrected to zero amplitude.

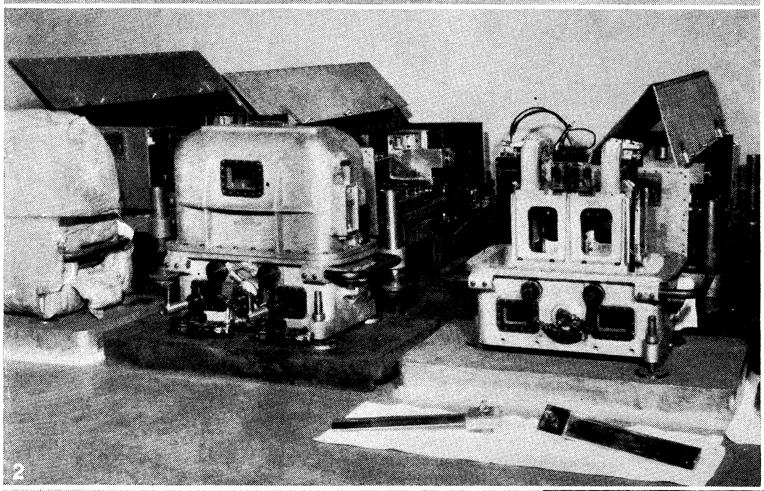
(2) Buoyancy. — The pendulum swinging in air is buoyed up by the mass of air displaced. Evidently this buoyancy is equivalent to a reduction in g acting on the pendulum and the result must be corrected accordingly.

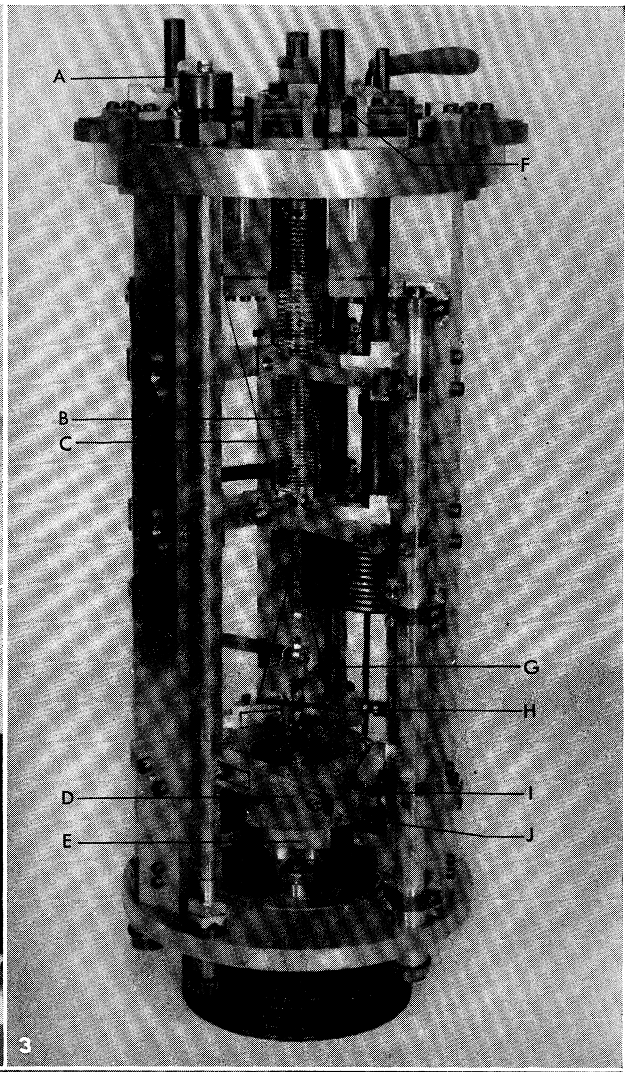
(3) *Aerodynamic.*—The pendulum drags a certain amount of air along with it in its motion and the increased effective mass thus produced increases the moment of inertia and hence the period of the pendulum. For a Kater-type pendulum it can be shown that this correction is zero if the external form of the pendulum is symmetrical about its mid-noint. the knife-edges heing placed equidistant from the centre of its geometrical figure though not its centre of gravity (c.g).

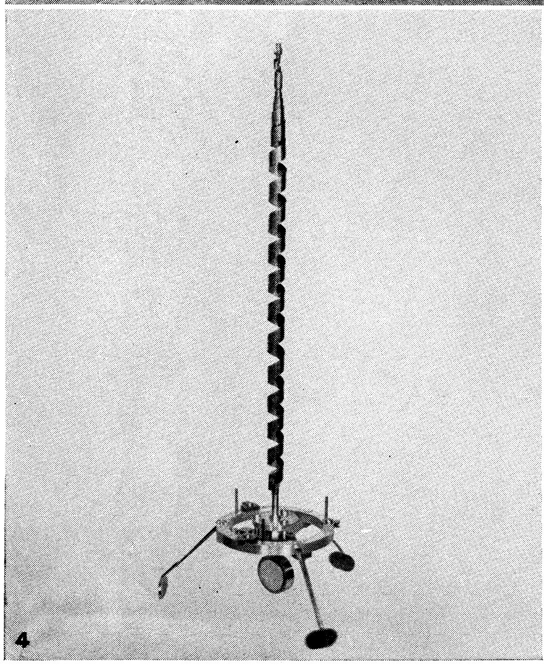
(4) Damping. — The viscous resistance of the air as well as energy dissipation at the knife-edge causes a damping of the pendulum oscillation which increases its period slightly as in all oscillating systems. This effect may be introduced along with the amplitude correction if the initial and final amplitudes are carefully observed.

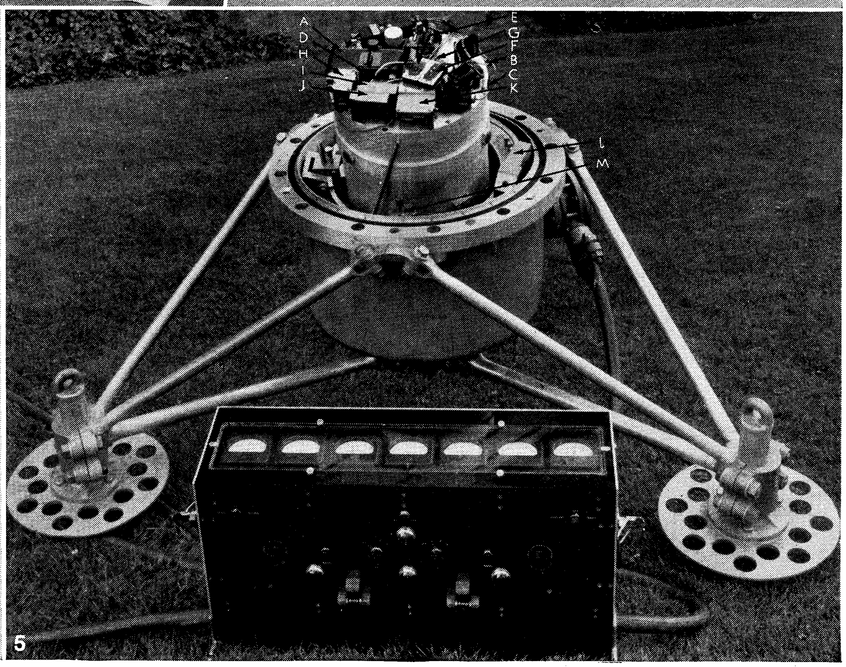
(5) Temperature. — Temperature changes will change the length of the pendulum in accordance with the thermal expansion co-











GULF RESEARCH AND DEVELOPMENT CO.

1. Gulf "minimum" pendulums. 2. Pendulum equipment for geophysical exploration. 3. Portable bifilar gravimeter: A. clamp control; B. Spring tension supports most of mass, torsion opposes bifilar torque; C. Bifilar suspension, drawn in to make visible; D. Ciamp arm; E. Mirror on moving system; F. Torsion head adjuster; G. Calibrating weight; H. Main mass; I. Ligament operating clamp arm; J. Damping magnet. 4. Hoyt gravimeter moving system. Ribbon-type supporting spring converts vertical displacements of mass to angular deflections. 5. Underwater gravimeter: A. Recording camera; B, C. Light sources for level units; D, E, F, G. Photovoltaic cells for level indications; H, I. Gear box and motor for film drive; J, K. Motor and gear box for clamping device; L, M. Remotely controlled levelling motors

efficient of the pendulum material.

(6) Sway of Support.—The supports on which the knife-edge rests will yield very slightly to the horizontal forces imposed by the swinging pendulum. Since the sway will be in phase with the pendulum oscillations it will be seen that the sway effect is analogous to a slight increase in the effective length of the pendulum and increases its period. In practical cases the sway may be measured by means of an optical interferometer or computed from the known mass of the pendulum, its amplitude, and the resilience of the knife-edge support as measured by an interferometer when a known horizontal force is applied at the support.

(7) Rounded Knife-Edge.—In theory, the knife-edge is assumed to be infinitely sharp. Actually it must have, effectively, a slight radius of curvature. As a result the pendulum swings on a "rolling" contact which tends to shorten the period. In the case of Kater-type pendulums, this correction is avoided if the radii of curvature of the two knife-edges are equal.

In practical cases, amplitude corrections (1) are minimized by holding the amplitudes to small values—but they must be measured. The buoyancy, aerodynamic and damping corrections (2, 3, 4) are minimized by swinging the pendulums in an evacuated case at relatively low air pressure (about 4 mm. Hg.). Temperature effects (5) are minimized by the use of material having low thermal expansion coefficients and by controlling the temperature. The sway of the support (6) can not be eliminated when swinging a single pendulum though it may be minimized by the use of a very rigid support for the entire pendulum case.

Relative Gravity Measurements—Pendulum Equipment.—Geodetic and geophysical problems concerning gravity may be adequately studied by means of relative measurements since only the differences in gravity at various points on the earth's surface are required with a high degree of accuracy, while the absolute numerical value is of secondary importance. Fortunately such relative determinations may be made with considerably higher precision than absolute measurements with the Kater pendulum. Thus a notable advance in gravimetric apparatus was made in 1882 when Von Sterneck introduced the quarter-meter invariable pendulum, which beat half-seconds (period = 1 sec.). Its compactness made it more practical to minimize some of the extraneous disturbances than was the case with more cumbersome apparatus. Moreover the pendulum itself, having no adjustable parts, was more rugged, and by virtue of the method of operation, length measurements were eliminated.

In principle, the period of an invariable (fixed length) pendulum was determined at a base station at which the absolute value of g had previously been determined by the Kater method. Using this period as the standardized value, and assuming that the pendulum remained fixed in length, observations were then made at other stations and any change in period observed was assumed to be due to a change in g as compared with the value at the base station, in accordance with equation (8.1). In effect the value of g at the base station is-transferred to the new stations and this transfer is effected with a higher precision than would ordinarily be obtained by a repetition of the Kater pendulum work at the new locations. For this reason all geodetic and related gravity pendulum observations are made by relative measurements using this principle.

Available information to date indicates that perhaps the most accurate pendulum measurements of relative g have been made with apparatus designed for use in geophysical exploration. Since this equipment incorporated all of the refinements developed during the period from Von Sterneck's day to about 1936 when other instruments replaced the pendulum, a brief description of this equipment should present an adequate outline of modern gravity-pendulum equipment.

Minimum Pendulums.—Referring to fig. 3 showing the properties of a compound pendulum it will be noted that at a certain length $l_{min.}$, the pendulum has a minimum period and any change of the length in either direction results in an increase in period of oscillation. Practical use of this property is made in the construction of an invariable pendulum by so designing it that the knife-edge is located at the point l_{min}. Because of the slow change in slope of the T vs. l curve on either side of the minimum point, such a pendulum will be far less sensitive to slight changes in l, caused by wear or inadvertent slight shifts of the knife-edge position, than is the more common pendulum comprising a heavy weight on a relatively long staff. It may be shown that this condition is realized when the distance from the knife-edge to the centre of gravity of the pendulum is equal to its radius of gyration about an axis through the c.g. and by suitable measurements this adjustment may be attained with adequate precision. (For theory see O. Meisser, *Zeitschr*. f. Geophysik, vol. 6, pp. 1–12.) However, this device does not eliminate certain other variables which may appear to be equivalent to a physical change in l_{min}.

Since changes in temperature will change the length of a pendulum in accordance with its thermal coefficient of expansion, a material having a very low coefficient is desired. Early pendulums were made of brass, probably to eliminate magnetic effects and because no superior nonmagnetic material was then available. Later invar, a relatively nonmagnetic nickel-iron alloy having a low thermal coefficient of expansion, was used. However, while its expansion coefficient is about 1×10^{-6} compared with about 18×10^{-6}/C.° for brass, the magnetic effects are not negligible and it is somewhat unstable physically, as evidenced by sudden unexplainable shifts in period. Fused quartz. having a thermal expansion coefficient of 0.25×10^{-6}/C.° is the most suitable material to minimize temperature corrections and is extremely stable physically. These desirable properties outweigh the disadvantages both of difficult fabrication and low density which decreases the energy of the swinging pendulum with a resultant increase in damping.

Such minimum pendulums designed for geophysical exploration are shown in Plate, fig. 1. They are about 30 cm. long, weigh 590 g. and have a period (complete oscillation) of approximately 0.89 sec. They are ground from a single piece of fused quartz except for the fused quartz plugs that form the knife-edges. These one-piece plugs, with a suitable ground and polished knife-edge, closely fit and are cemented in a hole in the head of the pendulum. Massive blocks of Pyrex glass with the top face ground and polished to an optically flat surface constitute the knife-edge supports or bearings. A conical centring hole is ground in the bottom face at one end of the knife-edge plug and with a V-groove at the other end, means are provided whereby two ball-point supports on a lifting device insure that the knife-edge is always returned to exactly the same spot on the flat supports. Since the pendulums must be lifted and clamped for transportation, after the centring lift-device has carried the knife-edge off the support, a secondary lifting device engages the bottom of the pendulum while the upper end enters a suitable socket whereby the pendulum is firmly clamped while the knife-edge plug is relieved of any load.

The adjustment of the K = l relation required of a minimum pendulum is attained with sufficient accuracy by preliminary adjustment of the design of a homogeneous metal pendulum and duplicating this replica in the quartz. Matching of the periods of a pair of pendulums to high precision as required in two-pendulum apparatus may be accomplished by grinding material from the lower end of the slow pendulum. Those of Plate, fig. 1 are matched within 2×10^{-6} sec.

Modern pendulum apparatus uses a pair of pendulums swinging with equal amplitude and 180° apart in phase, the matching of their periods being sufficiently accurate to assure that the phase opposition will be retained within sufficient tolerance for a run which may be for an hour's duration. This method of operating a pair of pendulums in phase opposition accomplishes two important results: (1) The horizontal acceleration imposed on the support by one pendulum is balanced by an opposite acceleration of the second pendulum thus eliminating the cause of sway and the sway correction which normally is very important but difficult to ascertain. (2) It permits elimination of the perturbations in phase and hence the periods of the pendulums caused by extraneous horizontal accelerations of the support such as seismic or similar random disturbances which may not average out over the duration of a run. Because any horizontal acceleration imposed on the support and advancing the phase of one pendulum will retard the other, the average of the two periods will be equivalent to a "fictitious" pendulum whose period is unaffected by the disturbance. ("Observations de pendule dans les pays bas," F. A. Vening-Meinesz, Pub. de la *Commission Geodesique Neerlandaise,* p. 12, 1923.) By recording each pendulum separately, the magnitude of any disturbing seismic effect may be observed while permitting its elimination by averaging the two periods.

The details of the remainder of the pendulum apparatus will depend upon the method of operation. In the exploration equipment two pendulums are mounted in a vacuum-tight cast-aluminum case. Clamping, starting and stopping of the pendulums are all done from the outside through vacuum-tight stuffing boxes without disturbing the vacuum. The cases will normally maintain a 0.1 mm. Hg, vacuum for months without pumping out. The case is surrounded by a net of electric heating nires and is covered completely by a thick eiderdown cover. A suitable thermostat controls the portable battery power to the heater and maintains the case within 0.1° of a fixed temperature some few degrees above the highest ambient temperatures encountered. By careful attention to these details the magnitude of corrections may be minimized and particularly, by keeping the operating conditions very nearly constant, variation of the corrections, which is the most troublesome factor in relative measurements, is thereby minimized. As a further example, amplitude corrections may be eliminated by always starting the pendulums at the same amplitude through careful maintenance of the adjustment of the operating levers, and with constant pressure in the case, the decrement is quite constant so that final amplitudes are the same from one run to another. The pressure is indicated by a suitable low-pressure gauge and an efficient drying agent in the case assures that no density changes result from humidity variations. Electrostatic charges on the pendulums which may be very serious because of frictional effects in the padded clamping device are completely eliminated by the ionizing effect of a small amount of radioactive material in the case.

Associated with the pendulum apparatus itself is the recorder equipment which, again, may depend on the method of operation. In the exploration equipment the recorder contains a small straight filament lamp to serve as a light source from which a beam of light passes into the pendulum case. This beam is divided into two beams, each of which is reflected four times from the faces of the two pendulums and a set of fixed mirrors. Finally the two beams are returned to the recorder where they fall on a moving photographic tape. The tape also records light reflected from two oscillograph elements. One of these is used for recording radio time signals and the other for recording a 500-cycle A.C. reference trace obtained from an electrically driven tuning fork. This joo-cycle trace serves to subdivide the second signals so that the transit of a pendulum through its equilibrium position and its phase with respect to any given time signal may be measured within about 0.0001 sec. regardless of slight variations in tape speed. A few seconds' running of the tape suffices to establish the phase of the pendulums with respect to an initial time signal and at the end of the run, say an hour later, another few seconds of recording provides the phase positions at the final signal. The periods of the pendulums are known accurately enough so that the number of whole swings in the run can be determined from the number of seconds (measured with a chronometer) between the starting and ending time signals. The fractions of a swing are obtained accurately from the tape measurements. Thus the measurements give for each pendulum the total number and fractions of swings over the interval of the time signals. With a reading error of the order of 0.0001 sec. it is not difficult to attain an observational accuracy of about 1 part in 10,000,000 for a run of 30 minutes' duration.

Evidently, if the above time signals are derived from a standard clock of high precision or from a modern crystal controlled clock, the periods of the pendulums and their average or "fictitious" pendulum period may be determined with high precision. Since the pendulums are assumed to be invariable, any changes in period from one point of observation to another are assigned to variations in g in accordance with equation (8.1) which may be written in the form

$$T=K/\sqrt{g} \text{ or } g=K^2/T^2$$

where K is a dynamic constant of the fictitious or average pendulum. It will be understood hereafter that in a two-pendulum apparatus the pendulum period T refers to this average. Then if T_0 is the period of the pendulum at the base station where gravity has the value g_0 and T_1 is its period at a field station of value g_1:

$$g_0= K^2T_0^{-2} \text{ and } g_1=K^2T_1^{-2},$$

and in the ratios,

$$g_0/g_1=(T_1/T_0)^2 \text{ or } g_1=g_0\left(\frac{T_0}{T_1}\right)^2,$$

the dynamic constant of the pendulum, being invariable, drops out. It will be noted that the periods enter as the square, hence the timing of the pendulums must be twice as good as the desired accuracy in the gravity differences.

For geophysical work it has been found convenient to use two or more identical pendulum units. In such operation one set of pendulums is operated at the base station where it is used in place of the above-mentioned standard clock. It is then only necessary to transmit suitable start and finish time signals which are recorded simultaneously at all stations. The number of swings of all pendulums over the identical time interval recorded on the several tapes may then be determined very accurately. The ratio of total swings of each pendulum to every other one is first determined with all pendulums operating at some base station. These ratios comprise the standardization of the pendulums. Thereafter when the pendulums occupy different stations during an observation, the changes in ratio of total swings, which ratios are independent of the absolute time involved, are assigned to the gravity differences between stations. Modern pendulums operated in this manner and in routine field work on stations separated up to 50 mi. have given probable errors of a single observation averaging about 0 25 mg. The customary duration of such observations was 30 min. With special care, as in establishing calibration stations for gravity meters, probable errors as low as 0.10 mg. (1 part in 10,000,000 of total g) have been attained. With similar equipment and the exercise of proper caution in handling it, somewhat comparable accuracy should be attainable on more widely separated stations. Several units of such exploration equipment including recorders are shown in Plate, fig. 2.

Gravity *Measurements* at Sea.—The success of the two-pendulum method of operation in the gravity surveys on unsteady terrain in the Netherlands led Frederik van Iterson, director of the Dutch government mines, to suggest to F. A. Vening-Meinesz the practicability of pendulum observations for gravity measurements at sea. In 1923 preliminary experiments in a Netherlands navy submarine showed such promise that extensive surveys nere planned and actually carried out. (F. A. Vening-Meinesz, Gravity *Expeditions* at *Sea, 1923–30,* Pub. of Netherlands Geodetic Commission, 1932.) This work, carried out in a submarine, established a belt of stations encircling the earth in a belt between 10°–40° N. latitude together with an extensive network of stations in the Netherlands Indies area. The accuracy of these stations, as given in the Vening-Meinesz report, was about 3 to 4 mg.

The apparatus used comprised essentially the twn-pendulum method although the older Yon Sterneck type bronze pendulums were used instead of the minimum period type already described. Two pairs swinging in planes go° apart were actually used instead of one pair. Also the recording was continuous against chronometers which were rated daily against radio time signals. The entire pendulum apparatus including the recorder was mounted in gimbals to minimize disturbances due to tilt of the submarine. In quiet harbour waters observations were made with the craft surfaced, but in the open sea observations were generally made while submerged at sufficient depth to minimize wave action.

It is of interest to note that gravity observations made from a moving craft must be corrected for the Eotvos effect, *i.e.,* the eastward speed of the craft adds to the earth's centrifugal effect while a westward component subtracts. Vening-Meinesz checked the underwater speed of the submarine from time to time by making an observation with eastward speed and again westward. The difference in the observed g gives twice the Eotvos effect. Thus he records Obs. No. 185—speed 3.7 knots, Obs. So. 222—speed 3.8 knots. He estimates the error in g due to uncertainty of speed and estimated ocean currents as about 2 mg. at the equator. At higher latitudes it would be multiplied by the cosine of the latitude.

Measurements of gravity from a ship at sea are handicapped not only by the horizontal accelerations but particularly by vertical accelerations of the apparatus. Theoretically the two-pendulum method is capable of eliminating the horizontal components of acceleration provided they are not of sufficient magnitude to cause skidding of the knife-edges. However, any vertical accelera-

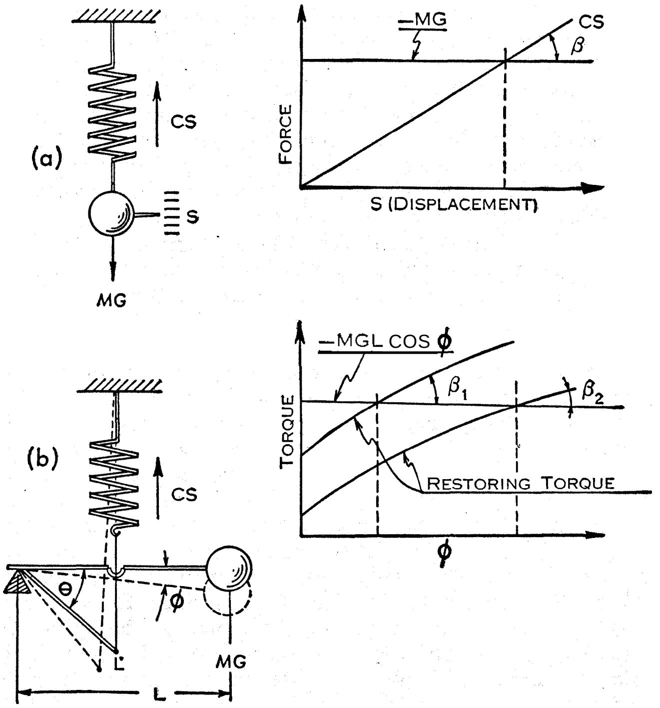


FIG. 4.— PRINCIPLE OF UNASTATIZED (A) AND ASTATIZED (B) GRAVIMETERS

tions are exactly equivalent to changes in the earth's gravitational acceleration and are measured as such with any gravity-measuring equipment that can be devised. On the other hand, over a sufficiently long period of time the up-and-down wave motions are of equal magnitude since the surface of the water maintains its average elevation. Hence to the extent that the up-and-down accelerations are averaged out, *i.e.,* integrate to zero over the duration of the observation, the resultant g will be free from motional acceleration errors. It is for this reason that to date the pendulum method as used by Vening-Meinesz constitutes the most accurate method yet devised for observations at sea. Any direct-reading gravity meter such as will be described later would have to be equipped with an accurate continuous integrating device whereby 'the indicated g would represent an average value over a sufficient interval of time to assure that the residual vertical motional acceleration was of negligible magnitude.

Relative Gravity Measurements by Gravity Meters.— The gravity meter or gravimeter is simply a spring balance comprising a constant mass supported by a spring system, the changes in elongation of which may be read with precision.

The total elongation S of a spring supporting a weight mg is

$$S=mg/c$$

where c is the spring constant or force per unit elongation. Since over any reasonable range a spring follows Hooke's law, the system is linear and any change in g is accompanied by a proportional change in elongation, S. The proportionality factor or sensitivity is m/c, *i.e.,* the ratio of the mass to the spring constant, and hence we may say that in such a simple spring gravimeter the sensitivity is proportional to the initial elongation of the spring.

The practical applications of gravimeters require an instrument capable of detecting differences in g of 0.1 mg. or less, and since such differences are unalterably superposed on a total g of some 980,000 mg., the instrument must have sensitivity of at least 1/10,000,000 g. That is, a simple gravimeter comprising a spring with a mass at the lower end and having an initial elongation of, say, 10 cm., would exhibit a change in gravity of 1 mg. as a change in elongation amounting to 1×10^{-6} cm. or about 1/50 the wave length of visible light. This example suffices to illustrate the magnitude of the sensitivity requirements.

On the basis of the means used for measuring these minute changes, gravimeters may be separated into two broad classes, (1) unastatized or stable type, (2) astatized or unstable type. In principle these two types are illustrated in fig. 4. Here at (a) is shown schematically the simple unastatized system. The accompanying force v. displacement diagram shows the constant downward force due to the weight mg and the upward restoring force CS of the spring, proportional to displacement. Obviously, the equilibrium displacement of the spring will be at the intersection of the two force curves and the sensitivity of the system will increase as the angle β decreases, a result which, because of the linearity of the curve CS, can be accomplished only by increasing the length and the equilibrium elongation of the spring if the spring loading is to be held within tolerable limits. This provides a direct-deflection instrument with a linear scale over any range of gravity, and a calibration constant which is a function only of the spring constant and the suspended mass regardless of any operational adjustments. However, as already outlined, such an instrument must be provided with a high order of mechanical and optical magnification to permit accurate measurement of the small deflections due to the small changes in gravity to be detected.

On the other hand, fig. 4 (b) illustrates the principle of astatization and the resulting torque v. displacement characteristics. Here the moving system comprises an arm hinged at one end and carrying a weight mg at the other end. With the spring attached to the weight arm, the system would have characteristics similar to the unastatized system (a). But the spring is attached to a lever arm L' at an angle θ with respect to the weight arm L and if the angle 0 is quite large the spring restoring-torque curve becomes strongly nonlinear. A similar effect results if the spring is attached to the weight arm L but its upper support is moved to the left so that its force is applied at an angle 0 to the moving arm. Now by adjustment of the system such as a change in the angle θ, the restoring torque curve may be made to have any desired characteristic intersecting the gravitational deflecting torque curve with angles β_1, β_2, or even vanishingly small angles. Thus angle β may be made arbitrarily small and the sensitivity arbitrarily great, up to the point of instability when $\beta=0$. By devices equivalent to fig. 4 (b) it is possible to simulate the behaviour of extremely long springs and thereby attain very high sensitivities. However, it is evident that with each change in adjustment the sensitivity and hence the scale value of such an instrument will be changed. Moreover, even for a fixed adjustment, if the astatization is pronounced the nonlinear feature precludes a strictly linear scale. This practically dictates the design of a null rather than a direct-deflection type instrument. Thus in astatized types a very fine auxiliary spring with linear restoring-torque characteristics is used to bring the moving system back to a fixed zero, this auxiliary spring having a linear scale calibrated to read gravity changes. Since the range of such an auxiliary scale may be limited, special provision must then be made to cover wider ranges.

Numerous embodiments of the astatizing principle are represented in a wide variety of gravimeter designs, a few of which have been developed into commercially successful instruments. It is of interest to note that some of these are basically vertical seismographs, since the sensitivity problems are identical, the gravimeter requiring high sensitivity to the steady acceleration g, while a vertical seismograph must record the periodic motional accelerations associated with seismic waves. It is pertinent to consider the relation between the sensitivity of a gravimeter and its period.

As already mentioned, the elongation S of a spring supporting a weight mg is

$$S=mg/c$$

where c is the spring constant or restoring force per unit elongation. The period of the same system. vibrating in simple harmonic motion is

$$T=2\pi\sqrt{m/c}.$$

From these two equations

$$S=gT^2/4\pi^2$$

and the elongation δS due to a change in gravity δg is

$$\delta S=\delta g T^2/4\pi^2.$$

Thus for a simple unastatized gravimeter the sensitivity is proportional to the square of the period.

The same considerations apply to the astatized type except that in all such instruments the geometry of the system permits adjustment of the effective spring constant to arbitrarily small values so that the period and sensitivity are correspondingly increased. Consider, for example, the elemental spring balance previously mentioned, having an initial displacement of 10 cm. and a sensitivity of 1×10^{-6} cm. per 10^{-7} g. The period of the system, fig. 4 (a) would be approximately 0.63 sec. Now to obtain an increase in sensitivity of 100-fold the astatizing device of fig. 4 (b) may be adjusted to a period of 6.3 sec., assuming the rotational moment of inertia of the beam system to be negligible. With such an adjustment the instrument simulates the performance of an elemental balance having an initial equilibrium elongation of the spring of about 1,000 cm. and yet the actual elongation need not exceed a few centimetres. Evidently the mechanical or optical magnification required in an astatized system, to obtain adequate gravimetric sensitivity, decreases with the degree of astatization. The practical limits are determined by the attainable stability of the adjustments. Clearly the astatized instruments represent a very attractive design from the viewpoint of attaining adequate sensitivity for portable instruments.

Attention is again called to the fact that the gravimeter and the seismograph are both acceleration-sensitive devices and moreover the sensitivity criterion of both instruments is identical—a long period. Since g represents a steady state vertical acceleration while seismographic disturbances are periodically varying accelerations having strong vertical components, a gravimeter having low seismic sensitivity without sacrifice of gravimetric sensitivity must incorporate a very low frequency filter between the moving system and the indicating device. In most devices this is wholly impractical and in any type the best that has been done is the elimination of high-frequency microseismic disturbances with some suppression of the long-period (10–20 sec.) earthquake waves. Thus no gravimeter has yet been designed that permits operation during earthquake disturbances and for this reason field operations may be effectively shut down for periods of many hours during which these transient accelerations far exceed the required gravimetric reading accuracy.

These considerations serve also to indicate the problem involved if direct-reading gravimeters were to be used on unstable supports such as ships or aircraft. Such use would be practicable only if an integrating device could be incorporated in the design so that the periodic vertical accelerations of the support could be averaged out over sufficiently long periods to assure that no residual unidirectional motional accelerations were included in the readings. And as an illustration of the minuteness of the accelerations involved, assume an aircraft sufficiently stable to permit the operation of a gravimeter in flight. Then a continuous unidirectional vertical acceleration sufficient to produce a total change in elevation of the aircraft of about 20 ft. in one hour would show on the gravimeter as a spurious reading of 10^{-7} g. Moreover the 20 ft. change in altitude itself would result in an actual change in g, or elevation effect, amounting to about 1.9 mg. or 1.9×10^{-6} g. Thus the impracticability of operating high-precision gravimeters on unstable vehicles while in motion is clearly indicated.

Design **of** Gravimeters. — The practical design of high-sensitivity gravimeters involves the following most serious problems: (1) The spring material must be stable so that creep rates and hysteresis effects are small. (2) Disturbances due to thermal effects may distort the system and modify the adjustment. Also changes in temperature will affect directly the spring displacement depending on the thermal coefficient of elasticity of the spring material. Nonuniformity of the temperature within the housing may create disturbing convection currents in the air resulting in spurious forces on the moving system. (3) The level sensitivity of the system must be carefully considered since the level tolerances for a given gravimetric sensitivity may be unattainable with any practical levelling device. (4) The moving system must be adequately damped if used for field observations and to minimize fluctuations induced by seismic disturbances. (5) Sensitivity to atmospheric pressure changes resulting in changes of buoyancy of the air must be eliminated by sealing the instrument against pressure changes. (6) Sensitivity of the instrument to magnetic fields due to ferromagnetic properties of the spring material should be eliminated.

Secrecy concerning the design details of many of the most modern gravimeters used in geophysical prospecting preclude a comprehensive outline of the expedients used in solving the above problems. In general, however, the following outline covers the subject broadly.

Spring Material. — The excellent mechanical properties of fused quartz have led to the use of this material in some instruments both in the form of helical springs or torsion fibres though its thermal coefficient of elasticity is relatively high. However, most commercial instruments use metal springs and certain nickel-chromium-iron alloys have excellent characteristics when properly cold-drawn or rolled, and heat treated. They are sufficiently magnetic to make shielding desirable in some designs. The creep of some of these alloys under load may be made very small by proper adjustment of the loading of the spring. The hysteresis effects resulting from changes in elongation of the spring are minimized by designing the weight-clamping device so that the spring displacement is always substantially constant. In many gravimeters this clamping means holds the weight in a fixed position within a few ten-thousandths of an inch.

Temperature Effects. — Practically all field instruments are provided with thermostatically controlled heaters to maintain the temperature at some fixed value above the ambient temperature. Such controls may inhibit short-period temperature fluctuations within 0.001°C. Because temperature changes may affect the instrument operation due to several causes, control of the temperature appears more practical than methods of compensation although reasonable diligence in providing such compensation is customary.

Level Sensitivity. — This is a very difficult problem in many cases and its solution depends entirely on the type of instrument and particular details of the design. In a few instruments the moving system comprises two separate systems operating in 180° relation so as to permit averaging of their readings and thereby eliminate the most serious component of level error.

Damping Devices. — The damping of all vibrational modes of the moving system is particularly important for portable field instruments. Air damping is commonly used and is satisfactory when carefully designed. The damping forces must be free of any minute unidirectional forces induced by periodic motions. Electromagnetic damping using permanent magnets with copper vanes in the air gaps is practical out careful attention must be given to the elimination of all traces of ferromagnetic material in the vanes.

Magnetic Shielding.—If necessary, due to the nature of the spring material, magnetic shields of a well-known type may be used for shielding the spring alone or the entire instrument. Alternatively, the instrument may be carefully oriented always in the same direction in the earth's magnetic field.

Typical Gravimeter Designs.—The idea of using direct-reading gravity meters rather than pendulums is old but the early aim was primarily to provide a gravity-measuring device sufficiently sensitive to record temporal variations in g rather than to use it as a portable instrument in the field. Thus as early as 1862 M. Perrot used the angular deflections of a disk suspended by a long helical spring in attempting to record the minute time variations in g resulting from tidal forces. Such an instrument is evidently equivalent to the simple spring balance of fig. 4 (a) except that advantage was taken of the rotation induced by vertical displacements of the helical spring to permit easy optical magnification by the use of long optical levers.

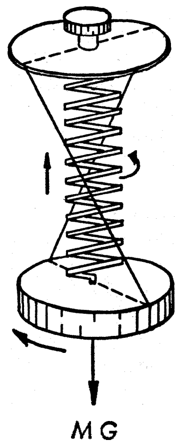


FIG. 5.— PRINCIPLE OF BIFILAR GRAVIMETER

Because the temporal variations in g (tidal forces) are of the order of only a few parts in 10,000,000 of total g, the sensitivity sought in these gravimeters was of the order of 10^{-9} g. This led to the early use of astatized instruments wherein the attainable sensitivity is limited only by the practical limits of maintaining their stability.

In 1837 C. F. Gauss had introduced the bifilar magnetometer. In 1898 A. Schmidt (*Beitr.* Geophys., vol. 4, pp. 109–115, 1900) replaced the restituting moment of Gauss' magnet by a helical torsion spring and created the trifilar gravimeter. Since then, bifilar and trifilar gravimeters have been perfected chiefly by W. Schweydar, A. Berroth, and particularly R. Tomaschek and W. Schaffernicht (Annalen der Physik, vol. 15, p. 787, 1932) who apparently were the first to use the nickel-chrome-iron (Krupp WT-10) alloy for the spring material.

While the trifilar instrument is somewhat more stable mechanically, in principle it is identical to the bifilar arrangement shown schematically in fig. 5.

In this class of astatized instruments the weight mg is supported partly by the helical spring and partly by the fine suspensions. The suspensions are held at an angle with respect to the vertical plane by a counterclockwise torsion of the helical spring. The vertical load mg, part of which is supported by the twisted suspensions, tends to pull the suspensions into a vertical plane with a resultant lowering and clockwise rotation of the lower disk. On analysis which is too complex to present here, it will be found that by proper adjustment of the relative load carried by the spring in tension, the load on the fibres, and the angle of twist of the fibres, the system may be brought to the point of instability characteristic of astatized systems. By adjusting the apparatus close to this point but within the zone of stability, very high gravimetric sensitivities may be attained. Considerable optical magnification of the rotational displacement of the system due to changes in g may easily be obtained by an optical lever using a mirror fixed on the lower disk. Tomaschek and Schaffernicht have reported that their gravity variometer is capable of a sensitivity of about 0.001 mg. or 10^{-9} g. However, the apparatus was by no means portable.

Evidently many mechanical modifications of this general type of instrument are possible. In some of these the central helical spring is eliminated and the necessary spring-restoring force obtained by using relatively stiff suspensions with torsional twist imposed on the suspensions. Plate, fig. 3 shows a developmental model of a typical bifilar gravimeter designed as a portable instrument for field use but not actually put into service. The thermostated and airtight container is not shown. The bifilar astatizing suspensions are drawn in to make them visible.

Another class of astatized gravimeters is designed with a horizontal torsion fibre or spring restoring force. This type is probably well exemplified in the G. Ising instrument (*Amer. Inst. Min. & Met. Engrs.*, vol. 1, p. 665, 1937) originally designed about 1918. The essential feature is a horizontal torsion fibre with a small rod mounted vertically at its mid-point. When the instrument is level the rod stands vertically. The instrument as a whole is then tilted through a small angle, resulting in a deflection of the rod towards a horizontal position. Measurements are made by tilting the instrument successively to one side and then the other by a known angle and measuring the resultant angular deflections of the small rod which serves as the active mass. Obviously the scale is very nonlinear and the quartz fibre used has a temperature coefficient of elasticity of about 10^{-4} per C.° so that very close control of temperature is required. An accuracy of about 0.5 mg. is claimed. By taking the readings of opposite deflections as described, levelling errors are effectively eliminated.

Similar in principle is the Wright gravimeter (F. E. Wright and J. L. England, "An Improved Torsion Gravimeter." Am. Jour. *Sci.*, Fifth Series, vol. 35A, p. 373, 1938) except that the torsion fibre is replaced by a horizontal "hourglass-shaped coil spring of quartz." At the centre of the spring is attached a short rod carrying a small weight at its outer end. As the ends of the horizontal spring are simultaneously rotated the weight is raised against gravity. As it nears a horizontal position it approaches a condition of instability. A reading of the angular rotation of the spring is made when it is adjusted to bring the rod to a fixed

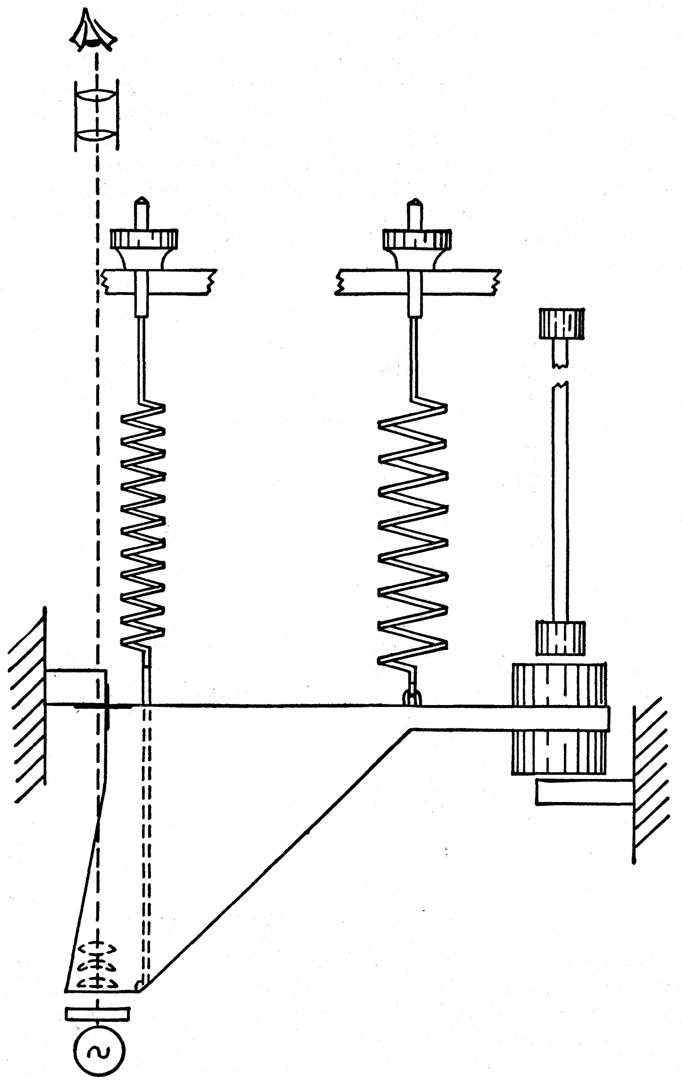


FIG. 6.— TRUMANASTATIEED GRAVIMETER

reference position near but just below the instability point. The reading is repeated with reversed rotation of the spring until the rod is brought up to a similar reference point in the opposite side. With a total rotation of some 1,400 degrees readable to about 10 sec., gravity can be read to about 10^{-6} g. Theoretically the reversed readings eliminate level errors but due to hysteresis effects inherent in all spring materials and since in the observations the spring is put through an entire stress cycle from zero to maximum and reverse, the attainable sensitivity is inherently limited. A similar limitation should apply to the Ising gravimeter. On the other hand, it is claimed that since the spring is normally under zero stress it has no detectable zero drift and therefore is a suitable instrument for relative gravity measurements between remotely separated stations. It was claimed in 1946 that a model at the Carnegie Geophysical laboratory, Washington, D.C., gave reliable readings within 1 mg.

The Mott-Smith gravimeter (L. M. Mott-Smith, *Geophysics*, vol. 2, p. 21, 1937) was designed particularly for gravimetric exploration. It comprises essentially a horizontal quartz fibre carrying at its mid-point a horizontal weight arm which is connected by a fibre to a light spring. The geometry of the linkage is such that the system is astatized, the torsion in the fibre and the tension of the "labilizer" fibre being nearly balanced. The entire system is constructed of fused quartz and is very small. The instrument proper is housed in a sealed container about 5 in. in diameter and 2 in. deep which in turn is contained in a liquid thermostat which holds the temperature constant to about 0.001°C. It is claimed that no clamping device is required because of the extremely light moving system and resultant high degree of air damping. The moving system, operated as a null device, carries an index point which is read with a microscope. These instruments have been used quite extensively in petroleum exploration and measurements to better than 0.1 mg. are claimed.

Another class of astatized gravimeters may be illustrated by

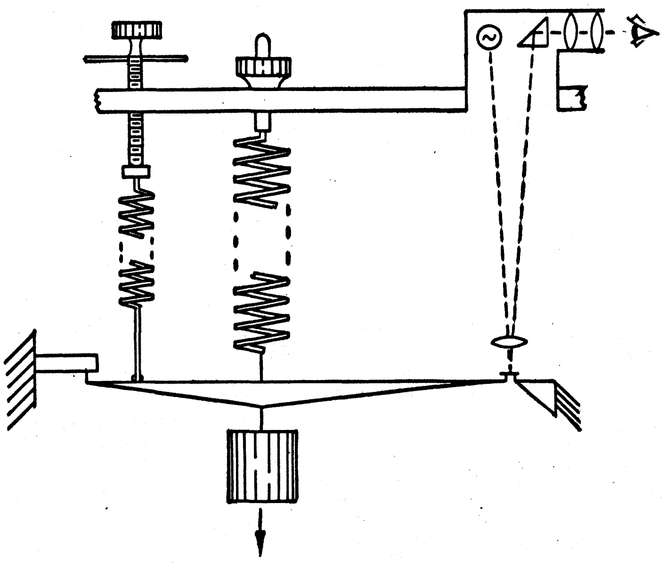


FIG. 7.— HARTLEY UNASTATIZED GRAVIMETER

the Truman instrument (described by A. B. Bryan, *Geophysics*, vol. 2, p. 301, 1937) and shown schematically in fig. 6. It, together with several others in commercial use, is similar in principle to astatic vertical seismographs. A mass is carried horizontally on a hinged triangular lever connected to two vertical springs. One spring is attached on the horizontal member between the hinge and the mass while the other spring is attached at the lower vertex of the triangular lever so that its line of action passes almost through the hinge point. By careful adjustment of the geometry of the system and the tensions of the springs the system may be brought close to the point of instability. Instruments of this type if carefully designed may be operated at very high sensitivity with springs of very short length, thus making for compactness. An index point is derived by optical levers or read directly from the mechanical lever system by means of a microscope. In general such instruments are provided with a very fine auxiliary spring whereby the index is always returned to zero so as to operate as a null instrument. The tension of the auxiliary spring is adjusted through a suitable micrometer arrangement calibrated linearly to read gravity changes. Obviously, auxiliary damping devices are required to insure adequate damping of all vibrational modes of the moving system and usually air-damping methods are used.

The Truman instruments or derivations thereof have been used extensively by the Humble Oil & Refining company and the Carter Oil company. It is safe to say that modern portable instruments of this type are capable of operating in the field with a probable error of the order of 0.05 mg. though exact data are not available. Of the more than 100 gravimeters which at times have operated simultaneously in geophysical explorations within the United States, doubtless the majority have been of this general type.

Unastatized Gravimeters--One of the earliest descriptions of an instrument designed for commercial geophysical exploration is that by K. Hartley *(Physics*, vol. 2, p. 123, 1932). As shown in fig. 7 it consists of a mass suspended on a spring. The position of the mass with respect to the supporting structure is determined by an optical lever. In Hartley's instrument the ratio of the motion of the fiducial spot of light reflected from the moving mirror to the motion of the suspended mass was about 60,000. A fine auxiliary spring served to bring the suspended system back to a fixed reference position for null operation. It is not known whether the device was used commercially.

It has been mentioned that in 1862 M. Perrot used the angular rotation accompanying the elongation of a helical spring to observe the changes in equilibrium position of a mass hung on a spring. F. Mielberg ("Uber perodische Veranderungen der Schwerkraft"—Pub. de L'Observatoire Astrononique de l'Universite de Tarter, vol. XXVII, no. 4, 1932) used a similar apparatus, again to measure temporal variations in g. About 1934, A. Hoyt in attempting to use the same principle in a portable gravimeter found the elongation-rotational conversion efficiency of a round wire helical spring inadequate for the purpose and moreover that the efficiency of conversion was a function of the internal stress distribution of the wire. Much greater rotation *v.* elongation was obtained using a thin ribbon helix. Fig. 4 in the plate shows the complete moving system of the Hoyt gravimeter. (Described by R. Wyckoff "The Gulf Gravimeter," *Geophysics*, vol. 6, no. 1, p. 13, 1941.) A ribbon helical spring about 10 in. in length and prestressed to decrease the equilibrium elongation, carries a mass at the lower end. The mass includes a mirror whereby the angular rotation may be measured and three arms carrying copper vanes which operate in the air gap of three small permanent magnets to provide damping. At the supporting end the helix is tapered to compensate rotational effects induced by bending of the spring at this point when the support is not exactly level. Also between the support and the main spring is a bimetallic loop which, with changes in temperature, introduces a slight rotational component to compensate for temperature effects in the spring.

The equilibrium displacement of the spring under total mg. results in a total angular rotation of the mirror of approximately 2,880° or 8 revolutions. Thus a rotation of about 1 sec. of arc results for 10^{-7} change in g. The rotation is observed by a multiple-reflection arrangement through the partially aluminized suspended mirror. Using the fourth reflection and an optical lever 22 in. in length, 0.1 mg. corresponds to 0.001 in. displacement under the micrometer-microscope. The reading accuracy at the micrometer is actually about 0.0001 in. The total range of the micrometer reading device is 25 to 30 mg. but the instrument may be adjusted for operation in any area by merely turning the spring supporting head to bring the readings back on scale. Such adjustments do not affect the scale constant since only a change in the spring constant itself or the mass can change the calibration of the instrument. Instruments in service for several years have checked their original calibrations to better than 0.5%.

The spring material is nickel-chrome-iron alloy hard-rolled and aged at somewhat elevated temperatures. The direction of creep is a function of applied stress so the mass is adjusted to operate the spring near its reversal point of zero drift. Drifts of 0.3 mg./24 hrs. are typical of a new instrument though in general the stability of the springs increases with age. It will also depend on operating conditions, for although the suspended mass is very carefully clamped in a fixed position for transportation the spring itself may be subject to some rather violent jars.

In the system of Plate, fig. 4 conditions are rather favourable for the elimination of short-period microseismic disturbances. Such disturbances cause vertical displacements of the weight but such displacements are observable in the optical system only when translated into rotation. The longitudinal period of the spring system is aboct 0.7 to 1 sec. whereas the rotational period is approximately 7 sec. and is quite heavily damped. This disparity in natural periods between the vertical and rotational modes, of which only the latter affects the optical system, results in a very inefficient conversion of short-period seismic disturbances to scale deflection. This filtering effect might be improved by increasing the disparity in periods but it would be impractical to carry it to a point that might eliminate normal long-period earthquake disturbances.

Observations at some hundreds of thousands of field stations have been made by the Gulf Oil corporation with this instrument with indicated probable errors of a single observation of 0.02 to 0.05 mg. depending on operating conditions.

Underwater Gravimeters. — The use of gravimetric surveys for reconnaissance exploration in the petroleum industry has led to the adaptation of gravimeters for work in coastal and other shallow waters. Such work has been accomplished, particularly in the case of null-type instruments, by the use of diving bells or similar devices whereby the operator may be lowered to bottom along with the instrument. In this manner a firm support is obtained and the observations are made as in the case of land stations. In other cases the gravimeter alone is housed in an adequate pressure-tight casing which is lowered and firmly planted on bottom. A cable to the surface craft provides electrical connections whereby the level of the instrument may be observed and corrected by remotely controlling small motors operating suitable levelling gear in the instrument casing. When accurate levelling has been achieved the moving system is unclamped by operating a suitable actuating motor, recording lamps are energized and a small camera with a moving photographic film records the instrument deflections. By such means observational accuracies equal to those on land stations have been achieved. There seems to be no special limit to the depths attainable with this latter type of device although other practical difficulties pertaining to exploitation problems have limited such work to water depths of 100 or 200 ft. A typical remote-controlled underwater gravimeter is shown in Plate, fig. 5.

Temporal Variations of Gravity. — Some modern gravimeters are well suited to the measurement of the temporal variations of gravity associated with the tidal forces caused by the attraction of the sun and moon. Measurements of this type have been rather sporadic to date, largely because the major effort since about 1930 has, for obvious economic reasons, been the development of instruments suitable for geophysical exploration. The work of Tomaschek and Schaffernicht already mentioned probably represents the most diligent recent effort on the subject concerning which there is any available information. However, sufficient data have been accumulated from various sources clearly to indicate that recording gravimeters are capable of measuring the temporal variations of gravity with sufficient accuracy to provide useful data pertinent to broad-scale geophysical studies. Thus gravimeter data have shown, as by other methods, that tides of very appreciable magnitude exist in the earth's crust. It is of interest, in conjunction with other associated methods of measurement, to obtain a considerable quantity of statistical data of high accuracy so as to permit proper analysis.

While the theoretical aspects of the analytical problem are too complex to be discussed here, in principle the possibilities may be made clear. Thus if we were to assume a perfectly rigid earth, any observed temporal variations in g must agree with the calculated tidal forces caused by the moon and sun. On the other hand, if the earth yields to these tidal forces in a perfectly elastic manner, tidal perturbances would appear on the earth's crust in response to the tidal forces. A gravimeter resting on the surface would thus observe an elevation effect added to the tidal force itself and the observed gravity variations would exceed those calculated on the basis of tidal forces alone by the amount of the change in elevation. Actually this greatly oversimplifies the case but serves to illustrate the nature of the results.

In addition to the broad-scale effects it may be said that the available scattered gravimeter observations prior to 1945 indicate that the earth tides differ from one geographical location to another; they are affected by loading of the land surface by ocean tides: and locally are doubtless affected by geological features (*i.e.*, W. D. Lambert, "Report on Earth Tides," 1936–38, *Spec.* Pub. 223, U.S. Department of Commerce, Coast & Geodetic Survey, 1940). And while other methods have long been used in an attempt to study these phenomena the gravimeter should provide very useful data in the attack on some phases of the problem. (*See* **TIDES.**)

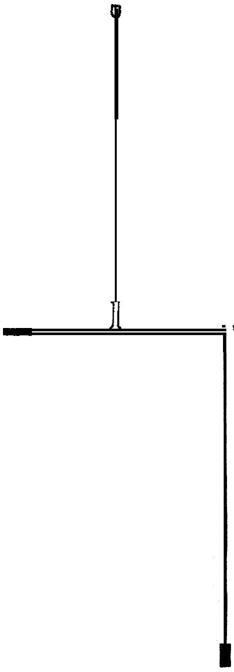


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FIG. 8.— SUSPENDED SYSTEM OF AN EOTVOS TORSION BALANCE

Measurement of Gravity Gradients. — Previous to 1888 researches on gravity were confined almost exclusively to investigations with the pendulum and the bubble level, but Eotvos (*Ann.* der *Phys.* und *Chem.*, B59, p. 354, 1896) using a different attack endeavoured to measure the variation of the force of gravity in the vicinity of a point. More exactly. he proposed to measure the rate of change or erddients in the gravitational field a< a point. Since these variations are extremelv small in comparison with the total force. Eotvos concluded that the method employed should measure the gradient directly. The result was the design of a torsion balance somewhat similar to the Cavendish balance. and which was capable of measuring with considerable accuracy gradient components of the gravitational field at a point.

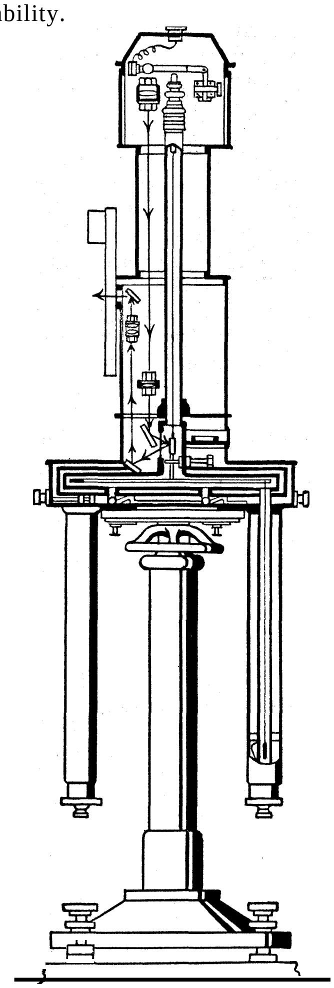
Evidently a suitable integration of the gradient results at a network of stations would permit the mapping of the intensity of gravity over the area.

The Eötvös instrument, fig. 8, differs from the earlier Cavendish balance in that it consists of a light horizontal beam which supports at its extremities two weights at different vertical heights, the whole being suspended on a very fine torsion wire and enclosed in a double- or triple-walled metal case which can be rotated about a vertical axis. A mirror attached to the centre of the beam system enables its angular deflection to be observed or recorded on a photographic plate.

In the instrument made by Süss, observations are taken visually and the instrument is rotated manually to the next azimuth position after each reading. In other types, *e.g.*, Bamberg and Oertling, fig. 9, the observations are recorded photographically and the instrument rotated to the next azimuth position automatically.

In order to reduce the dimensions of the instrument, without reducing the sensitivity unduly, or employing very thin wires, William Schweydar introduced a Z-shaped beam having one weight rigidly fixed above and the other below the plane of the beam. A reduction of the length of the torsion wire enables the height of the instrument to be reduced to 120 cm., the centre of gravity of the system remaining 70 cm. above the ground as customary in the larger instruments. In a design by Shaw and E. Lancaster-Jones the beam system is made irresponsive to "curvature" effects and is called a gravity gradiometer. The suspended system comprising a single beam carries a series of masses arranged in plan at the apices of a regular polygon, one mass being rigidly mounted well above the beam and the remaining masses fixed directly to the beam. The total length of the beam has thus been reduced to 4.5 cm.. resulting in more rapid operation and increased compactness and portability.

The Eotvos torsion balance measures the magnitudes usually expressed U_{yz} and U_{xz} which are the components of the gravity "gradient" in the north and east directions respectively, and represent the increase of the vertical component of gravity per unit distance north and east in the horizontal plane. The maximum "gradient of gravity" is the resultant of these components, its value being $[(U_{yz})^2+(U_{xz})^2]^{\frac{1}{2}}$ and its direction, tan $\Phi=U_{yz}/U_{xz}$. Two other magnitudes $U\Delta$ and U_{xz} give the "curvature value," or the deviation of the level surface of gravity from the spheroid. The meaning of this "curvature value" and the sensitivity of the balance to it may be visualized by noting intuitively that the beam of a Cavendish balance would tend to align itself parallel to an elongated cylindrical mass located with axis horizontal directly below the axis of the balance.



BY COURTESY OF MESSRS. L. OERTLING, LTD.
FIG. 9.—EÖTVÖS TORSION BALANCE —OERTLING AUTOMATIC PHOTO. VISUAL TYPE

The theory of the Eotvos balance is too complex to warrant presentation here. (See L. L. Nettleton, Geophysical Prospecting for Oil, 1940.) In practice, a single-beam balance would require readings of the beam deflections at five azimuthal orientations of the system in order to determine the desired gravitational quantities. Since the period of the balance beam is very long and may require from *30* to 50 minutes to attain its proper rest position for recording purposes, some *3* to 5 hours would be required for a single station observation. Commercial instruments are therefore designed with two identical beam systems oriented 180° apart whereby readings in three azimuthal positions suffice to determine the gravity quantities.

The sensitivity of the instrument is such that the unit chosen for expressing the results and known as the Eotvos unit (E), is 1×10^{-9} c.g.s. unit and represents a gravity gradient such that the vertical component of g changes by 1×10^{-9} gal per horizontal centimetre. In average field practice a probable error of about 3 to 4 E is attained. Because of the high sensitivity of the instrument to gradients caused by very local features, in the choice of field stations careful selection is required to minimize the spurious effects of "terrain" irregularities. It is the usual practice to grade level the station site for a radius of some 15 to 20 ft. and at greater distances measure the surface elevations carefully by levelling radially to about 100 ft. The effects of such terrain irregularities as well as more distant ones are then computed and applied as corrections to the observed data.

The torsion balance, introduced in the United States for petroleum exploration (particularly Gulf Coast salt domes) about 1923 saw extensive use by that industry until about 1936. At that time and progressively thereafter the gravimeter has replaced the torsion balance. This preference for the gravimeter arises from the greater speed of observation and the fact that its relative insensitivity to very superficial and hence spurious irregularities permits the construction of accurate gravity intensity maps adequate for geophysical exploration purposes, with far fewer stations than would be required from the very localized gradient observations such as are obtained by the torsion balance. The integration of a net of torsion-balance gravity-gradient observations into a total intensity map may be likened to the derivation of a topographic map from observations of the slope of the ground measured with a spirit level a few feet in length. Thus the torsion balance is essentially a detailing instrument whereas the usual application of gravimetric methods in geophysical exploration is for reconnaissance purposes. It is certain that the advent of the modern gravimeter has relegated the Eotvos balance to its logical function, the measurement of very local perturbations in the gravitational field.

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(H. SH.; R. D. W.)

GRAVURE, one of the major processes in commercial printing, is used to produce a wide range of printed materials, including newspaper supplements (*e.g.,* book-review sections, feature magazines), catalogues, illustrated magazines. illustrated books, advertising literature, calendars, greeting cards and wallpaper and patterns in textiles, linoleum and oilcloth. It is also employed for printing labels and wrappers on aluminum foil, glassine, cellophane, vinyl and similar materials.

Gravure is an intaglio process, so-called because the design to be printed is etched or engraved below the surface of the plate. At the start of the gravure printing process, the plate is covered with ink and the surface is then wiped clean. When paper is pressed against the inked plate, the paper penetrates the sunken parts slightly and draws out the ink. Examples of intaglio printing produced by traditional hand methods (*i.e.,* in which plates are inked by hand and printed on a hand-operated press) are etchings, engravings and aquatints. Hand methods are still used in some countries in printing postage stamps: paper money, bonds and other securities. Modern photomechanical applications are rotary photogravure, or rotogravure, which is used in the bulk of gravure printing; sheet-fed gravure, a slower method employed when high-standard reproductions are desired; and the original and now almost-extinct photogravure method, which is slowest of all but produces the finest results.

Rotogravure is a high-speed process that can print (from a roll of paper) the equivalent of 25,000 sheets per hour in one colour or 16,000 sheets per hour in four colours. with each sheet being about 44 by 70 in. or larger. The process is financially practical only on runs of 100.000 or more impressions. Sheet-fed gravure, in which sheets of paper are fed to the press mechanically and slower presses are used. is best for runs of 10.000 to 100,000. For press runs of less than 10,000 copies, the letterpress method usually is most economical (see PRINTING).

All copy (the material reproduced, or printed) in photomechanical gravure printing is photographed through a halftone screen; other printing processes employ screens only for reproducing photographs and other copy with tonal gradations. Type matter, therefore: is slightly hazier in gravure than in other processes but is quite readable. (See PHOTO-ENGRAVING: Halftone Plates.)

History.— In 1826 Joseph Nicéphore Niépce of France first used the action of light to make a plate for the printing press. He coated a pewter plate with a solution of Judean pitch (asphalt) and over this comparatively light-sensitive surface placed an engraved portrait of Georges Cardinal d'Amboise that he had previously made translucent by oiling. After the surface was given a long exposure to light to harden the asphalt, the soft lines were dissolved and the plate was etched and printed. *(See* PHOTOGRAPHY: *The Beginnings of Photography.)*

The basic principle of photogravure, and of almost all other photomechanical processes as well, was contributed by an Englishman, William Henry Fox Talbot. In 1852 he patented the first practical application of a phenomenon noted by Mungo Ponton in 1839 and Edmond Becquerel in 1840—that gelatin, when sensitized with a dichromate salt, hardens when exposed to light. The earliest form of the Talbot process involved coating a steel plate uith gelatin and dichromate of potash, exposing it under a positive, washing away the unhardened gelatin and etching with platinous dichloride. In a later version of the process, Talbot coated the plate first uith powdered resin to provide a stronger ink-holding grain, heated it to make it adhere and etched with ferric chloride.

Paul Pretsch of Vienna in 1853 bathed the exposed gelatin in cold water, thereby causing the soft parts of the gelatin to swell. An electrotype could be made directly from this relief, or from a gutta-percha mold. Pretsch patented his process in England in 1854 and set up the first commercial firm for photomechanical printing.

Karl Klic (Rlietsch) of Bohemia was instrutnental in making photogravure a practical commercial process. In 1878 he exposed a positive transparency over carbon tissue, a film made of coloured gelatin sensitized with potassium dichromate and backed by a sheet of paper. (Carbon tissue film had been invented in 1864 by Sir Joseph Wilson Suan of England.) The film was pressed down on a copper plate coated with an even layer of resin or asphalt powder. The carbon tissue was developed in water; this method of development made the softest gelatin swell and removed the paper backing. The plate was etched with ferric chloride in successive baths of varying strengths Klic's process produced sure and predictable results and became the preferred method for later workers.

Klic. working with Samuel Fawcett of Lancaster, Eng., also developed and introduced the method of rotogravure printing now in general use. In 1895 Klic formed the first rotogravure firm. the Rembrandt Intaglio Printing company, in Lancaster. The principle of the rotogravure press. however. was already known. Thomas Bell of England in 1783 had suggested using a doctor blade to remove ink from the surface of the plate. The most important early improvements in the design of rotogravure presses were made after 1904 by Edouard Mertens in Germany. *(See* PRINTING PRESS.)

Rotogravure Plates.—Procedures for making hand photogravure plates by the Klic method have already been described.

In rotogravure, separate negatives of type matter, other line copy and continuous-tone copy are assembled and positioned according to a prepared layout. After the negatives are retouched. a continuous-tone positive is made and also retouched to ensure opacity where desired. A sheet of carbon tissue is next exposed under a gravure screen. This screen is a film or sheet of glass on which fine transparent lines cross at right angles to form opaque squares. A screen nith 150 lines per inch (called a 150-line screen) therefore has 22 500 squares per square inch. The lines of the screen allow the light to penetrate to the film and harden the gelatin. The square "islands" remain soft. Gravure plates are usually made with 150-line or 175-line screens.

The continuous-tone positive is placed in contact with the carbon tissue and exposed under an arc light. The soft squares are hardened in proportion to the amount of light that penetrates the varying grays of the positive. The carbon tissue is squeegeed (pressed with a rubber roller) to a cylinder that has been previously coated with copper by electrolytic action. The squares are etched to varying depths depending upon the degree to which they were hardened. The crossing lines of the screen, which are entirely hardened, are not etched at all. In this way, pits or wells of different depths are etched into the copper. For very long press runs the cylinder can be plated with nickel or chromium. *(See* ELECTROTYPING.)

Rotogravure Printing.—In rotogravure printing, the cylinder usually is arranged so that during its rotary movement it passes through a trough filled with a thin solution of fast-drying ink. On some presses the ink is applied to the cylinder by other methods; *e.g.,* spraying. A thin steel blade (the doctor) moves across the cylinder with a slight oscillating action and removes the ink from the surface but not from the wells beneath. The plate cylinder then comes in contact with the paper, which travels around an impression cylinder, and the paper draws the ink out of the wells in the plate. After being printed, the paper shows through thin deposits of translucent ink, thus creating pale grays; heavier ink deposits from the more deeply etched wells appear correspondingly opaque. Thus a full range of tonal values can be printed. Since some ink is carried on the surface of the plate cylinder, particularly in the darker areas, the marks of the screen are almost entirely obliterated. In colour printing, a separate cylinder is prepared for each colour. *(See* PRINTING.)

Other Methods.—The Dultgen halftone intaglio process is widely used in colour work. Two positives are made from the continuous-tone copy, one through the conventional letterpress halftone screen and the other without a screen. For four-colour printing eight positives are made, two for each colour. The screened positive, which breaks up the image into soft dots on the carbon tissue, is exposed first, followed by the unscreened positive, which hardens the dots to varying degrees. When etched, the dots are therefore of different sizes and also of different depths. This method thus uses two methods for controlling tonal values.

Other methods in general use are the Henderson process, which prepares plates rapidly; the Huebner method, which dispenses with the use of carbon tissue; and Intaprint, which produces intaglio dots without depth gradations.

See also PHOTOENGRAVING.

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GRAY, **ASA** (1810–1888), U.S. botanist whose *Manual of Botany* (1848) remained the outstanding book in its field for a century, was born in Paris, N.Y., on Nov. 18, 1810. From James Hadley, professor of chemistry and materia medica, he obtained his first instruction in science (1825–26). In the spring of 1827 he first began to collect and identify plants. His formal education, such as it was, ended in Feb. 1831, when he graduated in medicine from the Fairfield Medical school. In 1836 his first botanical textbook appeared under the title *Elements of Botany,* followed in 1842 by *Botanical Text-Book for Colleges, Schools and Private Students,* which developed into his *Structural Botany* (1879). He published later *First Lessons in Botany and Vegetable Physiology* (1857); *How Plants Grow* (1858); *Field, Forest and Garden Botany* (1869); and *How Plants Behave* (1872). These books served the purpose of developing popular interest in botanical studies. His most important work, however, was his *Manual of the Botany of the Northern Cnited States,* within its geographical limits an indispensable book for the student of American botany, the first edition of which appeared in 1848. Throughout his life Gray mas a diligent writer of book reviews on natural history, and his reviews themselves often became treatises of literary and scientific value. The greater part of Gray's strictly scientific labour was devoted to a *Flora* of North America, the plan of which originated with his early teacher and associate, John Torrey of New York. Volume two of Torrey and Gray's *Flora* was completed in 1843; but for 40 years thereafter Gray gave up a large part of his time to the preparation of his *Synoptical Flora* (1878).

Gray's labours in the then new field of discovery and systematization of North American flora placed him at the head of U.S. botanists and on a level with the most famous botanists of the world. In 1856–57 he published *Statistics of the Flora of the Northern United States.* This paper was followed in 1859 by a memoir on the botany of Japan and its relations to that of North America, which Sir J. D. Hooker, English botanical explorer, called "in point of originality and far-reaching results its author's magnum *opus.*"

From 1855 to 1875 Gray was both a critic and exponent of the Darwinian principles, having been for years in correspondence with

Darwin. Though his religious views were those of the evangelical bodies in the Protestant Church, he openly avowed his belief that the present species were not special creations, but rather were derived from previously existing species.

In 1842 Gray accepted the Fisher professorship of natural history in Harvard university. He brought together by widespread exchanges a herbarium (later named the Gray herbarium), which became the largest and most valuable in America, and a library where there had been none and arranged the small garden already existing. Thereafter, the development of these botanical resources was part of his regular labours. His scientific life was mainly spent in the herbarium and garden in Cambridge, Mass.; but his labours there were relieved by numerous journeys to different parts of the United States and to Europe, all of which contributed to his work on the *Synoptical Flora.* He received from learned societies at home and abroad abundant evidence of their profound respect for his attainments and services. In 1872 he was elected president of the American Association for the Advancement of Science, and he was an original member of the National Academy of Sciences. He died in Cambridge, Mass., on Jan. 30, 1888.

His *Letters* (1893) were edited by his wife; and his *Scientific Papers* (1888) by C. S. Sargent. Also see *Gray's Manual of Botany,* 8th (centennial) edition—illustrated—largely rewritten and expanded by Merritt Lyndon Fernald, *et al.* (1950). (C. W. E.; X.)

GRAY, ELISHA (1835–1901), U.S. inventor, who had a famous legal battle with Alexander Graham Bell over the invention of the telephone. He was born in Barnesville, Belmont county, Ohio, on Aug. 2, 1835. Gray worked in a machine shop, reading in physical science at the same time, and for five years (1857–62) studied in Oberlin (O.) college, where he was professor of dynamic electricity from 1880 to 1901. On the same day (Feb. 14, 1876) that Alexander Graham Bell filed an application for a patent for a telephone Gray applied for a caveat announcing his intention of filing a claim for a patent for the same invention.

When Bell first transmitted the sound of the human voice over a wire ("Mr. Watson, come here; I want you") on March 10, 1876, he used a liquid transmitter of the microphone type previously developed by Gray and unlike any described in Bell's patent applications to that date and an electromagnetic-metal diaphragm receiver of the kind contrived and publicly used by Gray several months earlier. In the legal cases in which the Gray and Bell claims to have invented the telephone came into direct conflict it seems to have been established that Bell had first transmitted the sound of the human voice by electric currents in a wire, but evidence seems to show that the transmission took place by means of mechanisms developed by Gray. *(See* also TELEPHONE.)

His later years were spent in further electrical experiments. Gray died suddenly at Newtonville, Mass., on Jan. 21, 1901.

See the article on Elisha Gray in the *Dictionary of American Biography* and, especially, Lloyd W. Taylor, "The Untold Story of the Telephone," *The American Physics Teacher,* vol. 5, pp. 243–251 (Dec. 1937). (F. G. T.; R. S. FR.)

GRAY, SIR JAMES (1891–), British zoologist, outstanding for his work on the mechanism of cellular and animal movement, was born in London, Oct. 14, 1891. He was educated at Merchant Taylor's school and at King's college, Cambridge, where he was elected fellow in 1914. During World War I he served in the infantry. Returning to Cambridge in 1919, he gradually established one of the major schools of biological research in Britain. He became professor of zoology in 1937. For his own contributions to knowledge he received the royal medal of the Royal society.

He played a leading part in changing the main objective of 20th-century zoological research from evolutionary comparative anatomy to the functional analysis of living cells and living animals, particularly through his long and successful editorship of the *Journal of Experimental Biology.* Beginning research as a cytologist, his work was first particularly concerned with the mechanics of various kinds of cellular movements, and he is the author of a standard work on experimental cytology. Later he extended this application of mechanical principles to the analysis of animal movement in general. He has published numerous works, both specialist and popular, on movement of living systems of every size, from the spermatozoon to fish, whales, snakes and a great variety of terrestrial animals; and he has shown the interest and importance of the application of engineering principles to such biological problems. Among his publications are *Ciliary Movement* (1928), *Experimental Cytology* (1931) and *How Animals Move* (1953). (C. F. A. P.)

GRAY, JOHN DE (d. 1214), bishop of Norwich, Eng., a close supporter of King John, whose service he entered before his accession (1199), was rapidly promoted in the church until he became bishop of Norwich in Sept. 1200. By attempting in 1205 to make him archbishop of Canterbury King John started his long quarrel with Pope Innocent III, who quashed the election in favour of Stephen Langton. In 1209 De Gray was sent to Ireland to replace the baronial justiciar. There he extended the English frontier northward and westward, fighting campaigns on the Shannon and in Fermanagh but being defeated in 1212 by Art O'Maelsechlainn. He also carried out the reforms initiated by King John whereby the laws and customs of England were introduced into Ireland and a new coinage was struck.

On Gray's return to England in 1213 he brought 500 knights to Barham Downs, near Canterbury, for the muster assembled against the expected invasion of Philip II of France. He also acted for the king on embassies to the French king (*c.* Dec. 1203) and the emperor Otto IV (July 1213). After the king's reconciliation with Innocent in 1213 De Gray, with others of the king's chief advisers, was excluded from the general pardon and made to go to Rome; there he so greatly impressed Innocent that he was recommended for the bishopric of Durham, but he died on his homeward journey at St. Jean d'Audely in Poitou on Oct. 18, 1214. He is buried in Norwich cathedral. (M. DK.)

GRAY, LOUIS HERBERT (1875–1955), U.S. linguist and orientalist, whose work combined traditional and modern approaches with an insistence on thorough mastery of the languages investigated, was born in Newark, N.J., April 10, 1875. After studying at Princeton and Columbia (Ph.D. 1900), he devoted most of his life to teaching and research, except for a brief span at the Peace commission (Paris, 1919–20). He taught at Princeton, Nebraska and Columbia, retiring from Columbia as professor emeritus of comparative linguistics in 1944. His competence also included Celtic, Germanic, Armenian, Georgian and Semitic; he was expert in hagiography and church history. Besides numerous articles he published some ten books, including *Indo-Iranian Phonology* (1902), *Introduction to Semitic Comparative Linguistics* (1934) and *Foundations of Language* (1939). He died in New York city on Aug. 18, 1955.

GRAY, PATRICK GRAY, 6TH BARON (d. 1612), was descended from Sir Andrew Gray (*c.* 1390–1490) of Broxmouth and Foulis, who played a leading part in Scottish politics and was created a Scottish peer as Lord Gray, probably in 1445.

Brought up as a Protestant, and early married to the daughter of Lord Glamis, he soon repudiated his wife and became a Roman Catholic. By treachery and intrigue he gained the favour of James (afterward king of England). In 1584 he acted as an intermediary between James and Elizabeth I, whose support he gained by promoting a plot to secure the fall of the earl of Arran. Three years later he was again dispatched to England, ostensibly to save Mary's life, but his representations had no weight, and her execution led to his fall from power in Scotland. Though imprisoned and proved guilty of many crimes, he was saved by the king's favour, and rose to further honours. In 1609 he succeeded his father as 6th Baron Gray and died in 1612. In 1585 Gray married Mary Stewart and had by her six daughters and a son Andrew (d. 1663) who succeeded him as 7th baron.

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GRAY, ROBERT (1809–1872), first bishop of Cape Town and metropolitan of South Africa, was born at Bishop Wearmouth, Durham, on Oct. 3, 1809, and was the son of Robert Gray, bishop of Bristol. He was educated at Eton and Oxford, and took orders in 1833. After holding various English livings, he was consecrated bishop of Cape Town in 1847. In 1853 he was appointed metropolitan of South Africa in view of the contemplated establishment of the suffragan dioceses of Graham's Town and Natal. In that capacity his coercive jurisdiction was called in question in the case of Bishop Colenso (*q.v.*), and the judicial committee of the privy council decided against him. During his episcopate Bishop Gray effected a much-needed organization of the South African church, to which he added five new bishoprics, all carved out of the original diocese of Cape Town.

Gray died on Sept. 1, 1872.

See H. L. Farrer, *Life of Robert Gray, Bishop of Capetown* (1876, 2nd ed., 1883).

GRAY, SIR THOMAS (d. *c.* 13691, English chronicler, was present at the battle of Neville's Cross in 1346; in 1355, while acting as warden of Norham castle, he was made a prisoner, and during his captivity in Edinburgh castle he studied the English chroniclers, Gildas, Bede, Ranulf, Higden and others. Released in 1357, he was appointed warden of the east marches toward Scotland in 1367, and he died about 1369. Gray's work, the *Scalacronica*, is a chronicle. written in ?Torman-French, of English history from the earliest times to about the year 1362.

GRAY, THOMAS (1716–1771), English poet, whose *Elegy Written in a Country Churchyard* is one of the best-known English poems for its eloquent expression of universal feelings, was the son of Philip Gray, a prosperous scrivener in the City of London, by his wife Dorothy Antrobus. Born at their house in Cornhill on Dec. 26, 1716, he was a delicate boy, the only one of a large family who survived his infancy. He had a troubled childhood, because of his father's harsh and at times violent treatment of his mother, who was obliged to run a milliner's shop in order to pay for their son's education. This situation, however, had eased considerably before Philip Gray's death in 1741.

Thomas was sent to Eton in 1725, and was extremely happy there. His closest friends were Horace Walpole, a son of Sir Robert Walpole, the prime minister, and Richard West, whose father was a distinguished lawyer. The influence of Eton, with its beauty and its ancient traditions, remained with him throughout life. In 1734 he became a scholar at Peterhouse, Cambridge, and left without taking a degree in 1738. His habits, as at Eton. were studious and reflective, and he began to write Latin verse of considerable merit. Apart from a few translations, he had not yet composed any English poetry.

Early in 1739 he set out with Walpole on a prolonged Grand Tour. They spent the remainder of that year in France, and crossed the Alps in November. The whole of 1740 was passed in Italy, with a long sojourn in Rome and shorter excursions to Naples and elsewhere. The spring months were spent with Horace Mann, the British minister at Florence. They returned to Florence from Rome in August, and remained there until April 1741, when they set out for Venice. On the way there a violent quarrel took place at Reggio; the two friends parted in anger, and were not reconciled until 1745.

Gray spent a few weeks in Venice, and returned to England alone. On his way he stayed at the monastery of the Grande Chartreuse which had deeply impressed him on a brief visit earlier, and wrote there the beautiful alcaic stanzas beginning *O Tu, severi Religio loci.*

Throughout his years abroad Gray had continued his studies, and had acquired an intimate knowledge of classical and modern art. But at the age of 25 he had not prepared himself for any sort of career. He spent the first few months after his return to England at Stoke Poges in Buckinghamshire, where his mother and her sisters had retired to live after Philip Gray's death. He then took up residence as a fellow commoner at his old college of Peterhouse, in order to read for the degree of bachelor of laws, with a not very serious intention of an eventual career at the bar.

The spring and summer of 1742—the interval between his return from abroad and his establishment at Cambridge—witnessed a remarkable spell of creative activity. The sights and sounds of the Buckinghamshire countryside inspired him to write the "Ode on the Spring." Almost immediately after this he received news of the death of Richard West, to whom he had drawn closer since his estrangement from Walpole, and who was indeed his only intimate friend. His sorrow and loneliness found expression in the poems which now followed in close succession—the *Ode on a Distant Prospect of Eton College*, the "Hymn to Adversity," and the "Sonnet on the Death of Richard West." He also added to the ambitious philosophical poem *De Principiis Cogitandi*, which had been begun at Florence, some lines of remarkable intensity of feeling and beauty of expression. This passage was the culmination and the close of his Latin writing.

These poems hold an important place in Gray's exceptionally small output of verse. The "Ode on the Spring" and the Eton ode in particular revealed his ease and felicity of expression, his wistful melancholy, the evocative power which he possessed in so singular a degree. On the other hand not even his own century could wholly applaud the abstractions and personifications which abound in the Eton ode and the "Hymn to Adversity." The former poem was published in 1747; and it appeared again in Robert Dodsley's *Miscellany* of 1748, together with the "Ode on the Spring" and the graceful trifle about the cat drowned in a bowl of goldfish. They met with little attention, and there was no awareness that a new poet had arrived on a scene lately impoverished by the death of Pope.

Perhaps in 1742, perhaps at a later date, Gray embarked on a long meditative elegy. Opinions will continue to differ about the progress and the several stages of this poem's composition; but it was completed in its final form, and sent to Walpole, in the summer of 1750. In order to forestall its publication in a piratical magazine, which had chanced to obtain a copy, the *Elegy Written in a Country Churchyard* was hastily printed in the following year. Its success was instantaneous and overwhelming. It remains the most celebrated poem of its century, the most familiar perhaps of all English poems, the most frequently quoted, the best loved by the ordinary man. Tennyson, a century later, spoke of its "divine truisms that make us weep." The voice of Johnson, a critic not usually disposed to be cordial toward Gray, summed up the contemporary reaction: "it abounds with images which find a mirrour in every mind, and with sentiments to which every bosom returns an echo."

Among the admirers of the *Elegy* were the Dowager Viscountess Cobham, the *grande dame* of Stoke Poges, and her young relation and companion Miss Henrietta Jane Speed. They introduced themselves to Gray, and he celebrated their first meeting in a poem entitled "A Long Story," a gay and fanciful example of the humorous vein in which he too seldom indulged. An attachment developed between him and Miss Speed, and at one time there were rumours that they intended to marry. But Gray was a man tvhose emotions had been deflected into the channels of friendship. Miss Speed w-as a lively young woman of the fashionable world. A marriage between them would have been incongruous and almost certainly unsuccessful; and in any case the lady soon found a more appropriate husband elsewhere. Another outcome of the success of the *Elegy* was the publication in 1753 of the first collected edition of Gray's poems, in a handsome volume with remarkable illustrations by Walpole's friend Richard Bentley.

Through these years Gray had been living quietly at Peterhouse, reading, studying, taking short summer tours about England, cultivating his modest circle of friends and writing his admirable letters. He took no part in university or college business, but simply resided in college as a gentleman of leisure. Nor did his neu-found celebrity make the smallest difference to his habits. In 1756 he migrated from Peterhouse across the street to Pembroke hall, in consequence of a practical joke attempted by some undergraduates, who had become aware of his timidity about fire and the precautions he had taken in the event of an alarm. At Pembroke he continued, in a more friendly and congenial atmosphere, his accustomed way of life for the remainder of his days.

The popularity of the *Elegy* seems not wholly to have pleased him. Always distrustful of the popular voice, he chose for his next important poems the motto "vocal to the intelligent alone" from an ode of Pindar. The poems themselves were odes in the strict Pindaric form; and he intended that they should form the crown of his achievement. In "The Progress of Poesy" he set himself to glorify, with every adornment of rhetoric and eloquence, the poet's high calling. In "The Bard" he depicted a traditional episode during the final conquest of Wales. An ancient seer curses the invading forces and foretells the doom of the English monarchs who are to come, until a Welsh dynasty in the persons of the Tudor sovereigns ruled over the whole land of Britain. During the composition of this ode Gray was seized with an unwonted fervour of inspiration, so that, as he said later, "I felt myself the Bard."

The odes were published together in 1757. in a slender volume which was the first production of Walpole's private press at Strawberry Hill. They met with a mixed reception, and were widely criticized for their obscurity. Vnquestionably they are difficult poems, and were still more difficult without the aid of the footnotes which Gray refused to provide in the original edition. They are full of metaphor and veiled allusion. rhapsody and incantation. And yet certain passages have an authentic note of mystery and romance, a foreshadowing of Coleridge and Keats. By contrast, melodies almost Wordsworthian in their pure simplicity were sounded in a poem of this time which Gray left unfinished. and to which his editor, W. Mason, in an edition published in 1775, gave the title of "Ode on the Pleasure Arising From Vicissitude."

The reception of the two Pindaric odes brought deep disappointment to Gray, and thereafter he virtually ceased to write poetry. He burled himself even more completely in private study. and especially in English antiquities and in natural history. He greatly admired the productions which that dubious figure James Macpherson published as *The Poems of Ossian,* and made investigations of his own into the Celtic and Scandinavian past. He had long contemplated a history of English poetry, and made some translations from Welsh and Icelandic originals for incorporation into this work. "The Descent of Odin," "The Fatal Sisters." "The Triumphs of Owen" and the rest have their place in the history of the romantic revival in England and indeed in Europe His only other nritings during this stretch of years were occasional verses in a satirical vein. Most of these were destroyed after his death; but tao pieces, a political squib entitled "The Candidate" and the sombre and impressive lines on Lord Holland's villa on the North Foreland, have fortunately survived.

In 1768 the professorship of modern history was bestowed upon Gray by the duke of Grafton, the newly appointed chancellor of the university. He treated this office as a sinecure, although he had at first intended to deliver lectures and was much disturbed in conscience by his failure to do so He expressed his gratitude to the duke by writing an ode to be set to music and sung at the ceremony of his installation. This *Installation Ode* (published in 1769) contained some noble passages, and was indeed a return to the grand manner which he had seemed to abandon after the failure of his Pindarics 12 years before.

During the last decade of his life Gray's summer tours sometimes took him further afield than had previously been his custom. He visited Scotland in 1765, and the English lakes in 1767 and 1769, describing the landscapes through which he passed in some of his finest letters. Late in 1769 he made the acquaintance of a young Swiss nobleman. Charles Victor de Bonstetten, and conceived for him a romantic devotion, the most profound emotional experience of his life. De Bonstetten only remained a few months in England, and Gray's letters after his departure reveal how intensely he felt their separation. His health, which was never robust, and about which he displayed a solicitude almost amounting to hypochondria, had been declining for some years; and he died in his rooms at Pembroke, after a sudden illness which was probably an acute form of uremia, on July 30, 1771. He was buried in the churchyard of Stoke Poges.

As a poet Gray was admired and influential out of all proportion to his modest output of verse. He was unquestionably the dominant poetic figure of the middle decades of the 18th century, and a precursor of the romantic revival which was soon to come. He was also one of the supreme letter writers in English literature. A man of studious instincts. of a retiring and somewhat melancholy temperament, he nevertheless set his mark upon his age; and in one poem, the *Elegy Written in a Country Churchyard,* he made a lasting contribution to the English heritage.

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GRAY (GREY), **WALTER DE** (d. 1255), English prelate and statesman, nephew of John de Gray, bishop of Norwich, was educated at Oxford. He owed his rapid preferment to the favour of King John. He became the king's chancellor in 1205, and in 1210 was elected bishop of Lichfield by the chapter at the king's orders. But the papal legate quashed the election. He became bishop of Worcester in 1214, resigning his office of chancellor in the same year. Gray was with John when the king signed Magna Carta in June 1215; in the autumn he left England on the king's business, and during his absence was forced into the archbishopric of York, owing his election 'to the good offices of John and of Innocent III. He took action against the French invaders on the accession of Henry III and played a leading part during the young king's minority. When Henry took over the government he continued to employ de Gray, who carried out many important diplomatic missions and acted as the king's chief justiciar during Henry's absence in France (1242–1243). As archbishop of York de Gray's insistence on his right to have his cross borne erect in the southern provinces involved him in a dispute with Archbishop Stephen Langton, and he maintained his claim to the point of absenting himself from the king's second coronation in May 1220. The archbishop of Canterbury had an interview with him at Lincoln in 1222 on the subject, but no decision was reached. Later the archbishop absented himself altogether from public business for a time. but in 1255 he visited London to attend a meeting of parliament, and died at Fulham on May 1, 1255.

Gray was always anxious to assert his archiepiscopal authority over Scotland, and sought to assert it on the occasion of the coronation of Alexander II, but Innocent III, who desired the continued independence of the Scottish church, intervened in favour of the Scotch claim. De Gray built the south transept of the minister at York and is said to have built the west front of Ripon cathedral.

GRAYLING, a troutlike gamefish of the genus *Thymallus,* often placed in the family Salmonidae. It is a handsome silvery-purple fish, reaching a length about 18 in., distinguished by rather large scales; unusually large eyes; a small mouth with feeble teeth; and a long dorsal fin, with 20 to 24 rays. Six species are known from the cold. clear streams of Europe. Siberia and northern North America. Pollution of streams in North America has: however, seriously reduced the numbers of this excellent food fish.

GRAYSON, WILLIAM JOHN (1788–1863), U.S. poet, writer and politician. whose *Hireling and the Slave* is his best-known work, was born Nov. 12. 1788, in Beaufort, S.C. He graduated from South Carolina college in 1809, taught briefly, and then, after travel in the north, studied law and was admitted to the bar. He practised law in Beaufort county and served both as state representative and state senator in South Carolina.

From 1833 to 1837 Grayson was in the national house of representatives: he became collector for the port of Charleston in 1841. In 1854 he published *The Hireling* and *the Slave,* which contrasted the idyllic life of the southern slave with the difficult life of the northern worker. His other writings include *Letter to Governor*

Seabrook (1850), opposing secession; *Letters* of *Curtius* (1851), defending slavery; *The Country* (1858), praising rural life; *Marion* (1860); and *Life of James Lewis Petigru* (1866). Grayson died in Newberry, S.C., October 4, 1863. His autobiography, edited by Samuel Gaillard Stoney, was published serially in the *South Carolina Historical and Genealogical Magazine*, vol. xlviii–li (1947–50).

GRAYWACKE (GREYWACKE). The term graywacke, derived from German *grauwacke* for gray stone, was apparently first applied to certain Devonian and Lower Carboniferous rocks in the Harz mountains. Graywacke is a clastic rock, a microbreccia made up of fragments of pre-existing rocks, characterized by its dark-gray colour and toughness. Most graywackes consist mainly of angular quartz and rock particles, together with some feldspar and mica, set in a finer-grained matrix of shredlike chlorite and sericite. The rock fragments usually include slate, siltstone, phyllite, chert and a little felsitic material. Authigenic, that is, crystallized after deposition, carbonate and pyrite are common.

Graywackes occur in thin layers several inches to several feet thick, interbedded with shales or slates with which they form thick sequences. These are the "gray flags" or "grits" of the older petrographic literature. Associated rocks commonly include interbedded ellipsoidal greenstones, tuffs and thin-bedded cherts.

Graywackes may resemble basic tuffs but differ in their high quartz content and lack of volcanic glass. Although commonly feldspar-rich. graywackes differ from arkose (*q.v.*) sandstones in their dark colour, which results from the fine-grained chloritic matrix. Graywacke has been erroneously defined as the basic equivalent of an arkose, perhaps because of its superficial resemblance to wacke, the partially weathered residue from basalts and related rocks. Related to graywacke is subgraywacke (low-rank graywacke), which differs in its better-rounded constituents and in its precipitated mineral cement.

Graywacke occurs extensively in the Lower Palaeozoic of the Caledonian chain and in the Carboniferous of the Hercynian chains of Great Britain and Europe. In North America typical graywackes occur in the Pre-Cambrian of the Lake Superior region, in the Rensselaer grit of New York and Vermont, in the Carboniferous of the Ouachita mountains of Arkansas and Oklahoma, in the Franciscan (Jurassic) of California and in the Eocene of the Olympic mountains of Washington. In short, graywackes occur only in old orogenic belts.

Graywackes are probably of marine origin, perhaps deposited by turbidity currents in relatively deep water. This hypothesis explains the associated radiolarian cherts — supposedly of deep-water origin — and the lack of ripple marks, cross-bedding and benthonic (bottom-living) fossils, which characterize normal shallow-water sands, and the deposition of coarse debris concurrently with fine mud (of the matrix) as well as the graded structure seen in many graymackes. (F. J. P.; X.)

GRAZ, the capital of the Austrian Bundesland of Steiermark, on both banks of the Mur, at the opening of this valley into the broad fertile basin known as the Grazer Feld. The town (pop., 1951, 226,453) is enclosed on three sides by forested heights of the Styrian Alps, a small outlier of which, the Schlossberg, dominates the old town on the left bank of the river. This height (1,552 ft. and about 3jo ft. above the general level of the town) was an important fortified stronghold from pre-Roman times, but from 1839 has been laid out with beautiful parks. On its top is a bell toner (115 ft.) and a clock tower (92 ft.). Fine panoramas are to be seen of the town, the Mur valley and the mountains — to the north the Schockel (4,741 ft.), to the northwest the Upper Styrian Alps, to the southnest the Koralps and to the south the Possruck. At the foot of the Schlossberg to the west lies the river and to the east the town park with many marble and bronze monuments.

In the old town cluster the principal buildings of note. The 16th-century Landhaus in Renaissance style, the 17th-century Zeughaus or arsenal, maintained as it was 250 years ago, with its rich collection of 1jth–17th century weapons, and the 19th-century tonn hall in German Renaissance style and the 11th-century castle, now used as government offices, are worthy of mention. Among the many ecclesiastical buildings the most important is the 15th-century cathedral of St. Aegidius, mainly in late Gothic, though later decorations and modifications in baroque have altered the original purity of style. The interior is remarkable for its costly stained-glass windows, shrines and paintings. In the vicinity is the mausoleum church in baroque style (1614–1714).

Graz is rich in educational institutions, at the head of which is the university, founded in 1586 by the Austrian archduke Charles Francis and restored in 1827 after an interruption of 45 years. It is magnificently housed with well-equipped laboratories and a rich library and is attended by about 2.500 students annually. There is also a technical college, founded in 1814 by the archduke John Baptist, who also founded the Joanneum museum (1811). The museum has extensive collections of antiquities and natural history specimens in its old building and in the collections illustrative of the development of Styrian culture.

The outer suburbs of the town include the numerous factories, and this is particularly true of those on the right bank of the river, between it and the railway. For its active trade three factors are responsible. viz., the local situation at the contact of mountain and fertile Tertiary downland, the position with reference to important routes from Danube to Adriatic and their branching toward the Hungarian plain, and the presence of good lignite in the vicinity (Koflach). In addition to an active trade in the cereals, fruit and wine of the hill lands, large manufactures have developed. Iron-and steelworks, physical and optical instrument factories, brewing, milling, leather and paper and cloth industries, the preparation of chemicals, printing and lithographic trades and great railway workshops are among its major operations while visitors to the many interesting places and spas in the neighbourhood swell the growing volume of trade.

The early history of the town is obscure and it is first definitely mentioned in a document of A.D. 881, after which it became the residence of the rulers of Styria. Its strength and importance in the 15th and 16th centuries are exemplified by successful resistances to Hungarian (1481) and Turkish (1529, 1532) attacks. Protestantism established itself early there (1530) and flourished until oppressive measures by the archduke Charles restored the authority of Rome. After a long and fairly quiescent period the town figured largely in the Napoleonic Wars, being held by the French in 1797 and again in 1805, while in 1809 the citadel on the Schlossberg was blown up by Marshal Alexandre Macdonald in accordance with the terms of the peace of Vienna, only the bell tower and clock tower being left. The development of the town was most rapid during the 19th century, when it received many civic privileges through the interest of the archduke John. *See* also STYRIA.

See G. Fels, *Graz und seine Umgebung* (1898); J. Solch, *Das Grazer Hügelland* (1921).

GRAZIANI, RODOLFO, MARCHESE DI NEGHELLI (1882–1955), Italian soldier and administrator, notable for his service in Libya and East Africa, mas born at Filettino, near Frosinone, It., on Aug. 11, 1882. Before World War I he served in the army in Eritrea and later in Libya. In 1919 he was in command in Macedonia; he then served in Tripolitania until 1927. Graziani commanded the Italian forces in Libya in 1930–34. During this time he pacified the country, but in so doing became notorious for his harsh treatment of the natives. Graziani mas governor of Italian Somaliland (1935–36), viceroy of Ethiopia (1936–37) and honorary governor of Italian East Africa in 1938.

In 1939 Graziani commanded the Italian forces in Libya, and the following year advanced slowly against the British as far as Sidi Barrani. In 1941 his forces were heavily defeated by General Archibald Wavell and he resigned his post. After the Italian armistice in 1943 he took the side of the Germans and became defense minister in the Italian Republican government. In 1945 he surrendered to the U.S. forces, which imprisoned him until 1946, when he was handed over to the Italian government for trial. He was kept in Rome and in the spring of 1950 sentenced to 19 years' imprisonment. In August of the same year, however, he was released and later became president of the neo-Fascist Italian Socialist movement. He died at Rome on Jan. 11, 1955.

(E. B. BN.)

GRAZZINI, ANTON FRANCESCO (1503–1584), Italian writer mho played an active part in the literary and linguistic controversies of his day. Born in Florence. March 22. 1503, he becgme an apothecary. He was a founder of the Accademia degli Umidi, in which he was known as I1 Lasca.

In his numerous burlesque verses (mod. ed. *Le rime burlesche*, 1882), written in the manner of Francesco Berni, he strongly opposed humanism and Petrarchism, and in the discussions on the development of an Italian literary language he defended the Tuscan tradition. His own language is lively, at times approaching dialect, both in his comedies *(Gelosia, Spiritata, Strega, Pinzochera, Sibilla, Parentadi, Arzigogolo,* written 1540–50; mod. ed.. by G. Grazzini, 1953), and in his *Cene* (mod. ed.. by C. Verzone, 1890), a collection of 22 stories which, in the manner of Boccaccio. are told by a party of young people during a carnival. Although theoretically he maintained that modern comedies should not follow classical patterns, his own plays showed no originality of inspiration.

Grazzini died in Florence, Feb. 18, 1584. (G. A.)

GREASEWOOD, a North American shrub (*Sarcobatus vermiculatus*) of the goosefoot family (Chenopodiaceae). and a characteristic plant of strongly alkaline and saline soils in the high plains of the Rocky mountain region from Montana to Mexico. It is a much-branched, somewhat spiny shrub. 2 ft. to 10 ft. high, with small, fleshy, toothless and stalkless leaves. The creosote bush (*q.v.*), certain species of saltbush (*q.v.*) and various other plants are also called greasewood.

GREAT AWAKENING, a remarkable religious revival centring in New England in 1740–43; but covering all the American colonies by 1750. Its way was prepared by Jonathan Edwards (*q.v.*), who in 1734 inaugurated at Northampton the revival that, in 1740–41, was taken up by George Whitefield (q v.) in Massachusetts and Connecticut. He and his untrained clerical and lay followers by their emotional and dramatic preaching roused their hearers to so high a pitch of excitement and made such violent attacks on the many clergy who did not join them that it became necessary for Edwards personally to reprimand Whitefield; and when the latter returned to the colonies from England in 1744 he found that the faculties of Harvard and Yale had officially "testified" and "declared" against him and that most pulpits were closed to him.

The Awakening resulted in the formation of some separatist churches, which died out or became Baptist congregations; and the religious apathy of New England during the late 18th century may have been. at least in part, reaction against the gross methods often employed.

See also REVIVALISM.

See Joseph Tracy, *The Great Awakening* (1842); Frederick M. Davenport, *Primitive Traits in Religious Revivals* (1905).

GREAT BARRIER REEF: *see* BARRIER REEF.

GREAT BASIN, THE, named by John C. Frémont, nho crossed the area in 1843 and 1845 and described its physical features. is a unique natural basin-and-range region in the western United States. It occupies the western third of Utah and the entire state of Nevada and on its margins spills over into western California and southern Oregon and Idaho. The 189,000 sq mi. of the area resembles an inverted triangle with its 300-mi. base extending across northern Utah and Nevada and tapering on either side to the Mojave desert of California. The boundaries are rather sharply defined by the Wasatch mountains and Colorado plateau on the east and the Sierra Nevada on the west. To the north the Great Basin merges with the Columbia plateau. and the Mojave desert marks a rather indefinite southern border.

The topography, climate and drainage of the area set it apart from other natural regions of the United States. The Great Basin is divided about equally between rugged mountains and broad basins. The important mountain ranges are oriented north-south; they are commonly from 50 to 75 mi. in length and from 6 to 15 mi. in width. The mountains rise from 3.000 to 5.000 ft. above the surrounding valley floors. They have been referred to as fault-block mountains and their steeper faces are regarded as fault scarps. Between the ranges are the broad alluvial-filled basins. The elevation of these basins above sea level varies from 6,000 ft. in central Nevada to about 4,000 ft. on the east and west margins and 3,000 ft. on the south.

The climatic controls of the Great Basin tend to produce aridity. The high Sierras block the rain-bearing winds from the west. The annual rainfall averages about 10 to 12 in. in the basins, decreasing to 4 to 6 in, in the south. The limited summer rain comes in the form of torrential storms that cut arroyos and develop mud-rock flows; winter precipitation is generally in the form of snow. Summers are hot and winters cold, except in the south, where latitude and lower elevation combine to produce a mild winter.

The name "Great Basin" suggests the third natural feature of the. region, namely, interior drainage. It is not, however, one large basin, but a composite of many separate basins. Interior drainage is, in part, an expression of the dry climate of the area. The balance between evaporation and precipitation is a delicate one; lakes fluctuate greatly and some of them occasionally become dry. The water in many of them, notably Great Salt lake, is brackish or salty. Klamath, Pyramid, Carson and Utah lakes are all fresh water.

The vegetation of the Great Basin is an expression of the climate, soil and topography. Salt grass and greasewood grow on the alkaline soils of the valley bottoms; cottonwood trees edge the few streams that cross the lowlands; sagebrush, scrub oak and juniper appear on the better-drained slopes. In the southern part of the basin subtropical desert plants and species of cactus and other thorny growth are common. At the higher elevations forests of pine and spruce appear.

The valleys along the eastern edge of the region were occupied by the Mormons in 1847 and Salt Lake City has become the metropolis of that area. In a similar manner the valleys on the western edge were developed with Reno as the major centre of activity. The primary economic activities of the Great Basin are copper and iron mining, irrigated agriculture and livestock production and. more recently, manufacturing.

The population density of the area is less than 6 per square mile in contrast with 50 per square mile for the United States as a whole.

See also UNITED STATES (OF AMERICA): *Physiography.*

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(H. B. HA.)

GREAT BEAR LAKE, in Mackenzie district, Northwest Territories, is the largest body of fresh water entirely in Canada; 390 ft. above the sea, with depths that exceed 270 ft., it is 232 mi. long and 12,275 sq.mi. in area. From the northeast, reading clockwise. the five main inlets are Dease, McTavish, McVicar, Keith and Smith Arms. The eastern third lies in the Canadian Shield, the western two-thirds in the Interior Plains. Western and southern shores are well wooded, eastern and northern less so.

The outlet is by 70-mi.-long Great Bear river (used with a portage road as a freight route) to the Mackenzie river. The lake freezes over in winter and much ice may be present in mid-July. Radioactive ores, principally pitchblende. were mined from 1933 near the company town of Port Radium at the eastern end of McTavish Arm: during World War II production went to the U.S. Manhattan atomic bomb project. Twenty-five years of nearly continuous mining exhausted the reserves.

The settlement of Fort Franklin is at the western extremity of Keith Arm. (J. R. M.)

GREAT BEND, a city of central Kansas, U.S., on the Arkansas river, and the-seat of Barton county, was on the old Santa Fe trail, which passed through the courthouse square. The city was founded about 1870 and incorporated in 1871. East of the city are the ruins of Fort Zarah (established 1864), from which soldiers escorted wagon trains through the dangerous stretch beyond.

The region west of Great Bend was the home of vast herds of buffalo, antelope and deer, and was a famous hunting ground for the Indians of the plains and the scene of innumerable conflicts among the tribes. Near Great Bend was the alleged site of the mythical city of Quivira. sought by Coronado.

Great Bend became a shipping point for wheat, livestock and other agricultural products, and there are grain elevators and flour mills. For comparative population figures see table in KANSAS: *Population.*

GREAT BRITAIN, the official title of the political unity of England, Scotland and Wales. The name was used in 1604, after James VI of Scotland had succeeded to the English throne, and it was formally adopted in 1707 at the date of the union of the parliaments of England and Scotland. The following article deals with those subjects which concern Great Britain as a whole; *e.g.*, constitution, defense, finance and economics, etc. For those subjects which essentially concern each country separately (*e.g.*, geography. geology. population, religious denominations, etc.), the articles ENGLAND; SCOTLAND; and WALES should be consulted. (See also COMMONWEALTH OF NATIOKS; EKGLISH HISTORY; IRELAND; IRELAND, NORTHERN; IRELAND, REPUBLIC OF; LOCAL GOVERNMENT; and UNITED KINGDOM.)

CONSTITUTION

The British is unique among existing constitutions in antiquity of origin, length of endurance, continuity of growth, adaptability to circumstance and extent of influence. The distinguishing characteristic of this constitution is the sovereignty of parliament, combined with the exceptional importance of the sovereign's position as a constitutional link between several equal and sovereign nations of the Commonwealth of Nations. Following the Norman Conquest in 1066, the 12th century was the first of many centuries of almost uninterrupted and intense constitutional development in the parliamentary, judicial and administrative fields in England. The effective union of the principality of Wales with England dates from 1301 when Edward I's son was created prince of Wales, but Wales was not enfranchised until the reign of Henry VIII. After the Act of Union with Scotland in 1707, the representatives of the three nations met in the first parliament of Great Britain. By the end of the 18th century the structure of its constitution was solid enough to enable Great Britain in the 19th century to develop and elaborate governmental machinery for the greatest empire that the world had ever seen and, later, to modify that machinery by creating partnerships in a commonwealth of free and equal nations, each with similar institutions of its own.

Much of the peculiar genius of the constitution is attributable to the fact that it is partly unwritten and wholly flexible. It means that there is no basic constitutional document, comparable with the written constitution of the United States, the main sources of the British constitution being (1) legislative enactments of parliament, such as Magna Carta, 1215; (2) decisions of the courts of lam; (3) conventions of the constitution, such as the conduct of the crown, parliament and the cabinet in cases for which there is no formal law (*e.g.*, resignation of office by the government); and (4) literary sources, such as the textbooks of political theorists like A. V. Dicey. Since parliament, comprising the sovereign, the house of lords and the house of commons acting in concert, is sovereign, it has unlimited legal power, and acts of parliament, if complete and perfect. must be obeyed by all. though the right to test in the courts the legality of various applications of that power cannot be denied to the citizen. The action of one house of parliament was successfully challenged in the courts in the late 1830s when in the case of Stockdale v. *Hansard* a resolution of the commons claiming the protection of parliamentary privilege for certain documents printed by order of the house was held to be of no legislative effect. In the case of *Bowles* v. *the Bank of England,* 1913, the collection of taxes by authority of resolutions of the house of commons was held to be illegal since the resolutions had not yet been given the force of law by embodiment in an act to which the house of lords and the king had given their formal assent. Again, the crown is liable in tort and may be sued under the Crown Proceedings act, 1947, "in respect of torts committed by its servants or agents or for any breach of those duties which a master owes to his servants or agents at common law or in respect of any breach of the duties attaching at common law to the ownership, occupation, possession or control of property" (section 2). This legislative provision is of particular interest in providing an illustration of a change in the constitution by parliament; the act reversed a long-standing common law rule that the sovereign could do no wrong and that the subject had no remedy against torts committed by the crown's servants save by presenting a petition of right.

The theory that the legislative authority of parliament extends to all overseas possessions of the crown has long been modified in the case of the self-governing nations within the Commonnealth of Nations. By the Statute of Westminster, 1931, the British parliament virtually renounced all its former powers over the dominions (as they were then called) such as Canada and New Zealand. In 1947 acts of the British parliament conferred independence on India, which was partitioned into India and Pakistan, and Burma, which became an Independent republic. India became a republic within the Commonwealth of Nations in 1950 and Pakistan changed to the same status from that of a dominion in 1956. In 1949 another act recognized the establishment of the Republic of Ireland, while maintaining the separate status of Northern Ireland as an integral part of the United Kingdom.

The liberty of the subject under this flexible constitution is secured, as has already been indicated. by the rule of law, based on the essential constitutional assumption that all governmental powers rest on lam. Dicey claimed that this essential aspect of the constitution was characterized by the absence of arbitrary poaer, the subjection of officials to the courts and the ordinary common law, and that the constitution, being not the source but the consequence of individual rights, itself formed part of the ordinary law of the land. Dicey's view that there is no special privilege for officials and that equality before the law for officials and citizens alike distinguishes the British constitution from that of France, where special administrative law and tribunals exist side by side with the "ordinary law" and law courts, has been criticized as unreal; but since the distinction between the British system and others exists, it should be given due emphasis.

Although parliament is legally omnipotent, there are, even within Great Britain, many de facto limitations on its sovereignty. There have been cases of organized resistance to particular enactments; the tithe acts were resisted by groups of farmers for many years until an alteration in the law was made. The pressure of public opinion on members of the house of commons is constant and has proved a powerful sanction against any measure which has not the general support of the subjects. The doctrine of the "mandate," too, may become increasingly restrictive of freedom of action by the political parties in parliament. The doctrine is that no important measure should be passed unless the political party supporting the government has first included it in its program at a general election and so obtained the mandate or endorsement of popular approval. Although the principle of the mandate has not invariably been observed, its importance in the development of constitutional practice seems to be growing. In 1923, for example, the government of the day resigned because its desire to introduce trade tariffs had not first been submitted to the electorate.

The four main elements in the constitution of Great Britain are the legislature, the executive, the judiciary and the churches. The government, in the most general sense, comprises the first three, with many functions overlapping, since there is no separation of powers. The classical example of these overlapping functions is furnished by the office of lord chancellor. Its holder presides over the house of lords as speaker in his capacity as member of the legislature; he also presides in a judicial capacity over the supreme court when the house of lords meets as such. In addition he is a minister of cabinet rank.

Crown.—The crown unites all four main elements in the constitution. The legislature is comprised of the crown, the lords spiritual (bishops) and temporal and the commons; the crown is head of the judiciary, and justice is administered in the sovereign's name. Supreme executive power is vested in the sovereign and many executi e acts are also performed in the sovereign's name; and in 1534 the Act of Supremacy declared that the king was "the only supreme head on earth of the Church of England." This is the ultimate statutory authority for the appointment of the bishops by the sovereign on the advice of a prime minister (who, however, need not be and frequently is not a member of the Church of England).

This interlocking of the organs of central government is a result of their common origin in the *curia regis* of the Norman kings, a body which performed all the functions of government without differentiating between them. It was the king's court meeting to do the king's business, and the same is true of all the descendants to which in course of time, with the multiplication and elaboration of business, it gave birth, although the sovereign has long since ceased to attend in person, save on formal occasions at his privy council and in his high court of parliament. The crown is now held in hereditary succession as limited and defined in the Act of Settlement of 1701 and as modified by His Majesty's Declaration of Abdication act. 1936. This legislation, the first affecting the dominions under the terms of the Statute of Westminster, amended the Act of Settlement of 1701 by excluding Edward VIII (who became the duke of Windsor) and his descendants from succession to the throne and provided that the Royal Marriages act of 1772 should not apply to him. The influence of the monarch, though difficult to estimate, should not be underrated. He is kept fully informed, his advice, based upon uninterrupted public experience, is extremely valuable, and his consent is obtained to all measures; moreover, with the growth of the empire, and especially since the recognition of the dominions as coequal partners with the mother country, 'the crown has achieved unique significance as at once the symbol and chief constitutional safeguard of imperial union. Parliament authorized the monarch, by the Regency act of 1937, to appoint counsellors of state to exercise specified royal functions in the event of his absence from the country or his temporary incapacity to act. Those to be appointed counsellors of state by letters patent were the wife or husband of the sovereign and the four persons who were next in succession to the throne, excluding any person who would be disqualified from being regent.

Judiciary. — In Anglo-Saxon times the earliest forms of customary law were administered in three sets of courts: (1) national. those of the hundred and of the shire; (2) private. those of the thegns and of the lords of manors; and (3) municipal, those of the chartered boroughs. After the Conquest the local courts were slowly superseded by central courts and judges whose power emanated from the king, and the infinite varieties of customary law thus gave place to or were welded into one common law. This process was mainly achieved by extension of the use of royal writs; by introducing and extending the use of the jury (at first employed only where royal interests were concerned); by the institution and regulative influence of itinerant justices, who provided the necessary link between central and local government; and by the evolution from the *curia regis* of the three courts of common law at Westminster — common pleas, king's bench and exchequer. But, since the common law developed slowly and procedure lagged behind the needs of a progressive society, the *curia* was still called upon to mitigate and to supplement, and there grew up, in spite of the jealousy of common lawyers, a body of equity rules alongside the common law; the administration of the two was finally fused by the Supreme Court of Judicature act, 1873. As a result of the Judicature act and subsequent supplementary acts, all the existing superior courts were consolidated into one supreme court of judicature consisting of two primary divisions. the high court of justice, with the subdivisions chancery, king's bench (from 1952, queen's bench), and probate, divorce and admiralty; and the court of appeal from the decisions of the judges of each of these divisions. The old chancery procedure by way of petition for a rehedring was extended to the courts of common law, the decisions of which could till then be questioned only by alleging error apparent in some part of the proceedings. The house of lords became the final court of appeal from all the courts (other than ecclesiastical) of Great Britain, though the Administration of Justice (Appeals) act, 1934, stipulated that there could be no such appeal unless either the court of appeal or the house of lords itself gave leave, and that the jurisdiction of the house could be exercised only by peers judicially qualified. An appeal could not be heard or determined unless there were three or more of the following lords of appeal present: the lord chancellor of Great Britain; a member of the judicial committee of the privy council; a lord of appeal in ordinary; or a judge of the supreme court of England or of Northern Ireland or of the court of session in Scotland. The judicial personnel of the house of lords, together with such other members of the privy council as held or had held "high judicial office"as defined by the Appellate Jurisdiction acts, 1876 and 1887 (mainly commonwealth judges), constituted the judicial committee of the privy council, which was the final court of appeal from the rest of the empire and from the ecclesiastical courts of Great Britain; its jurisdiction was abolished in some instances, and from Canada appeal lay to the privy council only by special leave of the dominion supreme court.

Executive. — The *curia regis,* composed of the tenants in chief, royal officials and anyone else whom the king chose to summon, expanded or contracted according to the nature of its work. Daily routine would be left mainly to officials; the more serious the business the larger the attendance of tenants in chief; and on occasions of greatest importance the officials formed a numerically insignificant technical element in a large feudal assembly. The epithets employed to distinguish the larger and smaller gatherings achieved in time a technical significance until at last the larger assembly developed into the great council and the parliament, the smaller into the king's council. The latter, in spite of baronial machinations, had become, by the time of Henry VII, the instrument of the crown, and was used by the Tudors as the medium of prerogative government. True offspring of an undifferentiated *curia,* its authority was not confined to the exercise of any one function. Thus, though from it was to evolve the national executive, it retained also powers of legislation by ordinance and proclamation only vaguely subordinate to statute and common law, and a wide, if undefined, jurisdiction supplementary to the common law. Part of the latter had devolved on chancery, and much of the mercantile and marine business was absorbed by the court of admiralty constituted in the middle of the 14th century; but the stupendous labour involved in the Tudor conception of conciliar government necessitated further subdivision and specialization; thus, as in earlier times and for analogous reasons the *curia* had given birth and place to a number of descendant courts and councils, so now the king's council and its functions were split up and divided among the privy council, the courts of Star Chamber, of requests and of high commission. At the Restoration. of all the offspring of the king's council, there survived only the privy council, with nothing left of its former legislative authcrity, meeting to transact mainly formal business.

The cabinet, which in the 17th century evolved from a committee of the privy council as the effective national executive, was composed of an inner ring of confidential advisers of the crown. The king at first presided, but, when George I for lack of English ceased to attend, his place was taken by a minister, usually the first lord of the treasury, who in time became known as the prime minister. The latter, normally the head of the party commanding a majority in the house of commons, is appointed by the sovereign, with whose consent he in turn appoints the rest of the ministry and decides, though his choice is in practice narrowly restricted, which of them shall be members of the cabinet. Just as their predecessors sat originally in the parliament chamber, so now are all ministers members of one or other house of parliament, according as to whether they are peers or commoners. And they are individually and collectively responsible to crown, prime minister and parliament.

LEGISLATURE

Parliament was .originally a periodic public assembly of the *curia regis* at its fullest expansion. It was therefore competent to perform all functions of government. But the one mainly stressed was the judicial function, for law declaring precedes law-making. Any subject might present a petition, and parliament acted as a clearinghouse for such petitions, referring the suitor to the appropriate court and reserving for its own consideration in full assembly only such cases as were particularly difficult, protracted or important In the 13th century, however, the practice of summoning occasionally and ezperimentally delegates, sometimes from the shires. sometimes from the boroughs and sometimes from both simultaneously, was instituted for certain purposes. One of these nas the granting of money. To the demand for money the commons replied with a demand for the granting of the petitions they had brought with them. Considerations of these common petitions came to occupy so much of parliament's time that it was obliged more and more to leave the private petitions to be dealt with by council or chancery after parliament had broken up. In other words. it was abandoning the righting of individual wrongs a judicial function, in favour of the righting of the wrongs of the nation. a legislative function. It was Henry VIII, more than anyone else who helped parliament to climb by precedents toward a sovereignty which it finally wrested from his successors at the Revolution of 1688. For. though despotic, he liked to preserve legal forms and, still more, to shelve responsibility. Thus even to his most unconstitutional actions (e g., the Erastianization and spoliation of the church) he made parliament his partner; and particularly did he flatter the pretensions of the commons, of which he had no fear.

House of Lords.—In the parliament chamber sat originally the king. his counsellors and his greater tenants in chief, lay and spiritual. But the sovereign is now present only on rare and formal occasions, and with the growth of the doctrine of the peerage the presence of commoners became anomalous, so that counsellors who were neither peers nor bishops preferred, unless incapacitated by tenure of judicial office, to seek election to the commons The total membership in the house of lords of about 850 comprises peers who hold their seats by hereditary right or by the creation of the sovereign (about half of them created since 1906); law lords (peers who hold or have held high judicial office and life peers specially appointed); spiritual peers (2 archbishops and 24 bishops of the church of England); Scottish representative peers (16 elected for the duration of parliament); and 5 (in 1956) Irish representative peers (elected for life, but vacancies being no longer filled).[1] The Parliament act of 1911 disabled the house of lords from amending any bill certified by the speaker to be a money bill and limited the lords' veto on money bills to one month and on other bills to three successive sessions within two years; it also reduced the maximum duration of a parliament from seven to five years. The Parliament act of 1949 affected the lords' veto only on bills other than money bills; it was reduced to a period of two successive sessions and one year. Offsetting the monopoly of parliamentary taxation enjoyed by the commons, the house of lords became a court of appeal (see above, ***Judiciary),*** hearing being left to those members who were past or present holders of high judicial office or law lords specially appointed for life.

House of Commons.—The greatest power of state vested in the legislature is the power to impose taxes and to vote money to, or withhold it from. the various public departments and services. The exercise of this power is the right of the house of commons alone, making that house the chief authority in the state. By a convention of the constitution not established till the 20th century, the prime minister is always a member of the house of commons. instead of, as formerly, a member of either house; by thus directly submitting himself and a majority of his senior ministers to the daily criticism of that house, he further enhances its authority as compared with that of the house of lords.

Steps which led, over the course of centuries, to the financial ascendancy of the commons began in the second half of the 13th century, when counties and boroughs first received the royal writs of summons to send to Westminster representative knights and burgesses with full power to commit their constituent electors to the payment of taxes. The members of the commons so summoned took the opportunity to raise grievances, and by one of the earliest and strongest conventions of the constitution they established the principle of "grievances before supply."

In 1340 a statute recognized that no tax should be levied without parliamentary consent, but parliamentary control of taxation was not yet complete. The crown's taxes on imports were held by Tudor lawyers not to be taxes on English subjects. and it was held that exports could be taxed in view of the royal prerogative to regulate trade.

The last attempt of the crown to evade parliamentary control by devices in this manner was that of Charles I during the 11 years of absolute monarchy supported by revenue from "ship money." The parliament of 1640 declared the collection of tonnage and poundage without the consent of parliament to be illegal, and since the Restoration parliamentary control of taxation has never been challenged. Concurrently, the commons was establishing its supremacy over the lords in matters of finance by claiming the sole right of initiating taxation. In 1395 the grants demanded by the crown were made "by the Commons with the advice and assent of the Lords." In 1407 Henry IV conceded that "any grant by the Commons granted and by the Lords assented to" should be reported to him only by the speaker of the house of commons, a practice still maintained. Finally, in the decade 1660–70, the commons established the right to be the sole body to initiate measures proposing taxation when it refused to proceed with a number of lords bills which sought to impose taxes.

The house of commons consisted in 1953 of 625 members, 288 of them representing county divisions and the remainder borough (*i.e.*, urban) constituencies, while 12 of the total number represented Northern Ireland. Those disqualified for membership include minors, clergymen of the Church of England, ministers of the Church of Scotland, Roman Catholic clergymen, government contractors and judges. Provision was first made in 1911 for salaries of £400 a year for all members of the commons (but not of the lords) other than those receiving salaries as officers of the house, as ministers or as officers of the sovereign's household; the Appropriation act of 1937 authorized increased salaries of £600 a year, while in 1946 salaries were raised to £1,000 a year. In 1954 the recommendation of a select committee for a further increase to £1,500 was confirmed by a free vote of the commons; but in face of criticism in the country an allowance of £2 per sitting day (except Fridays) was granted instead.

Franchise.—The extension of the franchise by stages culminating in universal suffrage made the house of commons representative of practically all adults in the kingdom except the individuals who compose the house of lords.

The knights of the shire from 1429 to 1832 were elected in the county courts by the 40-shilling freehplders. Representation in the counties, therefore, though arbitrary (since other forms of tenure were ignored), was not the monopoly of class or wealth. But in the boroughs no such uniformity prevailed, and, as time went by, the franchise tended to become more and more restricted. For in early days popular indifference was content to leave the duty of nominating representatives to the authorities, who thus in time developed a prescriptive monopoly, and charters of incorporation, issued later on, when representation had come to be regarded as a privilege, usually conferred (or were interpreted as conferring) the exclusive right of election on the governing body. But, in condemning the old electoral system, critics usually base their calculations on the proportion of voters to population (2% in England, 2 per 1,000 in Scotland, at the close of the 18th century), forgetting that representation was not meant to be of population but of communities, and that. just as the county court stood for the county, so the corporation might stand for the borough. A sounder indictment would stress the point that the system had ceased to do what it was intended to do—to represent communities. For many boroughs returning members to parliament had decayed and some had actually ceased to exist, while many large and flourishing towns remained unrepresented; and, in county and borough alike, the franchise, as a result of corruption, was no longer a political privilege so much as an extremely marketable property. It was the agitation of the American colonies and the disasters resulting from George III's attempt at per-

[1] In Feb. 1956, there mere 4 peers of blood royal and 829 hereditary peers (21 dukes, 27 marquesses, 135 earls, 106 viscounts and 540 barons).

sonal government that at last aroused public interest in the matter. But reformers were divided on the question of compensation for expropriated borough owners, and the French Revolution and Napoleonic wars afforded an excuse for shelving the subject for another generation. The Reform act of 1832 marked the first stage in the process, continued by the acts of 1867, 1884, 1885 and 1918, of extending the franchise to all adult males and reshaping constituencies into fairly equal electoral districts. The act of 1918 further conceded the principle of woman suffrage, and the act of 1928 carried that concession to its logical conclusion by placing women on the same footing as men.

LIBERTY OF THE SUBJECT

The freedom of the individual, apart from the protection afforded by the franchise, is secured indirectly "by the strict maintenance of the principles that no man can be arrested or imprisoned except . . . under some legal warrant or authority, and . . . by the provision of adequate legal means for the enforcement of this principle." The most important of such means is the writ of habeas corpus, which enables the judiciary to review the actions of the executive, while the jury system protects the subject from judicial abuses; and the Bill of Rights reinforced by the Mutiny act (called after 1881 the Army act) removes the threat to liberty inherent in the existence of a standing army. Freedom of discussion and freedom of the press are secured by the law of libel (and more especially by Fox's Libel act, 1792) and amount to "the right to write or say anything which a jury, consisting of 12 shopkeepers. think it expedient should be said or written." The citizen is further protected in airing his views and grievances by the right to petition, secured by the Bill of Rights; by the right of public meeting, all meetings being legal until some illegal act has been committed; and by the right of association.

Curtailment of Liberty. — During time of war or national emergency the common good necessitated drastic limitation on individual freedom. In World War I the Defence of the Realm acts (D.O.R.A.), 1914–15, abridged the common law rights of the subject in many directions. The Emergency Powers act, 1920, permanent successor to this wartime measure, became effective only by proclamation of an emergency; the proclamation could [illegible] ([illegible] might be renewed) and emergency regulations under the act could continue in force for only a week unless parliament voted for their continuance. The act was brought into operation for a coal strike in 1921, for a general strike in 1926 and for other strikes in 1948 and 1949.

On the eve of World War II parliament passed the Emergency Powers (Defence) act, 1939, which authorized the making of defense regulations by order in council; unlike D.O.R.A., the regulations were subject to possible annulment by parliament within 28 days of being made. Some of the regulations created criminal offenses (as looting and sabotage), while others gave blank powers to be filled in by ministerial orders. Further wartime limitations upon individual freedom were imposed by the Control of Employment act, 1939, later superseded by the amending Emergency Powers (Defence) (No. 2) act, 1940, which gave complete governmental control over persons and property. Under the Civil Defence Duties (Compulsory Enrolment) order millions of men and women were compelled to serve part time or whole time as fire guards or in the wardens, rescue and casualty services, and after Jan. 1942 those working part time were no longer allowed to resign from their civil defense employment. The judiciary was also affected by wartime conditions. The Administration of Justice (Emergency Provisions) act, 1939, relaxed statutory requirements for the sittings and jurisdiction of courts (and also dealt a new and severe blow to the right of trial by jury), while the Courts (Emergency Powers) act, 1939, protected those unable to pay their debts because of circumstances attributable to the war, by preventing certain remedies from being exercised save by consent of the court.

CHURCH

Constitutionally, the Church of England enjoys the paramount position among religious bodies in England. The Act of Settlement, 1701, requires the sovereign to be a member of the Church of England, and he takes an oath of adherence to the faith of that church on accession to the throne. The clergy of the Church of England conduct the coronation and all other religious functions of the state; while the archbishop of Canterbury has special privileges in the granting of marriage licences and the conferring of degrees on notable ecclesiastical scholars. Since 1539 the state has had the power to alter the doctrine and articles of belief of the church by means of legislation, and the prayer book imposed in Edward VI's reign by the Act of Uniformity, 1549, is the basis of that in modern use, with only slight modifications permitted by subsequent acts. In 1928 an attempt by the authorities of the church to obtain a revised prayer book did not secure the necessary parliamentary approval.

Until the time of Henry VIII there was no church of England, but only two provinces of the church universal in England. The church had its own head, the pope, its own law, the canon law, and each province, Canterbury and York, had its own officials, archbishop and bishops, its own assembly, convocation, and its own courts of law. This diarchy of church and state was bound to lead to friction, more especially as the border line was vague and disputed and jurisdiction in some matters overlapped. Yet ecclesiastics, more than any other section of society, influenced the shaping of the constitution. They filled the chief offices of state; they were a permanent majority in the parliament chamber; for a time even representatives of the lower clergy attended the parliament; and for a century or more after the Conquest the archbishop of Canterbury had the chief say in determining the succession. After the Reformation their political influence declined. Few of them sat at the council board, and the disappearance of abbots and priors with the dissolution of the monasteries left them in a minority in the lords.

The final result of the Reformation, then, may be summed up as the abolition of the dual control of church and state, the transference to the state of complete control over the church and the substitution for the canon law of the king's ecclesiastical law; though a measure of legislative autonomy has since been restored to the established church by the Church of England Assembly (Powers) act, 1919. As a result of repeated quarrels between the two houses of convocation the latter was prorogued by royal writ in 1717 and not allowed to resume its sessions until 1852. Soon afterward, annual church congresses began to be held in which laymen took part, and in 1885 a house of laymen was formed in Canterbury and another a little later in York, elected by the diocesan conferences for the purpose of conferring with the respective convocations. From 1904 to 1919 there met annually a representative church council composed of the three houses in the two provinces sitting together; and the act of 1919 delegated to the newly constituted assembly of the church, subject always to the control of parliament, powers of legislature affecting the affairs of the church.

Although the ecclesiastical power has thus since the Reformation been subordinated to the secular power, the Church of England has retained much of its mediaeval structure, forms and titles. England is still divided into the mediaeval archbishoprics of Canterbury and York, and both archbishops sit with the judicial committee of the privy council when it is constituted the final court of appeal in all ecclesiastical causes. By 1953 there were 43 bishops, but only 26 (viz., the two archbishops, the bishops of London, Winchester and Durham and 21 other diocesans in order of seniority, excluding the bishop of Sodor and Man) had seats in the lords. There was numerous suffragan and assistant bishops. The established Church of Scotland is Presbyterian in constitution and is governed by its general assembly. It is presided over by a moderator (chosen annually by the assembly), to whom the sovereign grants precedence in Scotland, during his term of office, next after the lord chancellor of Great Britain. The sovereign is represented by a lord high commissioner. The Church in Wales was disestablished by the Welsh Church act in 1914.

Religious liberty, of which the first landmark is the Toleration art of 1689, was gradually attained by the repeal, one after another, of the many statutes penalizing persons not of the Anglican persuasion. There is no longer any restriction on freedom of worship in Great Britain; Roman Catholics and Nonconformists maintain their own organizations and churches, and the only disability attaching to public office is in the case of the Lord chancellor, who cannot be a Roman Catholic, as he performs many duties directly connected with the established church, such as administering to the sovereign the oath of adherence to the Anglican faith and summoning the bishops and clergy to meet in convocation, the ancient legislative body of the church.

See also CABINET; COMMON LAW; ELECTORAL SYSTEMS; ENGLAND, THE CHURCH OF; GOVERNMENT DEPARTMENTS; LOCAL GOVERNMENT; MINISTRY; PARLIAMENT; PRIME MINISTER; PRIW COUNCIL; PROCLAMATION; REFORM MOVEMENT; etc.

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DEFENSE: ARMY

Historical. — Before the Norman Conquest the English land forces, whether for defense or for maintaining order, comprised all freemen able to bear arms. For such training as they had and for inspection of their arms the sheriffs were responsible. But the county levy or fyrd was not intended or organized for anything but home defense, and Canute and his successors maintained, in addition, a body of household troops (*huscarles*); it was these which formed the core of resistance at the battle of Hastings.

After 1066 the Norman kings introduced into England the established continental system of warfare in which the decisive arm was the mailed horseman or knight. To be effective, the knight and his horses needed elaborate training, equipment and supply, and European society was largely organized so as to ensure the knight's maintenance and efficiency. Mediaeval land tenure was usually based on the obligation to provide knights, in number proportionate to revenue, for 40 days in the year. It was soon, however, found preferable to accept the money equivalent of this service (see KNIGHT-SERVICE; SCUTAGE) and use it to pay those willing to serve for the whole campaign.

Although the armoured knight was the unit in terms of which a mediaeval army's strength was calculated, it would be wrong to suppose that the. knights fought unaided. The knight, the actual combatant, needed. in the field, a team of auxiliaries — squire, page, groom, spare horse and pack animal, with the services at hand of the shoesmith and armourer. Mounted troops needed the support, in addition, of infantry and artisans for sentry duty, bridging and siege warfare. Nor, in Britain, was the general population freed from the older Saxon obligation to serve in person, an obligation which came to be exemplified in the posse *comitatus* and, later, the militia (*q.v.*). The sheriff, in summoning the posse *comitatus,* called together all males able to bear arms — in practice those more immediately at hand. This was usually to maintain order. The system was regularized by Henry II in 1181 and again by Edward I in 1285, their object being to define and subject to periodic inspection the weapons which each man, according to his means, was supposed to provide and maintain.

The British contingents which served in the crusades and the armies which successive kings of England led in continental wars were organized and equipped in the approved fashion of the day. Against Welsh and Scottish neighbours, however, orthodox tactics were found to be ineffective. In mountainous country the armoured horseman was often at a disadvantage, lacking forage, lacking a feasible path and lacking even any tangible opponent. There evolved, therefore, on the Scottish and Welsh borders, a type of frontier warfare in which light infantry played an increasing part and in which the knight tended to become a mere mounted officer. Just as elsewhere in Europe the cavalryman's ascendancy came to be limited by the crossbow and, later, the pike and halberd, so in Britain he was dismounted by the longbow. This weapon, developed in the Welsh wars of Edward I, differed from previous bows in being made from imported Spanish yew, in being six feet long and in shooting a yard-long shaft. In the hands of a strong man, trained in its use from boyhood, it was accurate at 100 yd. or more and effective, to some extent, against armour. It was Edward III who discovered that troops organized, paid and equipped as for warfare in Wales and Scotland, and reinforced by some of their former opponents, were more than a match for the chivalry of France.

The great period of the English archer extends from Crécy (1346) to Agincourt (1415) and on into Tudor times. For an astonishingly long period a divided France was dominated by a relatively small army of English mercenaries. They were mainly archers, riding while on the march, dismounting to fight and being led by officers of great experience. The wave of national feeling which eventually drove them out of France led indirectly to the Wars of the Roses in England. With the termination of those wars in 1485 there began a period during which warfare in Britain became extremely rare and warfare in France (for Englishmen) no longer attractive. The Tudor monarchy rested securely on the newly established navy (see below), on a monopoly of artillery, on a few household troops (the gentlemen pensioners and the yeomen of the guard) and on a male population armed with the bow and compelled by law to be proficient with this now traditional weapon.

It was the proved efficacy of the longbow which, perhaps as much as anything, retarded the adoption in Britain of the firearm. Cannon found ready acceptance in Tudor times, but the hand gun met the opposition of those who maintained that its adoption would lead to physical decadence. Musketry was therefore developed first in other countries, especially in Spain during the time of Gonzalo Fernández de Córdoba, and Tudor Britain profited only tardily by foreign example. The longbow, still the characteristic English weapon in 1519, did not in fact disappear until long after the next century had begun.

Serious large-scale warfare did not begin in Tudor times until the later years of Elizabeth's reign. The national forces raised in 1588 to resist a Spanish invasion threat included many officers with experience gained in the Netherlands, but the county levies were of doubtful quality and the main army was deficient in fire power and cavalry. The Elizabethan army made its chief task the conquest of Ireland, which would otherwise have become a Spanish base, and it was in Irish campaigns that generals such as Mountjoy learned their business. The Cadiz expedition of 1597 exemplified a growing British skill in combined operations, and the pacification of Ireland in 1600 showed that the soldiers were at least abreast of the times. Soon, however, the Dutch, technically in the ascendant in large-scale warfare, were able to improve their lead, for, from the accession of James I in 1603, England was at peace. A period of rapid development in weapons, tactics and organization began to which the British contributed little or nothing save through such English and Scots mercenaries as took service with the Swedish or Dutch. There were still no regular British land forces and no system for raising any except in the militia and the city-trained bands. Oldest of these nonregular corps was the Honourable Artillery company, dating from 1537, which remains the senior unit of the English land forces and perhaps the oldest regiment in the world.

The outbreak of the civil war between king and parliament in 1640 found no regular military forces in existence on either side, except for an English garrison in Ireland. Charles I had intervened in the Thirty Years' War to the extent of raising an army of 10,000 men, and it was a part of this force which he afterward billeted — a normal wartime practice — on householders. It was indeed one of the grievances held against Charles I that he tried to finance his army by forced loans and exacted the loans by the threat of billeting troops on those who failed to pay. These were among the matters set forth in the Petition of Right, and, in undertaking as he did to abandon these practices, Charles surrendered, in effect, his chance of maintaining an army at all. The immediate cause of the Great Rebellion lay in Charles's effort to raise an army against the Scots, which he mas unable to do without the sanction of parliament (see CIVIL WAR, ENGLISH).

By 1640 land warfare had assumed, in Europe, what was for long to be its permanent form. The mediaeval titles of rank—duke, baron, knight—had given way to the new ranks of general, colonel, lieutenant colonel, captain and lieutenant. Armies had become balanced forces of cavalry, artillery, infantry and engineers, with an organization based on regiments, companies and troops. But some of the problems implicit in the use of firearms remained unresolved. The massing of the infantry to combine fire power with pike thrust had produced a rigidity of formation from which no very decisive result was normally to be expected. The cavalry, on the other hand, improved as it was in speed by progress in horse breeding, was also equipped with firearms and had thereby partly sacrificed what should have been its advantage in impetus and weight. But for Gustavus Adolphus of Sweden, who taught his men to charge in with the sword after discharging their pistols, this sacrifice of impetus would have been complete. In the Great Rebellion the two sides, both officered by men with experience gained in foreign armies, were not unevenly matched as regards organization and skill. Royalists and Parliamentarians were alike the pupils of Maurice of Nassau and Gustavus Adolphus, and neither army could do more, at first, than emulate acknowledged continental masters.

The soldier most feared in the earlier phases of the war was Prince Rupert, the king's nephew, a foreign military expert. As a cavalry leader he found himself at the head of units whose disadvantage in equipment was outweighed by their excellent horses and fearless men. His innovation of the charge with the sword without any pause to fire pistols was initially caused, perhaps, by his men's having no pistols to fire. But he at once realized that pistols in any event represented a waste of time and impetus. Several Royalist successes (*e.g.,* near Worcester and at Edge hill in 1642 and at Chalgrove field in 1643) were the result of Rupert's reintroduction of shock tactics and charging at the gallop.

On the Parliamentary side there were officers as interested in horse breeding as were the Royalist duke of Newcastle (later to write standard works on the subject) and the king himself. But they realized that their chief tactical handicap lay in an organization derived from the militia. Regiments raised on a county basis were subject to desertion in proportion to their distance from home, even the officers being sometimes reluctant to subordinate the safety of their estates to any large-scale strategic plan. From this realization sprang the idea of the New Model army, first paraded in Windsor park on Feb. 15, 1645. Symbolic of its national basis of recruitment was the scarlet uniform chosen for all its infantry, superseding the county uniforms and remaining in use for 300 years. The strength of the New Model lay in its cavalry, which was particularly well paid, armed, equipped, horsed and disciplined, and the final Parliamentarian success was mainly attributable to Oliver Cromwell, who outmatched Prince Rupert as a cavalry leader.

Cromwell's achievement was primarily one of discipline. He accepted the Royalist innovation of charging with the sword but reduced the pace to a trot in order to maintain formation. What he thus lost in impetus he more than recovered in control and simultaneous impact. His units reformed knee to knee after initial success and could wheel, advance or withdraw as ordered by trumpet signal. The effectiveness of these tactics was shown not only against the Royalists, whose discipline remained weak, but against continental soldiers to whom this technique was a novelty. The professional discipline and nonlocal character of the New Model army made it a strong basis for Cromwell's dictatorship as protector, but the unpopularity of his military rule was to exercise a profound influence on later British history. The idea of a standing army was associated with political tyranny, and Charles II, on his Restoration in 1660, felt bound to disband the army (80,000 strong) as almost his first and most popular act. To this general dispersal there was one significant exception. The Restoration had been mainly brought about by one of Cromwell's generals, George Monk (later 1st duke of Albemarle), and his own infantry regiment, now the Coldstream Guards, was retained. Efforts to find employment for ruined Royalists led to the almost simultaneous formation of the troops which became, and remain, the Life Guards and Horse Guards, together with another infantry regiment which became the Grenadier Guards. This minimum provision for the king's safety, involving about 3,000 men in all, represented at that time the furthest extreme of militarism to which a jealous parliament would reluctantly assent.

Anxious to prevent a renewal of civil war and worried latterly about the succession, Charles II took what steps he could afford to strengthen the monarchy. His marriage with Catherine of Braganza, which brought him Tangier and Bombay, gave him a good pretext for forming garrisons in which his subjects could see no immediate threat to their liberties. Tangier (soon to be evacuated) was held by the 2nd or Queen's regiment of foot (1661) and a troop which later became the 1st Royal Dragoons. The Queen's regiment had to yield seniority in line to Dumbarton's regiment, the Royal Scots, which had a long record of service (representing, in fact, the Scots brigade of Gustavus Adolphus' army), but retained its seniority over the 3rd regiment (The Buffs), formed from soldiers who had similarly served with the Dutch and in units which had existed since 1572. A regiment formed to garrison Bombay was transferred to the East India company, and other units, raised to meet special needs in 1664, were disbanded when the immediate danger had passed.

Charles II's unpopular successor, James II, needed all the military support he could find. He used Monmouth's rebellion, which was crushed very largely by the Queen's regiment ("Kirke's Lambs," so called from their badge), as pretext for raising further units, including the Royal Fusiliers, and so finally brought his forces up to a total of 20,000. With this army, encamped at Hounslow, he hoped to overawe London, and he proposed, moreover, to disband the "constitutional" force, the militia. But any dreams he may have had of establishing his monarchy on a military basis were abruptly ended in the revolution of 1688. On the approach of William of Orange and his Dutch forces, James's officers mostly deserted to the enemy, while some of his regiments quietly disbanded themselves, to be reformed afterward in the army of William III. If the conduct of James II demonstrated afresh the dangers of a standing army, the revolution provided William and Mary with a permanent enemy in James and an example of how easily a throne can be overturned. Parliamentary opposition to a permanent land force was thus temporarily overcome by a desire to preserve the revolution settlement. More than that, the need to secure the loyalty of the troops to the new regime was now apparent. It was in fact a mutiny in favour of James which led parliament to pass the Mutiny act of 1689, which, while safeguarding the constitution, empowered the crown to try by court-martial any soldier accused of mutiny or desertion.

The accession of William III brought Great Britain into a large-scale continental war, affording scope both to the cavalry of the Cromwellian tradition and to the infantry regiments, which soon numbered 28. In 1690 parliament voted the maintenance of 62,000 men, thus sanctioning the Whig policy of intervention in Europe. While there may have been substance in the Tory contention that this policy was mistaken, it is beyond dispute that the modem British army first established its name during the period 1688–1713. John Churchill, 1st duke of Marlborough, was perhaps the greatest of English soldiers. Inheriting the regiments which had fought under William III at Steinkirk, Neerwinden and Namur, he made a European reputation for himself and for them. British infantry was famous for its steadiness, and the cavalry regiments distinguished themselves in the march across Germany in 1704 and in the battle which followed at Blenheim. The victories of Ramillies (1706) and Oudenarde (1708) further confirmed a British ascendancy which was upheld, though with heavy losses, at Malplaquet in 1709.

After the peace of Utrecht (1713) the army was reduced to 8,000 men in Great Britain and 11,000 overseas, the garrisons now including those at Gibraltar and Minorca as well as those in the colonies. The troops immediately needed on service, however, were those stationed in Scotland. These, after the accession of George I, had to suppress the rising of 1715. The subsequent period, from 1726, saw the disarming of the clans and the road-making activities of Field Marshal George Wade (1673–1748). Perhaps the oldest barracks in England are those at Berwick-on-Tweed, which date from 1717–21, at which period the billeting system was still, however, more normal. The 18th century was a period of relatively small standing armies, rigidly disciplined and trained. The Hanoverians had usually some German troops in British pay, perhaps because of the difficulties of recruiting in England. German influence was also apparent in the drill, the bugle calls and in military music. In administration the system remained personal. the colonel receiving an annual sum from which he was to recruit, clothe and pay his unit, whether at a profit or a loss. Regiments were raised by men of wealth, who often recovered something by selling commissions. This system of purchase did not prevent the ranker from reaching the rank of captain, but it enabled men of good family to achieve the rank of major early in life. While the dangers of this practice are obvious, it had the merit of enabling some officers to combine professional seniority with youth. For the lower ranks discipline was strict and often savagely enforced, partly because the tactics of the period demanded a rigid obedience and partly because recruitment was mainly from the lowest classes of the community.

In the War of the Austrian Succession (1740–48) British troops took part in continental campaigns, fighting at Dettingen in 1743 under the personal leadership of George II, the last king so to accompany his army. In the midst of these campaigns, in 1745, troops were hurriedly summoned to meet the danger of a Jacobite invasion based on the Scottish highlands. The defeat of the clans led to the final pacification of the highlands and this led in turn to the subsequent raising of the highland regiments, a plan to divert warlike instincts into a more useful channel. In 1745 (the year of Fontenoy) the army numbered 74,187 but was afterward reduced to a peace establishment (in 1750) of 18,857.

The Seven Years' War (1756–63) led to the raising of new regiments on an establishment which, in 1761, reached the number of 67,776. To the royal artillery was now added the horse artillery, used for close co-operation with the cavalry and copied from the army of Frederick the Great of Prussia, England's chief ally between 1756 and 1763. Fully maintaining the British fighting reputation (*e.g*, at Minden in 1759), the British army of this period gained greater success in colonial warfare and combined operations, the 39th regiment, for example, being present at the battle of Plassey. Other troops took part in raids on Rochefort in 1757, St. Malo and Cherbourg in 1; 58 and Belleisle. Still more conspicuous, however, was Gen. James Wolfe's capture of Quebec in showing the possibilities inherent in co-operation between navy and army, provided that the commanders could agree—as they sometimes failed to do. Afterward, however, in the American Revolution, it was painfully shown that the British army as then organized was quite insufficient to guard the now extensive empire without a superiority, both general and local, at sea. Even a temporary failure in sea power led to military reverses (as at Yorktown in 1781) which, though small in themselves, brought about strategic disaster. The loss of the American colonies simultaneously underlined the tactical implications of the rifle and the resulting importance of fieldcraft.

The army which had numbered 90,734 during the American Revolution was placed on a peace footing in 1783 and had been further reduced to 17,013 when war broke out in 1793. It was, in fact, being reduced in that year to 13,701, of which a large proportion were stationed overseas. With the French Revolution the character and scale of continental warfare had abruptly changed, small professional armies being replaced by conscript armies of vastly greater numbers, fighting not for adjustments of frontiers but for something approaching mutual destruction. The British regular army shared the fate of other similar forces at the outset of the war (1793–94) and withdrew to the British Isles. Thereafter the augmented land forces were destined for several years to operate mainly in the West and East Indies. The destruction of the French colonial empire was largely completed, and British overseas territory was widened at the expense of the Netherlands as well as of France. West Indian conquests were dearly purchased, however, in loss of life, not because of battle but because of yellow fever. During the same period of the war there were numerous combined operations, many on the French coast, which served (it was hoped) to dissipate the enemy forces in coastal defense. They were of more practical use, perhaps, in developing the technique which underlay later and better-planned landings on more promising shores; for example, in Egypt, Mauritius and Java.

Great Britain itself, meanwhile, was repeatedly threatened with invasion, sometimes from Ireland (as in 1798) and sometimes directly across the channel (as in 1803 and 1805). These threats came to nothing because of British naval superiority but led nevertheless to great efforts of military preparation. Besides the raising of new regiments and multiplication of battalions in the regiments already formed, and besides the embodiment of the militia, there was the volunteer movement. This began in 1793–94, the Dover volunteers being among the first units to be formed. In 1803 the younger Pitt was busy at Walmer, while out of office, in raising and training 3,000 men for the Cinque Ports volunteers, undergoing "the fatigue of a drill sergeant" in the process. The king reviewed 27,000 volunteers in Hyde park in 1803. Volunteer units were largely for middle-class spare-time soldiers and were based, in some instances, on existing professional or business associations, the East India house or the inns of court (The Devil's Own). Even so the toast "The Volunteers and a speedy meeting with the enemy on our own shores" expressed a confidence which events, had Napoleon's veterans landed, might not have justified. The volunteers reached a peak number of 380,000 and were later transformed into the local militia in 1808. This organization numbered 215,000 in 1812 as compared with the 70,000 volunteers still enrolled as such. These various associations, raised, uniformed, armed and equipped by voluntary effort, made a creditable appearance on parade but were never tested in battle.

Involuntary abstention from continental warfare for several years gave the government ample opportunity to study recent developments, absorb lessons, reorganize and retrain. Nor was this chance thrown away. The duke of York, whose reputation even as a commander in the field has been underrated, became commander in chief in 1798 and made it his business to introduce a new and uniform system of infantry training. This was based on the work of Sir David Dundas, who, after making a particular study of the Prussian and other continental armies, published the *Principles* of *Military Movements* in 1788. This in turn became the basis for the official *Rules and Regulations* of 1792 which the duke now sought to enforce. When the duke was out of office, moreover, in 1809–11, it was Dundas who took his place. Copying the French model, battalions were grouped in brigades and brigades in divisions, with artillery attached and formation headquarters developed. Whereas earlier drill aimed first and foremost at the maintenance of a continuous and steady volume of fire, the introduction of the backmoodsman's rifle. with its greater range and accuracy, suggested the reed for marksmanship and camouflage. In the green-uniformed rifle brigade there was introduced a skirmishing technique, with use of ground and open formation. In 1803–06 some line regiments learned something of the same art in the training camp at Shorncliffe under Sir John Moore, but they adhered nevertheless to the scarlet uniform and to close formation in battle.

It was a newly trained army which took the field in Portugal in 1809, soon proving itself up to the standard of the French in everything but numbers. In leadership the choice might seem to lie between generals who had been defeated in 1775–83, generals whose experience was of combined operations and raids. and generals with no war experience at all. But Britain had another army in India, and it was from this that there now came Sir Arthur Wellesley, the victor of Assaye, with a reputation already made. The command in Portugal fell to him soon after the death of Sir John Moore at Corunna, and it was he who raised the British military reputation to the height it had reached under Henry V, under Cromwell and under Marlborough. His army was a balanced force of all arms but it was on infantry that he mainly relied for victory. The Iberian peninsula was not the main theatre of war but it was the grave of the French legend of invincibility. In successive battles Wellesley (later duke of Wellington) gained an ascendancy over his opponents, and when the war ended for the time in 1814 he was leading his veterans into France. As the most uniformly successful of the allied generals he led the mixed army which defeated Napoleon at Waterloo, and by 1815 British military prestige was perhaps at its highest. The army in 1812 comprised 245,996, of which a fair proportion were serving or had served overseas. During the peace which lasted, almost without interruption, until 1854, military stagnation was all but complete. The army, fixed at a fairly high figure (71,790) in 1822, with the duke of York still commander in chief until 1827, rested on the legend of Waterloo. The duke of Wellington (commander in chief, 1842–52) was no reformer, and the army owed much to the prince consort, who joined with the duke in preventing duelling among the officers. More important than this reform mas the general superseding during this period of the flintlock smooth-bore musket by the rifle and percussion cap.

The army which was sent to the Crimea in 1854 was led by veterans of the Peninsular War but was without recent experience of warfare. The problems presented by the campaign were new in that the lines of supply were exceptionally long. Nor was it easy to maintain a force on hostile territory with no local friends nearer than the Turks and no more reliable ally than Napoleon III. The army was an agglomeration of battalions, individually of fine quality but unused to working together, without trained staff, administrative departments or army organization of any kind. The lesson of the winter before Sevastopol was dearly bought, but mas not thrown away. From that time several war ministers and one commander in chief laboured perseveringly at the thankless and difficult task of reforming army organization. Foremost in the work was Sidney Herbert (later Baron Herbert of Lea), the soldier's friend, who fell a sacrifice to his labours (1861) but not before he had done much for the army. The whole system of administration was revised. In 1854 it was inconceivably complicated and cumbersome. The secretary of state for war and colonies, sitting at the colonial office, had a general but vague control, practically limited to times of war. The secretary at war was the parliamentary representative of the army. The commander in chief was responsible to the sovereign alone in all matters connected with the discipline, command or patronage of the army but to the secretary at war in financial matters. The master general and board of ordnance were responsible for the supply of material on requisition, but were otherwise independent, and had the artillery and engineers under them. The commissariat department had its headquarters at the treasury, and until 1852 the militia was under the home secretary. In 1854 the business of the colonies was separated from that of war and the then secretary of state assumed control over all the other administrative officers. In the following year the secretary of state was appointed secretary at war also, and the duties of the two officeswere amalgamated; the commissariat office was transferred to the war department, and the board of ordnance was abolished, its functions being divided between the commander in chief and the secretary of state. The minor departments were gradually absorbed, and the whole administration divided under two great chiefs, sitting at the war office and Horse Guards, respectively. In 1870 these two were welded into one. and the war office now existing was constituted.

Corresponding improvements were effected in every branch. The system of clothing the soldiers was altered, the contracts being taken from the colonels of regiments, who received a money allowance instead, and the clothing supplied from government manufactories. The pay, food and general condition of the soldier were improved; his ordinary education and the military education of the officer were taken in hand. The Indian Mutiny of 1857, followed by the transference of the government of India, led to important changes. The East India company's white troops were amalgamated with the queen's army, and the whole was reorganized.

But it is not a British habit to profit by military experience. The mere fact that the difficulties of 1854 and 1857 had been surmounted ultimately led the nation and its representatives to forget their cost and waste. And the nation-wide rejoinder to the French threats of 1859—the creation of the volunteer force—contributed to a false sense of security. Thus the two obvious lessons of the German successes of 1866 and 1870—the power of a national army for offensive invasion, and the rapidity with which such an army when thoroughly organized could be moved—created the greatest sensation in England. The year 1870 is, therefore, of prime importance in the history of the regular forces, and the ensuing period of reform is connected indissolubly with the name of Edward Cardwell (later Viscount Cardwell), secretary of state for war, 1868–74. In the matter of organization the result of his labours was seen in the perfectly arranged expedition to Ashanti (1874); as for recruiting, the introduction of short service and reserve enlistment together with many rearrangements of pay, etc., helped to treble the number annually enlisted as well as to build up a reserve which in the South African War yielded 80,000 men to maintain the strength of the army in the field. The localization of the army, subsequently completed by the territorial system of 1882, was commenced under Cardwell's regime, and a measure which encountered much powerful opposition at the time, the abolition of the purchase of commissions, was also effected by him (1871). The machinery of administration was improved and autumn manoeuvres were practised on a scale previously unknown in England. In 1871 certain powers over the militia, formerly held by lords lieutenant, were transferred to the crown, and the auxiliary forces were placed directly under the generals commanding districts. In 1881 came an important change in the infantry of the line, which was entirely remodelled in two-battalion regiments bearing territorial titles. This measure (the "linked battalion" system) aroused great opposition; it was dictated chiefly by the necessity of maintaining the Indian and colonial garrisons at full strength and was begun during Lord Cardwell's tenure of office, the principle being that each regiment should have one battalion at home and one abroad, the latter being fed by the former, which in its turn drew upon the reserve to complete it for war. On these general lines the army progressed up to 1899, when the severe trials of the South African War hastened new schemes of reform, leading up to Richard (later Viscount) Haldane's "territorial" scheme (1907), which put the organization of the forces in the United Kingdom on a new basis.

Cardwell had left office before one of his most important reforms had been completed, organizing the forces in the United Kingdom in larger formations so that they could be employed as a field army, of which the strength was based solely upon the number of troops serving abroad, not upon any estimate of war requirements. The question of the uses to which such an army would be put was one that had never been properly determined. The army school of thought visualized an invasion of the British Isles and the primary need for a large field army to deal with such an emergency, while the navy considered that, given sufficient naval strength, invasion by foreign armies could be prevented by action at sea. The army view was reflected in the organization of the higher formations. These consisted of army corps, composed not only of regular forces but also of auxiliary elements under no obligation to proceed abroad. One of the first steps taken by Haldane was to advocate clear thinking in connection with army problems, and he developed the general staff, initiated by his predecessor, Arnold Forster, to undertake this important but previously neglected branch of military preparation. Within a few months, three principles had been laid down and officially accepted to govern the military defense of the empire. The first of these was the essential need for a navy strong enough to ensure the safety of troops crossing the seas. This was a natural outcome from Cardwell's system of cutting down oversea garrisons to a bare minimum on the assumption that the troops in the United Kingdom could be sent as reinforcements to any part of the world in times of emergency. The second principle was that of local provision for military defense in all parts of the empire. to the utmost extent to which such provision could be furnished. The third was that of mutual military support in times of emergency.

Instead of paper army corps, available only for home defense, the Haldane reforms provided for the organization of the troops in the United Kingdom in six infantry divisions, one cavalry division, and line-of-communication troops, as an "expeditionary force" (composed entirely of regulars) available for oversea service either as reinforcements for the small garrisons of different parts of the empire in the event of internal or external menace, or, if need be, as a field army capable of fulfilling treaty obligations. Furthermore, the need for strong drafts of men to keep units in the field in a protracted campaign was realized. In the Manchurian war of 1904–05 the Russians had made the mistake of reinforcing their field army with fresh formations, while leaving the veteran units already in the field to melt away for want of drafts to replace wastage in personnel. In order to avoid this mistake in British military policy, the militia was called upon to provide drafts of trained men in time of war for the expeditionary force. and its name was changed to the "special reserve" of the regular army.

A further point that was realized was that, whether the British Isles were or were not subject to the menace of invasion, they could not be left denuded of troops. Material in manpower lay readily to hand in the force of yeomanry and volunteers who, from patriotic motives, had volunteered to take part in the military defense of the United Kingdom in grave emergencies and to spend such time as they could spare from their civil vocations in undergoing training for the purpose. Lacking neither in zeal nor in numbers. they lacked all else required by a field army in the way of organization and training in higher units and most of the transport, material and equipment, of which the provision comes under the term understood by the expression "mobilization." Units of the different arms and departments had sprung up haphazard, according to the preference expressed by those who had been instrumental in raising them. No attention had been paid to the proportion of each arm and department needed for a grouping in such higher formations as divisions. In face of opposition and criticism similar to that faced by Cardwell, Haldane, with the loyal co-operation of the units concerned, used this material to establish the territorial force, of which the first units appeared under arms in April 1908. The act which established this force provided that either the units or the individuals serving therein might volunteer for oversea service in grave emergencies. The extent to which this appeal met with response during the years 1914–18 belongs to the story of World War I (*q.v.*). By Dec. 1914, 2,413 officers and 66,805 men in the territorials were serving abroad. By April 1917 these numbers had risen respectively to 17,859 and 487,237. Up to the close of 1915, the voluntary direct enlistments in wartime into the territorial force numbered 725,842. Apart from individuals who volunteered for the regular army, the yeomanry provided 1 complete division for oversea service, the territorial force of all arms 24 divisions.

Thirty "new army" divisions were also raised on a plan instituted by Lord Kitchener to supplement the 11 "regular" divisions employed overseas. The need for more troops compelled parliament to pass a conscription measure in March 1916, drafting men between the ages of 18 and 40, though soldiers were not to be sent out of the United Kingdom until their 19th birthday; the maximum age was later raised to 45 and, in 1918, to 50, while, because of the imminent peril, youths of 18 were also sent to fight in France. In Dec. 1918 the British field army comprised 4 mounted and 67 infantry divisions, of which all excepting 1 mounted (cyclist) and 4 infantry divisions were serving outside the United Kingdom. With a total establishment of 256,798, the British regular army began World War I with an actual peace strength of 247,432, an army reserve of 145,347 and "special reserve" of 63,933. The territorial force, with an establishment of 316,094, numbered 268.777. including 766 members of the officers' training corps, also established by Haldane, with an establishment fixed at 1,110. Between the outbreak of war and conclusion of the Armistice, England provided 4,006,158, Scotland 557,618, Wales and Monmouthshire 272,924 and Ireland 134,202 men for the British army, a total of nearly 5,000,000 for the United Kingdom. The total permanent wastage in British (Isles) military personnel up to Jan. 1919 amounted to 1,892,100, including 500,000 killed or died of wounds or other causes overseas, and about 37,000 in the United Kingdom.

Roughly speaking the number of British troops serving in various expeditionary forces at the time of the Armistice in Nov. 1918 may be put at about 2,100,000, with 1,380,000 in the United Kingdom (excluding about 250,000 volunteers), 94,000 in India and 11,200 as garrisons of defended ports. The total was about 3 600,-000. Some idea of the strain brought upon the British army in the days of unrest in the world after the Armistice can be gathered from a return showing that the numbers demobilized up to May 26, 1920, amounted to the vast total of 163,563 officers and 3,595,717 men, altogether nearly 3,660,000; while during the same period grave military responsibilities were undertaken in north Russia (up to Oct. 1919), in east Russia (Vladivostok), in Germany (Cologne area of occupation), in Arabia, in Trans-Caucasia (up to April 1919), in the Caucasus (up to Aug. 1919), in Mesopotamia. Syria (up to Jan. 1920), Palestine and East Africa. involving fighting in most of those areas. as well as in India and in Ireland; and while Britain was still technically at war with Turkey and actively at war with Afghanistan (May to August 1919). The tale is told elsewhere of these operations and of the strain brought subsequently upon the army by operations in India: in attempting to hold neutral zones covering the Dardanelles and Bosporus nhen the Turkish army had been allowed years to recuperate after the conclusion of an armistice in Oct. 1918; in attempting to maintain order in Ireland; and in military activities elsewhere.

Notwithstanding the necessity to preserve order in, and to defend, increased areas of territory in Asia and Africa, it was the policy of the British government for several years following World War I to maintain military forces of minimum strength. It was not until the training season of 1925. when four regular divisions and an extemporized cavalry division took part in army manoeuvres for the first time in 12 years. that normal conditions of peace organization and training again began to prevail. Behind this small expeditionary force stood a reconstituted territorial army of 14 divisions, liable to overseas service in grave emergencies, to which a definite promise had been made that, in such circumstances. they would go as units and not be called upon to provide drafts for the regular army, although that force had lost the special reserve which formed so valuable a feature of the Haldane reforms.

Year by year, however, hope for enduring peace in Europe gradually maned. Great Britain was in the forefront at every attempt to concert international amity, and not even the failure of the Conference for the Reduction and Limitation of Armaments in 1933 sufficed to persuade the country's leaders that the necessity for rearmament was inescapable. Nevertheless, the groning strength of potential adversaries began to make it imperative to introduce into the army some degree of modernization in weapons and organization. The territorial army was accorded full status in 1937, gaining access to the same standards and sources of instruction as the regular army; the following year, after the deeper implications of the Munich pact had been understood, a definite rearmament program was undertaken. Army life was made more attractive to junior officers in 1938, promotion by vacancy up to the rank of major being abolished. every subaltern automatically becoming a captain in eight years and every captain a major in another nine years. Early in 1939 parliament sanctioned the doubling of the strength of the territorial army. and in May of that year Great Britain, for the first time in its history, introduced peacetime conscription, the Military Training act requiring all youths of 20–21 years of age to undergo a special course of training for six months.

THE EVE OF WORLD WAR II

Recruitment and Service.—Until the measure of compulsion introduced in May 1939, all recruiting for the British army had been on a voluntary basis. For the regular army, normal engagements were for long service (12 years with the colours) or short service (in part with the colours and in part, to total 12 years, in the reserve); short periods of enlistment (one to four years) were also possible for all arms. Men enlisting on a normal engagement for general service were between the ages of 18 and 25. For the territorial army, enlistment for all arms was from 18 to 38 years, the term of service being four years; members were required to attend an annual training camp and to carry out prescribed annual drills.

Organization and Strength. — The peacetime composition of the regular army in the United Kingdom (excluding British troops in India) was five infantry divisions (14 brigades); one mobile division (2 cavalry brigades and 1 tank brigade) and 2 anti-aircraft brigades. One anti-aircraft brigade constituted a supplementary reserve, and the territorial army was composed of 12 infantry divisions (36 brigades), 5 anti-aircraft divisions (22 brigades), 1 tank brigade and 3 cavalry brigades. The officers' training corps provided students at schools (junior division) and universities (senior division) with elementary military training to provide a potential reserve of young officers to meet a national emergency.

While the regular army counted 237,736 men on July 1, 1939, the authorized establishment when the year began was 162,707. At that time, the establishment for other troops in Great Britain provided for the army reserve (estimated), 144,000; supplementary reserve, 67,945; territorial army, 249,480; and officers' training corps (officers and permanent staff), 1,034. This made a total of 625.166 officers and men available at home stations.

Colonial Forces.—While the self-governing dominions maintained their own permanent and nonpermanent military forces, Great Britain was responsible for the defense of the colonies and protectorates. On the assumption that reinforcement by sea in times of emergency would always be a practicable proposition, a mere handful of British troops was kept abroad, though permanent forces (in all totalling about 2,000) included the royal Malta artillery and the Hong Kong and Singapore royal artillery. Except that one British battalion was stationed in Jamaica with a detachment in Bermuda, the West Indies, the Americas and the islands in the Atlantic depended for their defense upon volunteer forces. East African possessions had, besides armed native police forces, the king's African rifles and the Somaliland camel corps (regular troops with native personnel), and in Kenya Colony a territorial force in which service was compulsory for Europeans. In West Africa local defense was provided primarily by the royal West African frontier force (also regular troops with native personnel), comprising the Nigeria and Gold Coast regiments, the Sierra Leone battalion and the Gambia company. In South Africa, outside the Union (for which *see* South Africa, Union of); Basutoland and Bechuanaland had native armed police forces. the Rhodesias had white volunteers and Swaziland a British rifle club and native police. Colonial possessions in Asia and islands in the Indian ocean had similar forms of protection. Volunteer defense forces were maintained in Ceylon, Hong Kong, the Straits Settlements and Mauritius; British North Borneo had a police force of various races, liable for military service; the Federated Malay States maintained volunteer forces of Europeans, Indians, Malays and Chinese; and Johore, in the Unfederated Malay States, had native regulars and volunteers as well as a European volunteer corps. In the Pacific ocean, small defense forces and armed police were found in Fiji, the Gilbert and Ellice Islands and the Solomon Islands.

Territories placed under the mandate of Great Britain had restricted defense facilities. Local forces in Palestine and Trans-Jordan consisted of the Trans-Jordan frontier force, a military unit, and the Palestine police and the Trans-Jordan police (or Arab legion), armed constabulary; the Cameroons and Togoland had armed police: in Tanganyika Territory were battalions of the king's African rifles and also the Tanganyika police force.

Egypt, the Anglo-Egyptian Sudan. Aden and the Arabian hinterland are dealt with elsewhere; *see* also the information under India for defense responsibilities that fell upon the British army. In connection with the principle of mutual defense, *see* also Austkai.i.i: Canada; New Zealand; and South Africa, Union of.

Higher Command. — The government of the British army was vested in the crown, command being placed in the hands of the army council. The army council, of which the secretary of state for war was president, included the chief of the imperial general staff, adjutant general, quartermaster general, master general of the ordnance and financial secretary. The war office included the army council, departments, a board for selection of officers for promotion to lieutenant colonel and higher ranks, and the judge advocate general's office. Excepting when in training camps or on actual military service, the territorial army was administered by county associations. The committee of imperial defense, of which the prime minister was chairman, had no executive powers, being an advisory and consultative body concerned with the co-ordination of defense policy.

Military Education. — Principal military educational establishments were the Royal Military academy, Woolwich (for artillery, engineer and signal corps cadets), the Royal Military college, Sandhurst (for cadets of cavalry, infantry and other arms), the Senior Officers' school, Sheerness (for senior regimental officers), and the Royal Staff college, Camberley (for the staff). Various other schools for specialists were also conducted, and an Imperial Defense college in London was for senior officers of the army, navy and air force.

THE ARMY OF WORLD WAR II

On Sept. 3, 1939, the day Great Britain declared war against Germany, the Military Training act of the previous May was superseded by the National Service (Armed Forces) act, which extended the liability for military service to all men between the ages of 18 and 41 years. At the outbreak of war, too, the territorial army, the strength of which had been doubled in the spring of 1939, was merged with the regular army. With the increased demand for men in the armed forces the maximum age for compulsory service was raised from 41 to 51 in 1941, and, in order to provide a pool of partially trained youths, the war office recognized the army cadets and also the junior and senior training corps, which had carried on the work performed prior to hostilities by the officers' training corps. Educational institutions for cadet-officers were closed when war began. Thereafter all commissions granted to officers were temporary and were obtainable only after passing through officer-cadet training units, candidates having to serve first in the ranks. Various independent organizations co-operated with the war office in providing educational facilities of a general nature in all units of the army.

Composition. — The infantry, main bulk of the army, was affected in its work by mechanization. While troop-carrying companies of the royal army service corps transported most of the men, headquarter, company and platoon trucks carried ammunition, tools, heavier weapons and packs. In rifle battalions, carrier platoons were provided with small-tracked, armoured vehicles for light Bren machine guns, tommy guns, anti-tank rifles and two-inch and three-inch mortars. Machine-gun battalions, entirely motorized, were equipped with medium machine guns, and reconnaissance battalions rode in light cars, carriers, motorcycle combinations and motorcycles. The tank corps of World War I was succeeded by the royal tank regiment, and this, in 1939, was united with mechanized cavalry and yeomanry units to constitute the royal armoured corps. Light tanks performed the reconnaissance previously carried out by cavalry; cruiser tanks, more heavily armoured, attacked under mobile conditions of open warfare. and infantry tanks, organized into army tank battalions, assisted infantry attacking enemy positions; armoured car regiments of the R.A.C. were employed in fighting reconnaissance ahead of attacking troops.

With the exception of mule-borne mountain and pack artillery and superheavy guns on railway mountings, all artillery in World War II was mechanized. The field branch, which included anti-tank artillery, supported the armoured and infantry divisions; the anti-aircraft branch had heavy, light and small guns for both static and mobile defense; and the coast artillery branch comprised counterbombardment, close defense and searchlight units. The royal engineers consisted of a field (or combat) branch working with the divisions and corps; line-of-communication troops providing construction, electrical and mechanical services and the like; and transportation services, concerned with railways ports and inland water transport. Companies were also trained in bomb disposal and in the location of anti-tank mine fields. Stemming from the royal engineers was the royal corps of signals, formed in 1920, which operated wire and wireless telegraph and telephone services and also maintained communication by motorcycle dispatch riders and pigeons. The royal army service corps, the supply and transport branch of the army, brought up foodstuffs by land or water, moved the infantry, carried the heavy stores of the engineers and drove the vehicles of the royal army medical corps and the army dental corps (royal army dental corps after 1946). The supply and maintenance of all stores for all units of the army was the primary duty of the army ordnance corps and of the royal electrical and mechanical engineers (separated from the R.A.O.C. and established in Oct. 1942).

The Queen Mary's army auxiliary corps of World War I was the pattern for the auxiliary territorial service, which was organized in 1938 and became the largest of the women's services; it was granted full military status on April 10, 1941, pay being roughly two-thirds that for male soldiers of equivalent ranks. Follouing passage of the National Service act, 1941, single women between 20 and 30 were drafted into the A.T.S. (which became the women's royal army corps in 1949). Besides working as cooks, telephonists and drivers of army vehicles, the women were employed in radiolocation, almost every duty with anti-aircraft batteries except actual operation of the guns, and in kine-theodolite duties.

The local defense volunteers were organized in May 1940 to supplement field troops, and in November were incorporated in the army as the home guard; enrolment became compulsory in March 1942 for all men from 17 to 6j in civil defense regions. Fully equipped, men served a maximum of 48 hours every four weeks, receiving subsistence allowances while on duty but no pay. Their primary role was defense, to delay the enemy until regular formations moved to the attack. Men up to 50 years of age were also enrolled in the pioneer corps (royal pioneer corps after 1946), which built huts and defenses for the army and cleared debris after cities had been bombed; open to alien volunteers, it contained many European refugees.

At the outbreak of war the regulars, with their reserves, and including British components of the Indian army. numbered about 400,000, and a like number was in the territorials. These numbers were augmented by volunteers and conscripts, and though heavy casualties were suffered abroad, the armed forces in Great Britain by the middle of 1942 were put at 1,500,000–2,000,000 men. To compare these figures with those of 1918, when British troops numbered about 3,600,000, would give the impression that the military effort in World War II was far smaller than in World War I. This was in fact the case, the difference being largely accounted for by the enormous manpower required to maintain, equip and supply a modern army and air force. In practice, moreover, the distinction between soldier and civilian had become less important. Whereas munition workers were subject to air attacks and were also liable for part-time service with the home guard, the proportion of enlisted soldiers who actually fought was relatively low, vast numbers of men being needed for administrative and technical work in base areas. The supply of men for actual fighting was exhausted by 1944 and it was found necessary to disband some formations in order that others might be up to something like establishment in 1945.

Preparation. — The expeditionary force which went to France under Viscount Gort in 1939 comprised the 1st corps under Sir John Dill and the and corps under Gen. Alan Brooke (later Viscount Alanbrooke); it totalled ten divisions in all, of which one was motorized. This force showed, if only in its shortage of tanks, the extent to which Britain had thrown away the lead in tank design which had been gained by the end of World War I. In the intervening years the army had suffered from unpopularity, from obsolete equipment, from unrealistic training and from a tactical doctrine which inclined to the defensive. It was almost as much through luck as through judgment that the bulk of the troops mere rescued from Dunkirk beaches when French resistance collapsed. Although the fall of France brought Italy into the war as an enemy, and although most of the British heavy equipment had been lost in the evacuation, the events of 1940 were a blessing in disguise. Instead of becoming involved in another continental war of the 1914–18 pattern, with casualties on a scale which Britain could certainly not have survived, the British army was given the opportunity (as in 1794) to withdraw to the British Isles, re-equip and reclothe itself, retrain its units and revise its ideas. Nor was the opportunity thrown away. For a period the threat of invasion, the guarding of concrete emplacements, the manning of road blocks and the training of the local defense volunteers (later the home guard) took up more time than was otherwise desirable. But as the pressure relaxed the army began to prepare for its future battles. With Sir John Dill as chief of the imperial general staff and Sir Alan Brooke as commander in chief, home forces, the army trained for mobile rather than static warfare. Tactical doctrine was revised in terms of armoured divisions and paratroops, individuals and units were trained in battle schools and the offensive spirit was recreated by the example of the commando units which raided the coasts of occupied France. Even so, it would have taken long to overtake the German lead and longer to regain lost confidence had not the Italian army been met and defeated in Egypt and Eritrea.

Initially, the troops with which Sir Archibald (later Earl) Wavell met Marshal Rodolfo Graziani in Sept. 1940 comprised only three divisions (including one Indian and one Australian), but the prompt collapse of the Italians had a tonic effect on the whole army. It also had the effect of drawing German troops into the African conflict, and it was these, under Field Marshal Erwin Rommel, which turned the tables in 1941, endangering Egypt afresh after troops from there had been diverted to Greece and Abyssinia. The same year, however, saw the whole situation changed by two major events: the German attack on the U.S.S.R. with 150 divisions and the Japanese attack on Pearl Harbor which brought the United States into the war against Germany. This made it possible to gain superiority in one theatre of war in 1942, and Africa was the obvious front to reinforce even if it meant, as it did, sacrificing Malaya to the Japanese. Forces in the Western desert were built up to a strength of two armoured and seven infantry divisions, and it was these, the 8th army, which faced Rommel in August.

Operations. — The results of recent training and re-equipment were shown at the battle of El Alamein soon after Gen. Sir Harold Alexander (later Earl Alexander of Tunis) had assumed command in the middle east with Lieut. Gen. Sir Bernard Montgomery (later Viscount Montgomery of Alamein) as commander of the 8th army. Rommel was defeated and then driven back into Tunisia. Simultaneously, the results of the United States' participation in the war were shown by the appointment of Gen. Dwight D. Eisenho er to a combined Anglo-U.S. command with headquarters at first in London and later at Gibraltar. This was the prelude to the landing of the British 1st army and U.S. 2nd corps in Algeria and Morocco, which began on Nov. 8, 1942. German and Italian forces had now to face pressure from two directions without anything like equality inaircraft. tanks or even infantry. Operations ended with the axis troops surrounded at Cape Bon, and there Gen. D. J. von Arnim surrendered with 250,000 men of May 12, 1943. From this point the British army began to display its historic genius for combined operations but with the added refinements of co-operating aircraft, gliders and paratroops. The introduction of aircraft had tended in itself to solve the problem of command which had so often in the past proved insuperable. The solution found was to appoint a supreme commander with commanders in chief for land, sea and air. This technique was proved in the opposed landings in Sicily (July 1943), which were themselves merely the prelude to the Italian campaign of 1943–45. This campaign was opportunist in character, being designed rather to exploit the collapse of Italy than to defeat the Germans on ground chosen for the purpose. It served to occupy 18 German divisions under Albert Kesselring for months of intense conflict leading up to the capture of Rome on June 4, 1944, two days before the invasion of France began.

While the actual landing in Normandy represented the culmination of British skill in combined operations, the later campaign, after Montgomery's initial success, witnessed the building up of the U.S. forces to a total (by Jan. 1945) of 60 divisions. Montgomery, the land commander under Eisenhower (as supreme Allied commander) until Sept. 1, was responsible for much of the initial success but yielded place to Eisenhower as the forces became, in fact, predominantly American. Meanwhile, on Aug. 15, a fresh landing was made in the south of France which had little effect on the campaign but which deprived Alexander of resources which he needed to finish the campaign in Italy. France was reconquered in 1944 and Eisenhower was on the Rhine early in 1945, with only 56 depleted German divisions to oppose him. The German air force had, moreover, exhausted its last resources in supporting Field Marshal K. R. G. von Rundstedt's offensive in Dec. 1944. The invasion of Germany began in March 1945 and the offensive of the 15th army group began in Italy in April. The German forces crumbled in both theatres of war, their troops surrendering in Italy on May 2, those opposite Montgomery's 21st army group surrendering two days later on May 4.

Commentary.— There can be no doubt that the army had suffered before 1939 from current pacifist talk as well as from peacetime economies. Its initial reverses showed, in some instances, a decline in fightipg spirit. As against that, national education had provided reserves of men sufficiently literate to learn a new trade and learn it quickly. The result was an army of high technical competence, with perhaps too high a proportion of specialized noncombatants and too low a proportion of infantry. But the infantry soldier himself had now to be master of as many as nine weapons and, apart from that, even the fighting units themselves contained a large number of specialized signallers, mechanics and drivers. The outstanding development, as compared with World War I, was undoubtedly in the air, and there were instances, as at Pantelleria, when a ground force was defeated by air power alone. More commonly, however, victories were won by a close cooperation between the troops and their supporting air force, and the army with air superiority had a physical (and, still more, moral) advantage even before battle was joined. The use of paratroops and gliders introduced a new element into warfare without revolutionizing accepted tactics. They were found to be of use only in conjunction with ground forces and when dropped, as at Arnhem, too far from the main columns, they were apt to suffer heavy casualties. What was essentially more revolutionary was the development of a system of air-borne supply. This was first tried in Burma, where the 14th army battled to keep the Japanese out of India and finally to destroy the Japanese forces in Burma itself. Under the supreme command of Lord Louis Mountbatten (later Earl Mountbatten of Burma) and under the immediate direction of Gen. Sir George Giffard and Gen. Sir William Slim, the technique was developed of maintaining communications by air alone. It was found possible to supply a ground force of as much as two divisions for at least a limited period, while columns of brigade strength could operate independently for three months or more at a time—at least when led by as resolute an officer as Brig. Orde C. Wingate. Operations on this small scale were possible only in the jungle, but their success pointed the way to a strategy in which ground communications would no longer play so vital a part. The development of such a strategy on the grand scale had to wait, in effect, until after the war and was exemplified by the air lift supply to Berlin, during what was virtually a siege in 1948–49. The daily average of 4,000 tons of food and fuel was proof of what could be done in this way, and further technical progress might enable a higher total to be reached in time of war.

THE ARMY AFTER WORLD WAR II

With the end of hostilities in 1945 it became clear that certain peacetime changes in army organization would be necessary. In the infantry it was decided to retain the well-tried regimental system. Operational organization — as in the war—was based on the armoured division and the infantry division. It was, however, apparent that for a long time the bulk of the regular army would be stationed overseas — in Germany. Austria, the middle east and the far east. This necessitated the abandonment of the Cardwell system (see above; by which units were linked in pairs, one serving at home and one overseas), which had served so well in the past. Conscription, first introduced in peace in May 1939, was continued, the period being for 2 years (except for a short time when it was 18 months) with the regular army and 3½ years part-time service with the territorial army or army emergency reserve. For the time being the need for a reserve for the regular army was met by the class Z reserve, consisting of fit men of certain age groups who had served during World War II. The territorial army provided most of the units of anti-aircraft command. Its field force units consisted of armoured and infantry divisions, and one air-borne division, organized on prewar lines; but with modern equipment and drawing most of their officers and men from national servicemen who had completed their two-year period of full-time service. The system for the supply of regular officers was changed to the extent that all potential officers had to serve in the ranks, but their training as cadets remained the same. In 1952 the home guard was reconstituted, on a full establishment in vulnerable areas and on a cadre basis in areas of less importance. For ten years this system, with minor modifications, met the country's needs. The main weakness was that, due to heavy overseas commitments, there was no strategic reserve of regular troops in Great Britain. By 1952 the territorial army had, however, been built up to strength by the influx of national servicemen.

By the end of 1954 circumstances had arisen which made a change in organization desirable in both the regular and territorial armies. These changes were necessary as a result of new weapons — nuclear weapons in particular — and changing political conditions overseas, which made essential some redeployment of the regular army. The main changes, which began in 1954, were as follows:

1. New scientific inventions had made existing anti-aircraft defenses obsolete. In 1955 anti-aircraft command was abolished and the anti-aircraft defense of the United Kingdom became the responsibility of the R.A.F. Existing anti-aircraft units — mostly territorial—were either disbanded or converted to other roles.

2. The Anglo-Egyptian agreement of 1954, by which all British troops were to be withdrawn from Egypt within 20 months, resulted in the redeployment in 1955 of army units which had been stationed in the Suez canal zone. A little more than one division was brought home to form the nucleus of a strategic reserve which had been lacking for so long. During the latter months of 1955 and the early part of 1956 part of this reserve had to be sent to Cyprus to deal with terrorist activities.

3. In Dec. 1955 a reorganization and modification in role of the territorial army was announced. Two infantry divisions were put on a "higher" establishment with the role of reinforcing the regular NATO division in the event of war. The remainder were placed on a "lower" establishment, the armoured divisions being converted to infantry and the air-borne division being disbanded—except for one parachute brigade which was retained. The task of the "lower" establishment divisions was home defense, including help in civil defense. They could also be used for expansion in time of war. The necessity for a home guard in war continued to be accepted, but the force was reduced to a cadre establishment.

4. In 1955 there was also a change in the conditions of national service. The two-year period of full-time service was retained, but the age of call-up (previously 18) was to be increased gradually to 19 (by March 1958). There was also a considerable reduction in a man's statutory liability during his three and a half years' part-time service. The latter was acceptable in view of the changed organization and role of the territorial army.

In 1956 the strength of the regular army was approximately as follows: regular personnel 196,000; national servicemen 201,000; women, 6,700. Of these, the equivalent of two divisions were in Great Britain, that of four divisions in Germany and that of about five and a half divisions were elsewhere overseas. As overseas contingents are often in small garrisons, these divisional strengths are approximate. The reserve army included about 264,000 in the territorial army (organized into ten divisions in 1956), about 189,000 in the army emergency reserve and about 6,000 women.

In April 1957 the government announced drastic changes in the fighting services, likely to result in a reduction in strength of the regular army to about 160,000 officers and men and the abolition of the national service call-up in 1960.

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DEFENSE: NAVY

Age of the Rowing **Vessel.**—Although the Romans must have brought to Britain some Mediterranean ideas of seamanship, shipbuilding and navigation, their tradition was subsequently broken, leaving the British to relearn the seaman's art from the Norsemen. Thus. to this day, such basic nautical expressions as "starboard" and "keel" are Scandinavian, and it was probably from the vikings that the 9th-century Britons had learned how to reach the neighbouring shores of France or Ireland. Sea fights are recorded as early as A.D. 833 and 840, but it was not until the time of Alfred the Great that the vikings were defeated (A.D. 878) by their English pupils. The vessels on both sides were at the time propelled by oars, with auxiliary sails, and were accordingly limited in size. Alfred himself possessed several of the larger 60-oared vessels, and the remainder were provided by the coastal shires. Nor was this system much changed at the time of the Conquest, the subsequent Norman kings similarly calling for aid in an emergency. Seaports rendered feudal service in this fashion, their bailiffs or port reeves being made responsible for equipping and manning a stated quota of ships. But the 11th and 12th centuries saw only a limited naval activity, for the kings of England were also dukes of Normandy and ruled both sides of the channel. For the Norsemen they were now clearly too strong. Thus established astride the Straits of Dover, the Norman and Angevin kings had continual need for a ferry service between England and the continent. In return for providing the passage of mails and troops, the port offering the shortest sea routes, the Cinque Ports (*q.v.*), were given special privileges, which they tended to abuse. The situation altered abruptly in 1207 when King John lost his Norman possessions and so brought his frontier back to the French coast line. The straits themselves he claimed as his from 1213 and later kings did the same. With French enemies so near at hand, naval defense became an urgent problem. It is in his reign that we first find mention of an administrative officer (William of Wrotham) called "keeper of the king's ships." These ships, 50 or more of them, were still rowing vessels and intended for use in the channel. They were thus logically based on Southampton, only rarely venturing as far as the Irish sea.

Age of the Sailing Vessel.—English overseas trade (as apart from coasting and fishing enterprise) began in the period after the loss of Normandy when Gascony still remained a possession of the English kings. The coastwise voyage to Bordeaux was thus an overseas but not a foreign voyage, being politically safe and only moderately venturesome as a feat of navigation. It was readily extended, moreover, to Spain and Portugal. the latter country being in normal alliance. These almost oceanic voyages involved the outward shipment of wool and the homeward lading of wine, both fairly bulky cargoes and unsuitable for any vessel which oarsmen could row. There accordingly developed on the Atlantic coast a type of ship in which the only oar was for steering, the ship itself being propelled by a single square sail on a single mast. Such a vessel was primarily a cargo carrier but could be converted into a temporary man-of-war by the addition of a fighting top at the masthead and a wooden superstructure at either end. These additions, being castellated to shelter the archers and crossbowmen, were called castles. The forward platform was thus called—and is still called—the forecastle. The ship was steered from the starboard (or steerboard) side of the aft castle, and it was near the helmsman that the military leader placed himself, making this the captain's part of the ship for centuries to come. During the 13th century the rowing galley and the broad-beamed sailing ship existed side by side, but rowing vessels. scarce in 1327, had disappeared altogether from Edward III's fleet of 1340–50. This Plantagenet sailing fleet had a measure of success but suffered neglect under Richard II (1377–99) and was not re-established in the channel until the time of Henry V (1413–22). He needed control of the channel in order to safeguard his communications while invading France. Such was his military success that his foothold in France seemed permanent, rendering his fleet (which included some large ships) almost needless. But Henry V's continental conquests and aspirations came to nothing under his successor, and the channel became once more the frontier, though with Calais still in English hands. Subsequent development of the sailing warships was steady despite the Wars of the Roses, and Edward IV's ships had three or even four masts instead of the single mast which had previously sufficed. These masts probably developed from flagpoles, the sails multiplying in proportion, and the steering oar gave place to the rudder. Guns were mounted on board English ships as early as 1410 but involved no revolutionary change in design. The established practice was to discharge arrows, bolts and stones and then close with the enemy and finish the action hand to hand. The small guns used in the 15th century merely added variety to the approach phase of the conflict; they did not alter the nature of the conflict itself, and whether the missiles were arrows or gunstones, the ship with the higher castle had an advantage. It was the tendency for these castles to rise to an impressive height, little suited for oceanic voyaging.

The **Tudor** Navy.—English seamen were used to bad visibility and did not expect, as did the Greeks, to be normally in sight of land. They did expect, however, to be within soundings, and it was only with reluctance that they went far outside the belt of shallow water which fringes the coasts of France and Spain. In the great age of Columbus and Magellan, therefore, the oceanic navigators did not come from England but from Genoa, Venice and Portugal. News of the Spanish discoveries led Henry VII (1485–1509) to employ the Genoese Cabots in exploring the North Atlantic, but the results were not obviously remunerative and the first Tudor king spent rather more effort in protecting his own coasts and his own disputed throne. His larger ships, the "Regent" and "Sovereign," were based on his new base at Portsmouth and were not intended for operations outside the channel. The Bristol seamen who had learned how to reach Newfoundland sailed in ships of about 100 tons and would have regarded any larger vessel as extremely dangerous, as on an unknown coast she certainly would have been.

The basis of Henry VII's maritime policy lay in the fact that he had abandoned the Lancastrian policy of invading France and substituted for it a policy of unifying the British Isles themselves. The limit to his marifime enterprise lay in the fact that the two long-distance trades—the trade to the Baltic and the trade to the Mediterranean—were in foreign hands. With the Hanseatic league and the Venetians the English merchants and seamen were in no position to compete. For a permanently strong navy the first necessity was a merchant service, providing funds, recruits and political support. No such merchant service existed and Henry VII limited his effort to what he could afford. His son, Henry VIII, observed no such moderation. His policy was essentially continental and his ships, designed for war with France, were not of an oceanic type. But his despoliation of monastic property gave him ample funds with which to secure the Reformation in England against foreign interference and he used a part of his wealth for that purpose. The result was a fleet, at one time of 85 vessels, with the "Great Harry" as flagship. This force served its immediate purpose but was excessive for the normal revenue of the crown and out of proportion to any trade it could protect. The interest, in fact, of Henry VIII's fleet lies in its organization rather than in its achievement. The mediaeval office of admiral was more legal than military. Various county officials had admiralty jurisdiction over certain stretches of coast line, and the lord high admiral combined a general supervision with legal rights over coasts not otherwise allocated. Only the highest of the nobility could aspire to this office and Henry VIII transferred the strictly naval duties to a deputy, the lieutenant of the admiralty, who was assisted by the treasurer of the navy, the comptroller of the ships, surveyor of the ships, clerk of the ships and general surveyor of victuals for the seas.

In each ship, when manned for war, the crew fell broadly into three divisions, the soldiers, the mariners and the gunners. The first group comprised the captain, the lieutenant, gentlemen, servants and soldiers; the second group comprised the master, pilot, boatswain, carpenter, sailmaker, cook and seamen; the third group comprised the gunner, his mate and assistants. The importance of the gunner increased in this period with the growth in the size of cannon. Larger guns were now being mounted below decks and made to fire through ports cut in the ship's side, an invention with far-reaching consequences but one which it is difficult to attribute to any one country, dockyard or shipwright.

In the later years of Henry VIII and during the reign of Edward VI, there was a tendency to regard Spain as a possible enemy, and this was perhaps reflected in the growth of the dockyards at Woolwich and Deptford and the creation (c. 1550) of the Chatham dockyard with Sheerness fort to protect it. These all faced the Spanish Netherlands just as Portsmouth faced France. The chief arsenal was at Calais, which was lost during the reign of Mary I (1553–58) at a time when England was nearly brought by marriage into the Spanish orbit. The main arsenal was then established at the Tower of London, where it was for long destined to remain. Elizabeth I's reign brought in an anti-Spanish reaction which encouraged private adventurers to raid the Spanish empire overseas. These activities centred on the Atlantic port of Plymouth and were initially bound up with the fortunes and enterprise of the Hawkins family. A feature of one privately organized expedition in 1564–65 was the loan of a queen's ship, the "Jesus of Lubeck" of 700 tons, contrasting in size with the privateers of 30 to 120 tons which accompanied her. One immediate result of this experience coupled with further experience with the "Minion" was evidently a firm refusal to brave the Atlantic again in a ship of that "high-charged" class. John Hawkins' return from a disastrous voyage in 1567–69 coincided with a worsening of relations between England and Spain and led the queen to accept his advice in the matter of ship design. The result was the construction of the 300-ton "Foresight" of 1570, followed by the "Swiftsure" and "Dreadnought" of 1j73 and the "Revenge" (450 tons) of 1575–77. These were ships of the new "Galleon" class, combining the lines of the galley with the strength of a ship, the fire power of the warship with the seaworthiness of the ocean-going privateer. These ships, to be based upon Chatham or Portsmouth, were designed in the light of experience gained at Plymouth. The "Revenge" was thought the perfect galleon and further ships were modelled on her, some older ships being rebuilt on the same lines. The process was intensified when John Hawkins became treasurer of the navy in 1577. With Lord Burleigh's support, he strengthened the defenses of Chatham, reorganized the system of refitting and ensured that the royal ships should be in good order when needed.

Open war between England and Spain broke out in 1585 and Philip II's admiral, the marquis of Santa Cruz, drew up a plan in 1586 for the invasion of England. It involved an expedition from Spain with 60,000 soldiers and 77,000 tons of shipping—a tonnage not in fact available even with ships hired from the Hansa and from Italy. Because of this shortage and Francis Drake's attack on Cádiz in 1587, the Spanish expedition was not ready until 1j88 and even then in a modified form. Instead of transporting an army from Spain, the fleet mas to embark the duke of Parma's army, already in the Netherlands, and land it in the vicinity of Margate. This was a more complicated program than that originally planned, and the whole conception was indeed fundamentally unsound. The two sides were roughly equal in strength and for the one fleet to attempt a landing while the other was undefeated was against all reason. It was not, however, at that time against all experience, for the principles of combined operations had still to be discovered and enunciated. Santa Cruz had died and the duke of Medina Sidonia, commander of the expedition, was hampered by strict orders enjoining him to concentrate on his ferrying task and not so much to overcome naval opposition as to ignore it. But for these orders Medina Sidonia might have surprised the English fleet at Plymouth, where it had been concentrated. Missing his chance on July 19, he was engaged in the channel by Lord Howard of Effingham on July 21 and again on July 25–26. The novelty of the action lay in a tactical device probably attributable to Sir Francis Drake. Whereas the practice in all previous naval engagements had been for the opposing sides to discharge all their guns and small arms and then close with the sword, Elizabeth's fleet never closed at all. The idea was to fight the whole battle at cannon range, making use of English skill in gunnery and preventing the Spanish from deriving any advantage from their superiority as soldiers. While these tactics clearly disconcerted the Spaniards, they produced no very tangible results. It would appear, in fact, that the guns were mostly ineffective at the range chosen. What was more serious, the scale of ammunition carried bore no relationship to this new idea of an artillery duel. There was not enough powder available or even perhaps in existence. The result was an indecisive battle in which the Spanish exhausted most of their ammunition without perhaps being aware of the shortage that troubled their opponents. The successful fireship attack on July 28, which dislodged the Spaniards from their anchorage at Calais, was the more effective in that Medina Sidonia probably thought the fireships explosive; as indeed they would have been had there been the powder to spare. As it was, they broke up the Spanish fleet, which was defeated in the battle of Gravelines on July 29 before any formation had been regained. This reverse compelled Medina Sidonia to lead his fleet round Scotland and so back to Spain without attempting to invade England and without having had the chance to refit, water and reprovision his fleet. As a voyage from Spain to England and back was utterly beyond the storage capacity of his ships, half of them foundered or were wrecked, and of his men only about a third survived the disaster.

The limitations of the Elizabethan navy were soon apparent in the years after 1588. A counteroffensive against Spain failed in 1589. An attempt to blockade the Azores in 1590–91 led merely to the loss of the famous "Revenge," and a new expedition to the West Indies in 1595 led merely to the deaths of both Hawkins and Drake. The Spanish fleet was rebuilt and sent against England again in 1597, only to be scattered by a gale, and Philip II died (while planning another expedition) in the following year. Spanish troops actually reached Ireland and were not evicted until 1601, two years before the death of Elizabeth and the end. shortly afterward, of the war. From all these operations the fact emerged that England lacked the overseas trade upon which its sea power might rest. Only commerce could have sustained a prolonged naval offensive and, lacking enough commerce, efforts at sea dwindled for lack of money, lack of seamen, lack of gunpowder and lack of political support. It was under the Stuarts and during a period of naval decline, from 1603 to 1650, that British trade and colonization grew to the point at which a strong government could maintain a large fleet without incurring financial ruin. But sea power had passed meanwhile to the Dutch, and it was Charles I's attempt to re-establish the royal navy by means of ship money (*q.v.*) that caused, or partly caused, the Great Rebellion. It was the development of shipbuilding and gunnery in his time which made men-of-war (now more fully differentiated from merchantmen) more costly to build and equip. The "Sovereign of the Seas" (of 1637), the first ship to carry heavy guns on three decks, symbolized at once the king's ambitions and a heavy expenditure which lie could not afford.

The Commonwealth Navy.—The effect of the Great Rebellion was to establish, by 1649, a strong government which soon turned into a dictatorship under Oliver Cromwell. Rivalry with the Dutch over trade and fisheries—a rivalry, essentially, for maritime supremacy in a field from which Spain had largely retired and in which French competition had still to arise—was now more possible. Cromwell could impose a scale of taxation (initially on defeated opponents) which Charles I would never have dared to contemplate. The result was a vast building program beginning in 1649 and reaching its peak in 1654. The Cromwellian fleet inherited from Charles I its aspirations and its ship design and from Elizabeth its tradition of gunnery. It evolved for itself, however, its discipline, administration, organization, officering and tactics. The policy was to apply to the navy the reforms which had been applied with such success to the New Model army (see *Defense: Army* above; *see* also CROMWELL, OLIVER). The ships were divided into six rates, each rate with its own establishment and scale of pay. Regulations were made governing prize money, pensions for widows and treatment or compensation for the sick and wounded. By 1656–57 £809,000 out of a total revenue of £1,050,000 was being spent on the navy. Initially the Commonwealth fleet included a number of merchantmen, bought in 1650–51, but these were mostly sold in 1652. Apart from that, the most significant development was the gradual withdrawal of merchantmen from the battle line. They made almost their last appearance at the battle of Scheveningen in 1653, and even before then the fighting had mostly fallen to the two-decked men-of-war of the third rate (of from 44–52 guns). With merchantmen thus eliminated, discipline became easier to enforce on military lines. Remembering, moreover, that it was by strictly maintaining formation that the Cromwellian cavalry had won its battles, the generals at sea (Robert Blake, Richard Deane, George Monk and William Penn) trained the fleet to fight in divisions, each in line ahead. This tactical method produced good results in the battle of the North Foreland in June 1653 and again at Scheveningen, and led to the advantageous peace which ended the first Dutch War in 1654.

The Navy of the Restoration. — The royal navy's continuous history dates from the Restoration of Charles II in 1660 and his establishment of the admiralty office under his brother, the duke of York, as lord high admiral. The outbreak, moreover, of the second Dutch War in 1665 found the fleet organized regularly into three squadrons (the red, the white and the blue), each under an admiral, vice-admiral and rear admiral. The English and Dutch were still very evenly matched, and Charles II drew sufficient revenue from the customs to pay for the upkeep of a regular navy in time of peace. He lacked, however, Cromwell's dictatorial powers in time of war and faced a more complex situation in which the new French fleet, organized by J. B. Colbert between 1660 and 1670, played a distracting role. The Dutch were defeated off Lowestoft by the duke of York, but in 1666 Monk was outnumbered in the Four Days' battle, while Prince Rupert was watching for the French fleet, and suffered a reverse. Recovery was rapid, however, and the Dutch were soon afterward defeated in their turn off the North Foreland. It was at this point that Charles, lacking funds to continue the war, laid up his main fleet in the Medway and began negotiations for peace. The Dutch under Adm. Michael de Ruyter seized their chance and attacked the Thames and Medway, with all the effects of a naval victory. The Peace of Breda was signed in 1667, marking a stage in an indecisive war which broke out again in 1672. This time the French fleet was, through Charles II's diplomacy, on the English side. But the third Dutch War, notable for hard fighting by the duke of York and the earl of Sandwich, was still more notable for the tactical brilliance of De Ruyter, who, outnumbered as he was, avoided defeat and exploited every failure in co-operation between English and French. Although ruined by a process of attrition, the Dutch were still undefeated when Charles II made a separate peace in 1674, leaving the French to continue the war until 1678, defeating the Dutch finally in the battle of Palermo. From the administrative point of view, the Restoration navy was notable for the work of Samuel Pepys (clerk of the acts from 1660, secretary of the admiralty 1673–79 and 1684–88), who established the admiralty as an organization. From this period dates the *Articles of War* of 1661 (governing discipline and courts-martial), the *General Instructions* (of 1663) and the fixing of war and peace establishments in 1677. He was largely responsible for the great building program of 1678–79 and also for the growing tendency to make experience, rather than influence, a claim to promotion. There existed by 1688 a professional body of officers whose service had begun as midshipmen and whose commissions had been granted only after examination. Although most of those who reached flag rank were gentlemen by birth, they had been bred as seamen and are recognizable as naval officers in the modern sense. When the revolution of 1688 brought William of Orange to the throne it was evident that these officers were more loyal to their class than to their king. Adm. Arthur Herbert and Adm. Edward Russell (later earl of Orford) joined the Dutch fleet which brought William to England, and Lord Dartmouth did little to oppose them — perhaps because his officers had been won over by George Byng. The fleet submitted to William III and Herbert (later earl of Torrington) took command of it.

War of the Spanish Succession. — Louis XIV had, in effect, allowed William to sail, thinking to see England plunged into civil war. The suddenness of James II's collapse took him by surprise and he tried to retrieve the situation by recognizing James and launching against William the French navy, at the height of its efficiency (due to Colbert) and fresh from its successes against the Dutch and Spanish. Disaster was barely averted in 1689 and 1690, but Louis failed to use his advantage and, allowing his Toulon fleet to return to the Mediterranean, left the count of Tourville to be defeated by superior forces at Barfleur and La Hogue in 1692. There was no further battle of note and the war ended in 1697. By then it was manifest that Dutch sea power was almost at an end and that maritime Supremacy lay either with England or France. And France was a more formidable opponent, in size and position, than the Netherlands had been. Despite its potential strength, however, the French fleet had been neglected since 1692, so that the outbreak of war in 1701 found Louis in no position to contest British supremacy in the channel. Instead the naval war shifted to the Mediterranean, where the French and Spanish fleets were in alliance. Adm. Sir George Rooke defeated a vastly inferior allied squadron at Vigo in 1702 and acquired in the following year the use of Lisbon as a base for future operations. Making use of this, he captured Gibraltar in 1704 and defeated the allies at the battle of Málaga. The French Toulon fleet was mostly destroyed in 1707 as a result of a combined operation, and this success led in turn to the capture of Minorca in 1708, which fairly interposed British sea power between the two main French bases at Brest and Toulon. This dominating position was still held after the war ended in 1715 and enabled Sir George Byng to destroy a Spanish fleet afterward in 1718. The peace from then until 1739 was a period of vast trade expansion under Robert Walpole's rule. It provided the economic strength for future naval efforts. But the navy itself was neglected, no ships being built after 1722 and peacetime establishments being reduced to a minimum. The older part of the present admiralty building dates from 1723–25, but there is little else to record of this period unless it be the decision taken in 1718 that future promotion to flag rank should be on seniority alone, and the appearance in 1731 of *King's Regulations and Admiralty Instructions.* Both these measures tended, perhaps, to produce an undue rigidity of ideas.

War of the Austrian Succession. — When war with Spain began in 1739, as the result of trading disputes and complaints from British merchant seamen, the earlier operations were relatively unimportant but sufficed to show the extent of British naval decline, especially in the Mediterranean. ,Apart from a voyage of circumnavigation by Commodore George Anson in the "Centurion" (174—44), the war entered its first significant phase in 1744 when France joined Spain and tried to unite its two main fleets at Brest. The Toulon fleet made, with the attached Spanish squadron, 28 sail, and it put to sea with the object of reaching the Atlantic. It was engaged by Adm. Thomas Mathews with a fleet of equal strength, the indecisive action which followed leading to Mathews' court-martial but not to any very useful result. It was not until 1747 that England could provide separate fleets for the channel and for the Mediterranean, and the French had by then ceased to attempt more than small-scale operations. They allowed themselves to be destroyed in detail by Anson and Edward Hawke, scoring their only success when Count Bertrand Mahé de la Bourdonnais took Madras. This war was notable for Lord Anson's work at the admiralty which began in 1744 and continued afterward until 1756 and again from 1757 to 1762. With periods at sea in 1746–47 and again in 1761, Lord Anson did great work in administration and in creating naval tradition. He tightened up discipline, resisted political influence and attempted to reform the dockyards. It was during his period of office that the frigate was introduced, copper sheathing invented (1761), the chronometer made (1761) and uniform clothing, for officers only, made compulsory by an order issued in 1748. More important still were the experiments in gunnery carried out by Benjamin Robins from 1743 to 1750, which eventually led to the invention of the carronade, the priming tube and the gun lock. It was Anson again who originated the system of close blockade. By contrast, he was no tactical innovator and Britain entered the next war with no advantage either in fleet movements or signals.

The Seven Years' War.--France began war in 1756 by a simultaneous threat against England and Minorca, and the invasion scare sufficed to ensure that the reinforcement of Minorca came too late. Vice-Adm. John Byng arrived with a small fleet and fought an indecisive action against a French fleet of equal strength. For failing to save Minorca—for failing, at least, to do all that was in his power to do—Byng was sentenced to death by court-martial and shot. With Minorca lost, Adm. Edward Boscawen had no base other than Gibraltar. He was able, however, to destroy a part of the Toulon fleet at Lagos in 1759. Hawke in the same year destroyed most of the Brest fleet at Quiberon bay. Thenceforward the French fleet counted for little and Great Britain was able to make a clean sweep of the French colonies in Canada, India, West Africa and the West Indies. Spain came into the war in 1762 and suffered for it in the sack of Manila and Havana with heavy naval losses. When the war ended in 1763 the British fleet was practically unopposed. The subsequent years of peace until 1775 saw the consolidation of the British position in India and the development, from 1770, of the trade with China. An empire had been built up on the basis of sea power and was now to contribute largely toward increasing the sea power to which its existence had been due.

The American Revolution.—By 1775, when war began between Great Britain and its American colonies, the royal navy was weakened by neglect and especially by the reduction of the estimates in 1767–69. It was weakened even more seriously by the revival of party politics after the accession of George III, and, once war began, it was weakened most of all by the loss of America itself as a source of manpower, ships, mast timber and naval stores. Britain had turned to North America as its principal source of mast timber in 1652 and was now dependent on New Hampshire for a supply which ended abruptly in 1775. It also appeared that many ships had been hurriedly built of unseasoned timber during the crisis of the previous war. As a result, no fewer than 66 ships foundered during the war, one, the "Royal George," sinking at her moorings. The results of this false economy might not have been serious in themselves but news of the British reverse at Saratoga brought France into the war on the American side in 1779. More than that, the French had rebuilt their navy from 1759 and, during the years 1763–70 (when the duc de Choiseul was in power), had reorganized and retrained their sailors, developing in the process a new system of tactics and signals, the invention of the vicomte de Morogues. To make matters still more serious, the French were presently joined as allies by the Spanish and Dutch. Against this alliance the royal navy was inferior in strength, unable to spare ships for the Mediterranean and slow even to reinforce the squadron in North American waters. Aware of the British shortage of mast timber, the French fired at their opponents' rigging, gaining several tactical successes. The worst period came in 1779 when Sir Charles Hardy with 35 ships was confronted in the channel by an allied fleet of 65. America was lost in 1781 through failure in sea power, and the West Indies were saved at the 11th hour by George (later Lord) Rodney's victory at the battle of the Saints in 1782. India and Gibraltar were both held, though with difficulty, and were still in British hands when peace was made at Versailles in 1783.

The Wars of 1793–1815.—The French Revolution destroyed the discipline and tactical advantage of the French navy and left it almost leaderless in 1793 to face a British navy trained in adversity and yet encouraged by the example of Rodney and Sir Samuel Hood. The French were everywhere defeated by 1796, but then found allies in Spain and Holland, causing the British Mediterranean fleet to be withdrawn. This and the feint against Ireland in 1796 left the French free to invade Egypt. Worse still, the British sailors mutinied in 1797, successfully demanding improvements in pay and allowances. The French failed to seize their advantage, however, and the Spanish and Dutch were severally defeated at Cape St. Vincent and Camperdown. This restoration of the British margin of superiority allowed the royal navy to re-enter the Mediterranean and end the threat to India by destroying the French fleet at the battle of the Nile (1798). Horatio Nelson, the commander in that action, was a tactical innovator and the officer who introduced into sea warfare the ruthless and total destruction which Napoleon had introduced on land. When peace was made in 1802 the French attempts to invade England, Ireland and India (via Egypt) had all failed and a last possible allied fleet—that of Denmark—had been neutralized at Copenhagen in the previous year. The French fleet was still in existence but too closely blockaded to gain experience at sea. As against that, British efforts against France had been ineffective and those against French colonies in the West Indies had been costly in lives.

War was renewed in 1803. Napoleon, having again found an ally in Spain, hoped to combine the French and Spanish fleets and use them to cover an invasion of the British Isles. The complex plan by which he hoped to lure the British fleet away from the channel proved impracticable, and the allied fleet ended not off Boulogne but in Cádiz. Giving up the invasion plan, Napoleon ordered his admiral to sail for Sicily. He did so and was brought to action off Cape Trafalgar in 1805, the allied fleets being defeated at the cost of Nelson's life. But while it is true that the French fleet never risked a general action again in the course of the war, it would be wrong to assume that the French thenceforward had no fleet. They soon had a fleet of some size and it became an object of British strategy to prevent any other fleet's falling into their hands. This policy led to the British capture of the Danish fleet in 1807, the removal of the Portuguese fleet to Brazil and the destruction of the Dutch squadron in Java. The same policy led to the Walcheren expedition in 1809, which failed to destroy the Dutch fleet, and the attempt by Thomas Cochrane at the Basque Roads. Efforts to annihilate every actual or potential enemy fleet were only partially successful, and French shipbuilding was on such a scale as to provide Napoleon with more than 60 sail of the line in European waters even after every effort had been made to reduce that number. But the morale of the blockaded squadrons had gone. By their existence they put a continued strain on British naval resources, but they lacked the experience and confidence needed to give battle even to inferior numbers. The British, by contrast, were by now overconfident, as events were soon to show.

By 1809 it was clear that sea power alone could do no more against Napoleon save through the slow pressure of blockade. By 1810, however, this pressure was beginning to yield results, especially in its effect on Russia. Simultaneously the British army was operating in Spain, and it is the measure of French naval impotence that it could there operate in safety. But the pressure which was felt by Napoleon's allies was also felt by the United States, which finally declared war on Britain in 1812. The operations which followed were unimportant in themselves and even trivial when compared with the simultaneous events in Russia and Europe, but they revealed a fact which had already been demonstrated on a small scale at Mauritius in 1810: that British naval efficiency had declined for lack of a worthy opponent. Nothing in this could affect the result of the war after 1812, which ended in French collapse and peace made triumphantly in 1815. Peace ushered in an era during which the British merchant service found itself with a tremendous initial advantage, with competing merchantmen largely swept from the seas and the trade routes opened, protected and surveyed by the royal navy. Actions such as those at Algiers in 1816 and at Navarino in 1827 showed that British sea power was being, and would be, upheld.

Beginning of the Age of Steam.—The inventions which ended the epoch of the sailing ship had mostly been made before or during the Napoleonic era, but the nature of the war had not called for much mechanical ingenuity and it was left to the next generation to see the transformation begin. The earliest steam vessels to have a revolutionary effect were the tug and the dredger but it was merely a question of time before sailing warships had auxiliary engines. In fact the finest wooden men-of-war (as regards design and material) were built with screw propellers after 1845. The navy of the period 1825–50 did not escape the reforming spirit of the age, the admiralty office being reorganized so as to absorb the navy board in 1832. Still more important was the introduction of the long-service system, creating a body of petty officers and seamen as permanently employed as were the officers of commissioned rank. The training of cadets was also regularized under various reforms culminating in the establishment of H.M.S. "Britannia" at Dartmouth in 1863. In the meanwhile, in 1854, the wooden sailing ships with auxiliary engines had taken part in the Crimean War and gained their first experience of the shell gun, with armour introduced as its antidote. The result of this was the building of the revolutionary "Warrior" of 1860, quickly followed by other ships of the same class. Retention of masts and yards was at first a problem for designers, who had also to plan machinery to work the far heavier guns which had now to be mounted. The broadside arrangement gave place to a central battery type, with a few heavy guns mounted in an armoured citadel in the centre of the ship. This method was in turn superseded by the revolving turret containing one or two heavy guns. The first seagoing turret ships in the British fleet were the "Monarch" and "Captain," carrying four 12-in. guns in pairs in turrets amidships. Both ships were fully rigged and had a large spread of canvas. In 1870 the "Captain," while under sail in the Bay of Biscay, capsized and foundered with the loss of nearly all hands, and this disaster brought about the final abolition of masts and yards. In the next decade a number of different types of ship were evolved in the search for the standard modern battleship, and by 1880 the British battle fleet was a collection of samples, no more than two ships being alike. It became recognized that the strength of a modern fleet depended to a great extent upon the similarity of the units composing it and hence the policy of building battleships and cruisers in classes was instituted. In 1880 the ships of the "Admiral" class, the first group of battleships built as a class, were laid down. With their heavy guns mounted in pairs at each end and a broadside battery of smaller guns, these ships were the prototypes of the battleships of the world for the next 25 years.

Growth of the Modern Navy.—The Naval Defence act of 1889 closed the transition period and laid down a settled building policy for the modern navy. The "Royal Sovereign" class, with the "Hawke" and "Intrepid" classes of cruisers, were the first outcome of the act, and the battle fleet was gradually built up by the "Majestic," "London," "Duncan" and "King Edward VII" classes, which, with their contemporary cruisers, joined the fleet in successive groups, each more powerful than its predecessor. The invention of the watertube boiler, followed by the turbine, and the use of oil fuel revolutionized engineering practice and greatly increased the speed and endurance of all classes of ships. The first destroyer, the "Havock," was built in 1893 and was followed by a host of others of ever-increasing size and speed. Large armoured cruisers came into being, ships of high speed, moderate protection and heavy armament, and 1901 saw the building of the first British submarine. In this department of naval warfare England had been outstripped by France, which had ordered its first submarine as early as 1886. This boat, the "Gymnote," was launched in 1888. Naval science made rapid strides in the closing years of the 19th century, especially in naval gunnery and in the use of the torpedo. Early in the 20th century the German menace, then "a cloud no bigger than a man's hand," was met by the gradual concentration of Great Britain's naval strength in home waters and by increased activity in training and practice.

The "Dreadnought" Era.—In 1906 the whole forces of naval science were embodied in the design of one ship, the "Dreadnought." Built with rapidity and secrecy, she sailed on her trials exactly a year after her first keel plate was laid. A battleship of 18,000 tons and 21 knots, she mounted ten 12-in. guns in five double turrets. In offensive power, protection and speed she eclipsed any fighting ship that had ever been built and she marked a new epoch in warship construction. The "Dreadnought" was followed by nine other ships with the same armament, and in 1910 a new and powerful 13.5-in, gun passed successfully through its trials. With this gun the "Orion," "King George V" and "Iron Duke" classes were armed, and 12 of these ships were in commission by 1914. Meanwhile the armoured cruiser had developed into a new type of capital ship, the battle cruiser, ships with the armament of a battleship, in which protection was sacrificed to speed. Cruiser duties with the fleet devolved upon yet another new type, the light cruiser, which appeared in 1913. These little ships of 3,000 to 4,000 tons were unprotected but had great speed and were armed with six-inch guns. By the middle of 1914 the British fleet was at the highest state of power and efficiency that it had ever attained in its long history. The ships were all that the scientific knowledge of the time could make them, the administration was sound and highly efficient, the dockyards were in first-class order and nothing was lacking to equip the fleet. More important still, the long-service personnel, officers and men, were incomparable and had been trained in the belief that a great war was coming in their time. The high command at sea was in the hands of a band of seamen who, when the test came, proved their worth. Under them, in 1914, the royal navy calmly faced the uncertainties of the titanic struggle before it; for its performance therein reference must be made elsewhere (see WORLD WAR I: Naval).

The Navy After World War I.—At the Armistice in Nov. 1918, more than 1,350 vessels were flying the white ensign, this number including 42 battleships and battle cruisers, with cruisers, destroyers, submarines and gunboats numbering 786 in all. By 1920 the ships in commission had been reduced to 332 and the numbers of officers and men reduced from 407,000 to 176,000. A reduction of this sort was normal at the conclusion of a war, but on this occasion all previous maxims of naval policy were reversed in the name of economy. The superiority in naval strength upon which governments had previously agreed was now abandoned in order to maintain cheaply an equality with the growing navy of the United States. By the same agreement, reached at the Washington conference of 1921–22, Japan, France and Italy were each restricted to a lower scale of naval strength, while Germany was prevented from having more than a skeleton fleet, lacking submarines and aircraft. This agreement marked the end of British naval predominance. More than that, it left the royal navy inferior in strength to an alliance, say, of Italy and Japan. The alliance with Japan was dropped in 1922 as inconsistent with the unwritten alliance now assumed with the United States. By 1931 Japan was counted as a potential enemy and in 1934 the Japanese declared themselves no longer bound by the Washington treaty. In the following year the Anglo-German treaty revived the German navy and completed the process by which the royal navy was rendered hardly superior to the combined navies of Germany and Japan. Britain was thenceforward unable to maintain an eastern as well as a home fleet. If the royal navy were to be engaged in home waters (against, for example, Germany and Italy), India, Australia and New Zealand would be defenseless against Japan. Without the eastern fleet advocated by Earl Jellicoe in 1919, the Singapore naval base, begun shortly after that date, was a provocation to Japan without providing any protection for the countries which Japan might menace.

The. royal naval air service of 1914–18 had subsequently been merged in the royal air force, but the difficulties inherent in a joint control of carrier-based aircraft led to the creation in 1937 of the fleet air arm under admiralty control. Shore-based aircraft operating over the seas remained under the control, however, of coastal command, R.A.F. A short-service branch was created in 1938 to build up a reserve of officer pilots, and naval ratings were allowed to volunteer for service as observer's mate and gunner. The construction of aircraft carriers was pushed forward on a scale which provided seven in existence and five being built when war broke out in 1939. Much was done to develop the fleet air arm, but few senior officers realized to what extent naval warfare was soon to be revolutionized. The question of whether a battleship could be sunk by aircraft was being hotly argued up to the date on which the first capital ships were in fact so lost. At the London Naval conference in 1930 and the further conference held in London 1935–36 it was still being assumed that naval strength was to be measured only in terms of battleships and cruisers. The same assumption underlay the naval limitation treaties with Germany and the U.S.S.R. in 1937.

Table I.—Comparative Naval Strengths at Outset of World Wars I and II

Type	Great Britain*		United States		U.S.S.R.		France		Germany		Italy		Japan	
	Bit.	Bldg.	Blt.	Bldg.	Blt.	Bldg.	Blt.	Bldg.	Blt.	Bldg.	Blt.	Bldg.	Blt.	Bldg.
Capital ships and battle cruisers														
World War I	71	11	35	4	9	11	25	8	39	ro	11	4	20	6
World War II	15	7	15	8	3	1	8	3	5	2	4	4	10	—
Cruisers														
World War I		8	32	—	14	6	27	—	50	6	17	1	21	—
World War II	1	21	37	4	7	2	19	—	7	4	22	5	43	1
Destroyers, torpedo boats, etc.														
World War I			73		132	36	174	3	197			18	109	2
World War II			221		51	6	74	11	36			—	130	10
Submarines														
World War I	75	20	39	12	36	19	67	9	30	?	20	8	15	2
World War II	59	9	94	20	146	20	75	13	56	9	105	9	59	16
Aircraft carriers														
World War II	,	5	5	2	1	1	1	1	—	2	1	—	5	2

*Excluding units of Australia, Canada, New Zealand, India and Union of South Africa.

The Eve of World War II.—Britain was nearly at war with Italy in 1935 over the Ethiopian crisis and the home fleet was dispatched to the Mediterranean. British warships took part in the attempts made in 1937 to prevent the shipment of war materials to either side in the Spanish civil war. Then, at the launching of the German battleship "Bismarck" in 1939, Adolf Hitler declared his intention to build up his submarine fleet to parity with Great Britain. He followed this by announcing his refusal to observe the naval limitation treaty of 1937. By the outbreak of World War II, however, Germany possessed only five capital ships with two under construction, its chief strength consisting of 56 submarines, in which type of warfare it had almost reached the parity with Britain at which Hitler professedly aimed. Had Hitler not been planning a battle fleet, his submarine fleet might have been very much larger. Italy, by comparison, had 105 submarines, but these, like other Italian naval units, were of doubtful quality. The strength of the Japanese navy in 1939–42 was only partly known, and its fighting qualities were difficult to estimate.

World War 11.—When Great Britain declared war on Germany on Sept. 3, 1939, the naval situation was favourable in so far as the Germans were the only opponents. As the German Adm. Karl Donitz confessed in 1945, "Germany was never prepared for a naval war against England. . ." For such a conflict Germany lacked sufficient surface vessels and did not expect submarine warfare. For commerce raiding, it lacked overseas bases, and for warfare in European waters the German navy had no air arm of its own; nor had the *Luftwaffe* been trained for operating against warships. The only area in which the German navy could operate was the Baltic and Scandinavian waters, hedged by various neutralities and well within range of air bases which Germany had or could readily seize.

The royal navy had made preparations for war which included the training of merchant service officers from 1937 and of seamen as well from 1938. On mobilization, 46,000 reservists were called up and large numbers of volunteers (and later, conscripts) accepted for training. Officers were at first taken from the reserves, but in 1940 there was introduced a system of drawing all temporary officers from the lower deck. The women's royal naval service was re-established on lines similar to those of World War I but with wider duties., Women replaced men in small craft and harbour boats and did valuable work as armourers. radio operators. clerks and drivers and as experts in such technical subjects as ciphers, meteorology and aircraft recognition. There was vast expansion of the fleet air arm from its initial strength of 340 first-line sea-borne aircraft, and the far larger numbers of land-based aircraft in coastal command came (in 1940) under the operational control of the admiralty while still part of the R.A.F. for all purposes of administration, training and maintenance.

With surface forces so unequal. operations were at first confined to a strict blockade of the German coast, to which Germany replied by unrestricted (but not at this period very extensive) submarine warfare. One British battleship, the "Royal Oak," was torpedoed and sunk, and several German warships, including the battleship "Deutschland" and the pocket battleship "Admiral Graf Spee," operated against British commerce in the Atlantic.

This phase ended for the time being when the "Graf Spee" was brought to action by three British light cruisers in Dec. 1939 and so damaged that she had to seek shelter in the neutral waters of the river Plate. When ordered by the government of Uruguay to leave, the captain of the "Graf Spee" destroyed his own ship and allowed the crew to be interned. During this phase of the war, with the allied French fleet operating in the Mediterranean, with no open threat in the far east and with the royal navy able, therefore, to concentrate its forces mainly in the North sea and Atlantic, the naval position was satisfactory. It began to deteriorate in April 1940 with the German invasion of Denmark and Norway, and deteriorated more sharply with the adverse results of the war on land. By June the British troops in Europe had been evacuated by means of all the available small craft in southern England, and French resistance had virtually ended in collapse. The immediate results included such heavy losses off Dunkirk and Norway as to reduce the number of British destroyers from 178 to about 100. Almost as immediate was the entry of Italy into the war as Germany's ally. Less immediate, but now inevitable, was the establishment of German bases for aircraft and submarines along the entire coast of Europe from Norway to the Spanish frontier.

The fall of France and the Italian declaration of war deprived Britain of the co-operation of the French navy (9 capital ships, 18 cruisers, 70 destroyers and 100 submarines) while confronting it with a new enemy fleet in the Mediterranean (6 capital ships, 19 cruisers, 49 destroyers and 100 submarines). Worse still was the prospect of the French navy, with its overseas bases, falling into German hands. This had to be prevented. The result was the bombardment of Oran, Algeria, which sank or immobilized four French capital ships in July 1940, followed in September by the damage done to a fourth at Dakar, French West Africa. The other French warships did not, in fact, fall into German hands. Nevertheless, the situation in the Mediterranean, where Britain had no effective naval base between Gibraltar and Alexandria (2,000 mi. apart), was extremely grave. In the Atlantic, meanwhile, a grim war to protect British commerce against submarines and air attack began. With Ireland neutral and its ports closed to the navy, and the eastern British ports under constant air bombardment, the main work of commerce protection had to be divided between Liverpool and the Clyde. Britain itself was threatened, moreover, with invasion and was compelled to deploy naval forces to watch the European coasts from Bremerhaven to Le Havre, which further caused an acute shortage of escort vessels. In fact more than 1,000 British merchantmen had been lost by June 1941, and the situation would have been worse but for the bargain in Aug. 1940 by which the royal navy acquired 50 obsolescent destroyers from the United States in return for the lease of bases in the Caribbean. Apart from this, the navy now made extensive use of two new classes of escort vessel, built more cheaply than destroyers and proving almost as effective for this particular purpose. These were corvettes and frigates, the former very small and slow and not designed—although extensively used—for operating outside coastal waters, the latter more nearly approaching the destroyer in size and armament. These and other escort vessels struggled to protect the convoys in a situation which showed no marked improvement until the autumn of 1942. The later successes against submarines were often the result of action by, or co-operation with, aircraft. Throughout, the royal navy received great help from the royal Canadian navy.

In the Mediterranean the war would have been disastrous had the Italian fleet acted with the enterprise which its strength would have justified. But the Italians did little more than blockade and bomb Malta while trying to intercept British convoys sent to its relief. Their capacity for doing more than this was curtailed in Nov. 1940, when half their capital ships were sunk or disabled by the British fleet air arm at Taranto. Early in 1941 the remainder of the Italian fleet was defeated by Sir Andrew Cunningham (later Viscount Cunningham of Hyndhope). This enabled the Mediterranean fleet to take part in the hunt for the German battleship "Bismarck," which had broken out into the Atlantic. She sank the battle cruiser "Hood" by a hit in the magazine, which blew up, but was disabled by aircraft from the carrier "Ark Royal" and finally sunk by the cruiser "Dorsetshire" after her guns had been silenced "by the greatest concentration of gunfire ever poured into a vessel." Two more German capital ships, the "Scharnhorst" and "Gneisenau," were pinned down at Brest in March 1941 and kept there under air attack for more than ten months. Their escape back to Germany through the English channel in Feb. 1942, though disappointing in itself, reflected the German realization that these ships could achieve nothing in the Atlantic. They had served in the meanwhile to occupy a part of the home fleet and distract British attention from what was happening elsewhere. For while the Mediterranean fleet was cutting the communications of the axis forces in Africa and while the Atlantic fleet was guarding Britain and the western approaches and, after June 1941, escorting convoys which were being sent to assist a new ally in the U.S.S.R., a ne danger had appeared in the far east.

The War Against Japan, 1941–42.—The Japanese entered the war by attacking the United States fleet on Dec. 7, 1941. The effect of Japanese intervention would have been far greater had it taken place before the German and Italian fleets had been largely destroyed. As it was, the mere existence of the remaining German battleship, the "Tirpitz," kept most of the latest British capital ships in the Atlantic. As against that it must be recalled that Japan was to some extent forced info the war by the United States' embargo of July 1941 and the high price demanded by the U.S. for an agreement to cease aiding China and to allow oil to reach Japan. Late as it came, the Japanese attack on southeast Asia fell with terrific force on an area in which no British fleet was stationed. Two capital ships, the "Prince of Wales" and "Repulse," were sent out just before the new war began as the nucleus of a far eastern fleet and "in the hope of steadying the Japanese political situation." It was intended to build up a balanced fleet, based on Singapore, with 7 capital ships and 1 aircraft carrier, 10 cruisers and 24 destroyers. But the Japanese did not allow time for this fleet to assemble. On Dec. 10, 1941, Japanese aircraft sank both British ships and so sealed the eventual fate of Singapore itself in Feb. 1942. The Japanese had 12 capital ships, 43 cruisers, about 6 aircraft carriers, 160 destroyers and 140 submarines. No comparable force could be deployed against them and they were not effectively checked until their aircraft were defeated over Colombo in April. The only other immediate measure was the Allied occupation of Madagascar in May. The operations against Japan in 1942–44 were left almost entirely to the U.S. navy. It was not until late in 1944 that a British Pacific fleet under Adm. Sir Bernard Rawlings (4 carriers, 2 battleships, 6 light cruisers and 17 destroyers) joined the flag of Adm. William F. Halsey (U.S.N.) and took part in air attacks on Japan and Formosa in 1945; and by then the Japanese navy had practically ceased to exist.

Combined Operations, 1942–45.—The temptation in 1942 was to divert British naval effort to the new theatre of war that had been opened in the Pacific and so attempt to protect Australia and India. But the Allied governments wisely decided to finish first what had been so well begun, the destruction (in that order) of the armed forces of Italy and Germany. This would necessarily be a military task in the main but possible only through naval co-operation. Apart from the continued struggle to keep open the Atlantic supply lines, the war was now to comprise a series of enormous combined operations. Efforts began, therefore, to create a vast fleet of landing ships and landing craft, varying in size and design to fulfil many specialized purposes. The Atlantic war had sufficiently progressed to allow of the first great landing operation's taking place in Nov. 1942. This was the invasion of North Africa. It led directly to the axis collapse in Tunisia and the subsequent combined operations which brought Anglo-U.S. forces into Sicily and then into Italy. All these landings in 1943 were supported by the royal navy, and it was under naval protection that the troops landed were afterward supplied. These triumphs of organization and close support were the prelude to examples on a still larger scale of a perfected technique, shown successively on the beaches of Normandy and the south of France. The navy played a vital, if not always spectacular, part in the campaign which liberated Europe. German submarines, deprived of the French ports, made their last efforts from Norway in 1945, but their morale was broken before Germany collapsed.

The War Against Japan, 1944–45.—It is important to remember that whereas Britain entered the war with definite superiority in aircraft carriers, a superiority used with effect against both Italy and Germany, it engaged no navy that was similarly armed. The result was that the royal navy, specializing latterly in anti-submarine warfare and in combined operations, took little part in the decisive campaigns by which the Japanese navy was destroyed. In fact, by Aug. 1945 the Japanese navy had been reduced to a mere fragment, with only four damaged aircraft carriers (and only one battleship) still afloat. The decisive battles of the Pacific war were fought almost solely by carrier-borne aircraft, with opposing fleets which seldom came within range of one another's guns. While it is true (as we have seen) that a detachment from the royal navy served latterly with the U.S. navy, it is also true that during the vital six months and in the battles of the Coral sea and of Midway Island the U.S. navy fought alone. (C. N. P.)

After World War 11.—After the end of hostilities in Europe and the far east the royal navy was reduced in size to meet peace-time needs. In the years 1946 and 1947 not only were the majority of the older vessels discarded, but also some of the units constructed during World War II.

Many ships were broken up or converted to mercantile use, while other ships were acquired by the commonwealth and foreign countries to replace obsolete tonnage. The personnel in May 1945 numbered 778,000. By 1947 this was drastically cut to 150,000. To facilitate this reduction, a great many ships at home and abroad were paid off or greatly reduced in complement, temporarily bringing down the effective strength of the home fleet to one cruiser and four destroyers. By 1955 all battleships were in reserve. There was a maximum strength of 133,000 in April 195j, including complements of royal naval air stations, marine commands and women's royal naval service.

The invasion of Korea in June 1950 caused many ships which had been laid up to be brought forward for service, British ships providing support for United Nations air and land forces.

By 1953 emphasis was concentrated on the construction of mine-sweeping and anti-submarine craft, on aircraft carriers and their jet fighters. The concept of a battle group centred on the

Table 11.—*Comparative Naval Strengths: 1946, 1949 and 1955*

Type	Great Britain			United States			U.S.S.R.		
	1946	1949	1955	1946	1949	1955	1946	1949	1955
Fleetaircraftcarriers	12	6	7	27	28	38	—	—	—
Light aircraft carriers	2			79	9		—	—	—
Escort aircraft carriers					66	66	—	—	—
Rattleships	14	5	5	19	17	14	3	3	3
Cruisers	50	25	25	72	69	74	8	14	28
Coast defense ships and monitors	3	2	...	...	1		...	2	4
Destroyers	182	111	74	364	363	405	50	60	159
Frigates and escort vessels	226	167	231	296	244	277	...	24	48
Submarines	97	68	82	zoo	172	208	100	360	370

modern aircraft carrier with its multipurpose squadron of aircraft was nearing realization by 1956. New cruisers and destroyers would be defended by anti-aircraft guided weapons. The reserve fleet was being reduced to facilitate rapid mobilization, necessitated by the possibility of thermonuclear warfare.

The work of planning a nuclear power plant for the propulsion of warships had started, nuclear power being first employed in submarines.

A fundamental change in the system of permanent cadet entry into the navy was introduced in 1954, after which all cadets of the permanent entry joined in one age group at about 18 to conform with the general trend of educational policy. They were to be trained for about two years at Dartmouth, partly on shore and partly afloat in a small squadron of frigates and mine sweepers.

As a result of the reduction of seagoing appointments for executive officers of the rank of commander and above it became impossible to provide all such officers with sufficient seagoing experience. It was therefore decided to divide them into two lists, the "posts list" and the "general list." Only officers on the "posts list" would be eligible for seagoing command.

Naval estimates steadily increased from £193,000,000 for the year 1950–51 to £401,670,000 for 1956–57.

See also AIRCRAFT CARRIERS; BATTLESHIP; CRUISER; DESTROYER; DOCKYARDS AND NAVAL BASES; FLEET, NAVAL; BUNKERING OF SHIPS; MARINES; MEDICAL SERVICES, MILITARY; SUBMARINE CAMPAIGNS (WORLD WARS I AND II); WORLD WAR I: *Naval;* WORLD WAR II: *The War at Sea.*

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DEFENSE: AIR FORCE

British military aviation began with the creation of a balloon section of the royal engineers, which first saw service in Africa in 1884 and took an active part in the South African War of 1899–1902, where balloons were used for scouting and the direction of artillery fire. On April 1, 1911, the balloon section was expanded into the air battalion, with one balloon company and one aeroplane company. About the same time, the navy permitted a few officers to learn to fly at their own expense at civilian schools. On May 13, 1912, the royal flying corps came into being, with naval and military wings, and a joint flying training establishment was established on Salisbury plain. Meanwhile, the balloon factory at Farnborough had been redesignated the Royal Aircraft factory and turned its attention to the design of airframes and aero engines, of which the BE (Bleriot Experimental) series was in production in time to take part in the early stages of World War I. Pioneer British aviators also turned to aircraft design though they made use exclusively of French engines.

World War I.—On the outbreak of World War I, the royal flying corps, possessing a total of 179 aeroplanes and 1,244 officers and men, sent an aircraft park and four squadrons to France on Aug. 13, 1914. The latter were, at first, used only for reconnaissance and spotting for artillery, but the progress of the war led rapidly to the specialization of aircraft types for fighting, bombing, reconnaissance and photography, while technical advances increased speeds from 70 to 150 m.p.h. and engine power from 70 to more than 400 h.p. before the end of the war. On the naval side, the original naval wing of the R.F.C. had very soon became a separate organization under the title royal naval air service, with its own bomber, fighter and reconnaissance squadrons.

The growth of the air forces and the realization that they had an important role to play independently of the other two services led late in the war to the creation of the royal air force as a separate service, controlled by its own secretary of state and air ministry. On April 1, 1918, the royal naval air service and the royal flying corps were absorbed into the new royal air force, which took its place as the junior partner among the three fighting services. In the last months of the war, a bombing force under the command of Maj. Gen. Hugh Trenchard (later Marshal of the Royal Air Force Viscount Trenchard, first chief of the air staff) carried out strategic bombing of targets in France and Germany independently of the army command.

The strength of the royal air force in Nov. 1918 was nearly 291,000 officers and men. It possessed 200 operational squadrons and nearly 200 training squadrons, with a total of 22,647 aeroplanes. In the course of the war it had suffered nearly 17,000 casualties, of whom more than one-third were killed.

Between World Wars I and II.—As soon as peace came, the royal air force, in company with the navy and army, was drastically reduced, and a peacetime pattern was produced for a service consisting of 33 squadrons, of which 12 were to be stationed at home and 21 overseas. The preponderance of overseas strength as compared with that of the air forces at home resulted partly from the fact that another war in Europe was considered to be unlikely and partly from the system that had been evolved by the air staff of making use of air power as a humane and economical means of maintaining order in undeveloped countries. During the next 15 years, relatively small air forces repeatedly crushed incipient revolts and restored peaceful conditions in Somaliland, Aden and the North-West Frontier Province of India. In Iraq, up to 1932, the R.A.F. assumed sole responsibility for the military control of the country with a force consisting of eight squadrons of aircraft and a few armoured car companies.

To train permanent officers for the general duties or flying branch of the service, a college was opened at Cranwell, Lincolnshire, in 1920 and a staff college at Andover, Hampshire, in 1922 to train staff officers for the home and dominions air forces. The need for specialist mechanics, skilled in the many trades peculiar to aviation, was catered for by the establishment of an apprentices' school at Halton, near Aylesbury, at which boys were received at the age of 15½ for a three years' course.

In order to ensure a constant supply of new pilots a short-service commission scheme was introduced in 1919. Young men were recruited for four years, of which one year was spent in flying training. At the conclusion of their active service, they passed to the reserve of air force officers for a minimum period of four years. The period of regular service was subsequently increased to six years. A medium-service scheme under which officers served for ten years' regular service followed by a period on the reserve was also introduced. In 1925 a new part-time organization called the auxiliary air force was formed; its members undertook flying and other training during week ends and at summer camps. By the outbreak of World War II, this force consisted of a number of fully trained fighter squadrons (together with a large number of balloon units) which did such good service during the war that it was awarded the prefix "royal" in its title at the end of hostilities.

By 1923 the political sky had begun to cloud over, and it was therefore decided to increase British air defenses. A new organization, the Air Defence of Great Britain, was set up in 1925, which was to be built up to a strength of 52 squadrons of bombers and fighters. Delays occurred, however, and in 1933, the year of Adolf Hitler's assumption of power, the R.A.F. possessed only 87 squadrons, regular and part-time, at home and overseas. With a rapidly worsening international outlook, a considerable further increase was undertaken, and from 1936 onward the aircraft industry was rapidly expanded. Among other methods employed, special factories were built at government expense as branch establishments of the existing aircraft construction firms, and motorcar builders turned to the making of aircraft. Meanwhile the R.A.F. volunteer reserve and the civil air guard were created to give flying training at civilian flying schools; university air squadrons in which undergraduates learned to fly and which were a fertile field for regular officers for the R.A.F. had been in existence since shortly after World War I. Balloon barrage squadrons for the protection of cities and other vulnerable points began to be formed in 1936; the observer corps. to give early warning of enemy aircraft attack, had been formed on a voluntary basis as early as 1924; the women's auxiliary air force (the descendant of the women's royal air force of World War I) was created in June 1939 from the (women's) auxiliary territorial service, an army-sponsored body established in 1938 which had recruited special air force companies. (In 1949 the W.A.A.F. resumed its World War I title and became the W.R.A.F.) Finally, though this did not occur until 1941, the air training corps replaced the air defense cadet units and school air cadet corps of the immediate prewar years. The A.T.C. was designed to give suitable boys some preliminary air force training, with a view to eventual entry into the R.A.F. The control of R.A.F. units embarked in naval carriers had long been a matter of controversy between navy and air force, and in 1937 the fleet air arm became an admiralty responsibility, shore-based units for operation over the sea remaining under the air ministry.

World War II.—At the outbreak of war at the beginning of Sept. 1939, the first-line strength of the royal air force in the United Kingdom was about 2,000 aircraft, divided among fighter command, mainly concerned with home defense, though a small proportion of it proceeded to France with the British expeditionary force; bomber command, for offensive action against the enemy; coastal command, consisting of all those shore-based aircraft which worked over the sea in the protection of maritime routes and were placed under the operational direction of the navy in 1940, though remaining under R.A.F. command. There were, in addition, balloon, maintenance, reserve and training commands. The progress of the war involved certain changes in the organization of commands, notably the formation of army co-operation command in 1940 and of ferry command (subsequently expanded into transport command) in 1941. Meanwhile great air forces were built up as required in North Africa, Italy, Burma, France and elsewhere as the tide of war ebbed and flowed in one part or another of the world-wide conflict. By the time the war ended, the strength of the royal air force was 963,000, to which must be added 153,000 women in the W.A.A.F. (For the part played by the R.A.F. in defense of Britain and in service overseas *see* WORLD WAR II: *Air Warfare Over Western Europe, Germany, Mediterranean and Italy.*

In order to provide the large number of air crew required to man the rapidly expanding front-line strength, training schemes in many parts of the British empire were started in the early months of the war. Canada, Australia and New Zealand combined to operate the vast empire air training scheme, under which each dominion agreed to recruit and train pilots, observers and radio operators for service with the R.A.F. Canada also undertook the additional commitment of training personnel sent from the United Kingdom. Similar arrangements were made for the training of R.A.F. air-crew pupils in South Africa and Southern Rhodesia. From June 1941 (before the United States entered the war) to the end of hostilities, British airmen also continued to be trained at a number of service and civilian-operated schools in the United States. Indeed, the United Kingdom forming the main base for air operations against the enemy and being itself under constant threat of air attack, virtually all basic training of air crew had to be carried out abroad. As country after country was overrun by axis forces in the early part of the war, numbers of foreign airmen found their way to Britain, and these were reformed into national air forces under the mantle of the R.A.F. volunteer reserve, which had become the main channel of entry into the service for all officers and men. Such national air forces wore royal air force uniform with a shoulder badge bearing the name of their country. Thus Poles, Czechs, Dutch, Belgians and Norwegians served in homogeneous units side by side with royal air force squadrons. Free French units mere also formed for service under R.A.F. command but retained their own uniform and internal organization.

In the course of the war the technique of introducing troops on special missions behind the enemy's lines, either by parachute or glider, was rapidly developed. The royal air force co-operated with the army in training and transporting parachutists and also in towing gliders, the pilots of which were normally soldiers who had been specially trained as glider pilots. Supplying isolated bodies of troops in jungle and other difficult country and the regular transportation of vast quantities of food, ammunition and even vehicles and guns became regular activities of transport aircraft, which were formed into a separate transport command with detachments as far apart as Canada and Burma.

For the protection of aerodromes against enemy attack a royal air force regiment was formed and trained on commando lines. Armed with anti-aircraft weapons, as well as with the ordinary infantry armament, they were normally under the orders of the commander of the aerodrome, but were so organized that they could fit smoothly into the army command pattern in case of a widespread enemy threat.

Development After World War II.—As a result of the general demobilization in 1945, the strength of the royal air force, including all overseas garrisons. fell to 150,000. The international outlook led, however, to an expansion of the services in 1951 and, with minor fluctuations. it remained thereafter round about 250,000. In 1956 the number of men and women in the service was 257,000, of whom approximately three-quarters were at home.

The wartime organization of the commands was retained, as follows: (home commands) bomber, fighter, coastal, transport, flying training, technical training. maintenance and home commands; (overseas) 2nd tactical air force (Germany), middle east air force and far east air force. In 1956 M E A.F. underwent a major reorganization. consequent upon political developments in that area. With its headquarters in Cyprus, it exercised command over two operational groups, one responsible for the "air control" areas in Africa and the Persian gulf, the other forming the axis of reinforcement in the middle east in case of major war, with air units in Iraq, Jordan, Cyprus and Libya.

The royal auxiliary air force, which had been retained as a fighter force during the period 1945–56, was disbanded in 1957 for reasons of economy. The royal air force regiment continued into peacetime, consisting of rifle and light antiaircraft squadrons. The women's royal air force became a regular arm of the service on Feb. 1, 1949, by virtue of the Army and Air Force (Women's Service) act. 1948. The royal observer corps was also perpetuated as a civilian volunteer force under the operational control of fighter command, with an establishment throughout the country of 28,000 part-time observers and a nucleus of permanent officers. Its strength in 1956 was approximately 20.000.

The air training corps for pre-entry training of boys 14–18 years of age was placed on a peacetime basis, the whole being administered by home command. The corps, organized on a territorial basis, with more than 700 squadrons throughout the country, numbered 36,000 in 1956. Glider training was added to the activities of the A.T.C. and, in 1956, the corps operated 21 gliding schools.

Organization and Training.—*In* the peacetime organization of the service, there are five main branches: genera! duties (flying), technical, secretarial, equipment and R.A F. regiment, with other ancillary branches such as airfield construction, education, marine, medical and chaplains. The normal method of appointment to commissions is through the ranks, but cadets of the R.A.F. college and university graduates are commissioned direct and a certain number of short-service commissions are also available. National servicemen are eligible to present themselves for training as pilots or navigators and are granted national service commissions. They may, if they wish, extend their compulsory service to a total of six years. For other air-crew categories, national servicemen are eligible only if they engage for nine years' regular service. In the ground trades, national servicemen may transfer to a regular engagement of 3 to 12 years.

Selection for air crew is made at the air-crew combined selection centre, Hornchurch. Essex, and preliminary training is carried out at an initial training school, after which the candidate receives his practical air training at a flying school in the United Kingdom or Canada, proceeding thence to an operational conversion unit, before being posted to a squadron. Specialist flying training is given at the central flying school (for instructors) and the R.A.F. flying college.

The needs of the service for long-service, highly skilled mechanics and other noncommissioned tradesmen of various kinds are largely supplied by means of five schools of technical training, of which the oldest-established is Halton, near Aylesbury, Buckinghamshire. There, boys are received between the ages of $15\frac{1}{2}$ and 17, undergo 18 months to 3 years' training and then pass into the service, where they engage to serve for no fewer than 12 years and may continue their service to qualify for a pension.

Equipment. — Though in the air World War II was fought almost entirely with aircraft powered by piston engines, the last year of hostilities witnessed the advent of the newly evolved jet engine. From 1945 onward great progress was made with jets, and the greatly improved speeds and climbing powers of jet aircraft pointed immediately to their value as fighters. Thus it was in this field that re-equipment first took place. By 1956 standard fighter equipment consisted of Meteors and Vampires, Venoms, Sabres and Hunters, and the Gloster Javelin (engined by two Armstrong Siddeley Sapphires) was beginning to come into service as an all-weather fighter. The English Electric twin jet (Rolls-Royce Avons) Canberra had shown itself the most versatile aircraft to be produced since the Mosquito, being in first-line service in medium bomber, photographic reconnaissance, long-range night intruder and high-altitude bomber versions. The bomber force was being built up as a "deterrent," designed to strike quickly at distant targets and to move rapidly from base to base with the assistance of transport command. The so-called "V" bombers were to form the backbone of the force, with Vickers Valiants (four Avons), Avro Vulcans (four Bristol Olympus) and Handley Page Victors (four Sapphires). By the temporary conversion of some of the bombers into tanker aircraft, a considerable portion of the bomber force could be refuelled in flight to give exceedingly long range. Plans had been made to station strategic bomber squadrons overseas in order to give better dispersion against atomic attacks and to bring a greater selection of targets within range.

A number of interesting prototypes were under test during 1956 and level speeds exceeding that of sound were clearly indicated for the next generation of fighters. Much progress had been made in the design of guided missiles and bomber development was predominantly directed toward the carriage of atomic weapons.

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NATIONAL FINANCE

Origins of the Modern System.—During the middle ages there was no distinction between the revenue of the government and the personal income of the sovereign. The king was expected to live and govern on the income from the royal demesne, the yield of import duties, which were either hereditary or granted by parliament for his life, and the fees derived from the administration of justice and the exercise of feudal rights. Other taxes, such as the Fifteenth and Tenth, were granted by parliament in emergencies. The rise in prices during the 16th and 17th centuries made the traditional sources of revenue quite inadequate, and this was one of the main causes of the constitutional struggles between the Stuarts and their parliaments.

Out of these struggles arose some of the main features of the modern system of national finance. It was finally established that the crown could not levy taxes without the authority of parliament. In the words of the Bill of Rights (1689), "the levying of money for or to the use of the Crown by pretence of prerogative without grant from Parliament for longer time or in other manner than the same is or shall be granted, is illegal." It was also established by convention that the house of lords could not amend, though it might reject, a money bill.

The revolution of 1688 also marked the beginning of a distinction between the royal income and the revenue of the government. An act of 1698 granted to William III, "for the service of his household, and family and for other necessary expenses and occasions," taxes designed to produce £700,000 a year, with the important proviso that, if the yield proved greater than was expected, no more than the £700,000 should be spent without the authority of parliament. From this there grew the distinction between the civil list and the supply services. The former included salaries and pensions of judges and other high officials, and it was not until the accession of George IV (1820) that these were separated from the purely personal income (or privy purse) of the sovereign. Expenditure on services not covered by the civil list came to be voted annually by parliament, with the important consequence that it became necessary for parliament to meet every year.

Linked with the annual voting of supplies was the practice of "appropriating" expenditure to particular purposes. This was one of the issues raised in the impeachment of the earl of Danby (1665), and after 1688 it became regular practice. Supply votes and appropriation regulate the making of expenditure, not the raising of revenue, and so parliament came to have a double control over the national finances.

Finance During the 18th Century. — The chief sources of revenue during the 18th century were a land tax, a tax on houses and a great variety of customs and excise duties. These revenues were not nearly enough to pay for the costly wars of the period and so there grew up a permanent national debt. The king had often borrowed in the past, but only for limited periods. The origin of the permanent debt is usually dated from the raising of £1,000,000 by the sale of life annuities in 1692. In 1694 a group of London merchants lent £1,200,000 to the state in return for a charter of incorporation as the Bank of England. The bank made further loans to the government, assumed the responsibility for the issue of exchequer bills and other loans, and also came to act as banker to the government. At the accession of Queen Anne the debt stood at £16,000,000. In 1715 it was £54,000,000; in 1763, £138,000,000; and at the close of the American Revolution (1781), £249,000,000. A considerable part of the debt (Lord North estimated it at £59,000,000 in 1776) was held by Dutch investors. Several attempts were made to reduce the debt. The ambitious plan of the South Sea company failed with the bursting of the South Sea Bubble (1720). Sir Robert Walpole established a sinking fund of £1,000,000 a year, but it was often raided both by himself and his successors. In 1786 William Pitt the younger provided that £1,000,000 a year was to be paid to commissioners for the reduction of the national debt. They were to buy government stock (bonds), which was not to be cancelled but to be held by them, and the interest was to be used to make further purchases. However, the plan had been in operation only seven years when it was overwhelmed by the immense new borrowings caused by the wars of 1793–1815.

The 18th century brought several important changes in financial administration. After 1714, the office of lord treasurer disappeared and was replaced by a body of lords commissioners. From Walpole's time the first lord of the treasury was the prime minister. The chief responsibility for finance fell to the chancellor of the exchequer. These t o offices were combined, but in later times the amount of work falling upon both made it necessary to keep them separate. The junior lords of the treasury hold minor political appointments unconnected with finance.

Walpole simplified the customs duties and introduced bonded warehouses for tea and coffee, but was prevented from extending the system to other goods by the defeat of his excise bill in 1733. In 1752 Henry Pelham converted a large block of different loans into a single issue, which came to be called the consolidated bank annuities, the first "consols." Among many reforms of the younger Pitt was a similar act of consolidation on the revenue side. Taxes which had previously been paid into a number of separate accounts earmarked for special purposes were, from 1787, all paid into a single consolidated fund. out of which practically the whole of government expenditure was paid. Another of Pitt's reforms was the appointment, in 1785, of a body of five commissioners to audit the public accounts.

The Wars of 1793–1815.—The French wars of 1793–181j were far more costly than any which had preceded them. Annual government expenditure rose from less than £20,000,000 in the early 1790s to more than £100,000,000 in 1813–14. The latter sum probably represented between a quarter and a third of the whole national income. In the first few years of war there was little increase in taxation, but after the financial crisis of 1797 greater efforts were made and the revenue rose steadily until, in 1814–15, it provided nearly £83,000,000 out of an expenditure of slightly less than £100,000,000. A landmark in wartime taxation was Pitt's introduction of income tax in 1799. At first the main responsibility for the collection of the tax lay with the general commissioners, recruited from the landed gentry. Gradually, however, a more centralized administration was built up under the commissioners for affairs of the taxes, with the surveyors of the house tax as their agents in the provinces. Another important development was the introduction, in 1803, of taxation at the source wherever possible. With these improvements in administration the yield of the income tax rose gradually to more than £15,000,000 a year, but very heavy indirect taxation was also necessary.

The failure to grapple with the financial problem in the early years had evil results which persisted until the end of the war. The government borrowed large sums from the Bank of England and the reserve of that institution was reduced to a very low level. In 1797 a rumour of a French invasion caused a run on the bank and it was obliged to suspend the payment of its notes in gold. This suspension was confirmed by parliament and remained in force until 1821. Freed from the obligation to pay its notes in legal tender money, the bank pursued the passive policy of discounting all good bills offered to it at the rate of 5%. This rate, though it was the maximum allowed by the usury laws, was far too low to check inflation. By 1814 general prices had risen to about twice their prewar level, while grain prices rose even more sharply as a result of a series of bad harvests. The wartime inflation was accompanied by controversies over monetary policy which had great importance for the development of banking. A significant result in the field of national finance was the passage, in 1819, of an act forbidding the bank to lend to the government for more than three months without the authority of parliament.

During the war the government was obliged to borrow on very unfavourable terms. Some 4% and 5% loans were issued, but the greater part of the borrowing was by means of 3% stock issued at a price of about £60 per £100 nominal value. From the point of view of annual cost to the government in the immediate future, a 3% stock issued at 60 and a 5% stock issued at par come to the same thing; both cost £5 per £100 borrowed. The 5% stock, however, offers far better opportunities for conversion when. as usually happens after the end of a war, interest rates come down.

Another anomaly was the maintainance of William Pitt's sinking fund, augmented by £400,000 a year plus 1% of all new loans. Genuine debt redemption can, of course, come only from a budget surplus. The process of raising new loans to buy back old ones was not only pointless but actually harmful, for the state usually paid rather more on its new borrowing than it saved on the loans purchased by the fund.

The net result of these operations was that, by 1816, the nominal value of the debt had risen to £846,000,000, involving an annual charge of £32,000,000. In relation to the national income the amount of the debt was as great, and the annual charge considerably greater, than that left by World War II.

Finance During the 19th Century.—The first few years after the end of the war were a period of great financial strain. A sharp fall in prices raised the real value of the debt charge and reduced the yield of taxes, and the difficulty of balancing the budget was increased when parliament insisted on abolishing the unpopular income tax in 1816. Gradually, however, the rapidly increasing wealth of the community made itself felt and the budgetary problem became less important. The growth of revenue and expenditure from 1820 onward is shown in Table III.

Table III.—*U.K. Exchequer Receipts and Issues, 1820–1913 (Decennial Averages)*

Financial years	Receipts	Issues	Expenditure as percentage of national income
1821–30	£55,600,000	£55,300,000	—
1831–40	47,200,000	47,800,000	—
1841–50	51,400,000	51,200,000	12
1851–60*	63,700,000	65,700,000	10
1861–70	70,600,000	69,600,000	8
1871–80	77,300,000	76,900,000	7
1881–90	88,200,000	88,100,000	8
1891–1900*	99,700,000	99,700,000	7
1901–10*	143,800,000	159,400,000	9
1911–13	192,600,000	179,700,000	8

*The expenditure figures for 1851–60 include the cost of the Crimean War; those of 1891–1900 and 1901–10 include the cost of the South African War.

The fourth column of Table III has not been completed for the period before 1840 because of the difficulty of making accurate estimates of the national income, and even the later figures must be regarded only as rough approximations. It will be seen, however, that, although expenditure was growing steadily from 1840 onward, the national income was growing as fast, or even faster, during most of the time.

Not only the amount but also the type of expenditure changed considerably during the century. In 1820 national debt charges took £32,000,000 out of a budget of £58,000,000. The army and navy took more than £16,000,000 so that less than £10,000,000 was left for all other services. The national debt charge was gradually reduced by conversions and repayments so that, in the financial year 1913–14, it amounted to only £24,800,000 out of a budget of £197,500,000. The cost of defense had grown, particularly as a result of the naval building program, and amounted to £77,200,000. The state was also beginning to incur substantial expenditure on the social services. Elementary education had been made compulsory in 1880 and free in 1891. The cost was divided between the central government and local authorities, and the share of the exchequer in 1913–14 amounted to £17,500,000. Other new developments included old-age pensions (1908), employment exchanges (1909) and the beginnings of health and unemployment insurance (1911). These services cost £14,600,000 in 1913–14.

Free Trade and Income Tax.—Sources of revenue also underwent a great change. The immediate aftermath of the Napoleonic wars brought the passage of the Corn law of 181j. placing a prohibitive duty on imports when the home price of wheat was less than 80*s.* a quarter (67*s.* for colonial grain), and the repeal of the income tax in 1816. However, disciples of Adam Smith were already creating a strong public sentiment in favour of free trade, which was expressed in a notable petition, drawn up by Thomas Tooke, on behalf of an influential group of London merchants, in 1820. Only minor changes were made during the next 20 years, but in 1840 a parliamentary committee on import duties reported in favour of drastic changes in the tariff. The first thorough overhaul was undertaken in 1842 by the ministry of Sir Robert Peel; William Ewart Gladstone was vice-president of the board of trade and played a leading part in drafting the legislation. Further reductions in duties were made in 1845, and the Corn laws were repealed in 1846. The free trade movement was continued and virtually completed in two further budgets, of 1853 and 1860, for both of which Gladstone was chancellor. The budget of 1860 was associated with the Cobden-Chevalier treaty with France, which gained some valuable reductions in the French tariff. After 1860 there were only 48 articles subject to import duties, out of many hundreds that had previously been taxed. Even these were mostly for revenue rather than protection, as they fell on things that could not be produced at home, and some of them were repealed later. Thus, from 1860 to 1931 Great Britain was virtually a free trade nation.

To compensate for the loss of revenue caused by the 1842 tariff reform, Peel reintroduced the income tax. The tax was intended to be only temporary, but it was never removed again, though it was reduced to only 2d. in £1 in 1874. The growth of expenditure after 1890 raised new budgetary problems and there was also developing a new climate of opinion about the social function of taxation. The incidence of taxation became a subject of keen discussion, and it was generally agreed that taxation should be progressive (*i.e.*, it should take more from larger incomes than from smaller ones).

This attitude was reflected in several changes. In 1894 Sir William Harcourt repealed a number of old duties on property passing at death and replaced them with the simpler and more productive estate duty and succession duty. The latter was paid by the person receiving a legacy and was graduated according to the degree of kinship. The estate duty was levied on the whole estate and varied (according to its value) from 1% to 8%.

The standard rate of income tax was raised and the tax was brought more into conformity with the new ideas of equity by the taxation of earned incomes at lower rates (1907) and by the granting of rebates to persons of small income and for dependents. In the budget of 1909 David Lloyd George introduced the supertax, on incomes of more than £5,000 a year, and the land taxes, an attempt to tax increases in land rents resulting from economic development. The house of lords,. precluded by convention from amending a money bill, rejected this budget. The government dissolved parliament and was returned to power after a general election. The lords then passed the budget, but the government prevented any repetition of the constitutional deadlock by passing the Parliament act of 1911, limiting to one month the lords' right of veto over a money bill. Incidentally, the land taxes, which had been the chief cause of the storm, never worked satisfactorily, and were eventually repealed in 1920.

The National Debt.—During the 19th century the capital value of the debt was reduced by repayments and the interest upon it by conversions. After several modifications, Pitt's sinking fund was abolished in 1829. In its place was put the simple rule that the surplus accruing in any year should be applied to debt redemption, and the sums thus made available came to be known as the "old sinking fund." By 1853 the debt had been reduced to £769,000,000, but the Crimean War raised it by £39,000,000. In 1875 Sir Stafford Northcote introduced the "new sinking fund." A sum of £28,000,000 (later reduced to £24,500,000) was set aside annually for the service of the debt. This was more than sufficient to meet interest payments, and the balance was applied, together with the old sinking fund, to debt redemption. By these means more than £300,000,000 was repaid. The South African War (1899–1902) brought £159,000,000 of new borrowing but, even so, the debt had been reduced to slightly less than £650,000,000 by 1914.

The interest charge was reduced by conversions in 1822, 1824 and 1829. A much larger operation was carried out by Henry Goulburn in 1844, when about £250,000,000 of $3\frac{1}{2}\%$ stock was converted into a new issue bearing $3\frac{1}{4}\%$ for ten years and then 3%. In 1888 G. J. Goschen was able to convert the three per cents into a stock yielding $2\frac{3}{4}\%$ until 1903 and $2\frac{1}{2}\%$ thereafter. These were the 24% consols which formed by far the greater part of the debt in 1914.

Another change of great future significance was the issue of the first treasury bills in 1878. Issued on the advice of Walter Bagehot, the bills were usually for three months and were modelled on the ordinary commercial bill of exchange, so as to enable the government to take advantage of the facilities of the London discount market. The size of treasury bill issues was small until 1914, but it increased greatly during World War I.

The economic importance of the debt was further diminished by the rapid growth of the national income and property. In 1914 the debt was a little over 5% of the estimated value of private property, but nearly half of it was in the hands of official bodies and public institutions. The annual interest charge was barely 1% of the national income.

FINANCE IN WORLD WAR I

World War I raised government expenditure from less than £200,000,000 to a peak, in 1917–18, of nearly £2,700,000,000.

Table IV.—*National Expenditure* **and** *Revenue, 1914–15 to 1919–20*
(In millions of pounds)

Years ending March 31	1915	1916	1917	1918	1919	1920	Total
Expenditure	560.5	1,559.2	2,198.1	2,696.2	2,579.3	1,665.8	11,259.1
Revenue	226.7	336.8	573.4	707.2	889.0	1,339.6	4,072.7
Deficit	333.8	1,222.4	1,624.7	1,989.0	1,690.3	326.2	7,186.4

The figures shown in Table IV include loans to allies and various other items which do not represent actual expenditure in Great Britain. So far as it can be calculated. government expenditure on British goods and services was somewhat more than £9,000,000,000, and at its peak in 1917–18 it formed nearly half the national income. These figures must not, of course, be taken to indicate the cost of the war. They include normal government expenditure which would have taken place had there been no war, and it is impossible to allow exactly for this or for some other corrections that would have to be made. In fact, there is little point in trying to make exact calculations of the cost of World War I, for prices were changing rapidly and consequently money figures cannot have an exact meaning.

In their search for revenue, wartime chancellors relied very largely on heavy increases in the prewar taxes. Income tax was raised to 2s. 6d. in £1 in the autumn of 1914, 3s. 6d. in 1915, 5s. in 1916 and 6s. in 1918. The rate of supertax was also raised until, in 1918, the highest incomes paid 4s. 6d in £1 over and above the standard rate of income tax. There were also heavy increases in the duties on alcohol, tobacco, tea and sugar. In the budget of Sept. 1915, Reginald McKenna made a minor break with the principle of free trade by introducing import duties on motorcars and motorcycles, clocks, watches and musical instruments. The most important new tax, however, was the excess-profits tax introduced in 1915. A standard rate of profit was fixed and all profits in excess of the standard were taxed. The rate of tax was originally 40%, but it was raised to 60% in 1916 and to 80% in 1917. The rise in prices created very large excess profits, and the tax, though it contained many anomalies, succeeded in bringing a large part of these profits into the treasury.

Table V.—*Yield of the Principal Taxes in 1913–14 and 1918–19*

Source of revenue	1913–14	1918–19
Income tax and supertax	£47,200,000	
Excess-profits tax	—	£285,000,000
Alcohol	38,800,000	50,400,000
Tobacco	18,300,000	46,200,000
Tea	6,500,000	16,100,000
Sugar	3,300,000	27,000,000

In spite of these efforts there was a very large budget deficit in each of the years 1914–15 to 1919–20, and in 1917–18 less than 26% of expenditure was covered by taxes. On the whole the proportion of expenditure financed out of revenue was considerably lower than in World War II and even in the Napoleonic wars.

At first the government tried to meet its needs by a series of long-term loans, tiding over the intervals between issues with treasury bills and ways and means advances from the Bank of England. Three great war loans were issued as follows:

Nov. 1914: a 3% loan (1925–28) at 95. The issue was limited to £350,000,000 and was fully subscribed.

June 1915: a $4\frac{1}{2}\%$ loan (1925–45) at par. The issue was unlimited in amount and yielded £587,000,000 in cash and £313,000,000 in conversions.

Jan. 1917: a 5% loan. (1925–47) at 95 and a 4% tax-free loan (1929–42) at par. The issue raised £998,000,000 in cash (including treasury bills surrendered) and £1,130,000,000 in conversions. All except £52,000,000 was in the 5% loan.

An objectionable feature of the borrowing was the right given to subscribers to the first two loans to convert into subsequent issues. and this explains the very large volume of conversions in the third loan. This form of borrowing was becoming very expensive and there were many technical difficulties in transferring such huge sums to the government in a short time. Hence, in 1917, there was a change of policy and no more large long-term issues were made until after the end of the war. Instead, money was raised by the sale of medium-term exchequer bonds and national war bonds, supplemented by treasury bills and ways and means advances. In April 1915 treasury bills were offered "on tap"; *i.e.*, the market could obtain them at a fixed rate at any time and in any quantity, instead of tendering for the fixed amounts previously offered from time to time by the treasury. Later in the war the same system was applied, with great advantage, to the medium-term issues.

The large ways and means advances from the Bank of England were associated with what is generally known as the "special deposits" scheme. Normally the Bank of England allows no interest on money deposited with it, but from 1916 onward it accepted special deposits which it relent to the government and on which it paid interest. One of the main objects of the scheme was to encourage foreigners to hold money in Britain, and from Nov. 1917 special rates were paid on foreign balances and a considerable reduction was effected in the rates for treasury bills and other short-term domestic loans. Another interesting feature of wartime borrowing was the effort made to encourage small savings. These could, of course, be lent to the government through the post office and trustee savings banks, and the second war loan was offered in small amounts through the post office as well as in the normal manner through the Bank of England. In Feb. 1916 there was made the first issue of savings certificates. The subscriber paid 15*s*. 6d. for a certificate entitling him to £1 after five years, but he could claim repayment at any time by the sacrifice of a small part of the accrued interest.

On March 31, 1919, the internal national debt stood at no less than £6,142,000,000. This scale of borrowing was far greater than the normal savings of the public could provide and was bound to lead to inflation. Moreover, there was no chance of the banking system's exercising any curb on the inflationary forces. The outbreak of war caused a crisis in the City, and one of the relief measures was the issue of government currency notes. These notes were formally convertible into gold, but few of the public knew this and, in fact, gold practically disappeared from circulation during the war. The notes were issued through the Bank of England and, until 1919, there was no limit to their amount. A commercial bank which required notes would draw them out and pay for them by a draft on its account with the bank. This sum would then be credited to the currency notes account, invested in government securities, spent by the government, and so would eventually come back to a commercial bank and be paid back into the Bank of England. Thus the banks, collectively, could always add to their holding of currency notes without causing any permanent decline in their other assets. So long as this was so, there was no possibility of inflation being checked by a shortage of legal tender money and a consequent curtailment of bank lending.

Prices rose sharply during the first two and a half years of the war. During 1917 and 1918 a comprehensive system of government controls was built up and this checked the price rise, but only at the cost of building up reserves of unused purchasing power which caused a further price rise in 1919–20 after most of the controls had been removed. Even so, by the end of World War I prices had doubled as compared with 1913, the volume of bank deposits had nearly doubled and the volume of legal tender money in circulation had more than doubled.

Pegging the Exchange.—Another problem of war finance was that of providing for purchases abroad, both British and Allied. Large loans were made to dominion and Allied governments to help finance their purchases in Great Britain and in neutral countries. The principal borrowers were Russia, France and Italy. Total lending up to March 31, 1919, was £1,741,000,000, of which £1,415,000,000 went to these three countries.

Thus Great Britain had to provide foreign exchange to cover both its own purchases and many of those of its allies in neutral countries. Imports were strictly controlled but, even so, drastic measures were necessary. From the autumn of 1915 the U.S. dollar exchange was pegged at a rate of $4.74 to £1 (as compared with a prewar par of $4.85). In order to maintain this rate, the government had to be prepared to sell dollars whenever private supplies were insufficient to meet demand. To obtain the necessary dollars, gold was shipped to the United States, more than £500,000,000 of British-owned securities were sold in the United States, and a number of loans were floated on the U.S. market. The situation was eased by the entry of the United States into the war in April 1917. British requirements in dollars were met by direct loans from the U.S. government, which also took over responsibility for Allied purchases in the United States. Smaller loans were also floated in other countries. Total foreign borrowing up to March 31, 1919, was £1,365,000,000, of which £841,000,000 was a direct liability to the U.S. government.

THE INTERWAR PERIOD

The finance of the period between World Wars I and II was different in many respects from that of the years before 1914. Before World War I government expenditure had never reached £200,000,000 a year; the lowest figure of the interwar period was £778,000,000 in 1933–34. Prices remained well above their prewar level, but even allowing for this there was a great increase in the scale of government expenditure. In 1913 it amounted to about one-twelfth the national income; during most of the period from 1920 to 1939 it was about one-fifth. The national debt had also become of much greater economic importance. Its nominal value had been raised to nearly ten times that of 1914, and it has been estimated that in 1924 government securities in private hands amounted to about a quarter of the value of all private property, The debt was also held to a much greater extent than formerly by banks and other financial institutions in the City of London, and so government policy with regard to it had a profound effect upon the whole capital market.

This policy was largely determined by the general monetary policy of the country, and this, in turn, was subject to two often-conflicting influences, the demands of the international situation and the needs of domestic industry and trade. The wartime inflation, the dislocation of trade caused by World War I and the loss of foreign investments all created difficulties in balancing international payments and tended to impair the exchange value of sterling. The traditional remedy for these ills was a policy of high interest rates and credit stringency. It was generally agreed, however, that such a policy was discouraging to domestic industry and, with unemployment rates ranging from 10% to more than 20% of the insured labour force, this was a powerful argument against it.

Return to the Gold Standard.—During the war gold had practically disappeared from circulation and in 1919 its export was prohibited. It was generally agreed, however, that national policy should be directed toward a return to the gold standard, with sterling at its prewar value, as soon as possible. The abandonment of many wartime controls in the spring of 1919 was followed by a very sharp rise in prices. The Economist index (1913 = 100) rose from 212 in March 1919 to 314 in March 1920. The bank rate was raised to 6% in Nov. 1919 and to 7% in April 1920, and it was maintained at this penal level for more than a year. In Dec. 1919 a treasury minute fixed a maximum issue of currency notes for 1920 and provided for a gradual reduction of the note issue by declaring that the actual maximum of any one year should be the legal maximum for the next year.

These measures broke the postwar boom, but only at the cost of creating very heavy unemployment. However, during the years 1923–24 there was a gradual improvement both in domestic trade and in the exchange value of sterling, and, in the budget speech of April 1925, Winston Churchill announced the return to a gold standard. Gold coins were not to be issued again, but the export of gold was permitted and the Bank of England was to buy and sell gold bullion at the prewar price. Thus gold was made freely available for international transactions. and this was sufficient to fix the exchange value of the pound at its prewar level. Three years later (1928) the currency note issue was transferred to the bank.

The Bank of England found it far from easy to maintain its gold reserve, and from 1925 to the end of 1929 the bank rate varied from 4% to $6\frac{1}{2}$%. It was reduced in the early stages of the depression of 1930–31, but the financial crisis of 1931 caused a rise to 6% and led to abandonment of the gold standard in September.

Cheap Money.—The end of the gold standard brought the beginning of a long period of "cheap money." The bank rate had fallen to 2% by June 1932 and it remained there, apart from a very short time at the outbreak of World War II in 1939, until Nov. 1951. In order to give some stability to the foreign exchange market. the exchange equalization account was set up in 1932. The account began operations with a capital in treasury bills. When it was desired to check an increase in the exchange value of sterling, the account would acquire sterling by disposing of its treasury bills and would then sell this sterling in the foreign exchange market for gold or foreign currencies. When once a reserve had been built up, the account was in a position to reverse the process and could check an undesired fall in the value of sterling by selling gold and foreign currencies. The proceeds of such sales would again be invested in treasury bills. Bills were issued to the account and to other government departments "on tap," though the tender system had been resumed for other buyers. The account thus made possible large international gold movements without any effect on the reserve of the Bank of England. It insulated the banking system from the effects of fluctuations in that reserve, which would have been felt under a gold standard, but its operations created an important new influence, particularly in the market for government securities.

Management of the Debt.—The big problems of debt management were the payment of the medium-term issues as they matured and the reduction of the floating debt (the very short-term debt consisting of treasury bills and ways and means advances). A victory loan was offered in June 1919, consisting of a 4% funding loan (1960–90) at 80, and 4% victory bonds, repayable at par by annual drawings, at 85. The issue raised £574,000,000 in cash and £192,000,000 in conversions, which was generally regarded as disappointing. The very high interest rates of 1920 made conversion operations impossible, but in 1921 a new $3\frac{1}{2}$% conversion loan (redeemable after 1960) was offered to holders of national war bonds on terms corresponding to a price of 62. The first offer was unsuccessful, but in later years a substantial amount of this loan was issued on terms much less unfavourable to the government. In July 1921 a new medium-term treasury bond was issued and this again was followed by further issues of the same kind. Holders of national war bonds also had the option to convert into 5% war loan (on the terms of the 1917 issue) and during 1923–24 a considerable amount was so converted. Other substantial issues were a $4\frac{1}{2}$% conversion loan (1940–44) in 1924; 4% consols in 1927; and a 5% conversion loan (after 1944) in 1929.

The impact of the cheap money policy was seen at once in the conversion of the 5% war loan into a $3\frac{1}{2}$% loan in 1932. Out of more than £2,000,000,000 only £163,000,000 had to be paid in cash. The money for this and some minor operations was raised by the issue of a 3% conversion loan (1948–53) and by two new treasury bond issues, a 3% bond (1933–42) and a 2% bond (1935–38). The downward trend in rates continued, and during 1935-36 a funding loan (1956–61) at $2\frac{1}{2}$% and a new series of treasury bonds (1939–41) at only 1% were issued. At the end of the interwar period, rearmament led to fresh borrowing, including the issue of $2\frac{1}{2}$% national defense bonds (1944–48) in the financial year 1937–38 and a 3% national defense loan in the following year.

These operations reduced the annual charge on the national debt from nearly £350,000,000 in 1920 to £212,000,000 in 1934. On the other hand, there was little net repayment of debt. The budget of 1923 provided a new sinking fund to replace that of 1875, and to incorporate payments due on the U.S. loan and various special sinking funds created in connection with some of the wartime loans. A budget surplus was still to be applied to debt redemption, but for the period as a whole the net surplus was very small. The nominal value of the debt, influenced by conversions as well as by repayments, was £7,247,000,000 on March 31, 1939.

The general tendency of these operations was to increase the amount of long-term and medium-term debt and to reduce the amount of short-term debt, and this tendency was accentuated by the fact that the exchange account and other official institutions were large holders of treasury bills. The result was an important change in the pattern of interest rates. Short-term rates always fluctuate more than long-term rates, but until 1921 there had been a close correspondence between the yield of long- and short-term loans averaged over a period of several years. About 1921, however, a gap appeared, and it was widened considerably by the cheap money policy. Short-term rates fell much more than those on longer-term loans, and in the years 1932–38 the average yield of consols was 3.3% and the average rate of discount on treasury bills was only 0.8%. The main item in the external debt was the loan, nominally payable on demand, from the U.S. government. By 1923 this amounted, together with accrued interest, to nearly $4,000,000,000. To set against it, Great Britain had nearly double this amount in loans to allies and in its share in German reparations. In 1923 an agreement was made for the repayment of the U.S. loan, with interest, over a period of 62 years by annual instalments of $161,000,000 for the first ten years and $184,000,000 thereafter. The international economic crisis led to a one-year moratorium (the Hoover moratorium) in June 1931. Germany did not resume reparations payments and Great Britain, unable to collect payment from its debtors, made token payments on the U.S. loan until Dec. 1933 and then ceased.

Revenue and Expenditure, 1920–39.—Government expenditure was maintained far above its prewar figures partly by the heavy debt charge and partly by the growth of expenditure on the social services. The unemployment insurance scheme was greatly extended in 1920. The revenue of the insurance fund was derived from contributions by employers, employees and the state, but with the very heavy unemployment from 1921 onward the fund fell increasingly into debt. In 1926 a contributory scheme was started for widows', orphans' and old-age pensions, and in 1934 the unemployment fund was put on a sound financial basis by the limitation of the period for which insurance benefit could be drawn. Those who had been unemployed so long that they had exhausted their benefit rights were transferred to a new body, the Unemployment Assistance board. This board (later simply the Assistance board) drew its revenue entirely from the state. The cost of education also increased, and these services accounted for 15.5% of the budget in 1927–29 and for 24.9% in 1935–37. Comparative figures of the main items for these years and for the years 1947–48 to 1951–52 are shown in Table VI.

TABLE VI.—*Expenditure (Exchequer Issues) of the United Kingdom; Averages of Financial Years*

(*In* millions of pounds; percentages in parentheses)

Item	1927–28 to 1929–30	1935–36 to 1937–38	1947–48 to 1951–52
Interest on debt	283.3 (34.2)	212.9 (24.0)	488.6 (13.6)
Defense	114.6 (13.8)	173.6 (19.6)	847.1 (23.6)
Education	50.9 (6.1)	59.2 (6.7)	232.7 (6.5)
Health, labour and insurance	78.2 (9.4)	161.6 (18.2)	710 0 (19.8)
Pensions (war)	59.0 (7.1)	44.9 (5.1)	93.6 (2 6)
Other expenditure	242.7 (29.3)	236.2 (26.6)	1,213.6 (33.8)
Total*	828.7	887.0	3,585.6

*Totals may not add because of rounding.

This heavy expenditure made it necessary to maintain many taxes at or even above their prewar level. The chief exceptions were the excess-profits tax (abolished in 1921) and the "breakfast table" duties on tea, coffee. cocoa and sugar, which were substantially reduced. The standard rate of income tax never fell below 4*s.* in £1, though considerable relief was given to incomes at the bottom of the taxable range by a new system of allowances introduced as a result of the recommendations of a royal commission in 1920. Surtax was slightly reduced in the lower ranges, but increased in the higher ones, and estate duties were raised on several occasions.

TABLE IX.—Government Expenditure on Goods and Services

(In millions of pounds)

Expenditure	1939	1940	1941	1942	1943	1944	1945
Government expenditure on goods and services	1,286	3,213	4,349	4,702	5,254	5,249	4,450
Less borrowing abroad and sale of foreign assets	250	804	816	663	680	659	875
Less domestic disinvestment	..	212	314	298	302	403	..
Provided out of current production	1,036	2,197	3,219	3,741	4,272	4,187	3,575
Plus domestic investment	299	..	..	..	..	..	121
Plus private consumption	4,379	4,627	4,828	5,133	5,218	5,474	5,884
Total production	5,714	6,824	8,047	8,874	9,490	9,661	9,580

Duties on tobacco and alcohol were sharply increased in 1920 and, in spite of slight reductions later, they remained above their wartime level.

The most important new taxes were the duty on hydrocarbon oils. which became an important source of revenue with the growing use of the gasoline engine, and the protective tariff. The McKenna duties were retained from the war and a few other protec-

TABLE VII.—*Revenue (Exchequer Receipts) of the United Kingdom; Averages of Financial Years*

(*In* millions of pounds; percentages in parentheses)

Item	1927–28 to 1929–30	1935–36 to 1937–38	1947–48 to 1951–52
Customs	116.8 (14.0)	209.8 (23.4)	866.2 (20.6)
Excise	133.6 (16.1)	110.0 (12.3)	709.5 (16.8)
Estate duties	79.2 (9.5)	88.3 (9.8)	186.3 (4.3)
Income tax and surtax	299.6 (36.0)	318.3 (35.5)	1,545.8 (36.7)
Excess-profits tax and profits tax	— —	— —	289.5 (6.9)
Other revenue	202.2 (24.3)	170.3 (19.0)	619.8 (14.7)
Total*	831.4	806.7	4,212.0

*Totals may not add because of rounding.

tive duties were introduced under the Safeguarding of Industries act, 1921. The main fabric of free trade remained, however, until 1931 when, as a result of the economic crisis, a duty of 50% ad valorem was hurriedly imposed on imports of manufactured and semimanufactured goods. It was still regarded as politically undesirable to tax most basic foods and raw materials, but the import of many of these was curtailed by quota restrictions. The new tariff was intended to be protective rather than revenue-producing, and at first the yield was small. It increased with the revival of trade in the late 1930s and in 1938–39 it amounted to about £35,000,000.

WORLD WAR II

The finance of World War II was greatly influenced by previous experience and by those developments in economic theory particularly associated with the name of J. M. (later Lord) Keynes. Keynes asserted that the dominant influence on the rate of interest aas the supply of and the demand for money in relation to the supply of and the demand for various types of security. Hence, by varying the quantity of money, and by adjusting its borrowing policy to meet changes in the demand for different types of security. the government could, within very wide limits, determine the rate of interest.

The truth of this was demonstrated during the 1930s and. later, by the way in which the vast government loans of 1939–45 were floated at rates very little above those of 1932–38.

Another development intimately associated with Lord Keynes was the use of national income statistics as an aid to budgeting. This led, in 1941, to the publication of the first White Paper, *An Analysis of the Sources of War Finance and an Estimate of the National Income and Expenditure*. The White Paper was continued annually, dropping the first part of its title at the end of the war but otherwise expanding steadily in scope and detail. In his budget speech of 1941 Sir Kingsley Wood used these estimates to calculate the "inflationary gap"; *i.e.*, the gap between the estimated spending, public and private. for the year and the current value of the goods that would be available for purchase. By incurring a budget deficit, the government takes less from private incomes than it spends; unless this difference is made up by normal savings, total spending will exceed the current value of goods coming to market and prices will tend to rise.

TABLE VIII.—Revenue and Expenditure During the Years 1939–40 to 1945–46

(In millions of pounds)

Year ending March 31	1940	9	1942	1943	1944	1945	1946	Total
Expenditure.	1,408.2	3,970.7	4,876.3	5,739.9	5,909.3	6,179.5	5,601.1	33,685.0
Revenue	1,134.7	1,495.3	2,174.6	2,922.4	3,140.2	3,354.7	3,401.2	17,632.1
Deficit	273.5	1,475.4	2,701.7	2,817.5	2,768.1	2,824.8	2,199.9	15,052.9

For government revenue and expenditure *see* Table VIII. Not all that expenditure was met out of current production. Some of it had its counterpart in borrowing abroad, and sale of foreign assets or the postponement of repairs and replacements to domestic capital equipment. The orders of magnitude of these are shown in Table IX, compiled from the national income White Papers.

The figures are for calendar years, not financial years, and government expenditure includes that of local authorities, but takes account only of expenditure on goods and services and not of transfer payments. From these figures it would appear that about 45% of current production was used by the government. It must be remembered, however, that the value of private purchases was swollen by heavy indirect taxation. If this is allowed for, approximately half of current resources was taken by public expenditure. Production was increased by the virtual disappearance of unemployment, by the conscription of married women and others not normally in the labour market, and by longer hours. Even so, a curtailment of personal consumption was necessary, and the real value of personal spending (after allowing for the rise in prices) was about 15% less from 1941 onward than it had been in 1938.

The actual diversion of resources from private use to war purposes was made by direct government controls and, to that extent, finance was reduced to a subordinate role. The main problem of the chancellor was to see that the private sector of the economy was not left with so much income as to create an intolerable pressure on the controls. It was here that the concept, already mentioned, of the inflationary gap assumed its importance.

Wartime Taxation — Taxationwas increased much more drastically and at an earlier stage than in World War I. A supplementary budget in Sept. 1939 raised the standard rate of income tax to 7s. in £1 and that of supertax to 9s. *6d.* in £1, over and above the standard rate on the highest incomes. It also imposed an excess-profits tax of 60% and raised the alcohol and tobacco duties.

The standard rate of income tax was raised to *7s.* 6d. in the first budget of 1940, 8s. 6d. in the second and 10*s.* in the budget of 1941. Together with the surtax of gs. *6d.*, this meant that the highest incomes were paying a marginal rate of 19*s.* 6d. in £1, and there was a virtual income ceiling at about £6,000 a year after tax had been deducted. Allowances were also reduced and this, together with the rise in earnings, meant that many weekly wage earners became liable to tax for the first time. It was possible to collect the tax efficiently by deducting it from wages on the "pay as you earn" principle, adopted in 1940 and extended to salary earners as well as wage earners in 1944.

Excess-profits tax was raised to 100% in 1940, and the taxes on beer and tobacco were raised in each of the years 1940 to 1943. Entertainment duties were also increased sharply. The most important new tax was a purchase tax on a wide variety of luxury and semiluxury goods. It was introduced in the second budget of 1940, at rates varying from $12\frac{1}{2}\%$ to $66\frac{2}{3}\%$ of the wholesale value of the goods, and was later raised to 100% on some articles. The main fabric of wartime taxation had thus been completed by 1941 and, apart from some increases in indirect taxation, later budgets made few changes. On the other hand, the yield of all taxes rose steadily with the rise in prices and money income.

Of a total increase in revenue of £2,400,000,000 between the two

TABLE X.—*Yield of the Major Sources of Revenue in 1938–39 and 1945–46*

Source of revenue	1938–39		1945–46	
	Million pounds	Percentage	Million pounds	Percentage
Income tax and surtax	398.8	39.6	1,442.2	42.2
Estate duties	77.5	7.7	119.6	3.5
Excess-profits duty ahd national defense contribution	22.0	2.2	465.7	13.7
Alcohol	110.8	11.0	385.3	11.3
Tobacco	84.8	8.4	416.3	12.2
Other customs and excise	144.9	14.4	190.9	5.6
Purchase tax	—	—	118.3	3.5
Miscellaneous	168.0	16.7	273.0	8.0
Total	1,006.8	100.0	3,411.3	100.0

years shown in Table X, more than £2,200,000,000 came from five main sources: income tax and surtax, excess-profits duty, alcohol, tobacco and purchase tax.

It was generally agreed that one of the main risks of inflation lay in the so-called "vicious spiral" of rising prices leading to increases in wages which caused a further rise in prices, and so on. An extensive system of price control was adopted, and in 1940 the government began the payment of subsidies to offset the rise in import prices of certain basic foodstuffs. In the budget of 1941 the chancellor announced the continuation and extension of this policy in order to keep the cost-of-living index at not more than 25%–30% above the prewar level. In return he appealed to the trade-union movement for moderation in wage claims. The index was stabilized (though the prices of some things not represented in the index rose considerably) and moderation in wage claims was secured, but the cost to the exchequer rose to more than £270,000,000 in 1945. Another novel feature of Sir Kingsley Wood's remarkable 1941 budget was the introduction of a system of forced saving advocated by Keynes. Income-tax payers whose payments had increased because of the reduction of allowances were to have the increase recorded as a "postwar credit" in the post office savings bank. Members of the armed forces were to receive a small part of their pay in a similar credit, and 20% of payments of excess-profits duty (less the appropriate income tax) were credited to the firms concerned for postwar reconstruction.

Wartime Borrowing.—In spite of these heavy increases in taxation, borrowing on an unprecedented scale was necessary. The internal debt rose from £7,247,000,000 on March 31, 1939, to £23,372,000,000 on March 31, 1946. Monetary policy was directed toward enabling the government to borrow on the cheapest possible terms. At the outbreak of war the gold reserve of the Bank of England was transferred to the exchange account and the fiduciary issue was raised to £580,000,000. Further increases followed whenever the reserve reached an inconveniently low level, and by July 1945 the issue had reached no less than £1,350,000,000. Freed from anxiety about its own reserve, the bank proceeded to confer the same freedom on the rest of the banking system and the money market by buying all bills offered to it through its official broker (usually known as the "special buyer"). Thus the banks were able to replenish their reserves at will, just as they had been in World War I, though the mechanism was different.

The treasury did not make the mistake, made in the previous war, of offering large blocks of long-term loans. There was an issue of £300,000,000 of 3% war loan (1955–59) in March 1940, but the other important issues were all "on tap" and were carefully adjusted to meet the needs of all types of investor. During the period from March 1939 to March 1946, treasury bills increased by £3,531,000,000 and ways and means advances by £477,000,000. A large part of this floating debt must have been held by the Bank of England (as cover for the note issue), the exchange account and other official bodies, and by dominion and foreign governments with balances in London, but much of it was also in the hands of the banks and the money market. The treasury also accepted deposits from the banks for six months at $1\frac{1}{8}\%$ for which it gave treasury deposit receipts. The treasury made known the amount it wished to borrow in this way week by week, and the banks arranged to lend on a quota basis in proportion to their deposits. More than £1,500,000,000 treasury deposit receipts were outstanding in March 1946. Medium-term loans included six issues of $2\frac{1}{2}\%$ national war bonds ranging in redemption date from 1945–47 for the first issue, made in 1941, to 1954–56 for the sixth in 1945. The six issues together brought in £3,410,000,000. A longer-term loan was provided by four issues of savings bonds. The first three were at 3%, with redemption dates from 1955–65 to 1965–75. The fourth issue (1965–67) carried only $2\frac{1}{2}\%$, but this was not offered until May 1946. The three wartime issues produced more than £2,700,000,000 and the fourth issue more than £700,000,000.

Great efforts were made to stimulate small savings. Four issues of defense bonds, the first three at 3% and the fourth at $2\frac{1}{2}\%$, were designed chiefly for the small personal investor and yielded more than £1,100,000,000. There was also an increase of more than £1,200,000,000 in the value of savings certificates and of £1,736,000,000in the deposits of the post office and trustee savings banks. These sums represented a far greater contribution from the small saver than had been made in World War I.

Oversea Payments and Lend-Lease.—The finance of purchases abroad was again a major problem, with the supply of U.S. dollars as its focal point. The exchange was pegged at \$4.03 to £1, and securities salable in the U.S. were again requisitioned. Reserves were within sight of exhaustion when, in March 1941, the U.S. congress passed the legislation commonly known as the Lend-Lease act, which authorized the president to transfer supplies without immediate payment to countries whose defense was considered vital to the defense of the United States. Ultimate settlement was to take the form of any benefit, direct or indirect, to the United States which the president might consider satisfactory. With the entry of the United States into the war, the British government reciprocated by providing certain supplies to U.S. forces in Britain and elsewhere, and the same principle was also applied by both countries to their other allies.

Even so, British expenditure in the United States amounted to more than £1,500,000,000, and heavy liabilities were also incurred in other foreign countries. Expenditure in India, Egypt and elsewhere was met out of funds provided by those countries in return for "sterling balances" (*i.e.*, short-term credits) in London. From Sept. 1939 to June 1945, total British disinvestment abroad was officially estimated at £4,198,000,000, made up as follows: sale and repayment of foreign investments, £1,118,000,000; increase in "sterling balances," £2,576,000,000; other foreign borrowing. £303,000,000; reduction in gold and dollar reserves, £152,000,000; unallocated, £49,000,000; total, £4,198,000,000.

FINANCE AFTER WORLD WAR II

The five years after the end of World War II were dominated by the high level of public expenditure, the need to control domestic inflation and to maintain a balance of external receipts and payments, and the desire to continue the cheap money policy. In some ways these were conflicting aims. The attempt to reconcile them involved the continuation of many wartime controls, the drastic restriction of private investment and the reduction of private expenditure by means of large budget surpluses. The latter was, of course, an extension of the principles applied to wartime budgeting. Just as a budget deficit leads to an "inflationary gap" by taking less from private citizens than the government is spending, so a budget surplus reduces inflationary tendencies in other parts of the economy by taking more from private persons than the government is spending.

The great extension of social services involved a heavy increase in government spending. As early as 1942 the government published a report by Sir William (later Lord) Beveridge, *The Social Insurance and Allied Services*. The main recommendations of this report were embodied in the National Insurance act and the National Health Service act of 1946, and the National Assistance act, 1947, though the provisions of these acts did not come into full operation until 1948. The scope of insurance, assistance and health services was considerably extended and a system of family allowances was introduced. The Education act of 1944 led to the raising of the school-leaving age to 15. The cost to the exchequer of the social services in 1953–54 is shown in Table XI. Large

TABLE XI.—Cost to the Exchequer of Social Services, 1953–54

Service	Cost	Service	Cost
National health service	£408,600,000	War pensions	£84,300,000
National insurance and family allowances	182,300,000	Education	241,600,000
National assistance	105,900,000	Other	182,900,000

sums were also spent by the National Insurance funds and by local authorities. The total cost of social services for Great Britain and Northern Ireland in 1953–54 was £1,975,700,000.

The food subsidies were continued, though there were some reductions by R. A. Butler and H. Macmillan after 1951, and the charge on the national debt had been raised by wartime borrowing. Defense expenditure fell immediately after the war, but then rose sharply from £740,700,000 in 1949–50 to £1,405,000,000 in 1955–56. Finally, the budget was, of course, swollen by the general rise in prices. As a result of all these influences, expenditure in the years 1953–54 to 1955–56 averaged £4,610,000,000, more than five times its prewar level.

Taxation. — The need to reduce private expenditure in order to avoid inflation was a dominant feature of taxation policy. Each of the years 1947–48 to 1955–56 showed a large surplus of ordinary revenue over ordinary expenditure. There were, however, substantial "below the line" payments (including repayment of excess-profits tax refunds and postwar credits, compensation for war damage and housing loans to local authorities) which are not included in the ordinary budget.

The need to raise this very large revenue precluded any major remissions of taxation. Excess-profits duty was abandoned from the end of 1946, but was replaced by a profits tax. The standard rate of income tax was reduced from 10*s*. to 9s. in £1 in Oct. 1945, raised to 9*s*.6*d*. in 1951, and again reduced to 9s. in 1953 and to 8*s*.6*d*. in 1955. There were several changes in allowances, in exemption limit and in the amount of income chargeable at less than the standard rate, which tended to reduce the burden of the tax especially on lower incomes. Business investment was also encouraged by changes in depreciation allowances. On the other hand, there was a heavy increase in the tobacco duty in 1947 and it was raised yet again in 1948 and 1956. Alcohol duties were also raised in 1948 and a new tax on betting was imposed. There were a number of other changes, including a tax on dividends and a "once and for all" special contribution on investment income (in 1948), but their yield was small in relation to that of the main sources of revenue. Taxation in 1955–56 is shown in Table XII.

TABLE XII.—*Yield of* Taxation, *1955–56*

Tax	Amount	Percentage
Income tax and surtax	£2,081,500,000	44.9
Estate duties	175,700,000	3.8
Profits tax and excess-profits tax arrears	210,950,000	4.5
Alcohol	408,083,000	8.8
Tobacco	668,175,000	14.4
Oil	324,781,000	7.0
Purchase tax	418,802,000	9.0
Other customs and excise	193,266,000	4.2
Other tax receipts	158,359,000	3.4
Total receipts from taxes	4,639,618,000	100.0

The Internal Debt.—With Hugh Dalton as chancellor of the exchequer in 1945, the cheap money policy was intensified. The new phase began with the curtailment of the rate on treasury deposit receipts from $1\frac{1}{8}\%$ to $\frac{5}{8}\%$ in Oct. 1945, and culminated in the issue of a $2\frac{1}{2}\%$ treasury stock (redeemable after 1975) at par in Oct. 1946. To achieve this reduction the assets of the insurance fund and other official funds were invested heavily in long-term debt, the treasury bill issue was increased and much of the increase was taken up either by the banks or by the money market with resources provided by the banks. The Bank of England, as in wartime. provided the banks with all the reserves they needed, and bank deposits rose by about £800,000,000 during 1946.

There was a change of policy in the spring of 1947, when official support was withdrawn from the long-term market, and the price of these securities was allowed to fall. This phase lasted until Nov. 1951. The Bank of England continued to provide the banks with virtually unlimited credit through the special buyer, and the volume of bank deposits continued to rise, though at a slower rate than in 1946, but there was a gradual decline in the prices of government securities. A further change in policy occurred, under R. A. Butler's chancellorship, in Nov. 1951. The bank rate was raised to $2\frac{1}{2}\%$ in November and to 4% in March 1952, and the activities of the special buyer were curtailed. In Nov. 1951, £1,000,000,000 of treasury bills, about half of them held by the banks, were converted into new short-term funding loan. Treasury deposit receipts, which had been declining in volume for some time, were suspended in March 1952. The general effect of these changes was to reduce the liquidity of the banking system and to bring about a further rise in interest rates. Treasury bill rate rose to about $2\frac{3}{8}\%$, and the yield on long-term government securities to somewhat more than 4%. There was a general fall in rates in 1953–54, but inflation and balance of payments difficulties in 1955–56 brought a renewed rise. The bank rate was raised to $4\frac{1}{2}\%$ in Feb. 1955 and to $5\frac{1}{2}\%$ in Feb. 1956. The yield on consols rose to about $4\frac{3}{4}\%$ and that on some short-dated government bonds to over 5%. This phase may be regarded as completing the reaction against the cheap money policy and establishing again the view that interest rates should be determined by general economic conditions and not by the convenience of the treasury in its debt management.

The External Problem.—At the end of World War II Great Britain was left with a reduced income from foreign investments and shipping and a disorganized export trade. The government, therefore, anticipated an adverse balance of payments during the period of recovery. The lend-lease arrangement came to an end in Sept. 1945, and a settlement with the United States was reached in the Washington agreement in December. Obligations in respect of supplies received during the war were cancelled, and Great Britain agreed to pay $650,000,000 for supplies shipped after the end of the war and for U.S. military installations in Britain. The British government also received a "line of credit" of $3,750,000,000. The combined sum was to be repaid, with interest at 2%, in 50 annual instalments beginning in Dec. 1951. As part of the agreement, Britain undertook to remove exchange restrictions on current transactions by July 1, 1947. A Canadian loan of £281,000,000 in dollars was also negotiated in March 1946.

The promised removal of exchange restrictions was followed by so rapid a drain on reserves that convertibility had to be restricted again after less than two months. There followed a period of fluctuations in the reserves, with gains in 1948, 1950 and 1952–54 and heavy losses in 1949, 1951 and 1955. In 1949 sterling was devalued from $4.03 to $2.80 to £1. The foreign exchange crisis of 1951 brought restrictions on imports and the changes in domestic policy already described. With the recovery in 1952–54 steps were taken to increase the convertibility of sterling, and there was a strong revival in its use as an international currency, though British residents could still not convert sterling into dollars without official permission. The loss of reserves in 1955 was met wholly by internal measures, and without any further restrictions either on imports or the foreign exchanges.

DEVELOPMENT OF GOVERNMENT FINANCE

The first half of the 20th century produced revolutionary changes in the economic significance of government finance. The national debt came to form a major part of private property. At the end of World War II government securities probably formed nearly half of all private property, and the proportion was increased still further by the nationalization of a number of basic industries between 1945 and 1950. The peacetime expenditure of the central government increased from about one-twelfth to about one-third of the national income. Expenditure on national debt interest and on defense declined in relative importance, and a whole new range of government-financed social services came into being. The weight of taxation increased enormously. Among direct taxes there was a great increase in the taxation of higher incomes and of large estates passing at death, while among indirect taxes there was a wide range of new protective duties. It is difficult to estimate how far these changes redistributed income, as it cannot be known exactly how indirect taxes were apportioned between differentincome groups. It is certain, however, that there was a drastic reduction in the real value of the higher incomes and a great alleviation of extreme poverty. The latter was achieved not only by transfers from rich to poor, but also by transfers within each income group; *e.g.*, the taxes of the single man help. to provide family allowances, education and health services for the large family. The growth of government expenditure raised problems with regard to parliamentary control. In theory parliament has a double control through its voting of taxes (in committee of ways and means) and through its authorization of expenditure (in committee of supply). These are both committees of the whole house. The ways and means committee discusses the budget proposals at some length, but supply days are traditionally days for the airing of grievances; the subjects for debate are chosen by the opposition and usually have little connection with finance. Two smaller committees. the select committee on estimates and the public accounts committee, examine estimates and accounts respectively, but it is inevitable that, once parliament has determined the general lines of policy, it should rely very heavily on the treasury for the supervision of details.

Local Government Finance.—Besides the services financed by the central government, there are important economic activities which are in the hands of local authorities. After 1875, a number of these authorities built up trading services, including water supply, gas, electricity and public transport. The nationalization of gas and electricity reduced the scope of these activities, and the National Assistance act of 1947 transferred some of the functions of poor relief from local authorities to the National Assistance board. Their most important remaining functions, other than the trading services, are education, housing, highways, police and fire services and public health. Expenditure (excluding capital expenditure) and revenue for the year 1954 were as shown in Table XIII.

TABLE XIII.—*Local Government Finance, 1954*

Revenue		Expenditure	
Central government grants	£432,000,000	Education and child care	£399,000,000
Rates	460,000,000	Health	56,000,000
Trading income	27,000,000	Roads and lighting	
Rent, interest, etc.	184,000,000	Police and fire services	107,000,000
		Debt interest	127,000,000
		Miscellaneous	208,000,000
		Surplus	109,000,000
Total	1,103,000,000	Total	1,103,000,000

Rates are a tax on land and buildings. In 1929 they were drastically reduced for agricultural land and industrial buildings. and the tax falls mainly on private dwellings and commercial premises. The government grant is paid partly in respect of specific services (*e.g.*, police and education) and partly in the form of a block grant which is not related to any one form of expenditure. The method of paying this grant was changed by the Local Government act of 1948, which provided for a revaluation of property and for the payment of equalization grants to local authorities with less than an average ratable value per head of their population.

An impression of the size of the combined operation of the central government, local authorities and the national insurance fund is given in Table *XIV*, compiled from the national income White Paper for 1955. When these figures are related to the national income, it appears that nearly 20% of all the goods and services produced by the nation were used by public authorities, that the power to purchase another 12½% was transferred from its original recipients to others, that nearly 30% of all private incomes was paid in taxes, rates and national insurance contributions and that more than 12% of all saving was done by public authorities.

TABLE XIV.—*Current Account of the Central Government, Local Authorities and the National Insurance Funds, 1954*

Income		Expenditure	
Taxes and rates	£4,601,000,000	Goods and services	£3,099,000,000
National insurance contributions	532,000,000	Subsidies	426,000,000
Property income	512,000,000	Debt interest	750,000,000
Grants from abroad	50,000,000	Other current transfers	1,021,000,000
		Grants abroad	53,000,000
		Surplus	346,000,000
Total	5,695,000,000	Total	5,695,000,000

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ECONOMICS AND TRADE

In the following account of the development of industry and trade, statistics must be understood to include Northern Ireland where applicable, although it should be noted that before World War II only a small proportion of industrial production was located there. No census of production is available for Northern Ireland for 1948. by which time, however, production had begun to increase (*see* IRELAND, NORTHERN). Figures for years before 1921 may also include the rest of Ireland, now the Republic of Ireland.

POWER RESOURCES

Coal.—Coal is by far the most important source of power in the British Isles. The amount of coal reserves has been variously estimated at different dates, and in 1950 coal reserves likely to be developed during the succeeding century were estimated at 21,607,000,000 tons. At rates of consumption in the 1950s the coal known to exist was expected to last for between four and five centuries. If, however, account was taken of probable and possible reserves, there was enough coal to last seven centuries, and there would be a further extension if means were found of using the small coal so largely wasted.

There is no definite evidence of the use of coal in Great Britain till between A.D. 1230 and 1240, when Northumbrian grants are extant of the right to take "sea coal," probably coal eroded and washed up on the shore. Outcrop mining seems to have begun in the northern coal field at the end of the century. In the 14th century elementary shafts began to be sunk, and from the 16th century onward fairly considerable quantities of coal for domestic uses were being brought to London from the northern pits by sea. But by modern standards production was still small; in 1800 it was about 10,000,000 tons a year, and it was not until the development of the steam engine that coal mining rose to its full importance. The coal fields of England are generally arranged in three groups, the southern, midland and northern. The southern includes the south Wales, Forest of Dean. Somersetshire and Gloucestershire and Kentish fields; the midland comprises the Yorkshire. Nottinghamshire. Lancashire, north Wales, Staffordshire, Leicestershire, Warwickshire and some smaller fields; and the northern includes the fields of Northumberland, Durham, Cumberland and Scotland. During the second quarter of the 20th century the south Wales fields declined while the midland group rose in importance.

Water Power.—Hydrometric statistics for Great Britain are given in the *Surface Water Yearbook* of *Great Britain 1945–53* (H.M.S.O., London. 1955). The most important potential sources of water power are in the Highlands of Scotland, north Wales and Cumberland. but throughout the industrial era the rivers, notably those of Lancashire, Yorkshire and north Derbyshire, have been used for industrial power purposes. As the output of coal developed and the scale of manufacture increased, many of the early installations fell into disuse; later, however, no doubt because of the improvement of steam turbines and electrical appliances, the use of these rivers tended to revive. British rivers can never be used as sources of electric power to an extent comparable with those of the Scandinavian countries or Italy; similarly, vast water-power projects are impracticable in Great Britain.

An exhaustive study of the water-power resources of the country was published by the Water-Power Resources committee, appointed by the board of trade in 1921. The committee came to the conclusion that schemes which were economically possible could not generate more than 40% of the electricity then generated by public and transport authorities. Practical development during and after World War II was mainly concentrated in the Scottish Highlands, and in 1943 the North Scotland Hydro-Electric board was authorized. By 1954 total British electricity generated by water power came to 2,237,000,000 kw.hr.

Fuel Oil.—The production of petroleum in Great Britain has been negligible, but supplies do exist which, though small, could probably in some instances be worked remuneratively. In 1918 the government began extensive investigations. Petroleum has been found in Derbyshire, Nottinghamshire, north Staffordshire, Yorkshire (near Rotherham), Cumberland, Lancashire, Shropshire and certain parts of Scotland, but none proved of commercial importance.

Oil shale exists in large quantities in Dorsetshire. Somersetshire, Norfolk, Lincolnshire. Yorkshire, Midlothian. Linlithgowshire and Lanarkshire. The most important fields in England are at Kimmeridge and Corton in Dorsetshire. But the only commercially important deposits of oil shale lie in Midlothian and West Lothian and in Lanarkshire. The reserve position is as follows: Midlothian 163,500,000 tons, Linlithgowshire 416,540,000 tons and Lanarkshire 16,630,000 tons. A group of oil fields in east Nottinghamshire was proved in 1943. In 1954 the total of British production from oil shale was 3,000,000 gal.

Atomic Energy.—The development of the theoretical basis on which the practical application of nuclear physics rests goes back to 1895. During World War II this development was diverted to the design of atomic weapons. The success with nhich this mas effected provided a strong impetus for the further development of less destructive aspects of nuclear physics.

On Oct. 29, 1945, the ministry of supply took over responsibility for further development from the Department of Scientific and Industrial Research. A comprehensive atomic energy research establishment was set up at Harwell, Berkshire. The Atomic Energy bill, empowering the government to control the use and development of atomic energy. became law on Nov. 6, 1946. Immediate control was vested in the minister of supply; but on the recommendation of the Waverley committee (Cmd. 8986) a non-departmental minister, the lord president of the council, was made responsible for the atomic energy program. By the Atomic Energy act, 1954, responsibility for the atomic energy project was transferred to the United Kingdom Atomic Energy authority under the lord president.

By the mid-1950s the following position had been reached. The Harwell establishment (responsible for basic research into nuclear physics and atomic energy) housed two experimental piles. Gleep (graphite low energy experimental pile) and Bepo (British experimental pile). It also housed a zero energy fast reactor (Zephyr) and a pile using heavy water called Dimple (deuterium-moderated pile low energy). Two further heavy-water piles were under construction (E 443 and RE 773). The Radio Chemical centre at Amersham, Buckinghamshire, was a subsidiary to Harwell. Production of fissile material was directed from the headquarters of the industrial group at Risley, Lancashire, and there were production factories at Springfield, Lancashire (for pure uranium), Windscale, Cumberland (for plutonium), and Capenhurst, Cheshire (for separating the uranium isotope U^{235} from the less scarce U^{238}). The Atomic Energy authority was building a nuclear power plant at Calder Hall, Cumberland, and a nuclear power reactor (working on the breeder principle) at Dounreay, Caithness. The Calder Hall station was designed to generate 50,000 kw, of electricity, enough to supply a medium-sized town.

In the early stages of nuclear development private industry was confined to working for the Atomic Energy authority and manufacturing nuclear instruments. Later the scope of private industry began to expand. By the mid-1950s a number of concerns were investigating the application of nuclear energy to the propulsion of ships, aircraft and land vehicles. One aspect of the nuclear development is the production of isotopes. In 1954 the British exports of isotopes were the biggest in the world.

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MINERALS AND MINING

Coal Output.—Great Britain's industrial supremacy during the 18th and 19th centuries was founded on the country's coal mines.

TABLE XV.—*Coal* Output

Decennial average or year	Production (tons)	Average number of persons employed*
1873–82	138,087,000	482,000
1883–92	169,922,000	552,000
1893–1902	203,323,000	713,000
1903–12	253,983,000	936,000
1913–22	241,109,000	1,068,000
1923–32	233,126,000	982,000
1933–42	221,155,000	754,000
1943	198,948,000†	708,000
1944	192,765,000	710,000
1945	182,784,000	709,000
1946	190,082,000	697,000
1947	197,464,000	711,000
1948	209,445,000	724,000
1949	215,166,000	720,000
1950	216,324,000	697,000
1955	223,074,000	704,000

'Prior to 1922 clerks and salaried persons are included. In that year they numbered on average about 24,000 and in 1946 about 21,000, inclusive in each case of clerks and salaried persons employed at headquarters Since 1946 the information about clerks and salaried persons at headquarters offices is not comparable. At the end of 1946 there were 13,800 clerks and salaried persons employed at the mines and, in Sept. 1951, 20,000. From 1954 a new method of recording attendance reduced numbers on colliery books by about 4,000. †Figures for coal from 1943 onward include opencast coal.

The output of coal in Great Britain and Ireland and the number of persons employed at the mines since 1873 are given in Table XV. The figures for 1913–22 and for the years after 1922 show that the position of the industry underwent a serious change. After the early 1920s the coal industry was. in fact, one of the sore spots of the British economic system. It had reached its peak of prosperity in the years preceding 1914; during World War I it was under government control, and in the years immediately following the course of international events prevented it from seriously feeling the direct effects of the postwar slump until 1924.

Until 1921 wages and hours of labour in the industry were governed by regulations put into force during the war, but in 1921, after a three months' stoppage, the miners secured a minimum wage, pay increases and the prospect of shorter hours. This agreement was made possible by a government subsidy of £10,000,000 to the mineowners. It lasted till April 1924, and, when a further stoppage became imminent, the government granted further subsidies and appointed a royal commission under Sir Herbert (later Lord) Samuel to survey the position. The commission's report did not prove acceptable to either side, and the miners ceased work on May 1, 1926. They did not return until the following November, by which time the unions' resources were completely exhausted. The miners were forced to accept an increase of hours, with wages to be settled by district agreements.

Meanwhile the position of the industry, both in relation to world trade and the national economy, was becoming clearer. Before 1914 the margin of profit depended largely on the capacity of the industry to export, which in turn depended on the facts that nearly all the important British coal fields were within 25 mi. of the sea and that the output per man-shift was higher in Britain than in any other European coal fields except those of Upper Silesia. After 1918 the European countries began again to compete with British coal mines for the export market, and at the same time considerable advances in methods of production were being made abroad while scarcely any improvements were being made in Great Britain. In 1913 the output per man-shift in Great Britain was 21.5 cwt., and in 1930 it was 21.6, but during the same period it had improved from 18.6 to 26.6 in the Ruhr, from 23.6 to 28.6 in Silesia and from 16.2 to 24.5 in the Netherlands. The stoppage of 1926 also compelled foreign buyers to obtain coal elsewhere, and some of the markets then lost were never fully regained. Table XVI shows the movements of British coal exports to the principal European markets.

The Samuel commission was fully alive to the disadvantages under which the British coal industry laboured because of its methods of production and its lack of proper organization, and its recommendations in large measure determined the course of later parliamentary legislation. The Mining Industry act of 1926 was passed to facilitate amalgamation of mines so that they could be worked on a more economical basis. The Coal Mines act of 1930 attempted to introduce a greater degree of compulsion. In addition, executive boards were set up to determine quotas of production for each coal-mining district, and provisions were made for

TABLE XVI.—*Coal Exports*
(In tons)

Destination	1913	1930	1939	1952	1954	1955
U.S.S.R.	5,998,000	39,000	—	—	—	—
Sweden	4,563,000	1,767,000	3,747,000	1,261,749	1,085,031	1,017,117
Norway	2,298,000	1,202,000	1,848,000	297,948	215,741	224,410
Denmark	3,034,000	1,921,000	3,594,000	2,568,616	3,393,793	3,631,561
Germany	8,952,000	4,926,000	2,826,000	452,962	1,536,185	1,145,481
Netherlands	2,018,000	2,860,000	1,525,000	520,035	832,221	795,510
Belgium	2,031,000	3,445,000	757,000	338,306	513,181	463,326
France	12,776,000	12,969,000	5,711,000	1,087,801	970,678	960,483
Italy	9,647,000	7,167,000	2,771,000	1,058,468	1,280,493	740,734
Spain	2,534,000	1,712,000	—	549,315	309,814	81,740
Portugal	1,202,000	1,136,000	771,000	305,093	301,158	349,690

the sale and transfer of quotas within each district. This act was only partially successful in overcoming the opposition of the owners to amalgamation. but the provisions concerning quotas succeeded in maintaining price levels and were extended until 1938, when the Coal act provided for the vesting of all the unworked coal in Great Britain in a coal commission, which was empowered to acquire it from the owners for a sum which had been set by a special tribunal at £66,450,000, and to administer the leases held by the mining companies. At the same time the commission received far wider powers to enforce reorganization and amalgamation. On July 1, 1942, the commission took over its rights in unmined coal, but its plans for organization were suspended in 1939 by the outbreak of war.

World War II virtually enforced the nationalization of the coal industry. Government control was established in June 1942, and by 1945 organization existed for planning production, increasing efficiency and maintaining manpower and welfare. The industry saw that the essential aspect of public ownership (viz.. centralization and concentration on efficient pits) would have to remain. The Foot plan (Jan. 1945) recommended establishment by the industry of a central coal board having authority over the whole of the industry, with powers of integration through the amalgamation, compulsory if necessary. of collieries. This principle mas admitted in different terms in the Technical Advisory committee's report (March 1945), which drew attention to the difficulty of eliminating uneconomic mines and to the industry's chronic financial embarrassment. Under C. R. Attlee's first Labour government, the National Coal board was constituted (July 1946) and the industry was taken over on Jan. 1, 1947. The compensation procedure was protracted over a number of years. The Nationalization act concentrated the responsibility for management with the board and provided no statutory machinery for decentralization. Under the board a number of divisions, and under these a number of areas, were set up. The Burrows committee (Nov. 1948) indicated that the board was not devoting enough time to general questions and that overcentralization existed.

During the decade preceding World War II profits were insufficient for the installation of new machinery. Manpower was not concentrated at the most productive units and mechanization was underdeveloped. The great bulk of British coal (86% in 1949) was won by longwall mining, which does not easily lend itself to mechanization. Capital investment was gradually increased during the early 1950s. Under a plan drawn up in 1950, more coal was to be produced in parts of Scotland, in east Durham, Yorkshire, the east midlands. north Staffordshire and Kent, and less in west Durham, Lancashire, parts of Cannock Chase. the Forest of Dean and Somerset. Little scope was found for developing new coal fields. Coal began to be imported on a growing scale in the mid-1950s. Opencast coal mining was begun in 1942. A peak of 12,440,000 tons was reached in 1949.

Other Minerals.—Table XVII gives the British output of some of the principal minerals since 1913.

Iron Ore.—Iron ore is very much the most important of these minerals, and it will be seen that production declined considerably during the decade 1923–32, though it recovered again in 1934. The quantity of imports is shown in Table XVIII.

The great bulk of British iron ore is produced in England, the most productive counties being Yorkshire. Lincolnshire, Northamptonshire, Cumberland and Staffordshire. The richest ores come from Cumberland, Lancashire and Staffordshire. Output reached a maximum in 1943, after which it declined. Production in 1951 was still above the immediate prewar average, however.

Tin Ore.—Tin ore is obtained almost exclusively from Cornwall. The fall in production (to 2,050 tons in 1935) was accompanied by an increase in retained imports. The capture of Malaya by the Japanese early in 1942 and the consequent cutting off of the principal sources of imports inevitably led to increased home production of tin. By 1950, however, production had fallen to 1,000 tons. In 1953 imports amounted to 62.363 tons.

Lead.—The British output of lead declined between 1919 and 192j, while imports rose. After 1926 this trend was reversed for a time. In 1949 no important reserves existed except for some small deposits at Wanlockhead in Scotland. In 1954 imports came to 197,500 tons.

TABLE XVII.—*British Output of Some of the Principal Minerals*
(In tons)

Year or average of years	Iron ore and ironstone	Tin ore, dressed	Lead ore, dressed	Zinc ore, dressed
1913–22	12,318,000	5,716	16,539	8,419
1923–32	9,843,000	3,511	21,942	1,603
1933–42	13,879,000	2,903	33,670	8,071
1943	18,488,000	2,216	5,323	7,775
1944	15,472,000	2,169	5,104	15,469
1945	14,175,000	1,648	3,588	6,360
1946–49	12,437,500	1,377	3,450	—
1950	12,963,000	1,390	4,193	71
1951	14,777,000	1,790	6,093	353
1952	16,232,000	1,549	7,418	2,777
1953	15,818,000	1,467	10,034	3,388
1954	15,557,000	1,397	11,057	2,475

TABLE XVIII.—*Iron Ore Imports**

Year	Tons	year	Tons
1913	7,442,249	1951	8,747,480
1919	5,200,696	1952	9,693,864
1924	5,917,393	1953	10,981,063
1939	5,308,416	1954	11,611,257
1945–49†	6,988,372	1955	12,896,400

*Including manganiferous ore. †Average.

Copper.—At one time Great Britain supplied almost three-quarters of the world's copper. By 1949 the richer deposits in Cornwall were exhausted and no evidence existed that new deposits were likely to be discovered.

Zinc.—Zinc was formerly mined chiefly in north Wales, the north of England, the Isle of Man and Dumfriesshire. In 1949 no important reserves were known to exist.

China Clay (Kaolin).—This mineral is of great importance in the ceramic, papermaking, bleaching and chemical industries. The whole British supply is derived from Cornwall. A large but varying amount is exported. Output was 776,621 tons in 1913, fell to a wartime minimum of 178,000 tons in 1943 and recovered to 974,000 tons in 1954. Imports are negligible in quantity.

Fluorspar.—This mineral is of considerable importance in the manufacture of steel and in other branches of metallurgy. The British production first became substantial at the beginning of the 20th century. Most of the acid-grade spar comes from Derbyshire. Reserves were estimated at 1,336,750 tons in 1949. Annual output was 69,000 tons in 1954.

Barytes.—This is an extender for paint and filler for linoleum, etc. Production was 66,400 tons in 1938 and 75,000 tons in 1954. The biggest field is in Shropshire and Montgomeryshire.

INDUSTRIES

Industrial Development.—The change from peasant to industrial civilization in Great Britain is thus described by J. L. and Barbara Hammond in The Rise of *Modern* Industry (1926) :

> The wants of the ordinary man were supplied in the early middle ages, as in the days oi Greece and Rome, either by himself and his family, or by his neighbours; in the next stage these wants were supplied by special persons plying a craft, in a village or small town, organised sometimes in guilds; in the third stage the provision of those needs became the business of individual or group production and large scale merchanting ; in the fourth it became the business of large scale production. At that point the world passes to the industrial age; to an age in which commerce and finance are no longer aspects, growing in importance, yet still aspects of its life, but the basis on which a society depends.

Though England was comparatively late in becoming a great commercial power, it was the first to develop the industrial system. Before the discovery of America and of the Cape route to the east, trade centred in the Mediterranean and the Mediterranean nations were the chief European traders. The opening of the Atlantic routes transferred commercial supremacy to the nations possessing coast lines facing them. First came the monopoly of Spain, broken by the defeat of the Armada in 1588; from that time till 1660 the Dutch led, their chief rivals being Great Britain and France. From 1660 till the end of the 18th century the two latter countries fought for commercial supremacy, which then passed to Britain. It was the development of large-scale commerce in Britain that made possible the development of that country's industrial system, since without wide markets the capital required for the development of machine production would not have been forthcoming. All through the 17th and 18th centuries England was developing its overseas trade and its home market side by side. The 18th century was marked by a long period of stable government at home. The development of the road system in the 17th century and of the canals in the 18th made the home market easy of access, while the establishment of a colonial empire stimulated overseas trade.

These were favourable conditions for industrial development, and this was helped forward by the Protestant refugees from Antwerp at the end of the 16th century, by the Huguenot refugees after the revocation of the Edict of Nantes, and by the Dutch immigrants who followed William III. By these were laid the foundations of British cotton, silk and other industries.

More important still was the existence of great coal supplies, which were made mobile by the development of the canal system. It was British coal that made possible the creation of a large iron and steel industry, and the development of machine production and of the steam engine. But this development could not have been brought about without the existence of enterprise and imagination of a high order, and the 18th century was the period which saw the birth of those inventions which made the industrial system a possibility. James Watt's first patent was taken out in 1769, and by the end of the century the steam engine was in use in mines, foundries, cotton mills, etc. The iron industry, dependent during the 17th and early 18th centuries on charcoal, began to languish with the gradual exhaustion of British forests. Coal began to be used effectively in blast furnaces as early as 1709. The use of coal in forges was made effective about 1785, thus altering the whole aspect of the iron industry, and the introduction of the steam engine was the finishing touch. The output of pig iron rose from 25,000 tons in 1720 to 68,000 tons in 1788; to 253,000 tons in 1806; and to 1,347,000 tons in 1839.

The cotton industry had a similar story. In spite of the exceptionally favourable climatic conditions in Lancashire, the English industry consumed only about 2,000,000 lb. of raw cotton annually during the early part of the 18th century. The invention of the flying shuttle for weaving in 1733 and of the spinning jenny less than 30 years later revolutionized the industry. Until 1785, however, the mills had to depend on water power. That year marked the introduction of the steam engine and the creation of the great cotton industry, which was to become the greatest exporting industry of the country, sending no less than 80% of its huge annual production overseas. In 1833 this industry, which 100 years before had used little more than 2,000,000 lb. of raw cotton annually, was importing no less than 300,000,000 lb.

"From the 12th to the 19th centuries the woollen industry was the premier English industry, and as such was largely responsible for the growth of the country's wealth and so for the accumulation of capital which has rendered possible the development of the homeland and the empire" (L. D. Stamp and S. H. Beaver, The British Isles, p. 442 [1933]). Originally the greater part of the wool produced in the country was shipped abroad for manufacture, but weaving gradually increased in importance and by the end of the 15th century England was "largely a nation of sheep-farmers and clothmakers." During the 16th and 17th centuries there were various periods, especially in the first half of the 17th century, when the industry suffered severely from foreign competition, but eventually the English cloth trade surpassed that of Flanders, and by the end of the 17th century woollen manufactures made up two-thirds of England's export trade. Workshops were scattered all over the country wherever the conditions of wool supply and running water for power purposes made the locality convenient. To this day the industry is very much more scattered than the cotton industry, although the great majority of it is now centred in the West Riding of Yorkshire whither it migrated when use of coal for power purposes began to develop. Subject to the above differences, the woollen industry followed very much the same course as cotton.

The story of these great industries was repeated in others, and it may be said that, before the introduction of railway transport during the second quarter of the 19th century, factory production was established in every important branch of industry. The establishment of the railways was the crowning achievement. enormously facilitating as it did the mobility of the working population, the supply of raw material and distribution of the finished commodities. With it the industrial system reached its characteristic form. The only further fundamental change was the introduction of the use of electrical power in the 1880s and, in transport, the introduction of the internal-combustion engine.

As to the general development of British industry, the first three-quarters of the 19th century saw a very rapid increase of production and export. From the middle of the century onward, however, the rate of increase in exports of manufactured goods began to fall, while the rate of increase of imports was accelerated. This tendency was a marked feature of the period after 1919.

1919 to 1939.—The immediate effect of the cessation of hostilities at the end of World War I was to create a boom in industry and trade which lasted for a little more than 18 months. By the end of 1920 there were clear signs of depression, which reached its peak in the winter of 1921–22. This depression was partly the result of currency disturbances abroad, but it was felt most in industries in which foreign competition was severest: coal mining, iron and steel, shipbuilding and cotton. Though 1924 saw a general return to prosperity, the industries just mentioned failed to recover from the depression; unemployment was rife in them, and it gradually became clear that England was becoming divided into two economic units, the prosperous south and the depressed north (with which must be included south Wales), where most of the industries alluded to were concentrated.

Elsewhere, however, the period 1924–29 was one of prosperity; employment remained steady and foreign currencies had been stabilized. New industries sprang up, and some, such as the manufacture of motorcars and electrical goods, made unprecedented progress.

Financial crisis in the United States late in 1929 was the forerunner of a world depression in trade and industry of exceptional severity. Unemployment rose alarmingly, and recovery was unusually slow, since it was not marked until 1937. As in 1924 the newer industries recovered first, and those which were already suffering most continued depressed. Recovery was aided by the abandonment of the gold standard, and the government hoped to stimulate it by the adoption of protective tariffs. The attempt made at the Ottawa conference to weld the empire into an economic unit was not so successful. It seemed in 1938 that another period of depression was approaching, but rearmament produced an improvement in the coal-mining, steel and shipbuilding trades.

There is little doubt that British industry was ill fitted to meet the difficulties with which it was faced between 1918 and 1938. It was only gradually realized that a return to trade conditions as they were in 1913 mould never come, and that the productive capacity of certain industries was greatly in excess of the demand. Equipment was out of date and capital for modernization difficult to obtain; organization and marketing badly needed overhauling. Only the newer industries, such as the motorcar industry, were able to follow the example of the United States and develop mass production. It took many bitter years to convince owners and employers in the depressed industries that the closing down of uneconomical works, amalgamation and reorganization offered them their only hope of salvation. This. however, is not the whole picture, in spite of the fact that problems of industry and unemployment were urgent throughout the period. London and southern England, on the whole, grew and prospered, largely at the expense of the depressed areas, and in certain fields of international trade Great Britain more than held its own.

Some idea of the progress of the principal industries during the 20th century can be formed from the various censuses of production. Before 1907 no such census had been undertaken; another was begun in 1912, but not completed because of World War I. Thereafter they were made in 1924, 1930, 1935 and 1948. In comparing the figures for these years some allowance must be made for variations in the purchasing power of money; for instance, 1907 figures should be increased by about 50% for accurate comparison with 1935. (See Table XIX.)

TABLE XIX.—*Industrial Production in Great Britain*

Product	1907	1935	1954
Coal (thousand tons)	266,558	221,624	224,090
Gas (thousand million cu. ft.)	196.29	303.4	514.8
Electricity (million kw.hr.)	..	17,568	74,706
Iron ore (thousand tons)	8,184	10,920	15,557
Crude steel (thousand tons)	636	9,880	18,520
Pig iron (thousand tons)	6,988	6,448	11,883
Motor vehicles			
Cars	8,800	338,304	769,165
Commercial		85,572	572,970
Locomotives (steam)	..	717	1,270*
Aircraft	..	644	388
Shipbuilding (thousand gross tons)	..	..	1,493
Cotton woven cloth (million linear yd.)	7,076	3,081	1,994
Woven wool fabrics (million sq. yd.)	418.39	261.8†	414.4
Rayon filament yarn (million lb.)	..	107.88	219.6
Rayon staple fibre (million lb.)	..	11.04	228.0

*Including diesel electric. †Linear yards.

Ajter World War II.—Like its predecessor, World War II introduced a drastic change. Inventiveness and investment were directed toward the production of arms and of ancillary products such as electrical equipment. The consumption goods industries, pre-eminently the textile industry, were deliberately restricted. After the war these trends continued to develop. The output of civil aircraft, motor vehicles, agricultural machinery, machine tools and electrical, textile and office machinery strikingly exceeded the prewar level. The output of textiles. on the other hand, though it recovered from the wartime restrictions, failed to rise significantly above the prewar level. One aspect of these changes was the greater output of capital goods and a corresponding vulnerability to the fluctuations of the trade cycle. Another potential weakness was introduced by the Distribution of Industry act, 1945, which sought to assist the former "special areas" (renamed "development areas") by favouring the establishment of industries within them. This was done through the licensing of factory construction by the board of trade. In this way certain industries were brought to the resident population rather than the other way about, and the economic significance of a favourable location was disregarded.

Industrial output was high during the early postwar period. From 1938 to 1954 the index of industrial production rose by 52%, while the number of persons employed in manufacturing industry rose by 20%. Much of the increase in production was the result of very full employment. The number of hours worked reverted to something nearer the prewar figure.

It follows that (if the war years are excluded) productivity increased at a flat rate of about 4.3% a year—a rate well above the prewar normal. This increase probably reflects fairly accurately the net additions of new plant and machinery to the national stock, additions which were kept low by scarcities, heavy taxation and high consumption.

Public Utilities and Power.—In 1954 the amount of coal used in gasworks and for the generation of electricity by public undertakings was 67,000,000 tons, or 33% of the total home consumption. Of this, 27,000,000 tons were used for gas and 40,000,000 for electricity. Domestic consumption accounted for about 32% of electricity generated under the electricity authority.

Gas.—The products of the gas industry for selected years are shown in Table XX. The gas industry was nationalized by the Gas act, 1948. Vesting day was May 1, 1949, when 1.037 undertakings passed into state ownership. For purposes of management

TABLE XX.—*Gas Industry Output*

Product	1935	1948	1951	1954
Total gas made (million cu. ft.)	303,400	448,430	498,135	514,800
Coke and breeze	7,640,000	13,497,000*	15,044,000*	15,163,000*
Tar (tons)	951,000	1,655,000	1,849,000	1,934,000
Sulphate of ammdnia (tons)	75,000	69,000	81,000	84,000
Benzol (thousand gal.)	17,509	24,434	24,441	27,900
Naphtha (thousand gal.)	901	1,119	961	1,986
Creosote oil (thousand gal.)	...†	103,000	103,000	100,000
Average number of employed				
Operative	106,282	105,508‡	107,800	106,350
Administrative		28,888‡	35,900	36,078

*Excluding that used for heating retorts. †64,000 in 1942. ‡Total of census.

the emphasis rests on the gas boards of the 12 areas into which Great Britain is divided. Above them is the Gas council. which deals with wider tasks. The council advises the minister of fuel and power on general questions, and assists the area boards. The latter deal with the development and supply of gas and coke (except metallurgical) and with the recovery of by-products. A gas consultative council in each area acts as a link between the boards and the public.

Compensation was paid to the former proprietors in 3% guaranteed gas stock, 1990–95, issued and redeemable at par.

Generation *of* Electricity.—Problems of electric supply were the object of considerable parliamentary attention after 1918. In that year a committee, headed by Sir Archibald Williamson, reported that electricity was generated and supplied by more than 600 different concerns, each with a monopoly within its own small district. The committee recommended that generation and distribution should be concentrated in 16 districts, and that a board of electricity commissioners should be set up with full powers. As a result the Electricity (Supply) act of 1919 was passed; the Electricity commission was set up, but provision was made only for voluntary co-ordination. so that it was not until the passage

TABLE XXI.—*Sales of Electricity*

Item	1948		1954	
	Units sold (million kw.hr.)	Total revenue	Units sold (million kw.hr.)	Total revenue
Lighting, beating and cooking	18,045	£107,518,000	27,821	£191,058,000
Power	19,581	75,966,000	32,029	152,283,000
Public lighting	257	1,644,000	576	3,376,000
Traction	1,398	5,432,000	1,451	6,738,000
Total	39,281	£190,560,000	61,877	£353,455,000

of the Electricity (Supply) act of 1926 that real progress was made. This act set up the Central Electricity board. The primary duty of this board was to carry out the work of concentrating energy in certain selected power stations and to erect a high-tension transmission line to interconnect these stations and link the regional systems into a national grid. The board did not own the generating stations and had no control over distribution. Its function was to make production more efficient through concentration and co-ordination. It was given power to obtain land compulsorily for wayleave purposes. By these means, frequencies were standardized and much uneconomical duplication was eliminated. The board derived its revenue from supplying bulk energy to the authorized systems, which supplied to the consumer. The members of the board were nominated by the minister of transport. The economies effected by the grid system are illustrated in Table XXII, which shows the average selling price in pence per unit of electricity over the years 1924, 1935, 1948 and 1954.

TABLE XXII.—*Electricity; Average Selling Price*
(In pence per unit)

Item	1924	1935	1948	1954
Lighting, heating and cooking	4.4	1.9	1.4	1.6
Power	1.2	0.7	0.9	1.1
Public lighting	2.3	1.2	1.5	1.4
Traction	1.1	0.6	0.9	1.1
Average	1.6	1.1	1.2	1.4

In 1937 a committee under Sir H. McGowan reported that it was still possible to establish greater uniformity in supply, voltages and tariffs, and recommended a substantial reduction in the number of systems. The report was accepted in principle by the government, but the pressure of international affairs prevented any legislative action. (This relative decentralization of the system enabled it to withstand the effects of German bombing.)

The British electricity industry mas nationalized on April 1, 1948. About 540 local electricity undertakings were taken over. At the head of the system stands the Central Electricity authority, which enjoys wider powers than the Gas council; under it are 12 area boards in England and Wales. In southern Scotland the South of Scotland Electricity board operates. The authority is responsible for the production of electricity and its supply in bulk to the boards. These, like the authority, are statutory corporations appointed by the minister. For purposes of management, the power stations and grid are divided into 14 generation divisions, which agree approximately with the regions under the area boards and buy electricity from the authority. The system covers Great Britain except for Scotland. where the secretary of state discharges the functions of the minister of fuel and power.

After the end of World War II the electricity industry continued its expansion. From 1938 to 1955 capacity increased from 9,365,000 kw. to 22,572,000 kw.; output from 25,708,000,000 kw hr. to 81,837,000,000 kw.hr.; and utilization of plant from 36.7% to 48.1%. The price of electricity was kept fairly low. Demand continued to exceed supply; the spread of electrification was a striking aspect of the postwar development of Great Britain.

TABLE XXIII.—*Aggregate* Capacity of *Generating* Sets

Table XXIII shows the types and capacity of the various generating plants in Great Britain in 1951. The numbers employed in the generation, transmission and distribution of electricity were 41,000 in 1924; 65,000 in 1930; 87,000 in 1935; 151,000 in 1948; 181,000 in 1951; and 195,000 in 1956.

Iron and Steel.—Table XXIV shows the amount of iron and steel produced (in thousands of tons) over a number of years, classified according to method of production.

The average number of blast furnaces in operation was 99 in 1938, rose to 105 in 1953, but declined to 100 in 1954. Steel furnaces rose from 619 in 1938 to 728 in 1954. While open-hearth furnaces declined from 446 (1938) to 397 (1954), electric furnaces rose from 104 to 232.

In the third quarter of the 19th century Great Britain produced half the world's output of pig iron and was by far the largest steel-manufacturing centre. But though the British output steadily expanded. world production increased on a much faster scale, and by 1913 Britain was producing little more than a tenth of the world total. During World War I the demand for weapons and munitions enforced the modernization of a somewhat lagging industry and brought about a great extension of production capacity, but after the war the industry soon began to encounter difficulties.

Productive capacity had been similarly increased in other parts of the world, and, while Britain maintained its policy of free trade, the iron and steel industry had to face competition from countries which were maintaining their own industries behind tariff barriers and at the same time had free access to the British market. In addition, the industry suffered heavily from the depression during 1931 and 1932, when unemployment was more than 40%.

Improvement began in 1933 with the imposition of a high tariff on imported iron and steel products, and the creation of the British Iron and Steel federation in 1934 was the first step in the reorganization of the industry on a more economic basis.

By 1937 recovery had made considerable progress and the industry was in a position to meet the demands first of rearmament and then of war.

After 1939.—The outbreak of World War II in 1939 found the British iron and steel industry repairing the injuries of the depression. More than £50,000,000 had been spent on modernization in the years immediately before the war, and the annual steelmaking capacity had been raised by about 2,000,000 tons. During the war steel production (about 12,750,000 tons a year) averaged barely 1,000,000 tons more than during the last years of peace. At the same time new steels, especially alloys, were developed. Plants suffered heavy wear and tear.

The industry's £240,000,000 postwar development plan was designed to continue the process of modernization and expansion interrupted by the war, the biggest of many projects being the integrated Abbey works of the Steel Company of Wales. By the end of 1950, £169,000,000 was actually spent. By 1954 pig iron production had been raised from 8,000,000 tons to 11,900,000 tons and steel output from 13,000,000 tons to 18,520,000 tons.

Increased capacity was accompanied by greater integration, more continuous processes, bigger furnaces and higher fuel efficiency, and the introduction of the continuous working week in steel melting shops. These developments had the full support of the trade unions, and between the end of the war and 1954 output per man rose by about 25%. Many new techniques and products were introduced, notably the special alloy steels for high-temperature work, which played an important part in the development of jet-propelled aircraft. The integration of works allowed the spare ores of Lincolnshire and Northamptonshire to play a growing part in the industry. The establishment of integrated works permitted the output of a relatively finished product direct from the raw materials, and it became economically practicable to provide for a continuous flow of certain types of product and hence for the continuous rolling mill. This in turn permitted the establishment of continuous heating furnaces as opposed to in-and-out batch furnaces. These developments had begun in the late 1920s, but continued with increasing vigour after World War II.

Since before the war the industry's central organization, the British Iron and Steel federation, provided common services to supplement the activities of the individual firms under general government supervision. During the war the ministry of supply iron and steel control formed the link between government and industry and ensured that the demands of the war effort were met. Between 1946 and 1949 public supervision was exercised by the Iron and Steel board, representing the employers, the trade unions, the treasury and consumers under an independent chairman. The

TABLE XXIV.—*Iron and* Steel Production

(In thousands of tons)

Product	1913	1924	1938	1941	1946	1951	1954
Pig iron							
Haematite	3,605	2,342	1,484	906	1,121	1,333	1,436
Ordinary							
Foundry	3,802	1,858	1,229	1,082	1,135	1,417	1,441
Forge		376	151	101	66	70	45
Basic	2,530	2,445	3,763	5,182	5,288	6,675	8,772
Direct castings		95	4	1	1		
Ferroalloys	324	191	130	120	150	172	187
Total	10,260	7,307	6,761	7,392	7,761	9,669	11,883
Steel							
Converter							
Acid	1,049	437	164	98	210	241	265
Basic	552	109	431	696	724	862	909
Open-hearth	3,811	2,410	1,720	1,808	1,229	1,259	995
Basic	2,252	5,125	7,743	8,945	9,900	12,277	15,249
Electric							
Ingots	..	42	160	411	345	575	621
Castings	..	23	63	161	134	245	309
All other ingots and castings	..	55	117	193	153	179	172
Total	7,664	8,201	10,398	12,312	12,695	15,638	18,520

Labour government's Iron and Steel act of 1949 transferred about 80 of the largest iron-and-steel-producing companies to public ownership in Feb. 1951, by vesting their securities in the new Iron and Steel Corporation of Great Britain. The Conservative government began to denationalize the industry in 1953.

TABLE XXV.—*Iron and Steel, Gross Value of Output*
(In millions of pounds)

Type	1935	1937	1948	1951	1954*
Blast furnaces	21.0	35.9	91.9	121.9	194.6
Melting and rolling	87.5	143.2	367.6	543.9	735.7
Iron foundries	39.4			151.7	186.2
t e e sheets	15.6	54.3	113.4	74.8	95.3
Wrought iron and steel tubes	16.3	22.8	49.4	98.2	120.0
			58.3		

'Provisional census results.

TABLE XXVI.—*Iron and Steel, Average Numbers Employed*
(In thousands)

Type	1935	1937	1948	1951	1954*
Blast furnaces	15.8	19.6	27.3	27.8	31.3
Melting and rolling	114.1	144.3	200.1	205.2	209.1
Iron foundries	110.7	129.1	118.9	120.7	121.6
Steel sheets	22.0	23.9	20.0	19.7	18.3
Wrought iron a n e l tubes	27.6	31.5	37.8	42.6	41.5

*Provisional census results.

Tin-Plate Industry. — Production and employment figures in the tin-plate industry during certain years were as shown in Table XXVII.

TABLE XXVII.—*Tin-Plate Industry*

Year	Total output	Average number employed
1907	f 8,425,000	20,628
1924	21,132,000	27,968
1935	13,663,000	21,985
1954*	74,800,000	14,600

*Provisional census returns.

Nonferrous Metals. — Table XXVIII shows the value of the gross output and the average employment in the principal branches of industry manufacturing nonferrous metals.

TABLE XXVIII.—*Nonferrous Metals*

Year	Total output	Average number employed
1924	92,300,000	115,000
1935	107,900,000	109,800
1948	246,821,000	104,345
1951	427,513,000	109,344
1954*	448,700,000	107,000

*Provisional census returns.

TABLE XXIX.—*Foreign Trade in Nonferrous Metals and Manufactures Thereof*

Imports and Exports	1939	1955
Imports	£32,717,394	£243,934,000
Exports	£15,658,397	£239,957,000

Increases over the period before 1914 were substantial, especially in the production of aluminum and of tin manufactures. Table XXIX gives the import and export figures.

Engineering. — Since it became possible to manufacture machinery with any degree of precision, engineering has held an important place in the British economy, though one vulnerable to the fluctuations of the trade cycle. A particularly important place was acquired during the 1930s by electrical engineering.

During this period the foreign trade oosition of the electrical industry was very satisfactory, since Great Britain's position as the chief exporting country in the world was challenged only by the United States, Germany (which easily led the world before 1914) having dropped back in the race. In spite of setbacks caused by the depression of the early 1930s, the industry continued to expand.

The average number of persons employed in general engineering establishments in 1938 was 913,000; in 1947 it was 1,261,000.

During World War II the engineering industries naturally expanded. They retained much of their added importance after the war, working partly for the industrial re-equipment of the country and partly for new industries developing abroad. The number of persons employed, including a large proportion of women, was about 49% greater in 1954 than in 1938. During this period exports of engineering products formed a greatly increased proportion of the total of British exports. Tables XXX and XXXI give an idea of the development of machinery output.

TABLE XXX.—*Machinery Output, by Value*
(In thousands of pounds)

Type	1935	1948	1951	1954
Mechanical engineering	103,178	452,864	763,500	1,067,000
Electrical engineering	55,846	225,629	379,000	498,400
Marine engineering	12,434	51,905	68,500	95,600
Locomotive manufacturing	17,878	61,062	70,200	90,700
Textile machinery, parts and accessories	12,000	59,000	76,000	70,000
Machine tools (metalworking)	6,000	33,000	49,000	66,000
Stationary internal-combustion engines	4,000	27,000	43,000	44,000
Mining machinery	3,000	17,000	20,000	20,000
Printing, bookbinding, etc., machines	3,000	11,000	18,000	18,000

TABLE XXXI.—*Agricultural Machinery Output*
(In units)

Type	1938	1946	1950	1954
Tractors	10,679	47,046	150,488	166,791
Plows	12,580	99,947	55,490	36,573
Mowing machines	4,641	9,338	27,076	19,554
Milking machines	...	6,041	19,447	10,238
Harvester-threshers	—	125	4,325	6,120

Motor and Cycle Industries. — Production figures in quantities and values for the motor and cycle trades were as shown in Table XXXII. The number of persons employed in the motor and cycle

TABLE XXXII.—*Motor and Cycle Industry*

Product	1907	1924	1935	1951
Complete motor vehicles, including commercial (number and value)	9,800 £3,323,000	133,400 £34,757,000	377,561 £58,354,000	739,258 £296,443,000
Complete chassis, including commercial (number and value)	£859,000	22,454 £8,113,000	63,697 £13,661,000	
Motorcycles (number and value)	£139,000	120,422 £5,877,000	64,600 £2,624,000	181,990 £17,494,000
Cycles (number and value)	615,300 £3,396,000	704,352 £3,859,000	1,987,000 £6,664,000	3,786,000 £30,380,000
Engines and parts (value)	£1,845,000	£29,366,000	£47,218,000	£231,036,000*

*Excluding motor bodies.

industries increased from 53,639 in 1907 to 169,288 in 1924, to 224,568 in 1935, to 316,150 in 1948 and to 338,000 by the end of Dec. 1955.

Import and export figures are given in Table XXXIII.

The motorcar industry enjoyed a measure of tariff protection, with but one brief interval, from 1915 on, and was enabled to develop while other industries were still feeling all the effects of foreign competition in the home market.

After the outbreak of war in 1939 the industry suffered for a time from declining markets, and it was not until after the fall

TABLE XXXIII.—*Value of Foreign Trade in Motorcars and Chassis*

Year	Imports				Exports			
	Cars		Chassis		Cars		Chassis	
	Number	Value	Number	Value	Number	Value	Number	Value
1913	6,820	£1,700,000	7,958	£1,900,000	7,595	£2,400,000	1,234	£500,000
1924	14,717	3,000,000	12,459	1,800,000	19,315	5,100,000	9,735	2,300,000
1939	5,097	730,000	1,935*	240,000	43,230	5,300,000	22,767	1,600,000
1951	2,415	1,134,000	1,308	188,000	309,119	108,200,000	59,618	10,900,000
1955	11,127	4,503,000	1,034	201,803	322,452	112,800,000	50,751	9,700,000

*Including chassis of commercial vehicles.

of France, in June 1940, that it was fully mobilized for war production. An important section of the industry was transferred to the manufacture of aeroplanes, but in 1942 it was producing tanks and other military vehicles at the rate of 257,000 a year. After World War II motorcars became an important export. In order to simplify production the range of models was reduced and much was done to standardize components. This process was accompanied by a structural simplification, and by 1956 only 20 independent car manufacturers remained. Experiments with gas turbines indicated an important technical development.

Aircraft Industry. — Production figures for various years from 1924 onward were as shown in Table XXXIV.

TABLE XXXIV.—*Aircraft Trade*

Item	1924	1930	1935	1951
Value of products .	£4,j54,000	£8,688,000	£13,919,000	£188,757,00c
Aeroplanes (with and without engines) (numberandvalue)	503	1,459 .	1,807	527*
	£1,904,000	£3,376,000	£4,602,000	†
Aeroplane engines sod separately (number and value)	884	1,973	3,030	t
	£1,479,000	£2,131,000	£3,918,000	†
Average number of persons employed . . .	11,735	21,322	35,032	157,575
Number of establishments .	20	A7	52	215

*Excluding military types except those for export. †Figures withheld for security reasons.

The figures in Table XXXIV reflect the very satisfactory progress of a young industry, but the actual number of aeroplanes produced in 193j was still considerably less than the number produced in 1918. Although the production of military aircraft was steadily increased from 1938 onward, it was not until after the middle of 1940 that the full urgency of the need for an air force capable of repelling German attacks became apparent.

Aircraft production was undertaken on a previously unparalleled scale during the last part of the year, and for a time became the most vital part of the British war effort. The rate of production was more than maintained, and by the first quarter of 1942 it was double that of the last quarter of 1940. World War II gave a powerful impetus toward new developments, and this was maintained during the internationally uneasy first decade after the war. The reciprocating engine was strongly challenged by the turbine; pure jet and turbojet engines were used to power bigger and faster aircraft for both military and commercial requirements. Aircraft of unusual shapes were becoming commonplace as new wing shapes (delta and swept-back) and metals were developed in attempts to overcome the thermal barrier.

Cotton. — Cotton Spinning. — No effective comparison can be made between 1907 and 1924 or later years, since no particulars were recorded in 1907 of the output of yarn used for manufacturing purposes by the spinning firms. The figures of output for 1924 and various later years are as shown in Table XXXV.

TABLE XXXV.—*Output of Cotton Yarn and Waste*
(Weight and value in thousands)

Output	1924	1935	1948	1951
Goods made for sale				
Cotton yarn, including sewing cotton, single and doubled	1,528,318 lb.	1,340,831 lb.	1,004,504 lb.	1,107,488 lb.
	£187,947	£69,945	£194,792	£369,542
Cotton waste, unmanufactured . . .	237,166 lb.	241,429 lb.	157,320 lb.	176,603 lb.
	£5,585	£2,634	£6,017	£14,725
Cotton yarn, purchased and reeled, wound, warped, etc.	10,769 lb.	28,616 lb.	16,994 lb.	10,708*
	£1,122	£1,930	£5,016	£5,418*
Total, goods made for sale	£194,654	£74,509	£205,825	£389,685
Goods made on commission				
Cotton yarn, including sewing cotton, single and doubled .	9,946 lb.	15,995 lb.	...	10,480 lb.
	£521	£289	£465	
Cotton waste, unmanufactured . . .	...	57 lb.	...	
	...	£1	...	...
Cotton yarn, reeled, mound, warped, etc. . . .	4,946 lb.†	39,754 lb.	...	18,114 lb.
	£66†	£328	£1,620	£2,503
Total, work done on commission . . .	£587	£618	£2,164	£3,702
Total, principal products .	£195,241	£75,127	£207,989	£393,387

'Including spun man-made fibre yarns. †So far as recorded.

TABLE XXXVI.—*Exports of Cotton Yarn*

Year	Weight (in lb.)	Value	Year	Weight (in lb.)	Value
1913 .	210,099,000	£15,006,291	1939 .	113,002,000	£8,940,240
1930 .	136,988,000	14,469,350	1948 .	59,062,000	16,766,982
1935 .	141,675,000	11,161,702	1955 .	35,600,000	14,900,000

The exports of cotton yarn for 1913 and various later years were as shown in Table XXXVI.

Cotton Weaving.—The total figures for cotton goods manufactured, together with their value in the census years, were as shown in Table XXXVII.

TABLE XXXVII.—*Cotton Weaving*

Item	1907	1924	1930	1935	1954
Thousands of linear yards .	7,076,203	5,588,808	3,100,000	3,081,138	1,994,000
Thousands of square yards	...	6,026,060	3,320,000	3,385,522	...
Thousand hundredweight	...	19,344	6,540	6,987	...
Net selling value	£81,578,000	£163,447,000	£64,946,000	£53,886,000	£239,200,000*

*Provisional census returns.

Cotton Piece Goods. — The aggregate number of persons employed in cotton spinning and weaving for the census years were as shown in Table XXXVIII.

TABLE XXXVIII.—*Employment* in *Cotton Spinning and Weaving*

Year	Males	Females	Total
1907	219,980	352,082	572,062
1924	197,087	350,690	527,777
1930	143,860	245,529	389,389
1935	128,338	220,981	349,319
1948	92,663	165,798	258,461
1955*	93,190	180,130	273,320

*Estimate at end of May.

With 1918 the cotton industry declined seriously and it was unlikely that it would ever regain the position in world trade it once occupied. The causes of this decline were twofold: increased competition abroad and insufficient adaptability within the industry at home. . Improved methods of production rendered obsolete much of the equipment of the Lancashire cotton mills, but replacements were not made, and the industry was unable to organize itself more economically by such means as amalgamation, joint marketing schemes, etc. Countries such as India and China which were formerly customers themselves became producers, and the rapid expansion of the Japanese cotton industry introduced the severest competition in world markets. The Cotton Industry act, designed to reduce the excess capacity of the industry and to increase consumption, was passed in Aug. 1939, but the coming of war prevented it from having the desired immediate effect. During the war many of the cotton factories were taken over and converted for various types of war production.

During World War II the cotton textile industry suffered the penalty for not being directly connected with the prosecution of the war. Raw materials mere rationed, production was concentrated in a restricted number of plants and labour was diverted to other tasks. The labour shortage persisted after the war and prevented the industry from sharing the general industrial expansion which then began. Soon after, the growth of cotton textile industries abroad threatened to provide a more lasting barrier to recovery. The industry continued to suffer from inadequate equipment and from excessive fragmentation. Nevertheless, through the inducement of a re-equipment subsidy, the Labour government did bring about a substantial consolidation of interests in the spinning section. In its search for export markets the industry moved strongly toward the manufacture of finer counts.

Woollen and Worsted Industries. — SemimanufacturedProducts. — The totals of semimanufactured products for 1907 and various later years are given in Table XXXIX.

TABLE XXXIX.—*Woollen and Worsted Production*
(In thousands of pounds)

Product	1907	1924	1930	1948	1955
Tops or slubbing	243,500	285,529	; A	275,929	309,500
Noils	430,000	535,785	385,989	404,336	538,800
Yarns . .					

Woollen and Worsted Fabrics. — The total values of woollen and worsted fabrics for the same years as those shown in Table XXXIX were as follows: (1907) £40,294,000; (1924) £89,578,000; (1930)

£59,960,000; (1948) £137,883,000; (1955, provisional returns) £618,200,000. Foreign trade figures are given in Table XL.

TABLE XL.—*Foreign Trade in Woollen and Worsted Products*
(In thousands)

Product	1913	1924	1930	1948	1951	1954
Yarns (lb.)						
Imports	32,994	17,801	19,058	9,673	6,809	3,145
Exports	80,415	65,893	49,573	26,888	26,554	25,480
Tissues (sq.yd.)						
Imports	65,183*	31,386	39,642	12,075	18,749	9,828
Exports	168,374*	221,563	113,753	98,035	118,728	99,000

*Linear yards.

The wool textile industry followed roughly the same course as the cotton industry after 1918, though its decline was far less serious. It was, however, subjected to similar foreign competition, losing considerable markets in the far east, and as partial recovery came after the depression years there was growing concern over redundancy of plant, with consequent attention to schemes of control and planning. Other developments affecting the industry were the increased use of synthetic fibres and attempts abroad to find substitutes for wool. Within the industry itself there was an increased demand for woollens at the expense of worsteds and for knitted fabrics at the expense of woven ones. Such factors influenced regional unemployment, since the various branches of the industry were highly localized.

The woollen and worsted industries underwent a contraction during World War II. They also maintained a high degree of specialization. Foreign competition was far less severe, and for a number of years after the war the industries' products were among the country's most valuable manufactured exports. The capital equipment, however, was tending toward obsolescence. The average number employed in the industry was 264,021 in 1907; 274,397 in 1924; 230,342 in 1930; 242,209 in 1935; 183,668 in 1948. It remained fairly steady for the next six years and estimated numbers at the end of May 1955 were 207,000.

Silk and Synthetic Fibres.— Output and employment figures are shown in Table XLI.

TABLE XLI.—*Silk and Synthetic Fibres*

Year	Value of gross output	Average number employed
1907	£5,236,000	32,198
1924	20,299,000	39,932
1935	36,110,000	81,825
1951*	200,800,000	92,200
1954*	198,400,000	84,300

*Provisional census returns.

This industry showed a steady expansion, as a result of the development of synthetic fibres. It is significant that before 1924 there are no statistics of production distinguishing synthetic fibres from silk, but in 1924 the output of natural silk and mixtures was valued at £3,558,000 and that of synthetic fibres and mixtures at £3,308,000. By 1935 the balance of production had changed remarkably; natural silk and mixtures had decreased to £1,579,000, but the value of synthetic fibres and mixtures had reached a total of £17,028,000.

After 1924 exports overtook imports and till 1939 the excess of exports over imports was steadily growing.

The synthetic fibre industry continued to expand after World War II. Unlike the production of other textiles, that of synthetic fibres remained in the hands of a small number of large undertakings. Nylon, first produced in the United States in 1939, assumed importance as a British manufacture after the war. Output of Terylene (known as Dacron in the U.S.) for 1956 was forecast at over 11,000,000 lb.

TABLE XLII.—*Foreign Trade in Synthetic Fibres, Yarn and Fabrics*

Year	Imports	Exports	Year	Imports	Exports
1924	£5,515,178	£4,310,225	1939	£1,957,670	£4,674,993
1930	7,545,626	5,934,853	1948	7,557,467	37,825,308
1935	2,948,759	3,985,781	1955	11,829,855	33,902,954

Forestry and Timber.— Great Britain was once heavily forested, but centuries of timber cutting and clearing have denuded the country of the original forests. In Europe as a whole about 31% of the surface is covered with timber, but in Great Britain, in spite of its well-wooded appearance, barely 4% of the surface is thus covered. It was estimated in 1926 that there were roughly 3,000,000 ac. of woodland of all types in the island.

World War I showed how dependent Great Britain was on imported timber, and stocks of native trees were seriously depleted to meet wartime needs. In 1919 a forestry commission was set up to meet the situation, and it embarked on a scheme for planting 1,777,000 ac. over a period of 80 years. By the end of 1938 it had acquired 1,097,000 ac., of which 340,638 ac. had been planted. A special feature of the activities of the commission from 1936 onward was its attempt to combine reafforestation with relief of the distressed areas in northern England and south Wales.

During World War II felling had to be undertaken on a large scale. Domestic production consequently dwindled and remained on a low level for several years after the war. From the peak of 1943 to 1954 production fell from 216,500,000 to about 87,000,000 cu.ft. Reafforestation was undertaken after the war. Great Britain is dependent on imported timber; exports are negligible. After World War II a reafforestation program began. It aimed at producing 5,000,000 ac. of fully productive forests.

Building Materials.— The production of these materials and the average number of persons employed in certain years are as shown in Table XLIII. It should be noted that the figures for 1930 and 1935 include returns made by certain firms which were assigned to the building and contracting trade for 1924. The number of persons employed in 1930 by these firms was about 2,000.

TABLE XLIII.—*Clay and Building Materials Manufacture*

Year	Value of gross output	Average number of persons employed
1907	£9,599,000	...
1924	9,599,000	20,307
1930	13,930,000	29,731
1935	15,045,000	30,561
1954*	126,600,000	67,000

*Provisional census returns.

Several items of interest are included under these headings. Thus, tar-paving and other road materials in 1930 were valued at £6,360,000 (Great Britain), whereas the total for 1907 was only £308,000, including Ireland. This reflects the increasing wear and tear on the roads through motor traffic. Another symptom is the heading of £1,649,000 for contract and job work on roads in 1924 (including paving materials used) for which no counterpart is to be found in the earlier year. Other items which increased materially as a result of the development of new methods of construction were artificial stone and roofing felts.

TABLE XLIV.—*Building and Contracting Industry*

Year	Value of gross output	Average number employed
1907	£87,967,000	513,993
1924	193,494,000	514,353
1930	194,288,000	453,807
1935	216,000,000	502,300
1954*	1,911,400,000	1,650,300

*Provisional census returns.

TABLE XLV.—*Furniture, Cabinetmaking and Upholstery Manufacture*

Year	Gross output	Average number employed
1907	£12,063,000	76,415
1924	26,108,000	67,555
1930	33,815,000	91,948
1935	33,015,000	91,093
1954*	161,600,000	105,200

*Provisional census returns.

After World War II building materials grew in variety; heavy arrears had to be made good, and standard materials such as timber were hard to get for several years. Innovations which seemed likely to stay comprised the greatly extended use of cement and artificial stone, plasterboard in place of plaster and laths for walls and ceilings, concrete and hollow blocks for floors and bituminous asphalt as a substitute for lead and zinc on roofs.

Chemical and Allied Industries. — The total output of chemical manufactures in 1907 was valued at £24,025,000. The figures for 1935, 1948, 1951 and 1954 were as shown in Table XLVI.

TABLE XLVI.—*Chemical and* Allied Trades
(In millions of pounds)

Product	1935	1948	1951	1954*
Total	194.6	452.4	1,283.3	1,707.9
Mineral oil refining . . .	7.8	42.5	181.3	302.0
Drugs and medicinal products .	19.0	73.0	111.3	125.5
Coke ovens and by-products .	16.5	75.1	93.8	...
Soap, candles and glycerin . .	20.5	55.6	91.8	100.7
Fertilizers and disinfectants . .	5.4	30.9	61.3	...
Dyes and dyestuffs . .	8.1	38.0	55.9	...
Explosives and fireworks . .	7.1	18.6	32.0	...
Toilet preparations and perfumery	6.4	17.1	25.0	...

*Provisional census returns.

The average number of persons employed was as follows: (1907) 52,257; (1924) 66,962; (1930) 70,475; (1935) 77,611; (1948) 165,532; (1955, May 31 est.) 519,490. The dominating position in the British chemical industry is held by Imperial Chemical Industries. Ltd. (*q.v.*).

When war broke out in 1914 British factories were equipped for manufacture of explosives only on a small scale, and the industry had to be expanded rapidly with government assistance. The position with regard to dyes and dyestuffs was even worse, since more than 80% of the world output came from Germany and only 2% from Great Britain. As a result the German patents were revoked, and by 1917 the essential requirements of the country were being met. After the mar the strategic importance of the industry was fully realized, and it was maintained by means of the Dyestuff (Import Regulations) act, which came into force in 1921 and prohibited imports except under licence. Though Germany recaptured the greater part of the export trade that it had formerly had, British output of dyestuffs in 1937 was 31,633 tons as against 63,000 tons in Germany.

The chemical industry expanded rapidly during World War II and was further strengthened by the Patents and Designs act, 1950. The productive capacity was estimated at £350,000,000 in 1948 and continued to expand rapidly for a number of years. Particular attention was given by the government to the refining of crude petroleum. Other new developments included, among chemical fibres, the production of nylon and Terylene and, in the pharmaceutical branch, of antibiotics, in particular of penicillin. Chemicals played a greatly increased part among exports.

The imports and exports of chemical manufactures are given in Table XLVII. It will be seen that British exports considerably exceed the imports.

TABLE XLVII.—*Foreign* Trade in Chemical Manufactures

Product	1913	1924	1930	1935	1939	1948	1955
Products other 'than drugs, dyestuffs, pigments, etc.							
Imports	£6,898,926	£7,802,122	£6.938.463	£6,470,779	£9,322,227	£21,243,879	£91,697,939
Exports	13,638,696	17,672,280	14,877,273	13,250,113	14,293,650	46,464,560	163,939,935
Dyes and dyestuffs							
Imports	3,082,916	2,839,760	2,396,066	2,331,074	3,013,643	4,607,891	6,680,740
Exports	311,386	1,010,982	996,157	1,571,337	1,621,330	8,517,937	11,571,646
Drugs and medicines							
Imports	1,984,637	2,246,443	2,167,622	1,291,641	1,817,014	1,275,593	7,696,104
Exports	2,351,781	3,119,835	2,835,857	3,038,997	3,252,410	15,746,351	35,896,600
Painters' colours, etc.							
Imports	1,369,316	1,728,850	2,069,237	1,507,991	1,767,305	3,608,121	6,193,764
Exports	3,231,525	3,675,276	3,249,189	3,468,056	3,620,795	12,818,022	21,410,324
Total							
Imports	13,335,795	14,617,175	13,571,388	11,601,484	15,920,189	30,735,484	112,268,547
Exports	19,533,388	25,478,373	21,958,476	21,328,503	22,788,185	83,546,870	232,818,505

TABLE XLVIII.—*Paint,* Colour and Varnish Manufactures

Year	Gross output	Average number employed
1907	£8,562,000	13,840
1924	16,948,000	18,502
1930	19,528,000	21,292
1935	22,140,000	24,893
1954*	116,800,000	41,830

*Provisional census returns.

TABLE XLIX.—*Plastics* Materials

Year	Gross output	Average number employed
1935	£2,233,000	3,962*
1948	26,975,000	15,947
1951	58,412,000	20,427
1954†	83,000,000	22,900

*Excluding firms of ten persons or less. †Provisional census returns.

TABLE L.—China and Earthenware *Manufactures*

Year	Gross output	Average number employed
1907	£7,585,000	68,168
1924	17,483,000	69,402
1930	14,603,000	69,873
1935	14,079,000	65,775
1954*	57,500,000	78,270

*Provisional census returns.

TABLE LI.—*Glass Industry*

Year	Gross output	Average number employed
1924	£12,962,000	36,849
1930	13,713,000	39,571
1935	17,056,000	45,869
1951*	80,966,000	69,374

*Provisional census returns.

TABLE LII.—*Foreign* Trade, Glass *Industry*

Year	Imports	Exports	Year	Imports	Exports
1913 .	£3,449,420	£1,207,918	1939 .	£2,244,166	£1,676,805
1924 .	4,580,417	2,499,534	1948 .	3,670,239	8,424,044
1930 .	5,348,850	1,854,615	1951 .	3,836,109	14,125,917
1935 .	3,817,857	1,530,023	1955 .	5,510,057	18,500,000

In spite of vicissitudes corresponding to general trade cycles, the record of the glass industry was one of development and expansion. The manufacture of glass was revolutionized after the beginning of the 20th century through the replacement of old methods by automatic and semiautomatic machines, which enormously increased productive capacity. New uses for glass were found, and many new types of glass were developed. The output of glass containers more than doubled between 1935 and 1952.

Rubber. — In 1938 Great Britain imported 168,200 tons (including synthetic) of crude rubber, of which 132,000 tons were retained for manufacturing; in 1954, 262,900 tons were imported, of which 236,400 tons were retained. In 1950 the gross output of the rubber trade was £162,069,000. Table LIII shows the values of the principal rubber manufactures.

TABLE LIII.—*Rubber Manufactures*

Product and employment	1907	1924	1935	1948	1954*
Rubber tires and tubes .	£2,824,000	£10,540,000	£18,325,000	£63,651,000	£219,800,000
Heels and soles .	314,000	819,000	825,000	1,520,000	
Other .	4,882,000	9,620,000	8,919,000	62,852,000	
Number of persons employed . .	24,039	47,496	55,593	87,145	104,000

*Provisional census returns.

The rubber industry of Great Britain, like that of the United States, suffered severe dislocation early in 1942 when the Japanese, by occupying Malaya and the Netherlands Indies, captured the principal sources of the world's rubber supply. After the war this was reversed. By 1948 imports of rubber exceeded the 1938 level and continued to expand. Tires and tubes remained the most important items of production.

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TABLE LIV.—*Printing and* Bookbinding Industry

Year	Value of gross output	Average number employed
1907	£24,709,000	174,116
1924	56,769,000	168,638
1930	56,597,000	167,849
1935	55,474,000	164,706
1954*	216,900,000	194,600

*Provisional census returns.

TABLE LV.—*Newspapers* and Periodicals

Year	Value of gross output	Average number employed
1907	£13,548,000	46,786
1924	45,298,000	56,724
1930	51,606,000	71,434
1935	50,372,000	78,448
1954*	214,000,000	109,000

*Provisional census returns.

Wartime Organization of Industry.—Comparatively little had been done before Sept. 1939 to put British industry on a war footing, although a certain amount of effective planning had been begun. In the aircraft industry, for instance, "shadow" factories had been organized, and new factories, as well as extensions of existing ones, had been authorized during 1938. But, in spite of many governmental controls, British industry, during the first eight months of war, followed a "business as usual" policy.

The complete reorganization of industry on a wartime basis did not begin until after the fall of France. First the aircraft industry, and gradually every other industry, was brought to the maximum of war production, until only the barest needs of the civilian population were supplied by such factories as were allowed to continue producing their usual products.

Control of Industry.—Until March 1942 production was directed by a production executive under the war cabinet. Under the production executive there were four main committees, and decentralization of the handling of production problems was achieved through the work of 11 regional boards.

Under the Emergency Powers act, the government specified that it should control: (1) the production, storage, distribution and consumption of all articles, and the price at which they might be sold or hired; and (2) charges for any aspect of essential work.

Many steps were taken to ensure the employment of machinery, materials and labour with maximum economy.

After the entry of the United States into the war the national effort was directed primarily toward procuring a maximum of manpower rather than toward the reorganization of industry, and for the rest of the war the severest shortage was that of workers. Censuses were taken of all types of machinery, and the machine tool control of the ministry of supply was strict in removing tools which were not fully employed. The regional boards and capacity clearing centres were active in exposing delays and bottlenecks. Finally the government had the power to appoint a controller to manage any business when it deemed it necessary. In the early stages of the war civilian supplies were cut down by the Limitation of Supplies order, which restricted supplies of certain raw materials to wholesalers working for the domestic market. This method was eventually superseded by a system of direct regulations and prohibitions for a wide range of civilian goods.

Concentration of Industry.—In March 1941 the president of the board of trade initiated a new plan for concentrating production of civilian and export goods in a reduced number of factories. In each industry a number of firms were to select "nucleus" firms to handle all their production. The latter were to work full time and would be guaranteed adequate labour and raw materials. The remaining firms were closed or converted for the duration of the war, their labour, machinery and factory space thus becoming available for the production of war goods. By April 1, 1942, after one year of operation, concentration had released 195,560 workers from 31 industries and it was expected that an additional 30,000 workers would be released. By March 1944 the total number of persons so released came to 290,000. Factory space thus made available was reallocated by the board of trade, and during the first year 52,000,000 sq.ft. of space was thus reallocated, one-third for production, two-thirds for storage.

Control of Labour.—In June 1940 steps were taken to prevent competitive bidding for skilled workers. An order was issued providing that workers in essential industries could be engaged only through the ministry of labour's employment exchanges.

By Oct. 1941, 19,000 undertakings had been scheduled under the various orders, including undertakings in the merchant navy, coal mining, building and civil engineering, iron and steel, dock labour, agriculture, railways, shipbuilding and cotton manufacturing. By June 1942, 8,000,000 workers were covered under the Essential Work orders.

Within industry itself there was a considerable growth of joint (*i.e.*, employers' and employees') machinery for the regulation of wages and working conditions. A further striking development in collaboration was the formation of joint production advisory committees within the factories to stimulate production.

Production.—No specific figures for output were issued, but it was clear that by mid-1942 British production was nearing its peak. Using the production of Jan. 1941 as equivalent to 100, production in June 1942 had reached the equivalent of 244 for aircraft and 289 for "other warlike stores." During the later years of World War II the claims of the fighting services led to a decline in the total volume of production.

Effects of the War.—The final impact of the war on the country's capital equipment was different in different sectors. From the beginning new investment had been strictly controlled and on balance there was a substantial loss in capital equipment. At the end of the war it was estimated that nearly 750,000 extra workers would be needed simply for the maintenance and renewal of plant. Maintenance and equipment were inadequate in transport, docks, gas, electricity, water and drainage and in all the manufacturing industries except metals, engineering and chemicals. The mines were somewhat and agriculture was much more heavily mechanized at the end of the war than they had been at the beginning. This distribution of investment exerted an important influence on the postwar development of industry.

EXTERNAL COMMERCE

British commerce underwent an enormous development after the first quarter of the 19th century. In 1826 the aggregate value of the imports into and exports from the United Kingdom amounted to no more than £88,758,678; the total rose to £110,559,538 in 1836 and to £205,625,831 in 1846. In 1856 the aggregate of imports and exports had risen to £311,764,507, in 1866 to £534,195,956 and in 1876 to £631,931,30j. Thus the commercial transactions of the United Kingdom with foreign states and British colonies increased more than sevenfold in the course of 50 years.

The important fact about the foreign commerce of the United Kingdom during the 20th century is that there was a steady increase in imports but no corresponding steady increase in exports of British produce and manufactures. Many industries, which formerly were mainly in British hands, were developed on the continent of Europe, in America and to some extent in the east. The movement began in 1872. Up to that time the exports of British home produce had kept on increasing with the imports, although at a lesser rate and far inferior aggregate value; but a change took place in the latter year. While the imports continued their upward course, gradually rising from £354,693,624 in 1872 to £375,154,703 in 1876, the exports of British produce fell from £256,257,347 in 1872 to £200,639,204 in 1876. The decline in exports, regular and

TABLE LVI.—*External* Trade of the United Kingdom
(In thousands of pounds sterling)

Period avenge or year	Net imports	British export.	Re-exports
1875–79	319,500	201,500	55,500
1880–84	343,600	234,300	64,000
1885–89	318,800	226,200	60,900
1890–94	357,055	234,450	61,537
1895–99	392,704	237,830	60,318
1900–04	446,040	289,230	67,379
1905–09	522,116	377,342	85,159
1910–13	610,990	474,233	106,958
1914–18	896,925	470,074	78,545
1919	1,461,410	798,638	164,746
1920–24	1,140,607	865,120	138,376
1925–29	1,112,862	717,687	126,494
1930–39	724,834	43,882	60,081
1940–44	1,534,156	348,738	16,178
1945	1,465,756	434,527	51,143
1946	1,250,750	914,699	50,269
1947	1,734,701	1,138,276	59,839
1948	2,013,342	1,581,797	64,698
1949	2,216,096	1,785,839	58,607
1950	2,523,496	2,171,327	84,750
1951	3,776,842	2,579,717	127,004
1952	3,477,868	2,584,686	144,000
1953	3,343,378	2,582,117	105,600
1954	3,373,925	2,674,238	100,800
1955	3,886,122	2,905,469	118,800

TABLE LVII.—*U.K. Imports, Exports and Re-exports, 1939–55; Total Trade, All Classes*
(In millions of pounds sterling)

Year	Net imports: Values	Net imports: Relative figures (1938=100)	U.K. exports: Value	U.K. exports: Relative figures (1938=100)	Re-exports: Value	Re-exports: Relative figures (1938=100)
		98	440	93	46	74
1939	1,126	131	441	87	26	42
		123	399	85	51	82
	1,053	146	915	194	50	81
1947	1,251 1,735	202 (89)	1,139	242 (62)	59	95 (126)
1948	2,014	235	1,583	336	64	103
1949	2,217	258	1,786	379	58	94
1950	2,523	294	2,171	461	85	137
1951	3,777	113	2,580	101	127	105
1952	3,338	103	2,550	95	144	144
1953	3,343	112	2,852	98	106	117
1954	3,379	114	2,674	104	101	109
1955	3,889	...	2,905	...	119	...

steady throughout the period, and with a tendency to become more pronounced every year, affected all the principal articles of British home produce. The external trade of the United Kingdom from 1875 onward is shown in Table LVI, which gives the total values of net imports, exports and re-exports.

The figures in Table LVI show for the earlier period a favourably steady upward movement in both imports, exports and re-exports, subject only to a decline in the five years 1885–89. The figures for 1919 and 1920 reflect the severe inflation of prices in those years, since they exceed by almost 2½ and 3 times, respectively, the average value of the imports for 1910–13, although the actual increases were only about 89.7% and 87.8%, respectively, over the 1913 imports. After 1919 there was a continued decline in the value of some important export commodities (textiles, coal, ships, iron and steel), but between 1924 and 1929 the value of nearly every other class of British exports showed an increase. In 1931, however, at the height of the depression, the disparity between imports and exports became so serious that Great Britain abandoned the gold standard and turned from free trade to protection. It was hoped to build up a system of imperial preference so that empire markets should be held and at the same time to use the tariff as a means of bargaining with other countries; but, while it is true that some industries were undoubtedly stimulated by protection, most economists agree that this change of policy was not the primary cause of Great Brit- [illegible] The plain fact is that "the depreciation of sterling and the adoption of protection left the volume of British exports much lower, and the amount of unemployment appreciably higher, than before the great depression" (F. Benham, *Great Britain Under Protection,* pp. 222–223. In 1933 both exports and imports started on an upward course which continued until 1939.

The excess of imports over exports, which was a feature of British trade balances after 1872 and which rose as high as £463,000,000 in 1926, is counterbalanced by the so-called "invisible" exports. These consist of the earnings of British shipping, insurance, commissions and London financial services. To them must be added the income from overseas investments and from the tourist industry.

While Table LVI does not include capital movements, it suggests reasons why Great Britain was able, as in 1928, to bear an apparently adverse trade balance of £352,000,000. On the other hand, the over-all adverse balance of current items amounting to £100,000,000 in 1931, together with the drain of gold from the country, caused the abandonment of the gold standard and the adoption of protective tariffs. The table also suggests that Great Britain's recovery from the depression was due to internal causes and not to a revival of exports, since in the very prosperous year of 1937 there was nevertheless an adverse over-all foreign balance of about £56,000,000. After 1939 the country had to draw heavily on its capital resources.

Between 1913 and 1930 the percentage of the total British trade with the commonwealth changed little. After the Ottawa conference of 1932, this trade increased. This is shown in Table LVIII.

Table LIX shows the geographical distribution of U.K. trade for certain years. Imports from Europe declined, but re-exports increased. The effects of Japanese competition are visible in the decline of exports to Asia, while the increase in trade with Oceania is largely the result of the Ottawa agreements.

World War II and After.—The outbreak of war in 1939 greatly increased the problem of earning enough by exports to pay for imports, which, of course, included munitions of war. The difficulty did not lie in finding markets—the elimination of German exports and general shortages made it certain that anything exported would be readily bought—but in getting the raw materials and labour needed to produce the goods. In tackling this problem the state directed labour and allotted the raw materials, while production and marketing were left to private enterprise. This arrangement worked fairly well, though the value of exports (1935 prices equalling 100) fell steadily from 94 in 1939 to 56 in 1941, after which the position was altered by the entry of the United States into the war.

The volume of imports decreased as the war went on, partly from shortage of money and partly from shortage of shipping. The weight of imports of food and feeding stuffs fell from an annual

TABLE LVIII.—*Total Trade*
(Value in thousands of pounds sterling)

Class of trade	1930 Value	1930 Per cent	1938 Value	1938 Per cent	1955* Value	1955* Per cent
Imports from						
Foreign countries	746,799	74.54	548,696	59.61	2,095,430	53.92
British commonwealth	255,088	25.46	371,742	40.39	1,790,692	46.08
All countries	1,001,887	100.00	920,438	100.00	3,886,122	100.00
Exports (British produce) to						
Foreign countries	326,955	60.99	236,067	50.13	1,490,500	50.96
British commonwealth	209,100	39.01	234,816	49.87	1,414,969	49.04
All countries	536,055	100.00	470,883	100.00	2,905,469	100.00
Re-exports to						
Foreign countries	66,552	86.23	50,138	81.38	100,628	84.79
British commonwealth	10,629	13.77	11,470	18.62	18,051	15.21
All countries	77,181	100.00	61,608	100.00	118,679	100.00

*Republic of Ireland included in foreign countries and not in British commonwealth.

TABLE LIX.—*Direction of Trade*
(In percentages)

Year and class of trade	Europe	Africa	Asia	N. America	S. America	Oceania	Sterling area
Imports							
1913	40.53	6.10	12.71	23.85	9.07	7.64	20.90
1938	33.37	6.92	13.53	25.41	7.35	13.42	31.20
1946	17.65	9.48	14.43	36.19	10.48	11.77	32.77
1951	31.47	12.66	18.46	19.20	6.86	11.35	35.80
1954	31.06	12.31	16.20	22.19	6.48	11.76	38.52
British exports							
1913	34.65	9.86	25.20	11.99	9.59	8.71	32.65
1938	36.39	15.69	16.73	11.46	7.36	12.37	44.92
1946	38.20	17.55	20.41	8.47	6.21	9.16	45.16
1951	30.65	16.36	17.43	12.98	6.51	16.97	50.87
1954	33.29	[illegible]	17.41	4.31	13.37	16.82	45.81
Re-exports							
1913	56.18	3.14	2.48	32.30	1.94	3.96	9.21
1938	76.15	2.71	2.58	15.63	1.18	1.75	16.87
1946	82.01	2.31	2.94	10.41	1.62	0.71	14.91
1951	72.47	3.33	3.85	15.94	2.29	2.12	13.61
1954	68.75	3.96	5.90	17.35	1.51	2.53	13.65

average of about 22,000,000 tons for 1934–38 to one of 10,800,000 tons for the first half of 1944. Imports of raw materials fell even more heavily. The shortage of shipping made necessary some thoroughly uneconomic developments: thus, while imports of iron ore fell by about two-thirds, those of steel ingots, semifinished steel and finished steel more than doubled.

These concomitants of total war destroyed anything approaching a balance of trade. The deficit was financed partly by the realization of foreign securities (these were reduced by fairly equal stages from £3,545,000,000 capital value in 1938 to £2,417,000,000 in 1945 and to £1,960,000,000 in 1948), partly by the accumulation of debts (the so-called sterling balances, which in June 1945 amounted to £3,052,000,000) and partly by lend-lease supplies from the United States amounting to £2,426,000,000 net. The existence of the sterling balances and the loss of foreign investments continued for several years after the war to overhang the British balance of trade. Another legacy of the war was the formation of the sterling area—that is, the large but shrunken region in which the pound sterling continued to be freely convertible.

The distribution of British overseas trade was profoundly affected—and distorted—by the war. After the war the world could be divided into five main areas: (1) the dollar area, a source of vital imports but too nearly self-sufficient to be an easy market for exports; (2) the rest of the western hemisphere, less important but relatively untouched by war; (3) the countries of the Organization for European Economic Cooperation (O.E.E.C.), trying to build up their injured economies by reciprocal action and U.S. aid; (4) other nonsterling countries; and (5) the sterling areas. Of these, the dollar area, the most important, took in 1938 about 10% of British exports and furnished about 22% of British imports. In 1947 the respective figures were 9% and 35%. After this, strong efforts were made to redress the balance, and by 1954 the balance of trade with North America was more satisfactory. The percentages for (2) underwent no great change, but those for (3) and (5) showed a greater orientation of British trade toward the O.E.E.C. and toward the rest of the sterling area. These increases occurred at the expense of (4), the other nonsterling countries, including of course the U.S.S.R. and the countries in its orbit. The structure of British overseas trade also underwent a substantial change. In 1938 imports of food. drink and tobacco made up about half the total, the rest being divided fairly equally between raw materials and manufactured articles. In 1945 this pattern had not greatly changed. But during the following nine years the share of food, drink and tobacco shrank until, in 1954, it made up only about 40% of the total. Raw materials gradually came to predominate, while imports of manufactured articles formed a smaller part of the total than in 1938.

In its main outlines, the structure of exports remained as it was in 1938, with manufactured articles dwarfing all other exports. (The only important raw material to be exported before World War II, coal, could not be spared in large quantities after 1945.) Within the list of manufactured exports some significant changes occurred: those of capital goods (notably electrical goods and machinery) became more important, while textiles, which had been growing less important before the war, fluctuated a good deal: but roughly held their position.

Unbalanced Trade.—From the outbreak of war until the end of 1954 the structure and distribution of British trade were less important than the net balance. This varied widely from year to year and was affected by political as well as by economic factors. The chief causes of the unbalance lay in the difficulties of the U.S. market and in the fluctuating terms of trade. The cost of this unbalance was high: U.S. and Canadian loans worth £1,210,000,000 and European Recovery program aid aggregating $2,694,000,000 were used up in an attempt to maintain the balance.

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SHIPPING AND SHIPBUILDING

Shipping.—The movement of British shipping from 1910 is shown by Table LX.

A feature of the situation before 1914 was the steady increase in British tonnage accompanied by a considerably more rapid increase in German, Scandinavian, Dutch and Spanish tonnages. In 1890 British tonnage represented 71% of total entrances and clearances, but the average proportion for 1910–13 was only 57%. From 1919 to 1928 British shipping seemed to be recovering its position, and in 1928 the percentage of entrances and clearances rose to 67%. Later, however, it steadily declined and in 1938 was 57%, a proportion almost identical with that of 1913.

TABLE LX.—*Tonnage of Vessels Entered and Cleared at British Ports*

Year	Entered		Cleared	
	British	Foreign	British	Foreign
1910–13 average	42,828,465	30,712,572	43,075,761	30,934,772
1925	52,020,734	31,997,047	52,839,274	32,450,835
1935	46,840,294	38,699,029	47,286,438	38,829,148
1939	45,353,000	34,845,000	44,832,000	35,061,000
1940	30,746,000	10,914,000	31,163,000	10,335,000
1941	18,712,000	6,784,000	19,825,000	6,855,000
1942	16,206,000	8,276,000	17,204,000	8,293,000
1943	16,754,000	13,847,000	17,333,000	13,706,000
1944	27,305,000	29,632,000	27,506,000	29,608,000
1945	32,801,000	22,840,000	33,104,000	22,651,000
1946	32,945,000	17,427,000	33,499,000	17,979,000
1947	36,753,000	17,605,000	37,128,000	17,572,000
1948	40,646,000	22,750,000	41,484,000	22,907,000
1949	42,771,000	24,363,000	43,115,000	24,537,000
1950	43,529,000	27,680,000	44,274,000	27,973,000
1951	44,905,000	33,355,000	44,886,000	33,614,000
1953	48,108,000	39,224,000	48,276,000	39,344,000
1954	49,884,000	40,668,000	50,280,000	40,736,000

World War I brought about a great change in the relative position of the chief maritime countries. An immense quantity of tonnage was destroyed by combatants, the total being estimated at 14,202,000 tons, of which Great Britain's loss was 5,202,000 tons. On the other hand, the United States added to its fleet no less than 6,729,000 tons. The world net loss of tonnage was, therefore, 7,473,000 tons. The German merchant marine, however, which in 1913 numbered 5,082,061 tons, was in 1921 reduced to 717,450 tons by surrender of reparation tonnage to the Allies.

The war years and those immediately succeeding witnessed a very high rate of construction. The result was that world shipping, which in 1914 aggregated 45,409,000 tons and in 1918 had sunk to less than 39,000,000 tons, had increased to 47,897,000 tons by the middle of 1919 and to 70,131,000 tons by 1931. It sank in 1935 to 64,886,000 tons, but by 1939 it had risen again to 69,440,000 tons. (For shipping losses in World War II *see* **SHIPPING INDUSTRY**: *World Merchant Fleets.*)

After World War II construction went rapidly ahead. World shipping rose to 80,290,000 tons in 1948 and to 100,569,000 tons in 1951. The total number of persons employed on vessels of a gross tonnage of 100 tons or more, engaged in home and foreign trade, was 236,188 in 1930. The number sank to 182,391 in 1935, and in 1952 it was 167,240. The number of persons employed on sea, river and canal transport was estimated at 223,500 in the census of 1951.

Shipbuilding.—The total value of the gross output in the census years of ships and for all classes of work, including repairs, for private shipyards in the United Kingdom, together with the average number employed, is shown in Table LXI.

Table LXII, taken from Lloyd's *Annual Summary of Shipbuilding*, gives the tonnage of merchant vessels launched in the United Kingdom and the total tonnage for the world from 1921 to 1955.

Fluctuations shown in Table LXII were shared fairly equally by British and foreign shipyards, but the table also illustrates the significant decline of shipbuilding in the United Kingdom. In 1913 the output of British yards constituted 58% of the world total, but between 1931 and 1939 it was only about 30%.

In 1946 the British output recovered to 53%, but the recovery of foreign yards brought the British share back to 26% in 1954.

One development in shipbuilding in which British yards had only

TABLE LXI.—*Shipbuilding*

Year	Value of output	Average number employed
1907	£37,091,000	188,312
1924	54,272,000	141,867
1930	62,724,000	133,453
1935	35,814,000	82,020
1954*	305,800,000	221,100

*Provisional census results.

a limited share was the construction of motor ships. Their increasing popularity was a result, first, of the disorganization of the world coal industry between 1919 and 1926 and, second, of a growing demand for oil tankers and the enormous increase in the use of fuel oils. A comparison, based on a table given in *Lloyd's* Register, is given in Table LXIII of the numbers of steel motor ships of 100 gross tons and more launched in the United Kingdom and in the rest of the world from 1936 to 1955.

TABLE LXII.—*Tonnage of Merchant Vessels of 100 Gross Tons and More Launched**

Year	United Kingdom	World†	Year	United Kingdom	World†
1921	1,538,052	4,356,843	1940	842,910	1,754,198
1925	1,084,633	2,193,404	1941	1,185,894	2,491,173
1926	639,568	1,674,977	1942	1,270,714	7,815,369
1927	1,225,873	2,285,679	1943	1,136,804	13,884,776
1928	1,445,920	2,699,239	1944	919,357	11,169,503
1929	1,522,623	2,793,210	1945	893,515	7,192,679
1930	1,478,563	2,889,472	1946	1,120,526	2,114,702
1931	502,487	1,617,115	1947	1,192,759	2,102,621
1932	187,794	726,591	1948	1,176,346	2,309,743
1933	133,115	489,016	1949	1,267,467	3,131,805
1934	459,877	967,419	1950	1,324,570	3,492,876
1935	499,011	1,302,080	1951	1,341,024	3,642,564
1936	856,257	2,117,924	1952	1,302,548	4,395,578
1937	920,822	2,690,580	1953	1,317,403	5,096,050
1938	1,030,375	3,033,593	1954	1,408,874	5,252,630
1939	629,705	2,539,424	1955	1,473,937	5,316,742

*Nonpropelled craft excluded after 1940 †Excluding the U.S.S.R.

By 1955 Great Britain was producing a large proportion of motor tonnage built, and much pioneering work was done in the development of the high-pressure steam turbine and of the electric drive.

At the outbreak of the war in Sept. 1939, the Germans immediately began a campaign of unrestricted sinking of merchant shipping. The occupation of Norway and the Atlantic coast of France in 1940 gave German submarines a far greater number of ports from which to operate than in World War I. British losses were heavy. The aggregate loss of British merchant shipping, from Sept. 1939 to Aug. 1946, amounted to 11,677,475 tons.

TABLE LXIII.—*Steel Motor Ships of 100 Gross Tons and More Launched*

Year	United Kingdom	Other countries	Year	United Kingdom	Other countries
1936	120	330	1947	187	299
1938	99	499	1948	182	406
1940	70	119	1949	181	407
1941	76	118	1950	151	529
1942	73	125	1951	172	614
1943	86	110	1952	179	650
1944	131	101	1953	135	722
1945	95	247	1954	163	778
1946	143	212	1955	196	992

During the war merchant shipping construction had to compete with the claims of the navy (over which it was at times given priority) and of repairs. The output of new tonnage was never sensational, the highest being 1,270,714 in 1942. A number of important technical improvements were made. After the pact of Munich (1938) it was found that some shipyard equipment was badly out of date, and in 1942 a modernization scheme, to cost £6,900,000, was approved. For the construction of some small craft prefabrication was adopted, and by 1943 some companies were building landing craft in 24 months where they had formerly taken 6 months. But the industry as a whole continued to suffer from obsolete equipment until well into 1943. After the war merchant building expanded steadily, and in 1954 G.K. launchings reached 1,408,874 tons. Large-scale welding had been introduced during the war; later its use was extended, for instance, to boilermaking. In tanker construction (tankers increased rapidly in size and number) the use of longitudinal frames developed. The long-term trend toward the construction of faster vessels generally continued, and the use of motor propulsion expanded rapidly.

See *Lloyd's Register of Shipping* (London, annual); *Shipping World Yearbook and Who's Who* (London, annual); *Fairplay's Annual Summary of British Shipping Finance* (London, annual).

TRANSPORT AND COMMUNICATIONS

Railways. — The first line of railway for regular passenger service, that from Stockton to Darlington. 38 mi. in length, was opened on Sept. 27, 1825. The first really important railway was the line from Manchester to Liverpool, opened on Sept. 15, 1830. The first sod for the London-Birmingham railway was cut at Chalk Farm, London, on June 1, 1834. All the great railway systems of England sprang into existence within less than ten years after the opening of the London-Birmingham line. The railway companies were at first authorized only-to construct and maintain the permanent way, charging tolls to the owners of locomotives and freight cars and coaches which used the lines. The next step was that they became providers of the locomotives which hauled the privately owned freight cars and coaches. Finally the companies became providers also of the freight cars and coaches, except in the case of mineral cars on the London, Midland and Scottish, Southern and Great Western railways.

There were 40 mi. of railway in Great Britain in 1825, 293 by 183j and in 1850 a total of 6,621 mi. The number of passengers carried per mile of railway increased from 4,860 in 1832 to nearly 12,000 in 1842.

At the outbreak of World War I in 1914 the government took complete control of the railways. guaranteeing the companies their prewar revenues. The fact that the war lasted for more than four years, and involved a far-reaching rearrangement and redistribution of the trade and traffic of the country made the strict terms of the agreement practically inapplicable. A large sum of money was required to put the companies back into their prewar condition of repair and efficiency. Rolling stock had been removed to other countries, stations closed, permanent may and other plant allowed to fall into comparative disrepair, staff seriously depleted and the arrangements for routing of traffic widely altered, The costs of operation had also risen enormously.

TABLE LXIV.—*Freight and Passenger Traffic Mileage and Receipts*

Item	1938	1945	1954
Passenger traffic			
Sumber of journeys	1,237,200,000	1,371,800,000	991,200,000
Estimated passenger-miles	18,993,000,000	35,248,000,000	20,712,000,000
Estimated average distance per journey (miles)	15.9	26.9	21.1
Average receipt per passenger journey (pence)	11.38	27.63	27.44
Average receipt per passenger-mile (pence)	0.74	1.03	1.35
Freight traffic			
Freight, mineral and livestock (tons)	265,700,000	266,400,000	274,040,000
Estimated net ton-miles	16,266,000,000	22,023,000,000	22,048,000,000
Average receipt per ton-mile (pence)	1.34	1.81	2.96

The government, foreseeing the difficulties which would arise if control were suddenly removed, passed in 1919 the Ministry of Transport act, which gave the minister powers to control the operation and charges of all existing means of internal transport. Later there was passed the Railways act, 1921, under which:

1. The 120 railways of Great Britain were amalgamated into four large groups, the Southern, the Great Western, the London, Midland and Scottish and the London and North Eastern. (The passenger transport of London and its suburban areas was separately amalgamated and placed under the London Passenger Transport board in 1933.)

2. A new tribunal called the Railway Rates tribunal was set up, its most important function being the regulation of fares and rates and conditions of carriage.

The Railway Rates tribunal was responsible for introducing a new classification of merchandise into 21 classes to determine freight charges, and it drew up a schedule of standard charges to which the companies were obliged to adhere. Somewhat more latitude was allowed the companies in determining passenger fares. The principle by which rates were fixed was defined in the act when it stipulated that they should "yield, with efficient and economical working and management, an annual net revenue equivalent to the aggregate net revenues in the year 1913 of the constituent companies." This was £50,000,000, a figure which actually was not reached until World War II. Under the 1921 act the relations of the companies and their employees were to be governed by an elaborate system of conciliation councils, of which the chief were the Central Wages board and the National Wages board. In addition, the companies received from the government £60,000,000 in final settlement of all war claims—a sum which brought to nearly £150,000,000 the amount thus paid.

The economic condition of the railways after World War I was dominated by their rigid cost structure on the one hand and the emergence of formidable competition from road transport on the other. The railways were badly hit by the world slump of 1929–32, and the companies made a vigorous attempt to cut costs by reducing wages by 10%. A cut of less than 5% was secured, but the companies gave notice of their intention to withdraw from the National Wages board and the Central Wages board. After a temporary breakdown new conciliation machinery was established in 1935, and the railway owners concentrated their attention on the fight against the competition of road transport.

Under the 1921 act the railway companies were not allowed to maintain any road services, and it was not till 1928 that this provision was relaxed. Thereafter they attempted to acquire and maintain some of the services which had been competing against them. But the situation was far from satisfactory.

A royal commission, appointed in 1928, issued its lengthy and inconclusive final report on the co-ordination and development of transport in 1931, and in the following year a conference of rail and road experts, under the chairmanship of Sir Arthur Salter, made a number of more restricted, but more practical, recommendations, some of which were embodied in the Road and Rail Traffic act of 1933. By this act local traffic commissioners were empowered to license vehicles carrying goods, authorize routes and prevent duplication. This system worked fairly well until 1938, when the railway companies began an agitation for freedom from legislative shackles.

On the outbreak of World War II the minister of transport took control of the railway companies and the London Passenger Transport board. The railways were to be paid a sum based on the prewar profits which in 1941 was altered to a fixed annual payment of £43,000,000. During the war the railways' receipts largely exceeded this sum. The number and length of passenger journeys increased, while the number of trains running was reduced. The average load carried by passenger trains was 125% greater than before the war. These special conditions ended soon after the war, while costs continued to rise. By the middle of 1946 they were 70% above the prewar level. From 1947 the railways ran at a loss. In 1955 a 15-year modernization scheme, to cost about £1,200,000,000, was announced.

Nationalization.—A radical change in the entire transport system was introduced by nationalization, which was effected through the Transport bill of 1946 (enacted in 1947 and brought into force on Jan. 1, 1948). The object was to secure "the provision of an efficient, adequate, economical and properly integrated system of public inland transport." The machinery of the act placed the minister of transport at the head. Under him was the Transport commission, with five executives, in charge of railways, road transport. docks and canals, London transport and hotels. Large powers of direction were reserved to and sometimes employed by the minister of transport.

Integration proved a slow and difficult undertaking. The lack of progress toward it, as well as political considerations, caused Winston Churchill's Conservative government to pass the Transport act (May 1953) for denationalizing the road transport services and decentralizing the railways. The act abolished the executives except the London Transport executive. Further changes were effected in Oct. 1953 and Jan. 1955. The British Transport commission was put in charge of major policy and general direction, while a measure of departmental authority was transferred to the six geographical regions into which the railway system was already divided. The Railways Reorganization scheme provided for further decentralization by transferring powers to the area boards, one of which was set up in each region. The boards were given wide powers of initiative and management.

A high level of business activity helped in the optimum utilization of existing resources. The average train load in 1938 was 125 tons; in 1951 it was 162 tons. In British Road services—the nationalized haulage concerns—empty vehicle-miles tended to form a lower percentage of loaded vehicle-miles run. But these indications of efficient and progressive practice were not accompanied by clear proof that the main objective—integration—was being achieved. Co-operative machinery was extended—in 1948 a standing conference for co-operation was set up, and in 1949 liaison conferences between the different executives were established. Under the Transport act of 1947 road transport was nationalized with the exception of vehicles carrying a trader's own goods. A vacillating policy was followed with regard to these services. Under Winston Churchill's government vehicles began to be sold back to private owners, but in 1955 it was decided to retain the larger vehicles. A sort of compromise between integration and competition was thus reached.

Canals.—The majority of the canals in Great Britain were built during the early stages of the Industrial Revolution and before the railway era, so that they fell more and more into disuse with the development of more modern methods of transport.

The British canal system labours under serious disadvantages in comparison with the much greater systems on the continent. British canals are narrow; the frequent locks slow down transport; there is a good deal of duplication; and multiplicity of ownership hinders the most economical working. The amalgamation in 1930 of eight canal companies into the Grand Union Canal company enabled 300 mi. of waterway, linking London and the midlands, to be improved so as to accommodate 100-ton barges.

During World War I the use of canals for transport increased considerably, and with the outbreak of war in 1939 there was a similar increase. A central canal committee was set up in 1941 to co-ordinate six regional committees, and the canals, which before World War II carried an annual total of 15,000,000 tons, were handling much larger quantities, particularly of coal, under government supervision. After the war the canal system was nationalized under the Transport act. Traffic by 1954 had dropped to 12,250,000 tons, mostly fuel in various forms. For an account of proposals in the early 1950s for the reorganization and development of canals *see* INLAND WATER TRANSPORT.

Roads.—"The high road, a hundred years ago, was not the grass-grown desert of the present time; it was alive with traffic and gaiety," wrote William Makepeace Thackeray in The Virginians (1857). His point of view was that of the railway age, but later years saw a return to the conditions of the 18th century on a scale previously undreamed of. The modernization of British roads owed most to the passage of the Development and Road Improvement Funds act of 1909, which based the road improvement fund on the proceeds of a gasoline tax and provided for its nationwide administration.

The enormous increases in expenditure on roads and their upkeep are shown in Table LXV.

There were, by 1954, in Great Britain 187,040 mi, of public highways, of which 95% were hard-surfaced. These were divided into the following classes: (1) trunk roads, 8,250 mi., the direct responsibility of the minister of transport with moneys for their maintenance and improvement provided entirely from central funds; (2) class I roads, 19,533 mi.; (3) class II roads, 17,697 mi.; (4) class III roads, 48,682 mi.

Roads thus classified are maintained by the county and urban highway authorities whose areas they pass through. Apart from county boroughs these highway authorities receive state grants of 75%, 60% or 50%, according to the classification of the roads. The remainder of the roads are unclassified and receive no grants-in-aid.

The great extension in the use of roads is a result, of course, of the development of the internal-combustion engine. There were 17,810 motor vehicles in Great Britain in 1904, 45,020 in 1906

TABLE LXV.—*Expenditure Other Than Loan Charges on Highways and Bridges, Great Britain**

Year	Expenditure	Year	Expenditure
1912–13 . . .	£15,876,057	1938–39 . . .	£58,284,000
1923–24 . . .	50,556,085	1946–47 . . .	60,598,000
1929–30 . . .	65,469,691	1950–51 . . .	72,836,000
1936–37 . . .	58,528,000	1953–54 . . .	90,335,000

*This table gives expenditure on class I, II, III and unclassified roads. Class III roads were adopted as from 1946. Expenditure on trunk roads is included from 1938, when they were introduced.

and 388,860 by 1914. Increases after that time are shown in Table LXVI, which gives the number of licensed vehicles in 1922, 1930, 1938, 1945 and 1955.

After 1918 the more striking developments in road transport were the establishment of rural bus services, which opened up the English countryside. and the growth of public haulage services, which seriously competed with the railways.

To cope with the constantly growing volume of traffic on the roads various measures were adopted. Ribbon development (*i.e.,* the building of houses for miles on either side of main roads leading out of towns, to the detriment of traffic) was restricted

TABLE LXVI.—*Motor and Horse-Drawn Vehicles in Great Britain*.

Licences current on Nov. 30 (approximate)	1922	1930	1938	1945	1955
Total motor licences* .	933,308	1,969,649	2,883,285	2,582,927	6,260,000
Cars.	293,740	959,353	1,819,376	1,473,742	3,472,000
Cycles	352,340	508,241	370,240	307,787	1,188,000
Freight vehicles . .	158,856	340,545	483,865	478,056	1,045,100
Motor hackneys . .	72,263	83,177	75,003	98,198	94,100†
Horse-drawn vehicles .	237,342	53,015	9,274	‡	‡

*These figures exceed the aggregate of those given below because of omitted categories. †Buses, coaches, taxicabs. ‡Not known.

by an act of 1935. More and more bypasses were built so that main-road traffic could skirt the towns on the route. The Trunk Roads act of 1936 put 4,460 mi. of main roads under the direction of the ministry of transport instead of the local authorities to ensure their uniform development.

From Sept. 1939 onward, war conditions greatly affected the use of the roads. In July 1940 the manufacture and sale of new cars was stopped. On June 30, 1942, allowances of gasoline for private cars ceased and private motoring was no longer possible.

After World War II the number of road-using vehicles increased substantially. Between Feb. 1939 and Feb. 1952 they increased from 2,571,000 to 3,820,000 (government-owned vehicles excluded) and to 6,412,000 by Sept. 1955. During the first decade after the war nothing was done to provide a road system to cope with the increased traffic, though a development plan was put forward in 1954.

Tramways.—An act passed in 1870 to facilitate the construction of tramways throughout the country marked the beginning of their modem development, but they did not spread rapidly until after 1890. After 1924 they declined, and in 1931 the royal commission on transport regarded them as obsolescent because they "caused much unnecessary congestion and considerable unnecessary danger to the public." It therefore recommended that they should be gradually eliminated.

The number of tramcars licensed in 1924 was 14.448; in 1938 it was 7,207. After World War II the replacement of trams by trolley buses and motorbuses continued. The number of trams licensed in 1953 was 2,560.

Air Lines.—Air transport first became a commercial reality after World War I, the first commercial passenger plane crossing to Paris in Aug. 1919. The first airmail contract was made by the government in the following November. In 1924 the British air lines merged in the state-aided enterprise of Imperial Airways Ltd., a £1,000,000 company with government representation on the board. In 1939 Imperial Airways and British Airways (Imperial Airways' principal competitor after 1924) became, by act of parliament, the government-controlled British Overseas Airways corporation (B.O.A.C.).

Great Britain is ill suited to internal air communications, since distances are so short that the saving of time made possible by flying is of comparatively little consequence. The early air services between Britain and the various parts of the continent were always regarded as steppingstones to the time when it would be possible to link the whole empire by air. The formation of Imperial Airways was the first step in the development of such services. From 1921 to 1927 the royal air force conducted an airmail service between Cairo and Baghdad, and this was taken over by Imperial Airways as soon as it had established its service to Cairo on a satisfactory basis. At first there were difficulties to contend with in Europe, since various European countries placed restrictions on aircraft flying across their territory, but in 1938 the normal route to Cairo was via Marseilles, Brindisi and Athens.

From Egypt, routes were extended in various directions. The Baghdad service went on first to Basra and then, in 1929, to Karachi. Eventually an agreement was reached with the Indian government and the service was extended to Delhi, Calcutta and Singapore and finally, in 1934, after negotiations with the Australian government, to Sydney. Hong Kong was linked to the service in 1935. Services were also extended southward. first to Nairobi in 1931 and then to Cape Town in 1932. Various branch lines connected the west coast of Africa with the system.

The next step was obviously the development of a transatlantic service, and here Great Britain was behind not only the United States but continental countries such as Germany and Italy as well. During 1937 trials were flown across the Atlantic and a regular service was instituted from Bermuda to New York city.

In the extension of all these services the carrying of mails either preceded or began simultaneously with the carrying of passengers. Airmail rates were steadily lowered until the postmaster general (Sir Kingsley Wood) announced the empire airmail scheme, under which all first-class mail would be carried at the normal rate of $1\frac{1}{2}d.$ an ounce. The service to South and East Africa was inaugurated in 1937, and in 1938 it was extended to India, Malaya, Australia and Hong Kong. Table LXVII furnishes some details of the progress of British commercial aviation.

The coming of war in 1939 brought great changes in civil aviation. The government was already in control of British Overseas Airways, and inland air lines were taken over from 1940 until 1945. The empire airmail scheme had to be suspended. The principal wartime developments in transatlantic flying, however, took place in 1941, 400 crossings being made by British Overseas Airways on the northern route in 18 months. When the service began in Nov. 1940 the journey took 16 hours. but two years later it frequently took no more than 8. New Zealand was linked to the empire services in April 1940, and in June 1940 regular services

TABLE LXVII.—*U.K. Regular Air Services; Totals for All Companies**

Year	Number of flights	Passengers carried	Cargo carried (short tons)		Aircraft mileage
			Mails	Freight	
1928	4,800	27,300	93	818	916,000
1938	95,100	222,200	3,867	2,830	14,331,000
1946	89,556	423,500	3,014	4,572	33,017,000
1947	114,085	586,joo	3,362	5,657	39,522,000
1948	102,133	713,400	4,751	9,080	44,206,000
1950	131,272	1,156,300	7,264	21,668	48,299,000
1951	138,772	1,415,100	8,931	37,527	52,455,000
1952	158,800	1,732,800	9,492	34,764	58,140,000
1953	177,614	2,160,000	9,792	62,892	61,716,000
1954	180,040	2,443,200	10,332	73,500	59,568,000

*B.O.A.C., British European Airways and private companies operating scheduled services under associate agreement.

to Lisbon, which immediately assumed the utmost importance, were inaugurated. In 1942 British Overseas Airways was still flying over routes of more than 50,000 mi. Communications with the middle east were maintained via Lisbon, Bathurst and Freetown, and Khartoum. In the summer of 1940 the "horseshoe" route from South Africa to Sydney via India and Singapore came into operation, and it mas maintained as far as Calcutta after the Japanese occupation of Burma. Malaya and the Netherlands Indies. An agreement with the Brazilian government in Nov. 1941 foreshadowed further links between Africa and the two American continents. From 1939 up to about 1946, practically all new commercial aircraft in operation were of U.S. origin, since British factories were concerned solely with war production.

The end of World War II brought two changes: a release of the pent-up forces toward a wide expansion, and nationalization. By the Civil Aviation act. 1946, side by side with the British Overseas Airways corporation, the British European Airways (B.E.A.) corporation and the British South American Airways corporation (both with fields of operation explained by their names) were set up. The latter, after a chequered career, was absorbed by B.O.A.C. under the Airways Corporations act, 1949. The resulting structure left the great bulk of civil aviation in the hands of the state, a small residue being left to private charter and liner companies. The postwar expansion of civil aviation is shown obviously in Table LXVII. By 1955 the main services operated by B.O.A.C. covered New York city, Chicago, Montreal and the Caribbean; Australia, India. Ceylon, Singapore, Hong Kong, Tokyo and the middle east; and Cairo, Accra, Nairobi and Johannesburg. B.E.A. operated services within Great Britain from London to most of the greater cities, the main network following the north-south axis of the islands. In Europe it ran services which fanned out clockwise from the London-Oslo line to the London-Gibraltar line, the greatest density lying in western Europe.

Communication. — The *Post* Ofice. — The first inland post was established in England in 1635. Early charges were *2d.* per 80 mi., *4d.* for 140 mi., 6d. for greater distances in England, 8d. to Scotland. At first the volume of correspondence was very small, and Sir Walter Scott in The Heart *of Midlothian* mentions that one day in the late 17th century the mail from London to Edinburgh consisted of a single letter. The institution of mail coaches in 1784 marked a great step forward. Mails were first sent by rail in 1830, and the penny post was established in 1840. The sending of telegrams was originally in the hands of various telegraph companies, the transfer to the state taking place in 1870. After 1880 the then novel and undeveloped system of telephony was carried on under licence from the state, being held to be within the state telegraph monopoly.

The National Telephone company gradually absorbed all other licensees and obtained a licence which expired in 1911. The state, however, had control of all trunk lines. The National Telephone company's system was transferred to the post office on Jan. 1, 1912. The number of exchanges increased from 1,566 in 1910 to 3,971 in 192j and 5,951 in 1953; the number of telephone stations increased from 619,399 in 1910 to 1,357,908 in 1925 and 5,843,979 in 1953. The use of automatic exchanges developed after World War I. By the end of 1927 these were working in more than 60 provincial towns, and the first automatic exchange in London was opened at Holborn in that year. The same year witnessed a great extension of telephone connection with foreign countries, and in the succeeding years further extensions of the service gradually made it possible to speak by telephone or radiotelephone to practically any town in the world as well as to passenger ships at sea. A popular innovation which gave an impetus to the use of the telephone was the introduction in 1933 of the shilling trunk call between any two points in Great Britain after 7 P.M.

Tables LXVIII and LXIX give some idea of the magnitude of the business handled by the post office. First are given the numbers of letters, parcels, telegrams and telephone calls handled annually, then the balances in the expenditure and income accounts for each of the services. It should be mentioned in connection with Table LXIX that there was an over-all deficit in the post office accounts for the years 1920, 1921 and 1922, but after that the balance was always favourable.

An interesting development during World War II was the institution in 1941 of the airgraph mail to the forces in the middle east. The letters were written on special forms and then photographed on miniature film. The film was flown to its destination, and the addressee received a print from the negative.

After the war the transport of mail by air expanded largely, both inland and overseas, particularly to the commonwealth and North and South America. In 1951 the first "inland" night-mail service was introduced to Northern Ireland and the Republic of Ireland, and air parcels services were being run to most parts of the world. In 1950 the post office took over the assets of Cable and Wireless, Ltd., though the company continued to operate its overseas services and to own the assets pertaining to them.

TABLE LXVIII.—*Post-Office Business*

Service	1938–39*	1954–55*
Letters, etc.	8,150,000,000	9,500,000,000
Parcels	184,000,000	242,796,000
Airmail letters (commonwealth and foreign)	91,000,000	234,000,000
Telegrams		
Inland	50,395,000	25,706,000
International	8,915,000	22,313,000†
Telephone calls		
Trunk		
Inland	111,553,000	306,332,000
International	2,064,000	3,783,000
Local	2,123,400,000	3,615,000,000

"Financial year. †Including telex calls.

TABLE LXIX.—*Post-Office Surplus or Deficit After Charging Interest on Capital*

Year ended March 31	Postal	Telegraph	Telephone	Total
1930	£9,658,770	£800,312*	£513,214	£9,371,672
1935	10,910,819	651,235*	1,684,983	11,944,567
1940	6,982,679	550,994*	995,156	7,426,841
1945†	16,860,000	100,000*	23,090,000	39,850,000
1950	9,086,465	4,405,959*	9,133,050	13,813,556
1952	4,438,159	[illegible]*	4,347,555	5,407,820
1955	3,340,658	2,465,009*	4,274,930	5,156,005

*Deficit; all others surplus. †Approximate.

Cables and *Wireless* Telegraphy. — The first submarine cable was laid across the channel in 1850, and the Atlantic was conquered in 1866. In 1922, when the Eastern Telegraph company, the group which practically controlled the whole system, celebrated its jubilee, the total mileage of cable in the world had grown from less than 1,000 to 325,000 and the capital invested in this one group alone to £25,000,000, with a total for all companies of about £60,000,000. The system, protected by the royal navy, was of extraordinary importance during World War I, for whereas Germany was at a very early stage completely isolated, the British cables were cut at only two points and these were quickly restored.

For several years after 1918 there was severe competition between the cable and wireless companies. In 1924, for instance, the Marconi company entered into a contract with the government to provide beam stations for communication with Canada, Australia, India and South Africa. In 1928, however, the Imperial Wireless and Cable conference recommended the co-ordination of these services, and as a result Imperial and International Communications, Ltd. (name changed in 1934 to Cable and Wireless, Ltd.), was formed to operate most of the extra-European communications. After 1950 it came under post office ownership.

A later development in the telegraphic service was the transmission of photographs and drawings, particularly of news photographs. As early as 1927 attempts were made to work out plans for a two-way service with the United States for transmitting pictures by television, but experience showed that for long-distance transmission the cable was then far superior to wireless.

Cable and Wireless, Ltd., became national property under an act of 1946. The end of the war found the cable system in need of repair. Arrears were not made good until 1950, and development on the whole favoured the wireless side of the undertaking. Long-distance radiotelephony and radiophototelegraphy expanded. Traffic development followed commonwealth lines, particularly to the middle and far east and to the West Indies. The volume of traffic expanded with a tendency to follow the fluctuations of the trade cycle.

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AGRICULTURE AND FISHERIES

Agriculture. — In spite of the rapid growth of manufactures and commerce in Great Britain after the middle 1800s, agriculture remains one of the largest industries of the country. It usually employs about 750,000 persons. The area devoted to it in 1954 was about four-fifths of the country's land—more than 47,900,000 ac. out of the total area of 56,200,000 ac. The agricultural output of Great Britain in 1955 was officially estimated at (gross) £1,500,-000,000. A radical change was introduced into British agriculture by World War II. Emphasis was placed on grain at the expense of livestock; at the same time there was a thoroughgoing mechanization. The agricultural land is classified into three groups: arable, permanent grass and uncultivated rough grazings. Table LXX shows the area of each in 1938 and 1955.

In Scotland more than two-thirds of the land used for agriculture is uncultivated rough grazings, mostly of mountain type, while more than two-thirds of the cultivated area is arable-land; in England and Wales about 36% of the cultivated area is under permanent grass and only one-sixth of the agricultural land is rough grazings. In these circumstances the number of persons employed per acre is much lower in Scotland than in England and Wales.

TABLE LXX.—*Land Use, 1938 and 1955*
(In thousands of acres)

Land and year	England and Wales	Scotland	Total
Arable land			
1938	8,878	2,983	11,861
1955	13,423	3,148	16,571
Permanent grass			
1938 . .	15,833	1,577	17,410
1955 . .	11,045	1,239	12,284
Rough grazings			
1938	5,615	10,448	16,063
1955	5,211	10,953	16,164

Apart from the stringencies of war periods. when special efforts were made to produce as much home-grown grain as possible, economic influences for many years prior to World War II had led to the laying down of arable land to permanent grass. The increased production of grains in America and also Australia caused prices of grain to fall and the production of meat and milk to become relatively more profitable, until World War II stimulated the home production of grain.

The reduction in the arable area was relatively less rapid in Scotland than in England and Wales, possibly because of the fact that much of Scotland's arable land would very quickly revert to rough grazings if left for many years under grass. Changes were, however, much less marked in some parts of England than in others, the eastern counties, where rainfall is small and good permanent

TABLE LXXI.—*Arable Cultivation, 1871–1955*
(In thousands of acres)

Average or year	England and Wales		Scotland		Great Britain	
	Arable land	Permanent grass	Arable land	Permanent grass	Arable land	Permanent grass
1871–75 .	14,766	11,799	3,476	1,085	18,242	12,884
1881–85 .	13,747	13,838	3,604	1,195	17,351	15,033
1891–95 .	12,676	15,116	3,543	1,356	16,219	16,472
1901–05 .	11,914	15,545	3,463	1,429	15,377	16,974
1911–15 .	11,131	16,013	3,313	1,494	14,444	17,507
1921–25 .	11,144	14,805	3,298	1,422	14,442	16,227
1926 . .	10,548	15,128	3,194	1,499	13,742	16,627
1938 . .	8,878	15,833	2,983	1,577	11,861	17,410
1946 . .	14,370	9,947	3,305	1,115	17,675	11,062
1955 . .	13,423	11,045	3,148	1,239	16,571	12,284

pasture difficult to maintain, showing the smallest decreases in arable land.

Areas Devoted to Chief Crops.—During the period before World War II the three chief grain crops did not share equally in the reduction of the grain area; indeed the area under oats increased, the decrease being confined to wheat and barley. In the 50 years from 1871–75 to 1921–25, the area under wheat was reduced by about one-half and that under barley by more than one-third, while the acreage of oats was increased temporarily by one-eighth. The heavy reduction in the wheat acreage, as compared with other cereals, was no doubt mainly a result of the greater fall in price of this grain, while the increase in the acreage of oats was apparently a result of the substitution of this crop for other cereals, as the bulk of it was used for feeding to stock on farms and its selling value was not the chief consideration.

The relatively low prices for grain crops after 1921, as compared with most other classes of farm produce. led to further reductions in the area of grains. Nearly one-half the total acreage of wheat in Great Britain is ordinarily in the ten eastern counties

TABLE LXXII.—*Acreage of Grain Crops in Great Britain*
(In thousands of acres)

Crop	Average. 1871–75	Average, 1928–37	Average. 1941–50	Average, 1951–55
Wheat . . .	3,527	1,592	2,462	2,156
Barley . . .	2,367	1,022	1,906	2,155
Oats . . .	2,672	2,406	3,155	2,749

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of England from the East Riding to the Thames as far inland as Bedford and Huntingdon, while more than one-half the barley acreage is in the same ten counties. The acreage of oats, on the other hand, is fairly evenly distributed throughout the country, this being by far the chief grain crop in the west and north, where the total arable area is smallest.

The absolute acreage devoted to the main crops underwent a drastic change under the policies adopted during and after World War II. Bet een 1938 and 1955 the biggest percentual increase among the chief crops was that for barley, potatoes, rye and sugar beets. The area devoted to potatoes did not follow the decline in the arable area but increased, in spite of a slight falling off for several years after 1925. This increase in the potato acreage was necessary to meet the requirements of the increasing population. Potatoes were grown most extensively in Lancashire and Cheshire in the west of England and in the south of Lincoln and the Isle of Ely in the east. After 1880 the acreage of potatoes changed little in Lancashire and Cheshire, but in the eastern counties named above and in the adjoining counties the acreage was trebled between 1880 and 1930. Potatoes are also an important crop in some of the eastern counties of Scotland. During and after World

TABLE LXXIII.—*Acreage of Certain Arable Crops and Bare Fallow in Great Britain*
(In thousands of acres)

Crops and fallow land	Average, 1871–75	Average, 1921–25	Average, 1928–37	Average, 1941–50	Average, 1951–55
Potatoes . . .	550	652	615	1,160	969
Turnips and swedes .	2,129	1,249	930	728	585
Mangolds . . .	340	391	258	283	218
Sugar beets . .	—	23	306	414	422
Clover and rotation grasses. . .	4,389	4,017	3,777	4,424	5,857
Bare fallow . . .	627	441	393	294	309

War II potatoes became a most important crop, the acreage being nearly doubled between 1938 and 1950.

The acreage of mangolds was maintained until 1925 because of the value of this crop as a food for dairy cattle, the numbers of which had increased. On the other hand, turnips and swedes, expensive crops to grow and more liable than mangolds to damage by pests and adverse weather conditions, were grown on rapidly declining areas, so that they came to occupy less than one-half the area of 80 years earlier. After the war the unpopularity of turnips and swedes continued. The acreage of clover and rotation grasses expanded very considerably. With the aid of the sugar subsidy sugar beets became a crop of importance.

Yields.—Crop statistics showed little change in the productivity of the land after produce statistics mere first collected in 1885. Average yields per acre of the chief crops in Great Britain are shown in Table LXXIV.

TABLE LXXIV.—*Average Yields per Acre of the Chief Crops in Great Britain*

Crops	1885–94	1901–10	1928–37	1941–50	1951–54
Wheat (cwt.) . . .	16.2	17.5	17.9	19.5	22.8
Barley (cwt.) . . .	15.8	16.0	16.3	18.2	21.3
Oats (cwt.) . . .	13.6	14.3	15.9	16.8	19.1
Beans (cwt.) . . .	14.0	16.2	16.3	15.0	16.7
Seed hay (cwt.) . .	28.2	30.1	28.0	28.3	31.0
Meadow hay (cwt.) .	23.9	23.8	20.1	19.8	22.7
Hops (cwt.) . . .	7.7	9.0	12.5	13.7	12.9
Potatoes (tons) . .	5.8	6.1	6.7	7.0	8.0
Turnips and swedes (tons) . . .	13.1	14.4	13.2	14.6	17.2
Mangolds (tons) . .	17.4	20.0	18.5	20.0	23.1

Livestock. — With the conversion of arable land to grass before World War II, livestock became of increasing importance in the agriculture of Great Britain, but the increase was confined to cattle. Pigs fluctuated about a mean which showed little change for many years, but in the 1950s their numbers began to increase rapidly.

Cattle. — Before World War II cattle occupied a predominating position in British agriculture, accounting for about 40% of the total output from the farms of Great Britain. In the 50 years from 1871–75 to 1921–25 the total number of cattle increased by 20%, while the increase in the dairy herd was even greater, the addition being nearly 40%.

In neither case, however, did the increase keep pace with the increase in population, the number of the dairy herd per 1,000 of population being 10% less and of other cattle about 20% less in the later than in the earlier period. The needs of the increasing population for fresh milk were met by the additions to the dairy herd, but this was not the case as regards butter and cheese, of which more was imported as the years advanced. Similarly more and more beef was imported to supply the increased demand. When imports fell during and after World War II consumption was reduced. Despite the war the cattle herd increased considerably from 1938 to 1954, the increase being particularly noticeable for heifers in calf with first calf.

TABLE LXXV.—*Numbers of Cattle in Great Britain*

Year or average	Cows and heifers in milk or in calf	Other cattle	Total cattle
1871–75	2,204,000	3,609,000	5,813,000
1881–85	2,353,000	3,757,000	6,110,000
1891–95	2,562,000	4,078,000	6,640,000
1901–05	2,627,000	4,147,000	6,774,000
1911–15	2,825,000	4,272,000	7,097,000
1921–25	3,053,000	3,942,000	6,995,000
1926	3,207,000	4,244,000	7,451,000
1938	3,576,000	4,454,000	8,030,000
1946	4,067,000	4,649,000	8,716,000
1955	4,487,000	6,060,000	10,547,000

The check in the increase in the number of cattle in 1921–25 was the result of an extensive slaughter of calves at the end of the war food control, primarily because of the decontrol of veal prices in advance of those of other meat; but after 1921 there were increases each year, and in 1938 the number was the largest ever recorded. The density of cattle on the land is naturally larger in the grass areas of the west of the country than it is in the east.

Sheep. — The number of sheep in Great Britain, though fluctuating to some extent, on the whole declined after about 1870. The ravages of liver fluke and unfavourable weather in the first part of this period caused a sharp fall which was subsequently partially recovered, while the numbers were reduced very sharply toward the end of World War I, and immediately thereafter, after which there was a good recovery. Between 1920 and 1926 the flocks of the country were increased by 4,320,000 or 22%. During World War II the sheep population fell by about a quarter, and the severe winter of 1946–47 caused a further heavy fall, after which a recovery began. Changes in the number of sheep in Great Britain have varied, as will be seen from Table LXXVI.

Until 1938 the numbers of sheep were maintained in Scotland and increased in Wales, the reduction being confined to England. A subdivision of the figures for England, however, shows that there was practically no reduction in the northern counties, while in the eastern counties numbers were less than one-third those of 1871–75,

TABLE LXXVI.—*Number of Sheep in Great Britain*

and in every other part of England except the southwest the decreases were about 50% during the same period. The reduction in the sheep population, therefore. was most drastic in the arable counties, and sheep breeding made headway or at least held its own in those areas where costs were low because of the existence of extensive rough grazings on hill land. As a result of World War II, the sheep populations of Scotland and Wales followed the declining trend previously confined to England.

Pigs. — Since pigs may be bred much more quickly than other farm livestock there are relatively much more rapid changes in the

TABLE LXXVII.—*Number of Pigs in Great Britain*

Year	Number	Year	Number
1871–75	2,485,000	1921–25	2,825,000
1881–85	2,433,000	1926	2,345,000
1891–95	2,483,000	1938	3,821,000
1901–05	2,491,000	1946	1,644,000
1911–15	2,585,000	1955	5,854,000

numbers from year to year, and consequently sharper rises and falls in prices. From 1871–75 to 1951 the numbers moved up and down with fair regularity every five years, with little change in the general level. World War II entailed a very heavy fall in the number of pigs; but by 1954 the 1938 figure was far surpassed.

Pigs are kept rather more in the eastern counties of England than in most other districts. The numbers in Scotland are relatively small.

Poultry. — The number of fowls on the farms of Great Britain continues to increase. The earliest figures available relate to 1908, when there were 32,360,000 fowls in Great Britain; in 1926 there were 41,600,000, and in 1938 there were 59,920,000. World War II led to a heavy culling of flocks, but by 1949 the prewar figure was exceeded.

Value of Agricultural Output. — The ministry of agriculture estimated that the value of the farm produce sold off farms or consumed in farm households in 1938 in England and Wales was £224,500,000, and if comparable figures were available for Scotland it would probably be found that the value of the agricultural output of Great Britain was in the neighbourhood of £270,000,000 to £280,000,000. Of this output. livestock and livestock products accounted for the bulk—at least 70%.

The value of the gross output for 1955 was estimated at £1,500,000,000. Because of the change in the value of money, and the incidence of subsidies, a comparison with the figures before World War II would have little meaning. It should be explained that the sums received from the sale of livestock and livestock products have to cover the cost of growing those grain, root and fodder crops used for feeding to livestock, and it is only those proportions of the crops which are sold off the farms which are valued as crops in the figures quoted above.

Sizes of Agricultural Holdings. — The total number of agricultural holdings in Great Britain in 1955 was 453,995, of which about 290,000 were of less than 50 ac. of cultivated land.

While it is true that many holdings of agricultural land are separately included in the agricultural returns without being economic farm units, since they are small pieces of land attached to residential properties or detached fields separately returned, etc., there is a very large number of separate farm units in the country. From 1895 to 1938 there was a fairly steady reduction in the number of holdings, especially in those of less than 20 ac. After 1895 there was no very marked change in the number of small and medium holdings of from 20 to 300 ac., but the number of holdings of more than 300 ac. increased. After World War II the trend was irregular. There was an increase in the smallest and the largest classes of holding.

Persons Employed. — It is clear, from the population censuses of the 60 years before World War II, that the number of persons employed in agriculture (excluding horticulture) in Great Britain declined considerably, from about 1,500,000 in 1871 to about 1,170,000 in 1931 (about 770,000 in 1952). This reduction had several causes. among which the decrease of arable cultivation and the increased use of machinery are no doubt the most important.

Capital Invested. — The capital invested in agriculture in England and Wales was estimated in 1931 at £925,000,000 of which £645,000,000 was the value of the land, including farmhouses and buildings, and £280,000,000 the working capital of the occupiers of the land. Assuming similar figures per acre for Scotland, for cultivated land and rough grazings, respectively, the total capital invested in the whole of Great Britain in agriculture amounted to nearly £1,176,000,000.

By 1950 the market value of farms in Great Britain was estimated at £1,748,000,000, tenants' capital in the form of crops, livestock and machinery at £1,280,000,000 and tenant-right valuation in the form of cultivations, etc., at £100,000,000.

Agriculture After 1939.—World War II caused radical changes in British agriculture. The effect was to cut off large imports of foodstuffs, and the country had to become as nearly as possible self-sufficient. This meant a far-reaching change from grass to arable, a change which was largely maintained after the war. The shortage of labour led to extensive mechanization.

Under the defense regulations the minister of agriculture was given wide powers to control and direct agricultural production. The war agricultural executive committees were the essential link in the chain of direction between the minister and the industry. The committees gave direct aid to farmers, being in control of machinery pools which enabled them to undertake such work as moorland reclamation, heavy drainage and the plowing out of rough grassland beyond the scope of ordinary farm equipment.

During the war and later, much-needed money was being provided for the industry by extensive subsidies for plowing out, moorland reclamation, liming and the purchase of fertilizers and (under the hill and marginal lands schemes) by the provision of roads and modernization of farm buildings.

The new importance of agriculture was recognized and consolidated in the Agriculture act of 1947, which embodied some of the wartime ideas and machinery. This instrument gave stability to the industry by a system of guaranteed prices and assured markets for the leading agricultural products. It provided measures to encourage efficient farming, giving the minister powers to dispossess offenders. It revised the relationship between landlord and tenant, with the objects of giving the tenant greater security and ensuring good farming. It embodied a small-holdings policy designed to ensure that small holdings went to people fit to run them. Finally, it provided the necessary administrative machinery. The chief instruments were the county agricultural executive committees (successors to the county war agricultural executive committees), which are joint bodies, partly appointed by the minister and partly recruited from the industry. The Agriculture (Scotland) act of 1948 extended the system to Scotland.

During and after the war security with regard to prices was given by an annual price review, when the ministries of agriculture and food and the National Farmers' union agreed in joint consultation on minimum prices for appropriate periods. The differences between farm prices and those charged to the consumer under the policy of keeping down the cost of living was made up by subsidies. The price review was also the machinery for directing agricultural production into the channels desired by the government. Thus the need for economy in the use of cargo space during the war made it essential that the country should produce the maximum of bulky products, such as grain and potatoes, while care for the health of the rising generation, as exemplified in the free milk scheme, made it necessary to increase milk production. The price review was used to attract farmers into this line of production. at the expense principally of meat. By 1949 exchange difficulties and the shrinkage in world meat supplies necessitated increased home production of meat, and again the price review was the main instrument.

Measured in terms of land utilization the wartime concentration on grain reached its culminating point in 1944, when the total of permanent grassland was 11,735,000 ac. as compared with 18,798,000 ac. in 1938. After this the gradually developing difficulty in importing meat led to a slight increase in grassland. But even in 1951 the change in the layout was very pronounced. The total area of agricultural land was virtually unchanged between 1939 and 1954; but whereas in 1939 arable made up about 41% of the total, the proportion of arable in 1954 was 58%.

Under the stimulus of the war and of the postwar shortages of food, a number of new techniques were introduced. The most valuable single instrument in raising the production of milk and of arable crops and, above all, in bringing into arable production a very large area of the country where the dominant tradition for generations had been that of livestock and permanent grass, was that of ley farming; *i.e.*, the introduction of temporary grass into the crop rotation system. This technique had been practised for a considerable time in the Scottish lowlands. but was new to much of England. Great advances were also made in grassland husbandry, in pest control (*e.g.*, by systematic use of insecticides) and in weed control through chemical means and by the use of hormonal weed killers. Stock farms tended to become increasingly self-sufficient. Stock farmers grew more fodder crops, which they were helped to utilize by improvements in the existing methods of grass conservation; *e.g.*, by ensilage and drying.

The advance in technique was accompanied by intense mechanization which continued after the war and made British agriculture among the most highly mechanized in the world. The change in the country's stock of plows gives a good illustration. From 1942 to 1954 the total number of plows mas almost unchanged. So was the arable acreage. But whereas in 1942 there were about three times as many horse-drawn plous as there were tractor-drawn ones, there were in 1954 three times as many tractor-drawn as horse-drawn plows. Much of the farm machinery was owned and hired out by commercial concerns specializing in this work.

Fisheries. — Great Britain's sea-fishing industry is among the most important in the world. The principal kinds of fish caught are herring, cod. haddock, plaice and hake. classed as wet fish, and. among shellfish, oysters, crabs and lobsters. The annual consumption of wet fish is about 18 lb. per head of the population, and with improvements in the methods of preservation (by refrigeration) and transport, consumption should be increased. The principal grounds frequented by British fishermen are the North sea, Iceland, the Faeroe Islands. south of Ireland. west of Scotland, Barents sea, west of Ireland, Irish sea and English channel. A notable event was the opening in 1927 of new halibut fisheries off the Greenland coast. This was made possible by the adoption of new methods of brine freezing.

During World War II fishing grounds and catches were restricted. Fleetwood for a time became the most important fishing port. Immediately after the war, landings and consumption rose rapidly, but by 1950 had relapsed to below the prewar level. The proportion of foreign-caught fish was higher than before the war, and measures were enacted in 1944, 1945 and 1948 to assist the herring, the inshore and the whitefish industries with grants for boats and equipment. The wartime and postwar shortage of meat helped raise the price of fish, and though the weight of British-caught landings in 1950 was one-sixth lower than in 1938, the value was half as high again. After the war efforts were made to modernize the fishing fleet, many of its vessels being then very old. Some new devices were introduced, among them echo sounding for the location of shoals. Table LXXVIII shows the number and total of fishing vessels on the register in Great Britain for certain years from 1913 to 1954. The decrease in total numbers of vessels is to some extent offset by the gradual conversion from sail and steam to motor propulsion.

TABLE LXXVIII.—*Fishing Vessels on the Register in Great Britain*

Year	Total vessels	Net tonnage	Year	Total vessels	Net tonnage
1913	17,465	319,060	1938	11,522	245,404
1924	16,013	288,960	1946	12,935	186,913
1930	13,099	179,127	1951	11,864	199,169
1935	12,583	268,656	1954	8,365	...

The number of fishermen in Great Britain before and after World War II cannot be exactly compared because of a change in the basis of computation, but it certainly diminished.

For 1938 and 1954 the total figures for landings in Great Britain were as shown in Table LXXIX. Despite the decline in numbers of vessels engaged in fishing and in the numbers employed, the amount of fish landed showed a tendency to increase during the 20 years before World War II in spite of the fact that exports

TABLE LXXIX.—*Quantities and Value of Fish* Landed in Great Britain, 1938 and 1954*

Landings	1938		1954	
	Weight (cwt.)	Value	Weight (cwt.)	Value
British caught				
England and Wales	15,532,692	£12,233,209	12,909,425	£33,316,998
Scotland	5,380,562	3,826,671	6,145,151	11,197,490
Total wet fish	20,913,254	16,059,880	19,054,576	44,514,488
Shellfish	...	488,490	...	1,498,727
Imports of fresh and frozen fish†	1,682,995	2,453,912	1,448,584	5,427,117

*Excluding salmon and trout. †Including shellfish; excluding salmon and trout.

of fish declined. After the war landings were on a lower level. Exports are shown in Table LXXX.

The most important factor in the export trade is herring, which represents about 68% of the total. The canned fish industry of

TABLE LXXX.—*Exports of Fish of British Taking or Curing*

Year	Quantity (cwt.)	Value	Year	Quantity (cwt.)	Value
1913	10,998,771	£7,503,468	1938	4,381,587	£3,870,262
1924	8,142,816	8,438,243	1946	997,496	2,698,508
1930	7,173,671	7,039,973	1951	1,270,226	5,685,653
1935	4,588,064	3,750,926	1955	5,778,433	986,275

the country is peculiar in that Britain imports the great bulk of the canned fish (principally salmon and sardines) which is consumed and exports most of what is actually canned in the country — herring. Fresh-water fisheries, in spite of serious attempts made between 1914 and 1918, have never contributed substantially to the feeding of the British population.

Considerable attention has been given to research and organization in the fishing industry. A great deal of research has been carried out by the government and under government direction (ministry of agriculture and fisheries). Government vessels have continuously studied the movements, habits and feeding of fish both inshore and at sea. Research has been carried out in hydrography and into methods of capture, into the breeding and cleansing of shellfish, etc.

See *Agriculture* (H.M.S.O., London, monthly); *Scottish Agriculture* (H.M.S.O., Edinburgh, quarterly).

INDUSTRIAL AND SOCIAL CONDITIONS

Population. — The population of Great Britain by mid-20th century was aging and seemed virtually certain to fall during the third quarter of the century. In 1939 young men up to 34 years of age constituted 56.4% of the total male population; in 1954, only 52.3%. For women and girls the corresponding percentage of the total female population fell even more strikingly, from 52.3% to 48%. The prospective burden of age in the welfare state (see below) is obvious.

A later development, a result of the extension of state socialism during and after the war, was the growth in the number of persons employed on national and local government service.

In 1937 a royal commission was appointed to inquire into the distribution of the industrial population. Its report was not published till 1940, but it sharply focused attention on certain well-known tendencies which had been in progress for more than a century. The growth of large cities is not a phenomenon peculiar to Great Britain, but England (as distinct from Scotland) is among the most thickly populated areas in Europe. and it is necessary for the proper utilization of the natural resources of the country that the spread of population be controlled. For details of population by counties, and of urban and rural population, and other vital statistics, see ENGLAND; SCOTLAND; WALES.

Two tables compiled from censuses and mid-year estimates (Tables LXXXI and LXXXII) show first the distribution of the whole population and then the distribution of the occupied population. They are best commented on in the terms of the commission's report:

> These tables illustrate the outstanding feature of the geographical distribution of the industrial population in modern times, namely, its concentration to an increasing extent in particular areas of the country. The seven specified areas constitute only 27% of the total area of Great Britain. In 1801 they contained about 45% and in 1931 (the latest year for which figures are available) 73% of the occupied population. . . .
>
> Over the 19th century the total and occupied population of all the specified areas, except the Midland group of countries, increased both absolutely and proportionately to the country as a whole. Early in the' present century signs of a change began to appear in some areas; both Lancashire and Mid-Scotland lost ground between 1901 and 1911 in relation to the country as a whole. Since the war [of 1914–18] that experience has become more widespread: between 1921 and 1931 the proportion of the total population declined in Lancashire from 12.6 to 12.3, in Northumberland and Durham from 4.6 to 4.4, in Mid-Scotland from 6.2 to 5.8, and in Glamorgan and Monmouth from 3.6 to 3.2. . . . So far as the distribution of industrial population is concerned, those changes are completely overshadowed by the experience of London and the home counties where the occupied population has increased both absolutely and relatively, to a far greater extent than in any other part of Great Britain.

These changes of population reflect economic changes. The continued depression in the special areas. and the decline of coal mining, cotton and shipbuilding, tended to drive workers away from the areas and industries concerned to the southeast where industry was expanding and comparative prosperity was to be found. This general picture per-

TABLE LXXXI.—*Distribution of the Total Population*

Region	Population in thousands				Proportionate population			
	1921	1931	1951	1954	1921	1931	1951	1954
London and southeastern	9,457	10,330	10,902	10,960	22.1	23.0	22.3	22.2
Eastern	2,183	2,433	3,096	3,258	5.1	5.4	6.4	6.6
Southern	1,919	2,135	2,648	2,773	4.5	4.8	5.4	5.6
Southwestern	2,512	2,615	3,021	3,065	5.9	5.8	6.2	6.2
Midland	3,546	3,743	4,422	4,490	8.3	8.4	9.1	9.1
North midland	2,763	2,939	3,378	3,437	6.5	6.6	6.9	6.9
E. and W Ridings of Yorkshire	3,765	3,929	4,096	4,098	8.8	8.8	8.4	8.3
Northwestern	6,071	6,197	6,445	6,441	14.2	13.8	13.2	13.0
Northern	3,013	3,038	3,140	3,151	7.0	6.8	6.4	6.4
Scotland	4,882	4,843	5,096	5,124	11.4	10.8	10.4	10.4
Wales (incl. Monmouthshire)	2,658	2,593	2,597	2,601	6.2	5.8	5.3	5.3
Great Britain	42,769	44,795	48,841	49,398	100.0	100.0	100.0	100.0

TABLE LXXXII.—*Distribution of Total Manpower in Great Britain*
(In thousands)

Item	[redacted]	June 1953	June 1954	June 1955
Total working population	22,780	23,373	23,667	23,874
Armed forces	846	865	839	803
Total in civil employment	21,569	22,238	22,604	22,895
Principal manufacturing industries				
Agriculture, forestry, fishing	1,178	1,087	1,074	1,052
Mining and quarrying	876	877	867	864
Treatment of nonmetalliferous mining products other than coal	312	333	338	341
Chemical and allied trades	439	487	500	513
Metal manufacture	530	548	551	569
Engineering, shipbuilding and electrical goods	1,776	1,899	1,957	2,065
Vehicles	934	1,090	1,142	1,201
Textiles	922	963	985	953
Clothing	597	643	640	629
Food, drink and tbbacco	726	845	863	886
Paper and printing	463	507	531	549
Building and contracting	1,450	1,437	1,453	1,465
Distributive trades	2,484	2,664	2,743	2,793
Transport and communication	1,787	1,731	1,715	1,714
Gas, electricity and water	312	372	373	378
Professional, financial and miscellaneous services	3,954	4,004	4,077	4,092
Public administration	1,382	1,320	1,326	1,315

sisted during the first five years after World War II. Within the total of persons employed the contribution of London and of the south generally increased from 1939 to 1950; in the midlands and the north (except for the region embracing Durham, Northumberland, Cumberland. Westmorland and the Sorth Riding of Yorkshire) it diminished. The Welsh contribution grew. The exceptions just mentioned relating to the north, and the case of Wales, were partly the outcome of official policy which controlled the location of industry. This was the result of (1) the Distribution of Industry act, 1945; (2) the already existing system of building licences; and (3) the Town and Country Planning acts, 1947. The government thus could foster the industrial development of the former distressed or special areas, now renamed development areas.

Prices and Wages.—Any statistical account of variations in the standard of living must be based on a correlation of prices and wages. The difficulty, however, of carrying such an investigation back for any long period is very great.

Prices.—During the 19th century the course of prices could best be illustrated by index numbers compiled from wholesale prices because retail prices fluctuated so much between different localities and even different retailers that representative data were practically unobtainable. On the other hand, wholesale quotations for the principal commodities could be easily obtained. In the 20th century, however, and especially in the period of continuously rising prices after 1938, this became untrue, as is seen when the rise in wholesale prices between 1938 and 1955, shown in Table LXXXIII, is compared with the much less marked rise in the cost-of-living index shown in Table LXXXV.

TABLE LXXXIII.—*Index* Numbers of Wholesale Prices, *1800–1955*

Year	Index number	Year	Index number	Year	Index number	Year	Index number
1800	235	1908	97	1924	182	1940	160
1810	237	1909	99	1925	177	1941	179
1820	172	1910	104	1926	163	1942	187
1830	135	1911	107	1927	159	1943	191
1840	145	1912	113	1928	155	1944	195
1850	107	1913	113	1929	146	1945	198
1860	132	1914	113	1930	120	1946	206
1870	128	1915	144	1931	101	1947	225
1880	117	1916	181	1932	90	1948	257
1890	96	1917	233	1933	102	1949	270
1900	100	1918	256	1934	105	1950	307
1902	92	1919	277	1935	111	1951	375
1904	93	1920	329	1936	117	1952	384
1905	96	1921	192	1937	136	1953	385
1906	103	1922	164	1938	119	1954	387
1907	107	1923	165	1939	121	1955	399

Table LXXXIII (which shows the fluctuation of wholesale prices after 1800), based on one compiled by W. T. Layton from W. S. Jevons' index number from 1800 to 1865 and A. Sauerbeck's from 1865, has been continued to 1938 by Sauerbeck's (Statist) index and from 1938 by the board of trade index.

Prices from 1800 to 1820 were abnormally high (the figure of 235 for the year 1800 comparing with 100 of the year 1900) and subject to violent fluctuations as a result of the disturbance caused by the Napoleonic Wars. The years 1820 to 1825 saw a boom in trade because of the rapid development of transatlantic commerce. This was accompanied by an inflation of credit and deflation of banking reserves, ending in a serious crisis. About 25 years of falling prices followed, until after 1850 an upward movement was started by the discoveries of gold in California and Australia. The continued fall throughout the last three decades of the 19th century was related to a steady decline in the gold output and the gradual adoption of the gold standard by various countries, leading to an increased demand for gold, while the rise in prices after 1900 follows an upward movement in the volume of gold production, a result of the development of South African supplies. Intermediate events were the world financial crises of 1856–57 and 1863–64; the Overend Gurney and Co. failure of 1866; the Austrian, U.S. and German crises of 1873, which caused a fall not interrupted till the trade revival of 1879; the French and U.S. crises of 1882 and 1884; the Baring crisis of 1890; followed by a U.S. crisis in 1893, the effects of which were felt till 1897; the South African War of 1900, which interrupted the succeeding revival; and the steady upward movement of trade and prices from 1903 until the outbreak of World War I, interrupted only by the U.S. financial crisis of 1907.

The effects of World War I require separate mention. During the war the gold standard was abandoned and the currency divorced from gold. As a result the high-level record attained during the Napoleonic Wars was surpassed (more than $33\frac{1}{3}\%$) by the figure in July 1920.

Statistics for the course of prices after 1920 show that, apart from seasonal fluctuations. prices fell steadily from the end of 1920 until the middle of 1924. After a slight rise late in 1924 the downward course continued with little interruption until 1935, when prices began rising slowly again. This rise continued from the beginning of World War II in 1939, but Table LXXXIII shows clearly the results of government efforts first to check any rapid rise in prices and then to stabilize as much as possible the cost of living. Food prices in particular were held in check, and in March 1942 were only 25% above those of the month before the war, the index figure for food alone being 60 on April 1, 1942.

Stabilization of prices during World War II was achieved by various means. The board of trade was empowered to fix maximum prices on goods and services and to limit margins of profit. Rents were also stabilized. The food ministry fixed prices on a wide range of foods, and prices paid to farmers for produce were determined by negotiation with the ministry.

By 1941 the cost of living had risen by about 25%. It was then kept steady until June 1947, when a new and more realistic collection of items affecting the cost of living was drawn up, to be followed by a fairly exhaustive one in Jan. 1952. Between 1947 and 1955 the cost of living, on the new definitions, rose by 50%. A further index was introduced in Feb. 1956. It was based on the assumed spending schedules of about 90% of the households in the country and reflected the great improvement in the standard of living since before the war. It included such items as television sets, motorcars and washing machines.

Wages.—Commensurate with the rise in prices during 1914–18, wages rose sharply and continued to do so until 1920, when the average percentage increase over the 1914 level reached 180. From 1921 to 1923 they dropped rapidly and, as Table LXXXIV shows, remained fairly stable between 1926 and 1938, in spite of serious fluctuations in employment. For the prewar years the table is based on the average for 1924, which is reckoned as 100, and this in turn represents a 70% increase over the 1914 figure; for the postwar years the base of 1947=100 has been taken. Table LXXXIV gives half-yearly averages.

TABLE LXXXIV.—*Index Numbers* Showing the General Course of Weekly Rates of Wages*

Year	June	December	Year	June	December
1926 . .	101½	101½	1937 . .	101½	103%
1927 . .	101	100	1938 . .	106	106
1928 . .	99	99	1947 . .	100	103
1929 . .	99	98%	1948 . .	106	107
1930 . .	98%	98	1949 . .	109	109
1931 . .	97	95½	1950 . .	110	114
1932 . .	95	94%	1951 . .	119	126
1933 . .	94	94	1952 . .	129	134
1934 . .	94%	94%	1953 . .	135	138
1935 . .	95½	96	1954 . .	142	144
1936 . .	98	99	1955 . .	152	154

*For years 1926–38, average for 1924=100; for years 1947–55, June 30, 1947=100.

Real Wages.—When prices rise rapidly there is a natural tendency for wages to follow them, but, unless they overtake prices, the wage earner, of course, is no better off for his higher pay. It is worth inquiring in what ways the condition of the British wage earner substantially changed after the late 1800s, and to do this it is necessary to investigate the relationship between prices and wages in order to discover changes in "real" wages.

It is now agreed that statistics from 1850 and 1880 are not sufficiently precise for such an attempt to be made for that period, but it is fairly clear that, subject to fluctuations in 1865–68 and 1874–79 especially, real wages rose by about 33% during the period of 30 years.

In his Wages and Income ***in the United*** Kingdom Since 1860 (1937) A. L. Bowley related changes in retail prices with changes in wage rates in an attempt to measure real wages. His table, for the period 1880–1936, is reproduced in Table LXXXV, with some figures of his (*Journal* of *the Royal Statistical Society,* 1952) interpolated between 1914 and 1924, and it is continued after 1936 by utilizing index numbers of retail prices and rates of wages as shown in the "Bulletin of the London and Cambridge Economic Service," published in *The Times Review* of *Industry.*

TABLE LXXXV.—*Index Numbers of Money Wages and of the Cost of* ***Living,*** *1880 to 1955**

Year	Index numbers			Year	Index numbers		
	Wages	Cost of living	Real Wages		Wages	Cost of living	Real Wages
1880	72	105	69	1930	191	157	122
1885	73	91	81	1931	189	147	129
1890	83	89	93	1932	185	143	129
1895	83	83	100	1933	183	140	131
1900	94	91	103	1934	183	141	130
1905	89	92	97	1935	185	143	130
1910	94	96	98	1936	190	147	129
1911	95	97	97	1937	198	154	128
1912	98	100	97	1938	205	156	131
1913	99	102	97	1939	207	159	130
1914	100	100	100	1940	230	186	123
1915	108	123	88	1941	250	203	123
1916	110	146	76	1942	268	216	124
1917	142	176	81	1943	283	223	127
1918	189	203	93	1944	300	228	132
1919	230	215	107	1945	315	231	136
1920	284	249	114	1946	341	235	145
1921	273	226	121	1947	358	251	143
1922	212	183	116	1948	105	107	98
1923	188	174	108	1949	108	110	98
1924	194	175	111	1950	110	113	97
1925	196	175	112	1951	119	125	95
1926	195	172	113	1952	129	136	95
1927	196	167	117	1953	135	140	96
1928	194	166	117	1954	141	142	99
1929	193	164	118	1955	150	148	101

*1914=100; discontinued after 1947. New index based on 1947=100 from 1948.

At no time in the period was the rate of increase in real wages rapid, and for 15 or 20 years before World War I no advance at all was recorded. In the early years of World War II prices rose more rapidly than wage rates, but by 1944 real wage rates had recovered to the 1938 level and by 1946 showed an improvement of 11%, near which level they remained. With full employment, opportunities for getting paid more than the minimum, for increasing income by more intensive work at piece rates or from bonus schemes and for overtime mere greater than previously and by 1955 earnings had inereased since 1938 by 38% more than the index of wage rates would lead one to expect. Table LXXXVI gives some information about average earnings per week obtained from wage censuses of the ministry of labour covering most major industries but excluding agriculture, coal mining and rail transport.

The position of wage earners has also been improved by the development of social expenditure on health and education services, on pensions, sickness and unemployment benefits and on family allowances, partly offset by direct contributions of wage earners to national insurance and by their income tax payments.

TABLE LXXXVI.—*Average Weekly Earnings*

Year	Men (21 and over)*	Women (18 and over)*	All (incl. youths and girls)*	Index of earnings*	Index of wage rates
1938	69s. 0d.	32s. 6d.	53s. 3d.	100	100
1941	99s. 5d.	43s. 11d.	75s. 10d.	142	122
1944	124s. 4d.	64s. 3d.	96s. 8d.	182	144
1948	137s. 11d.	74s. 6d.	117s. 4d.	220	177
1950	150s. 5d.	82s. 7d.	128s. 0d.	240	186
1951	166s. 0d.	90s. 1d.	141s. 1d.	265	201
1952	178s. 6d.	96s. 4d.	151s. 11d.	285	218
1953	189s. 2d.	102s. 5d.	160s. 1d.	301	228
1954	204s. 5d.	108s. 2d.	171s. 9d.	323	238
1955	222s. 11d.	115s. 5d.	187s. 2d.	351	254

*Figures relate to October except in 1941 and 1944 (July).

Hours of Work.—Between 1919 and 1955 the hours of labour were reduced in nearly all industries, Table LXXXVII. given in the *Ministry of Labour Gazette,* showing the aggregate amount for the whole country.

By 1939 the working week had been generally fixed by collective agreement at 44–48 hours for adult males, excluding overtime, with a 48-hour maximum for women and young persons. At the outbreak of war extensions were permitted. At the spring crisis of 1940, the ministry of supply ordered contractors to work a full seven-day week. Most munitions plants worked two 12-hour shifts, or 70–75 hours weekly. There were similar long hours in aircraft factories and shipyards. Only where it was possible to organize a three-shift system was the maximum week limited to 56 hours. It was found, however, that in spite of these long hours production began to decrease. The causes were fatigue, ill-health and accidents. The Industrial Health Research board reported that there was little gain, and probably an actual loss, if working hours exceeded 60–65 for men and 55–60 for women. Accordingly, the ministry issued a memorandum stressing the need for maintaining maximum production by adjusting hours of labour. The ministry recommended, wherever machines could be run nonstop, the adoption of three shifts and a 55–56 hour week as soon as sufficient skilled labour could be made available. Where it was not available, a 60-hour week was permitted for men, and the provisions of the Factory act were restored for women and young persons, subject to modification in an emergency.

TABLE LXXXVII.—*Hours of Labour**

Year	Approximate number of workpeople whose normal hours of labour mere		Aggregate net increase (+) or decrease (−) in weekly hours
	Increased	Reduced	
1919	1,150	6,305,000	−40,651,000
1920	2,000	570,000	− 2,114,000
1921	31,500	12,900	+ 14,500
1922	16,000	302,700	− 93,000
1923	325,000	9,600	+ 108,750
1924	13,150	16,150	+ 12,500
1925	1,300	3,925	− 11,750
1926	934,200	340	+ 3,984,650
1927	18,700	1,700	+ 59,000
1928	1,400	2,000	− 200
1929	4,050	1,050	+ 8,750
1930	13,175	349,225	− 873,500
1931	294,000	111,000	+ 142,000
1932	6,000	3,750	7,000
1933	2,500	12,500	− 36,000
1934	520	5,000	− 11,500
1935	2,450	43,700	− 153,850
1936	600	160,600	− 804,500
1937	1,500	390,650	− 960,000
1938	1,950	166,650	− 371,100
1939	—	396,000	− 1,412,000
1940	54,000	193,000	− 633,000
1941	16,000	10,000	− 2,500
1942	4 000	10,000	+ 5,000
1943	8,000	141,000	− 256,000
1944	3,000	—	+ 4,400
1945	—	22,000	− 42,000
1946	—	2,128,000	− 5,719,000
1947	—	5,223,000	−18,429,000
1948†	—	616,000	− 1,834,000
1949	3,500	1,017,000	− 1,471,000
1950	108,500	1,500	+ 105,500
1951	1,100	10,000	− 26,000
1952	2,500	56,000	− 164,000
1953	—	300	− 1,000
1954	—	199,000	− 318,400
1955‡	—	179,500	− 249,300

*In addition to the workpeople for whom figures are given in this table, there were 8,000 workpeople in 1939, 214,000 in 1942, 33,000 in 1943, 12,500 in 1945, 48,000 in 1946 and 183,000 in 1947 who were affectedby increases and also by reductions of equal amount within the same year. †The figures for 1948 and later years are not strictly comparable with those for earlier years, since particulars relating to employees in government establishments and shop assistants were introduced for the first time in 1948. ‡Figures preliminary and subject to revision.

By 1954 over-all hours of work in a large range of industries had returned almost exactly to the level of 1938. Within this total the hours worked by women underwent a fairly substantial reduction, while those worked by men slightly increased.

Unemployment **and** Its **Relief.**—Between 1900 and 1914 the percentage of workers unemployed never rose above 8%, and the average for the years 1911 to 1914 was less than 3%. On the other hand, after 1918 unemployment was one of Great Britain's most serious problems. When the Unemployment Insurance act came into operation in Nov. 1920, accurate statistics became available. From 1923 to 1929 the average number of insured persons unemployed was about 10%; at the height of the depression it rose in 1932 to 21.9%, and by 1936 had only fallen to 13%.

Table LXXXVIII, issued by the ministry of labour, shows the actual numbers of workers included in these percentages and brings the figures down to the end of 1955. It will be seen that unemployment reached its apex in 1932, and that from 1934 to the outbreak of World War II there was slow but steady improvement. After World War II prices tended to rise, the result partly of shortages, partly of monetary inflation and partly of a growing will to spend on the part of the public. Very full employment, fuller than theoreticians nould have believed possible, was a by-product of this rising price level.

TABLE LXXXVIII.—*Average Number on the Registers of Employment Exchanges i n Great Britain and Northern Ireland*

Year	Wholly unemployed	Temporarily stopped	Unemployed casual workers
1928	869,573	309,359	75,972
1929	900,553	268,595	79,440
1930	1,347,840	527,720	98,941
1931	1,994,471	587,719	115,678
1932	2,136,052	574,315	102,675
1933	2,037,517	456,743	94,098
1934	1,763,911	369,002	88,1jo
1935	1,706,783	312,757	86,581
1936	1,491,051	251.568	79,081
1937	1,284,123	205,369	67,509
1938	1,433,248	380,484	67,625
1939	1,308,212	220,990	60,599
1940	829,458	165,962	39,252
1941	314,507	62,124	14,890
1942	125,311	8,615	5,346
1943	93,408	2,825	2,842
1944	85,392	2,332	1,865
1945	167,782	1,942	2,262
1946	397,519	4,061	4,297
1947*	349,693	156,039	4,829
1948	324,237	8,628	5,107
1949	323,393	9,571	5,033
1950	327,160	9,036	4,897
1951	259,485	17,259	4,617
1952	363,550	94,132	4,851
1953	351,500	23,700	4,800
1954	298,000	14,900	4,900
1955	239,200	21,000	4,300

*The 1947 averages exclude the numbers unemployed during the fuel and power crisis early in the pear, who did not register as unemployed at employment exchanges.

Before 1911 assistance to the unemployed had only been given by the poor-law authorities in the form of relief on the ground of destitution. In that year was passed the first Unemployment Insurance act.

It covered only 2,250,000 workpeople, out of about 14,000,000, being confined to the building, woodworking, engineering and shipbuilding trades, which were at that time peculiarly affected by unemployment. The premium under the scheme was contributed compulsorily by the employer. the workman and the state in equal shares! and benefit was at the rate of 7*s.* per week. In 1916 the scope of the act was extended to cover certain trades which had been excessively expanded to meet the war emergency, against the anticipated postwar deflation, and in 1918 an emergency act was passed to provide relief for all persons thrown out of employment by the cessation of the war; this scheme was not covered by premium contributions, and it was ultimately succeeded by a new Unemployment Insurance act of 1920. This act covered about 12,000,000 persons; *i.e.*, speaking generally, all industrial workers with the exception of agricultural and domestic employees.

When the act came into force unemployment was increasing, and for the next ten years there followed a series of amending acts extending the limits of insurance and making various financial adjustments. To enable benefits to be paid it became necessary for the Unemployment Insurance fund to obtain loans from the exchequer. In 1930 a royal commission was appointed to determine whether the fund could become self-supporting, and many of its recommendations were incorporated in the Unemployment act of 1934. A consolidating act mas passed in 1935, and in the following year unemployment insurance was extended to cover agricultural workers. Further minor modifications and extensions in the scheme were made in 1938, 1939 and 1940.

Ministry of labour estimates suggest that the number of persons insured against unemployment increased from 11,000,000 in 1922 to 14,000,000 in 1936. In 1939 the estimate gave 15,157,000 persons in Great Britain and Northern Ireland as insured under the general scheme and 741,000 under the agricultural scheme. The Unemployment Insurance fund. as has already been mentioned, was forced during the depression to obtain advances from the exchequer which by 1934 had totalled £115,000,000. This debt was then funded, and more favourable industrial conditions in succeeding years enabled the fund to show a credit balance. As a result, outstanding debt had been discharged by the end of 1941.

Employment Exchanges.—In connection with the unemployment insurance scheme the ministry of labour and national service established numerous employment exchanges. On becoming unemployed a worker must register at an exchange in order to receive his insurance benefits, and it is the function of the exchange to find him fresh employment as soon as possible. There were about 1.000 employment exchanges by the mid-1950s. Under them were about 200 branch employment offices and local agencies affording limited facilities in remote places

There were some specialized exchanges (*e* g., for women and for the hotel and catering trades) and youth employment offices, about half of them run by local authorities. Benefits were paid on an agency basis on behalf of the ministry of national insurance and of the National Assistance board. Both in 1938 and in 1954 (the first a year with heavy and the second a year with virtually no unemployment) about 2,500,000 vacancies were filled.

Mention should also be made of certain subsidiary services provided by the ministry. Where employment is scarce in a worker's district but available for him elsewhere. he can be granted fares for himself and his family and financial aid to meet the cost of removal and resettlement. In certain circumstances he can also qualify for a lodging allowance. In addition, the exchange can arrange for him to attend a government training centre in order to acquire a new skill. During World War II, the problem of transferring workers from peacetime industries to war nork assumed large proportions; the ministry's training centres proved inadequate for the numbers of workers involved, and arrangements were made. wherever possible, to train skilled workers in the factories in which they would be employed.

Other Remedies for *Unemployment.*—Other methods adopted by the state to deal nith the problem of unemployment after 1920 included the provision and subsidizing of relief nork in various forms. Among the classes of nork thus subsidized were road work, land drainage, water supply, forestry, etc. There were also two schemes designed for the general stimulation of trade, viz., the trade facilities and export credit schemes.

Under the first of these the treasury nas emponered to guarantee the interest and capital of loans raised for expenditure calculated to promote employment. The guarantees mere mainly confined to public utility undertakings between the years 1921 and 1928. The total so guaranteed nas about £75,000,000, and by March 31, 1939, the amount outstanding had been reduced to £27,000,000. The export credit scheme was initiated in 1920 and was amended several times thereafter. The board of trade is authorized to grant exporters credits in connection with exports to foreign countries and to insure risks not otherwise insurable on reasonable terms. After the outbreak of World War II in 1939 the scheme was extended. not to relieve unemployment but to maintain certain trade relations that were felt to be of importance.

Special Areas.—The unrelieved depression over a long period in the regions of Durham and the Tyneside. Cumberland and south Wales caused them in 193j to be designated "special areas." Commissioners were appointed to superintend and organize relief nork, and between 193j and 1939 more than £16,000,000 had been spent on various schemes initiated by the commissioners New industries were brought to the depressed areas under subsidy, and numerous schemes for public works were developed. These areas were later renamed development areas (see above).

Emigration.—It was pointed out by some authorities that the exceedingly high unemployment figures betneen World Wars I and II were due in some measure to the natural increase of population and the decline of emigration. The ministry of labour's statistical survey of 1927 stated that, in spite of increased numbers of unemployed during the previous decade. the actual number of workers in employment was higher than it had ever been before. If there had been emigration on the scale of the years before 1914, the available supply of labour in Great Britain might even have been inadequate for the needs of industry at that time.

The decline of emigration after 1919 was largely due to restrictions on immigration imposed by the United States and the British dominions. The United States Immigration act of 1924 imposed a rigorous quota on the number of immigrants admitted in each year, and the dominions strongly opposed unrestricted immigration on the ground that it would be liable to disturb their internal economies. It is notex\-orthy that from 1931 to 1937 there were more arrivals in than departures from Great Britain. This reversal of a century-old trend was a result of the fact that the depression was world-aide and that emigrants who had been unable to succeed abroad tended to return home.

SETTING UP OF THE WELFARE STATE

World War I1 made manifest the benefits of full employment and, by so doing, impressed on all concerned the moral and political inexpediency of allowing the unemployment of the prewar years to recur. At the same time, war (a great socializing force. as Bernard Shaw had pointed out as long ago as 1916) provided ample experience in the erection and working of administrative machinery permitting the vigorous moulding of people's lives on the largest scale. World War II gave many people a chance to improve their standard of living; at the peak of the war effort the national expenditure (in terms of 1938 prices) on beer, tobacco and entertainment rose. Winston Churchill, the prime minister. laid it down that the standard of living must not be lowered to primitive levels. These factors led to the coinmissioning and rendering of a report by Sir William Beveridge on social security and allied services (Nov. 1942) which "takes freedom from Want as its aim, and sets out a Plan for Social Security to achieve this aim." In Sept. 1944 the coalition government put forward proposals for social insurance and family allowances, and in November the ministry of national insurance was instituted. The great body of social legislation was, however: the work of C. R. Attlee's first Labour administration. Details of this legislation will be found in the article SOCIAL SECURITY.

The institution of the welfare state was accompanied by a far-reaching redistribution of incomes. For this there were a number of causes: (1) the continuing scarcity of labour, with the result that real wages underwent a slight increase, while most other types of income dwindled; (2) the cost of the various schemes described was raised by taxation, the bulk of which fell on the higher-income groups; (3) in a similar way money was raised for

TABLE LXXXIX.—*Distribution of Personal Incomes (Before Tax)*

Income	1938 per cent	1954 per cent
Wages	37.9	42.4
Salaries	17.9	21.3
Pap of armed forces	1.3	2.3
Income from self-employment	12.8	11.3
Employers' contributions	2.5	4.1
National insurance benefits and public grants	5.4	7.0
Rent, dividends and interest	22.2	11.6

the cheapening of food (£369,000,000 net in 1950), houses (£65,000,000) and other commodities (grand total £479,000,000). The result is shown in Table LXXXIX.

Social Insurance. — In the 18th and 19th centuries the principal means available to the worker for insuring himself against sickness or other disabilities was to become a member of a friendly society, to which he paid his regular contribution. But friendly societies were only for the better-paid and more thrifty workers; for the less fortunate there was nothing but charity and poor-law relief. Between 1911 and 1936 national health insurance was made compulsory for all workers earning less than £250 a year between the ages of 14 and 65.

The first Old Age Pensions act was passed in 1908, and it provided a pension of js. a week for old persons over jo. In 1925 the first contributory scheme for pensions was introduced, and it was later extended. Pensions of 10s. a week were payable to an insured man when he reached the age of 65 and to his wife when she reached the age of 60; insured unmarried women became eligible for pensions at the age of 60. Pensions were also paid to widows of insured men, with additional allowances for children under the school-leaving age, and to orphans. Supplementary pensions of varying amounts were paid to pensioners requiring additional assistance, providing they could establish their need. In 1938, 20,678.499 persons in Great Britain were contributing to the pensions scheme and 1,945,509 were receiving benefits under it. In the same year the pensions service was costing £48,158,951, of which £17,000,000 came from a parliamentary grant.

Under the National Insurance act, 1946 (amended in 1949 and 1951), in principle all persons over school-leaving age (except persons of pensionable age and married women occupied in their own homes or who elect not to be insured) are insured. They fall into three classes: (1) employed persons; (2) self-employed (persons in business on their own account); and (3) nonemployed. Contributions are payable by the persons insured, by the employers of employed persons and by the state. The benefits cover insurance against unemployment and sickness, maternity grants, industrial injuries. widows' benefits, guardians' allowances, retirement pensions and death grants.

TABLE XC.—*Contributions Payable by Insured Persons, 1956*

Insured persons	Employed	Employer of employed person	Self-employed person	Nonemployed person
Men over 18	6s. 9d.	6s. 11d.	8s. 5d.	6s. 6d.
Women over 18	5s. 6d.	4s. 6d.	7s. 2d.	5s. 2d.
Boys under 18	3s. 11d.	2s. 10d.	4s. 10d.	3s. 9d.
Girls under 18	3s. 3d.	[illegible]	4s. 3d.	3s. 2d.

To finance the system two funds were established: the National Insurance fund and the National Insurance (Reserve) fund. The former receives the income derived from contributory payments, exchequer grants and interest; it pays out the statutory benefits and provides for the costs of administration. It also pays a contribution to the national health service. It is actuarially revised every five years.

In financial 1953–54 the Insurance fund received £594,800,000 (mostly contributions from employers and insured persons) and disbursed £485,400,000, of which £334,100,000 was for retirement pensions. None of these benefits was subject to a means test.

The Industrial Insurance acts replaced the various Workmen's Compensation acts from 1925 to 1945. About 70% of the total contributions are derived from employers and employees and one-sixth from the exchequer. The insurance covers injuries, disablements and death. In the year to March 1954 payments relating to injuries amounted to £11,000,000; and those relating to disablement totalled £12,200,000.

The National Assistance act supplemented the National Insurance act. It was designed to sweep away the poor-law system and to replace it by one more comprehensive and also more liberally worked. The act, administered by the National Assistance board, granted assistance (mainly in cash) to persons without, or with inadequate resources. The board's expenditure in 1954 reached £130,000,000, the great bulk of which was accounted for by national assistance (£104,200,000), and noncontributory old-age pensions (£19,500,000). At the end of 1954 the total number of persons receiving allowances was 1,796,000, over half of these being paid in supplementation of retirement pensions. The average weekly payment was 21s. 11d.

TABLE XCI.—*Benefits Payable Under the National Insurance Acts in 1956*

Benefit weekly rate	Men	Women (single)	Girls and boys (under 18)	Married women
Unemployment	48s.	40s.	23s.	30s.
Sickness		40s.	23s.	25s.
Maternity				
Grant				£10
Weekly rate*				40s.
Widow†				55s.
Widowed mother				51s. 6d.
Widow's pension‡				40s.
Widow's basic pension				10s.
Guardian's allowance		18s. for each child		
Retirement pension		40s.		
Death grant				
Men 55–65 years	£10			
Women 50–60 years				
Men under 55	£20			
Women under				
Children				
Under 3 years	£6			
3–5 years	£6			
6–17 years	£15			

*Payable for 18 weeks. †Payable for 13 weeks. ‡Payable under certain conditions.

The board also administers noncontributory old-age pensions under the Old Age Pensions act, 1936. It further provides reception centres (formerly workhouses) for persons without a settled way of living. Under the Legal Aid and Advice act, 1949, and the Legal Aid and Solicitors' (Scotland) act, 1949, it investigates the resources of certain persons applying for legal aid and determines their maximum contribution.

Health Service.—The ministry of health is responsible for the administration the National Health Service act, 1946. The service was originally entirely free, but certain dental and prescription charges were introduced in June 1952. The act covers England and Wales; Scotland (*q.v.*) is covered by a special enactment of May 1947.

The service works under three main authorities divided on a functional basis.

1. Hospitals. The regional hospital boards administer the hospital and specialist services of a regional area covering three or four counties and are based on their own university centre. Under each board a number of hospital management committees each administers a single hospital or a number or group of adjacent hospitals. Members of the boards are appointed by the minister from nominations submitted by various bodies; members of the committees are appointed by the regional board. Teaching hospitals are administered by separate boards or governors.

2. General practitioner health services, which are administered by local executive councils based on local health authority areas. The councils are divided into professional and lay representatives. Professional representation is made up of seven doctors appointed by the local medical committee, three dentists appointed by local dental committees and two pharmacists appointed by local pharmaceutical committees. Lay representation is made up of eight members appointed by the local health authority and four nominated by the ministry. As the buying and selling of practices was discontinued by the act, local executive councils are responsible for filling vacancies.

3. Public health services, which are administered by the local health authority through its health committees. The local authorities lost their hospital services as a result of the National Health Service act, but they acquired the new responsibility of finding premises for health centres. In addition, there are certain statutory responsibilities under the act; *e.g.*, the care of mothers and young children.

The original form of remuneration for doctors was a capitation fee, paid in respect of each patient on the list, up to a maximum of 4,000, with an additional 2,400 if an assistant was employed. In cases where doctors were starting in practice in unestablished practices, they could claim a basic salary of £300 a year if they could show reasonable prospects of obtaining a list of 500 patients within a specified time, which varied with circumstances; the application had in the first instance to be approved by the local medical committee. Later modifications provided for a practice allowance of up to £600 on condition that the new practitioner started in an area which was not restricted. (The Medical Practice committee had divided the country into restricted, intermediate and open areas.) Doctors were also encouraged to combine in partnerships. Group practices were encouraged by the promise of loan capital for the establishment of joint surgeries and kindred purposes.

A revolutionary change introduced by the act was the setting up of a dental service. During World War II it was found that 80% to 90% of young recruits needed dental treatment; the nation's general dental health mas poor, and the Teviot report (Oct. 1944) found that the number of new entrants into the profession was inadequate. To correct this tendency a scale of fees giving substantially higher incomes was introduced.

The dental service operates under the executive councils (*see* above), with the help of local dental committees. Proposals for major treatment go before the Dental Estimates board, whose statistical material enables it to study trends.

Family Allowances.—The Family Allowances act, 1945, provides for the grant of cash allowances for children other than the first child. It is administered by the ministry of national insurance.

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Education.—For an account of the development of education in Great Britain, *see* EDUCATION, HISTORY OF. The pattern of education in Great Britain in the mid-20th century was set by the Education act, 1944, for England and Wales and the Education (Scotland) act, 1946. (Similar legislation for Northern Ireland was contained in the Education act Northern Ireland, 1947.)

These acts organized education in three stages: primary (to age 11; compulsory from 5); secondary (12–18); and further, from the end of full-time compulsory education (15; to be raised to 16 as soon as practicable); and made, at a date to be determined, some part-time education compulsory between the school-leaving age and 18. Furthermore, it was to be the duty of the state, through the local education authority, to provide free education at all three stages, and not only at the elementary (5 to 14) stage as previously.

TABLE XCII.—*Grant-Aided Schools, 1900–38*

Year	Elementary		Secondary		Special		Vocational*		
	Pupils (000)	Teachers (000)	Pupils (000)	Teachers (000)	Schools	Pupils	Full-time	Part-time†	Art
1900–01	5,772	119.4	—	—	182	8,153	—	—	—
1920–21	5,902	167.9	349.7	18.1	500	36,459	14	796	46
1930–31	5,572	171.8	435.3	22.6	607	48,934	8	940	59
1937–38	5,098	169.8	501.5	26.2	611	51,422	14	1,230	68

*Numbers of establishments. †Including evening.

TABLE XCIII.—*Development of Education in England and Wales After World War II*

Type of School		1946–47			1953–54		
		Schools	Pupils (000)	Teachers	Schools	Pupils (000)	Teachers
Grant-aided:							
Primary	Nursery	353	6.0	2,167	457	22.6	990
	Infant	5,197	892.1	27,424	5,585	1,175.9	35.090
	Junior	9,132	1,635.5	54,795	13,959	2,684.4	84,416
		9,662	1,208.1	40,764	3,957	693.6	24,595
Secondary	Modern	2,843	719.7	34,814	3,480	578.6	53,389
		1,199	8	25,321	1,181	257.4	28,013
	Technical	324	59.9	3,629	300	30.8	4,545
	Bilateral	—	—	—	77	37.4	1,926
	Multilateral	—	—	—	3	2.3	11
	Comprehensive	—	—	—	13	12.3	614
Special		528	38.5			56.4	3,298
Direct grant		344	98.3			100.2	5,603
Independent*		949	144.6	12,827	1,324	249.4	17,576

*Inspected and recognized by the ministry of education.

Secondary education was provided in three different types of school: modern, technical and grammar. By 1956 some bilateral, multilateral and comprehensive secondary schools had been developed; *i.e.*, schools combining any two of these types of education (bilateral); schools providing all three types in separately organized streams (multilateral); and schools providing secondary edu-

TABLE XCIV.—*Further Education in England and Wales, 1946–47 and 1954*

Type of institution	1946–47				1954			
	Number of establishments	Students (000) Full-time	Part-time day	Evening	Number of establishments	Students (000) Full-time	Part-time day	Evening
Major establishments (excl. art)	470	32	174	451	556	49	342	725
Art schools	211	13	23	74	195	11	31	93
Evening institutes	5,078		—	827	9,032			1,860
Universities and university colleges*	24	68	17		24	80	15	

*Great Britain.

cation without an organization in three sides (comprehensive).

As well as schools maintained by the local education authorities, there nere some schools which received government grants direct from the education department; these mere known as direct-grant schools. By the 1944 act. independent schools, which received no grant, were also to be inspected and recognized as efficient.

The figures in Tables XCII. XCIII and XCIV refer only to England and Wales, unless otherwise stated. See also the sections on education in the articles SCOTLAND and IRELAND, NORTHERN.

Housing. — Even before 1914 British housing fell sadly short of the ideal standard. The census of 1911 showed a tenth of the population in overcrowded conditions; *i.e.,* more than two to a room (including living rooms). The shortage extended to both town and country, and in addition a number of the working-class houses in occupation were dilapidated and insanitary, large areas in many cities being characterized as slum. At the end of World War I there was estimated to be a shortage of houses of between 300,000 and 400.000, in addition to considerable arrears of work to be done in slum clearance and making good defective dwellings. This deficit had arisen from two causes. There had been a distinct slowing up of the normal rate of building from 1910 to 1914, and during the war very few working-class houses were built. The estimated normal annual requirements to meet the natural increase of the population are 70,000 new houses and 30,000 to replace those which go out of use for various causes.

The position at the conclusion of World War I was further complicated by the great shortage of building materials and building-trade workers, with a concomitant rise in the cost of building. Therefore not only was there a severe shortage of houses, but it seemed impossible that houses to make good this shortage could be supplied by normal methods at rents which would be within the means of the working classes to pay and which would adequately remunerate the capital expended. Therefore it became necessary to take special measures. Local authorities had already under existing legislation (the principal acts being the I-lousing act of 1890 and the Housing and Town Planning act of 1909) considerable powers of providing for the working classes and improving the standard of existing houses. In 1919 a new act transformed the position of those authorities, converting a power into a positive obligation and enabling the state to reimburse them all expenditure exceeding the produce of a penny rate.

Housing policy between 1920 and World War II fell into two periods. In the first; up to about 1930, housing was encouraged by government subsidies not only to local authorities but to private enterprise as nell. By the end of 1928, 826,973 subsidized and 447,127 unsubsidized houses had been built. However, it gradually became apparent that most of the new houses were being let at a rental beyond the means of most labourers.

From 1928 increasing financial stringency was felt. and the subsidies were gradually withdrawn. In 1928 and 1929 they were withdrawn from private enterprise; and in 1930 from the local authorities for all dwellings except class C houses, or cheap houses which could be rented to the poorest classes. Finally. in 1933 all subsidies except those which would make slum clearance possible were stopped.

The advent of World War II brought about an almost complete cessation in new housing. For six years building was limited to the erection of a small number of special houses for particular war workers. Repairs to existing mar-damaged houses did, however, become necessary on an immense scale. According to a White Paper published on Nov. 28, 1944, out of about 13,000,000 houses at the outbreak of war, 202,000 were totally destroyed; 255,000 heavily damaged and unhabitable and 4,073,000 slightly damaged. To meet the cost of repairs and compensation, the government instituted a scheme of compulsory insurance under the War Damage act of 1941. By Sept. 1945 the War Damage commission received notifications of damage to 3,281,953 properties, including 1,400,245 in London. Contributions under the act totalled about £200,000,000, but by Jan. 1949 about £750,000,000 had been absorbed by war damage payments.

At the end of hostilities three serious housing problems emerged. Not only was there a reduction from the 1939 complement of houses. due to losses by bombing. but there was also a great volume of damage arising from enemy action and still awaiting permanent repair under the War Damage act. Second, there was an accretion of ordinary maintenance repairs on almost all houses. Third: an increase in population had taken place for which no housing provision had been made. In 1944 legislation widened local authority housing powers, and empowered the government to build prefabricated bungalows in partnership with the local authorities; 124,970 such bungalows were erected between 1945 and 1948.

The end of hostilities in 1945 made vitally urgent the recommencement of house building on a grand scale by local authorities. The Housing (Financial and Miscellaneous Provisions) act, 1946, authorized the payment of exchequer subsidies and rate contributions sufficient to enable local authorities to build houses to let at reasonable rents. Furthermore. it authorized the minister of health to make special grants to authorities using more expensive, nontraditional materials or forms of construction. A special subsidy was made available for houses built for letting to agricultural workers. Under the 1946 act were built most of the houses completed from 1946 to 1952. By the middle of 1954 about 1,900,000 houses had been built in Great Britain since early 1945. The numbers built and the subsidies granted were atiected by political as well as by economic considerations. In 1954 (as before World War II) special attention was again being given to slum clearance. During the period the lion's share in new construction was assigned to the local authorities. An overriding control over land utilization was provided by the Town and Country Planning act, 1947, and by the Town and Country Planning (Scotland) act, 1947, which coordinated planning throughout the country. Most of the privately on-ned houses were let subject to rent control. Table XCV shows the development of housing before and after World War II.

TABLE XCV.—*Number of Houses Built With and Without State Assistance, 1939 to 1954*

Year*	Total	For local authorities?			For private owners†			Other§
		With exchequer assistance	Un-assisted‡	War-destroyed houses rebuilt	With exchequer assistance	Un-assisted‡	War-destroyed housrs	
	England and Wales							
1939–40	195,962	40,231	10,221	—	2,849	142,661	—	..
1940–41	42,498	11,802	3,606	—	648	26,442	—	..
1941–42–1944–45 (av.)	7,681	1,348	968	—	69	2,687	—	2,609
1945 (April-Dec.)	1,445	366	—	142	901		36	
1946	51,090	18,633	—	2,569	26,780		2,940	168
1947	127,541	83,615	—	2,952	30,202		9,424	1,348
1948	206,405	168,971	—	1,850	18,882		12,328	4,374
1949	171,780	141,079	—	687	19,275		5,413	5,326
1950	172,360	139,158	—	198	24,108		2,468	6,428
1954	308,952	199,604	—	38	87,755		273	21,282
	Scotland							
1939	25,529	18,902	216	—	58	6,353	—	..
1940	14,206	10,357	117	—	228	3,504	—	..
1941–44 (av.)	3,516	3,203	19	—	38	256	—	..
1945	1,569	1,428	—	—	27	111	3	..
1946	4,310	3,633	—	178	52	445	2	..
1947	12,149	10,551	—	222	70	1,239	45	22
1948	21,211	19,273	—	274	124	1,376	41	123
1949	25,847	24,096	—					
1950	1	24,292	—	84	170	868	64	565
1954	38,653	35,331	—	22	182	560	40	715
				—	305	2,286	17	714

*Years ended March 31 from 1939–40 to 1944–45 for England and Wales. Thereafter calendar years. †The Scottish national housing companies, Scottish Special Housing association and the New Towns development corporations are included in the figures for local authorities. ‡Before April 1945 the figures for England and Wales exclude houses having a ratable value exceeding £78 (of £105 in the metropolitan police district). §Accommodation ior the families of police, prison staffi, thr armed forces and members of certain other services. From April 1945 figures include housing associations except Scottish Special Housing association and Northern Ireland Housing trust. In periods for which separate figures are not available, houses for government departments are included under unassisted houses built for private owners.

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SAVINGS INSTITUTIONS

Apart from deposits in the joint-stock and other banks and in building and co-operative societies, and investments in securities and property of all kinds, British savings are held in four main forms; namely. deposits at the trustee savings banks. deposits at the post-office savings bank, savings bonds and savings certificates. The establishment of the savings bank in Great Britain dates from the year 1810, when the first private bank was founded. The post-office savings banks were founded in 1861, at which date more than £40,000,000 was invested in the trustee banks. The government institutions gradually overhauled. the other system, and at the end of the century, whereas the trustee banks had only increased their deposits to about £50,000,000, the post-office banks had more than £140,000,000 deposits.

TABLE XCVI.—*Development of Post Office Savings Banks*

Year ending Dec. 31	Average number of accounts	Average amount of deposits	Average balance in each account			Average number of offices
1863–68 . . .	663,000	£7,000,000	£11	3*s.*	5*d.*	3,290
1869–74 . . .	1,373,000	18,000,000	13	5	3	4,498
1875–80 . . .	1,889,000	29,000,000	15	12	5	5,742
1881–85 . . .	3,088,000	42,000,000	13	11	3	7,348
1886–90 . . .	2,248,000	59,000,000	13	16	10	9,025
1891–95 . . .	5,776,000	83,000,000	14	7	0	10,888

Table XCVII shows the figures for the total amounts standing to the credit of depositors in the United Kingdom at the end of 1914 and in certain succeeding years.

TABLE XCVII.—*Post-Office Savings; Amount Due Depositors*

Year (Dec. 31)	Amount	Year (Dec. 31)	Amount
1914	£190,533,000	1944 . . .	£1,493,914,000
1918	234,633,000	1945 . . .	1,776,622,000
1921	264,157,000	1946 . . .	1,981,895,000
1933	326,654,000	1947 . . .	1,943,174,030
1937 . . .	470,495,000	1948 . .	1,948,051,000
1938	509,293,000	1949 . . .	1,947,615,000
1939	551,372,000	1950 . . .	1,934,332,000
1940	654,368,000	1951 . . .	1,875,920,000
1941	822,915,000	1952 . . .	1,813,300,000
1942	1,005,431,000	1953 . . .	1,747,500,000
1943	1,240,032,000	1954 . . .	1,727,300,000
		1955 . . .	1,698,700,000

In 1916 the national savings movement was instituted. The instrument adopted was the "war savings certificate," a government security, registered and nonnegotiable. accumulating compound interest over a fixed period free of income tax. After the end of the mar the War Savings committee and war savings certificate (see *National Finance* above) dropped the word "war" from their titles and became part of a national savings group which now embraces local committees, savings associations, regional advisory committees and a National Savings committee. Certificates are repayable at any time at the option of the holder, but because of the exemption from income tax it was thought necessary to impose an upper limit which has varied from time to time.

During World War II the national savings movement concentrated on the sale of defense bonds. which were introduced in 1939 with certain features designed to attract the small investor. as well as of national savings certificates. This movement continued after the war. The element of personal savings plays a recognized part in balancing the national economy, and chancellors of the exchequer have come to allow for it in framing the budget. In Oct. 19jj national savings certificates outstanding (including interest) came to £2,384,000,000, post-office savings bank balances to £1.722,000,000, trustee savings bank balances to £1,050,300,000 and stock on the post-office register to £968,200,000—total, £6,124.500,000. (W. H. JN.)

GREAT CHAIN OF BEING, a conception of the structure of the universe that had a pervasive influence in western thought in Neoplatonism during the Renaissance and the early modern period. particularly in the 17th and early 18th centuries. The term denotes three general features of the universe: plenitude, continuity and gradation. The principle of plenitude states that the universe is "full." exhibiting the maximal diversity of kinds of existences; everything possible (*i.e.,* not self-contradictory) is actual. The principle of continuity asserts that the universe is composed of an infinite series of forms, each of which shares with its neighbour at least one attribute. According to the principle of linear gradation. this series of forms ranges in hierarchical order from the barest type of existence through all possible grades up to the *ens perfectissimum,* or God.

The idea of the chain of being was first systematized by the Neoplatonist Plotinus. though the component concepts were derived from Plato and Aristotle. Plato's "idea of the good" in the *Republic,* eternal, immutable. ineffable. perfect, the universal object of desire, is fused with the demiurge of the *Timaeus,* who constructed the world of becoming because "he was good, and in one that is good no envy of anything else ever arises." for, "being devoid of envy . . . he desired that everything should be so far as possible like himself." Aristotle introduced a definition of the continuum and pointed out various graded scales of existence. Thus, in the words of Plotinus: "The one is perfect because it seeks for nothing. and possesses nothing, and has need of nothing: and being perfect. it overflows. and thus its superabundance produces an Other." "Whenever anything reaches its own perfection, we see that it cannot endure to remain in itself, but generates and produces some other thing. . . . How then should the most perfect being and the first good remain shut up in itself, as though it were jealous or impotent—itself the potency of all things. . . . Something must therefore be begotten of it" (*Enneads,* v. 2, 1; and v. 4. 1). This generation of the many from the one must continue until all possible varieties of being in the descending series are realized. "The world is a sort of life stretched out to an immense span, in which each of the parts has its own place in the series. all of them different and the whole continuous. and that which precedes never wholly absorbed in that which comes after" (*Enneads,* v. 2, 2).

The scale of being served Plotinus and numerous later writers as an explanation of the existence of evil in the privative sense of lack of some good. It also offered an argument for optimism: since all beings other than the *ens perfectissimum* are to some degree imperfect or evil, and since the goodness of the universe as a whole consists in its fullness, the best possible world will be one which contains the greatest possible variety of beings and consequently all possible evils.

The concept of the chain of being was unorthodox for scholastic theology because it was thought to conflict with the freedom of will of the deity. However! it had been clearly enunciated by Abelard in the 12th century. During the Renaissance and more especially in the 17th and early 18th centuries, it was almost universally accepted. A. O. Lovejoy points out that next to the word "nature." "the Great Chain of Being" was the sacred phrase of the 18th century. In Pope's *Essay on Man* (Epistle i, 1732) it is expressed most clearly. He speaks of the best possible systems (which infinite Wisdom must form)

> Where all must full or not coherent be,
> And all that rises, rise in due degree; (45–46)

And later:

> Vast chain of being! which from God began,
> Satures aethereal, human, angel, man,
> Beast, bird, fish, insect, nhat no eye can see,
> So glass can reach; from Infinite to thee,
> From thee to nothing —On superior pom'rs
> Were we to press, inferior might on ours;
> Or in the full creation leave a void,
> Where, one step broken, the great scale's destroyed:
> From Nature's chain whatever link you strike,
> Tenth, or ten thousandth, breaks the chain alike. (237–246)

The principle of plenitude was really a disguised version of the principle of sufficient reason, fundamental to the systems of Leibniz and Spinoza. This principle required some reason for the existence of every entity; namely its roots in the eternal order. in the necessities belonging to essences and their relations. Thus seen. the principle of plenitude asserts that the universe is completely rational and intelligible.

The main 18th-century critics of these ideas were Voltaire and Samuel Johnson, who conclusively refuted the whole theory of "the scale of being." though their criticisms failed to gain proper recognition at the time. Nevertheless. it became increasingly apparent that the objects of our sensible experience do not constitute an unbroken continuum of forms. The principles of plenitude and continuity could, therefore. be saved only if it were assumed that the forms became actual in the course of a long period of time. The chain of being had to be seen as growing in time and so became a sort of cosmic evolutionism. Already Leibniz had spoken of "a cumulative increase of the beauty and universal perfection of the works of God, a perpetual and unrestricted progress of the universe as a whole."

See A. O. Lovejoy, The *Great Chain of Being (1936)*.

(B. R. Ma.)

GREAT CIRCLE, any circle on .the surface of a' sphere marking the intersection of the sphere with a plane passed through its centre. All meridians of longitude of the earth are great circles. but the only parallel of latitude which can qualify is the equator.

Since the shortest distance between any two points on the surface of a sphere is along the arc of a great circle, it is important for an airplane or ship to follow a great-circle course whenever practical.

See also MAP: *Map* Projections; NAVIGATION. (M. H I.)

GREAT DIVIDING RANGE, Australia: *see* EASTERN HIGHLANDS.

GREAT FALLS, the largest city of Montana, C.S., is 93 mi. N.E. of Helena in central Montana. at an altitude of 3.330 ft., on the Missouri river, 12 mi. above the falls of the Missouri (93 ft. high) from which it derives its name; it is the seat of Cascade county.

The region is noted as a great wheat-growing and grazing area, although Great Falls is primarily an industrial city serving a large area as the manufacturing, commercial, financial and jobbing centre. The main industries include a copper and zinc refinery, which also fabricvtes copper and aluminum wire, power plants and flour mills. The municipal airport and the Malmstrom air force base gained importance as stations on the polar route to Europe and through Alaska to the orient.

In 1805 Lewis and Clark observed the nearby Giant Springs, one of the largest in the world, with a daily flow of 388,800,000 gal. of water, at a temperature of 52° F. the year around. The city was founded in 1883 by Paris Gibson of Minneapolis, Minn., and incorporated in 1888. Gibson planned the wide tree-lined streets and a fine system of parks which were linked later by many boulevards. The Charles M. Russell Memorial Studio and museum is a favourite cultural attraction.

The population of Great Falls increased from 29,928 in 1940 to 35.214 in 1950, and by 1960 had reached 55,357. The Great Falls standard metropolitan statistical area which consists of Cascade county had at its establishment in 1960 a population of 73,418. (For comparative population figures see table in >$OKTANA: *Population.*)

The College of Great Falls. a Roman Catholic school. was established in 1932. The State School for the Deaf and Blind and a rehabilitation centre for crippled children, which serves the state. also ore in Great Falls. A civic centre building contains a large auditorium, exhibit and recreational facilities in addition to city offices. (M. G. Bu.)

GREAT HARWOOD, an urban district in the Clitheroe parliamentary division of Lancashire, Eng., 5 mi. N.E. of Blackburn. Pop. (1961) 10,718. Area 4.5 sq.mi.

Mainly a cotton-manufacturing town, it also has light engineering and the making of leather goods. It is the birthplace of John Mercer (1791–1866), the inventor of the mercerizing process for cotton cloth.

GREATHEAD, JAMES HENRY (1844–1896), British civil engineer, whose name was given to a tunneiing shield. was horn at Grahamstown, South Africa, on Aug. 6. 1843. He came to England in 1859 and was P. W. Barlow's pupil (1864–67). Barlow patented a tunneling shield—an iron ring forced forward by hydraulic jacks against the last erected lining ring of cast-iron segments, while men worked on the earth face ahead. Barlow proposed a subway under the Thames near the Tower to exemplify his method, and Greathead contracted for the work, completed in 1869.

The Grenthead shield was used to bore the City and Southwark and the Waterloo and City railways under his direction, and on all the other railway "tubes" that were bored deep in the London clay after his death.

Greathead first proposed cable traction for tube railways, but changed to electric. Apart from his tunnels he was engaged on numerous railway works and took out a number of patents. He died at Streatham, London, on Oct. 21, 1896.

See memoir in *Proc. Inst. Civil Engineers,* vol. cxxvii (1897).

(S. B. HN.)

GREAT LAKES, THE. The Great Lakes and their connecting waterways of the United States and Canada form the largest group of lakes in the world. The Great Lakes proper are Lakes Superior, Michigan, Huron, Erie and Ontario extending roughly from west to east. Their combined area is 95,170 sq.mi., and they drain a land area of 295,200 sq.mi. The lakes are connected to form a single drainage system which discharges down the St. Lawrence river. This system constitutes a waterway that extends nearly halfway across the North American continent. The distance by water from Duluth, Minn., at the head of Lake Superior, to the open Atlantic ocean is 2,340 mi.

Exploration.— Jacques Cartier ascended the St. Lawrence river as far as Montreal in 1535. Samuel de Champlain, founder of Quebec, traveled up the Ottawa river and explored the Georgian bay area of Lake Huron in 161j. Champlain and Étienne Brulé discovered Lake Ontario later in 161j, and it is probable that Brulé saw Lake Superior in 1622. Jean Nicolet traversed the North channel of Lake Huron and visited Lake Michigan and Green bay in 1634. Pierre Radisson and Médard des Groseilliers traveled extensively on Lake Superior in 1655.

The first white man known to have seen Lake Erie was Louis Jolliet, who returned from the Lake Superior country by way of the St. Clair river, Lake St. Clair, the Detroit river and Lake Erie in 1669. Lake Erie was the last of the Great Lakes to be discovered, partly because the powerful Iroquois Indians, who were unfriendly toward the French and their Indian allies, controlled the two lower lakes, and partly because the system of the Ottawa and Mattawa rivers leading to the upper lakes was a route more suitable to canoe travel than were the' open waters of Lakes Ontario and Erie and the impassable Niagara river with its gorge and falls. By 1671 France had claimed all of the territory of the St. Lawrencc river-Great Lakes region. The explorations of Jolliet and Father Jacques Marquette in 1673–74 added much to knowledge of the region about Lake Michigan. The first sailing vessel: the "Griffin," built under the direction of Robert Cavelier de la Salle, traversed Lakes Erie, Huron and Michigan in 1679, but was lost on the return voyage.

France dominated an extensive fur trade for nearly a century, but the entire French territory embracing the Great Lakes was ceded to England in 1763, at the close of the French and Indian War. After the Revolutionary War a treaty in 1783 fixed a boundary between Canada and the United .States in the Great Lakes region. That boundary was contested but not appreciably altered by the War of 1812. During that war extensive but generally indecisive conflict occurred on Lake Ontario. The battle of Lake Erie, in which a U.S. fleet under Commodore Oliver H. Perry was victorious, secured U.S. claims to the northwestern part of the region.

Physiography.— The lakes, which lie between latitude 41° 22' and 49° 00' N. and longitude 76° 04' and 92" 06' W., occupy elongated, somewhat crescentic basins, the long axes of which are oriented in several directions. Lake Superior, the most northerly and westerly of the group, extends from west to east for 383 mi.

and is 160 mi. from north to south; Lake Michigan extends from north to south for 321 mi. and is 118 mi. from east to west; Lake Huron extends from northwest to southeast for 247 mi. and is 101 mi. from east to west; Lake Erie extends from east to west for 241 mi. and is 57 mi. from north to south; and Lake Ontario extends from east to west for 193 mi. and is 53 mi. from north to south.

The combined shore line of the Great Lakes is more than 8,300 mi. and a water surface of 95,170 sq.mi. is enclosed. Of this, 60,960 sq.mi. are in the United States and 34,210 sq.mi. are in Canada. The drainage basin. including the lake surfaces, is 295,200 sq.mi. Mean annual precipitation in the region ranges from 29 in. at Lake Superior to 34 in. at Lakes Erie and Ontario.

The levels of all of the Great Lakes fluctuate seasonally, reaching their lowest stages in late winter and their highest stages in late summer. The usual range between the winter and summer mean levels, in any one year, has been between one and two feet. In the 100 years from 1860 to 1959 the differences between the lowest and the highest monthly mean stages of the whole period have been between 4.0 and 6.6 ft. in the various lakes. Short-period changes in level. caused by storms, generally do not exceed two feet but a maximum change in lake level of ten feet has occurred within a few hours.

The water of the lakes is fresh and generally clear at all depths, with dissolved solids amounting to between 60 and 400 parts per 1,000,000. The water temperature in all of the lakes. below a depth of about 100 ft., remains close to 39° F. throughout the year. Surface water temperatures range from 32° F. in winter to 60° or 70° F. in summer. There are no appreciable lunar tides in the lakes, and surface currents generally are slight. Waves reach dangerous size, particularly during autumn and winter storms. Shore erosion, caused by storms occurring during years of high-water stages, has destroyed valuable lake-front lands.

Lake Superior, at the head of the system, stands at an average altitude of 602 ft. above mean sea level and it is 1,333 ft. deep. It is the largest of the Great Lakes. with a surface area of 31,820 sq.mi., and it contains over half of the water of the entire system. The largest tributary is the Nipigon river, entering from the north, which drains Lake Nipigon, a body of water with a surface area of 1.870 sq.mi. The St. Marys river is the outlet of Lake Superior, connecting Whitefish bay with Lake Huron 63 mi. to the southeast. The mean annual discharge of the St. Marys river is 73,300 cu.ft. per second. (See SUPERIOR, LAKE.)

Lakes Michigan and Huron, which are connected by the Straits of Mackinac, are similar in many respects. They are at the same level, 581 ft. above mean sea level, and have about the same surface area. Lake Michigan, which lies entirely within the United States, covers 22,400 sq.mi.; Lake Huron covers 23,010 sq.mi. The greatest depth of Lake Michigan is 923 ft.; the greatest depth of Lake Huron, 750 ft. Lake Michigan includes Green bay, a large embayment lying on its western side. Lake Huron includes Georgian bay and the North channel, which lie on the northeastern and northern sides of the main lake. (See GEORGIAN BAY; HURON, LAKE; MACKINAC, STRAITS OF; MICHIGAN, LAKE.)

From the southern end of Lake Huron. the St. Clair river flows directly south for about 40 mi. into Lake St. Clair. which, at an altitude of 575 ft., is 6 ft. lower than Lake Huron. Lake St. Clair, which is 26 mi. from north to south and 24 mi. from east to west, has a surface area of 490 sq.mi. and a maximum natural depth of about 23 ft. An improved channel in the lake bottom connects the mouth of the St. Clair river with the head of the Detroit river. Lake St. Clair is connected with Lake Erie 32 mi. to the southwest through the Detroit river. The mean annual discharge of the Detroit river is 178.000 cu.ft. per second. (See SAINT CLAIR RIVER: ST. CLAIR, LAKE.)

Lake Erie. which is 572 ft. in average altitude, has a surface area of 9.930 sq.mi. Because its maximum depth is only 210 ft., it is the only one of the Great Lakes whose bottom does not extend below sea level. With an average depth of only 58 ft., the lake has a water volume of 109 cu.mi., a little more than one-thirtieth of Lake Superior's volume. (See ERIE, LAKE.)

From the northeastern end of Lake Erie, the Niagara river flows about 34 mi. in a northerly direction. It descends 60 ft. to the brink of Niagara falls, drops 167 ft. in the falls and descends nearly 100 ft. farther in the course of the Niagara gorge. After leaving the gorge, the river traverses a plain for a distance of 7 mi. and enters Lake Ontario. The mean annual discharge of the river is 195,800 cu.ft. per second. (See NIAGARA RIVER AND FALLS.)

Ontario, the most easterly of the Great Lakes, has an average surface altitude of 246 ft. above sea level. The maximum recorded depth, 778 ft., is 532 ft. below sea level. With a surface area of 7,520 sq.mi., Lake Ontario is the smallest of the Great Lakes in area but it ranks third in maximum depth and its volume far exceeds that of Lake Erie. (See ONTARIO, LAKE.)

The St. Lawrence river leaves Lake Ontario at its northeastern end and flows 265 mi. to tidewater (sea level) at Trois Rivières (Three Rivers), Que.; from there to Quebec the distance is 77 mi., and from Quebec to the open Atlantic ocean the distance is about 750 mi. The mean annual discharge of the upper St. Lawrence river is 233.900 cu.ft. per second. The principal tributary to the St. Lawrence is the Ottawa river. (*See* ST. LAWRENCE RIVER; ST. LAWRENCE SEAWAY.)

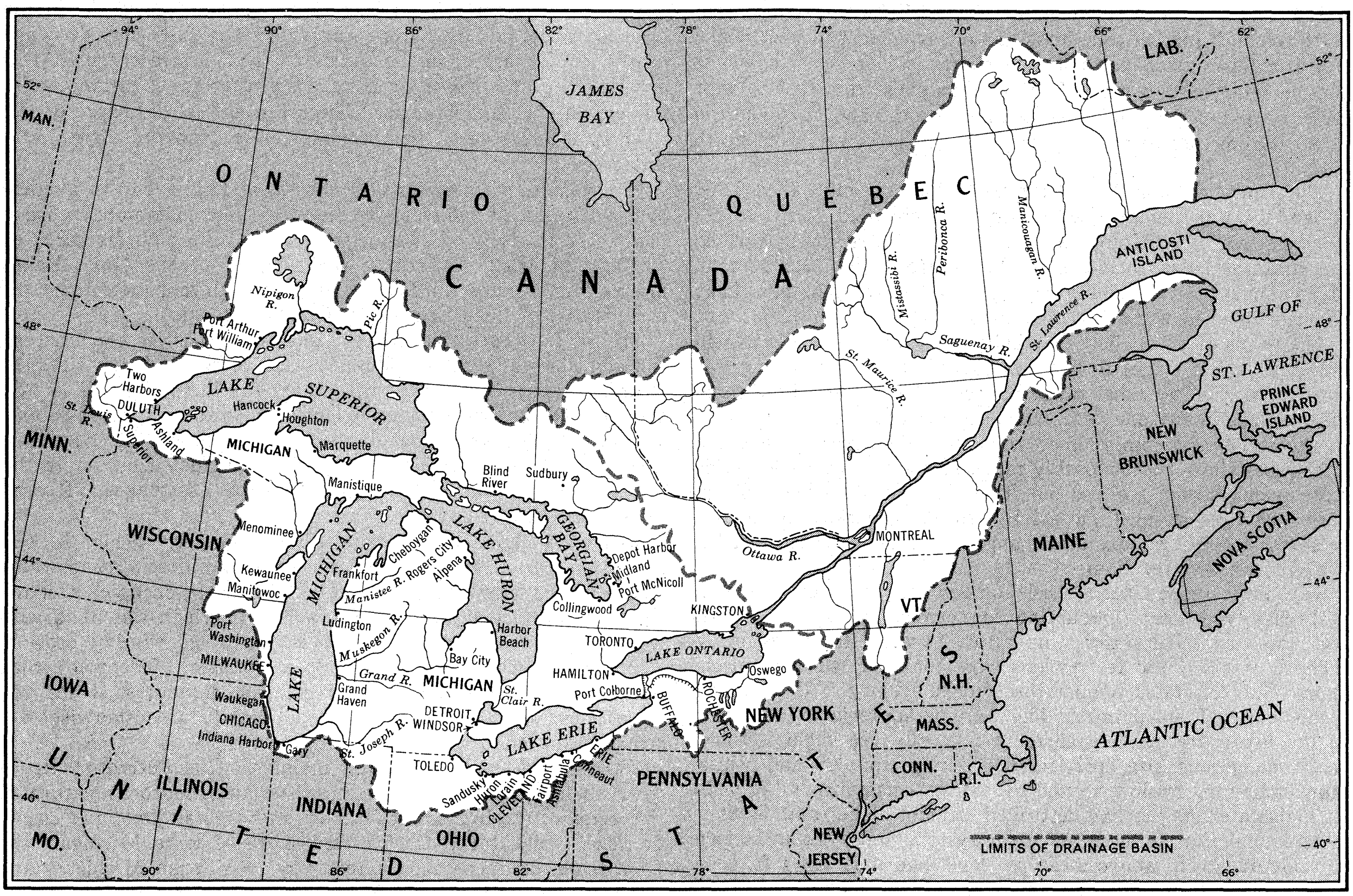
Geology.— Lake Superior lies almost entirely within the Canadian shield, an area of very old (Pre-Cambrian) rocks which generally are hard and dense. The lake basin occupies a structurally downwarped and downfaulted basin which was filled with weaker rocks and then reopened in later geologic time by erosion. The other four Great Lakes lie in a younger (Paleozoic) rock province mainly consisting of limestones, dolomites, shales and sandstones which have been consolidated but otherwise not strongly altered or deformed.

The lake basins are situated mainly in the outcrop belts of weak shale formatidns. The most striking bedrock feature in the region of the four lower lakes is the Niagaran Dolomite cuesta or ridge. which forms the western shore of Lake Michigan, the Door peninsula, separating Green bay from Lake Michigan, and the northern shore of Lake Michigan; extends eastward. forming the islands which separate Lake Huron from the North channel and Georgian bay; curves southeastward to form the Saugeen peninsula between Lake Huron and southern Georgian bay; and, farther southeast, swings eastward south of Lake Ontario. where it forms the escarpment over which the Niagara river drops at Niagara falls. The region, in general, is a lowland of gently rolling hills and ridges separated by plains, swamps and lakes.

There is ample evidence that the Great Lakes did not exist before the Pleistocene (glacial) epoch. The deep lake basins were once broad valleys of trunk streams and their many tributaries, eroded generally in the belts of weaker rock. Several advances of the great continental ice sheets covered the region and further deepened many of the preglacial valleys. When the margin of the last major glacier retreated northward into the lake basins, only about 18,000 years ago, the first known lakes were formed. These were narrow ice-margin lakes which spilled southward over the divides and drained down the Wabash, Ohio, Illinois, Wisconsin and blississippi rivers.

As the ice margin retreated the lakes expanded and coalesced; some of them then drained through new, lower outlets. Re-advances of the ice margin caused several modifications of the glacial lakes. including temporary return of their outflow to the older southern outlets. Further retreat of the ice reopened northern outlets and permitted further enlargement of the lakes. As the ice disappeared from the region, the land. which had been depressed under the weight of the ice. rose slowly and this caused further shifting of outlet channels. Uplift of the land in the northern parts of the region is still in progress, amounting to more than a foot per 100 years. (See PLEISTOCENE EPOCH.)

While bedrock formations constitute the framework of the Great Lakes region and form some of the higher lands, the rocks generally are covered by unconsolidated deposits left by the Pleistocene glaciers. These deposits include gravel, sand and clay of commercial value, and many of the rich soils of this agriculturally important region were formed on some of these deposits. The principal mineral resources which provide the basis for steel pro-



MAP OF THE GREAT LAKES-ST. LAWRENCE REGION

duction in the region are iron ore in the Lake Superior district, coal in Pennsylvania. Ohio and Illinois and limestone suitable for flux, quarried mainly on the shore of Lake Huron near Rogers City, Mich. Limestones and shales, produced in many areas, are the ram materials for the manufacture of cement. Other valuable mineral products of the region are copper irom the Keweenaw peninsula of Lake Superior; nickel, cobalt and uranium from the district north of Lake Huron: and salt irom New York. Pennsylvania, eastern Ohio and Michigan.

Commerce. — Because of the position of the Great Lakes deep in the North American continent and on the boundary between the United States and Canada, their utilization is of great importance. Towns and cities line the shore, no small part of whose gronth and importance is directly associated nith the abundant supply of fresh water available to them. Two of the five cities of the United States with populations of 1.000.000 or more, Chicago and Detroit. and the two largest cities of Canada. Toronto and Montreal, are on the Great Lakes and the St Lawrence river.

Since the international boundary follows the long axes of four of the five Great Lakes, a boundary waters treaty was signed in 1909 which guaranteed the Great Lakes to be free and open to inhabitants of both countries on equal terms and established the principles concerning the use of boundary waters. An international commission of three members from Canada and three from the United States was established, and it is a source of great pride in international relations that there are neither fortifications nor warships along the Great Lakes boundary.

Transportation. — The Great Lakes and their connecting waterways constitute the most important system of inland water transportation in the world. Because of their situation in the interior of a continent which is a producer of heavy commodities, the Great Lakes provide the transportation system for enormous quantities of bulk freight hauled at a rate considerably lower than for other comparable inland systems.

Not far distant from the western and southern shores of Lake Superior, in Minnesota, Wisconsin and the upper peninsula of Michigan: are iron mines which furnish an enormous amount of bulk freight which moves to the iron and steel centres at the southern end of Lake Michigan and south of Lake Erie. Coal from the Appalachian fields southeast of the lakes is an important return commodity from Lake Erie. Wheat from the spring-wheat region of the United States and Canada west of Lake Superior moves down the lakes to the cities on the southern and eastern shores. Stone moves down the lakes from Michigan, and pulp wood and petroleum move up the St. Lawrence.

Lake Michigan, the only lake to interrupt east-west railway and highway traffic; has a well-developed year-around railroad car. automobile and passenger ferry traffic. Eastbound, the railroad cars are loaded with iron and steel goods, wines and liquors and flour. grain. sart-mill and fabricated paper products. Westward. the cars are loaded with coal, building cement, rock, newsprint and steel ingots. blooms, billets, slabs, sheets and bars. (See also INLAND WATER TRANSPORT.)

Carriers. — Since most of the traffic on the Great Lakes consists of heavy, bulky, nonperishable commodities, special boats were designed to carry maximum loads under the specific conditions of the lakes, especialiy the length and depth of the locks in the canals. The characteristic lake bulk carrier, except on Ontario. is long and narrow, with machinery in the stern, the navigating bridge forward and crew quarters both forward and aft, and it has a cargo capacity of about 15,000 tons.

Special port facilities have been developed to accommodate the bulk carriers. At the ore docks on Lake Superior, boats are loaded in a matter of minutes, and special unloaders at the steel mills on Lake Erie and southern Lake Michigan remove the cargo in a few hours.

Overseas Trade. — Chicago, Toronto, Detroit, Cleveland, Milwaukee and Green Bay are leading ports engaged in overseas trade. In dollar value the principal exports are machinery and machine parts, edible animal oils and fats, hides and skins, motor vehicles and vehicle parts, chemicals and tobacco; the principal imports are alcoholic beverages, steel-mill products, electrical and other machinery, motor vehicles, glass and glass products, wood pulp and tools.

Navigation Improvements. — The relatively regular shore lines of the Great Lakes limited the number of harbours. Private interests as well as the governments of the United States and Canada built docks and harbours, dredged channels, dug canals: installed locks and otherwise improved the lakes for navigation. Most of the major lake ports developed at the mouths of the short rivers which flow into the Great Lakes. These ports usually had an inner harbour on the dredged portion of the river and an outer harbour protected by extensive breakwaters constructed of piling, rock and concrete. Coast guard stations and storm warnings, as well as radio communication, protect traffic over the entire Great Lakes.

Although there are about 200 harbours of all types, the important ones are the commercial and industrial cities of the southern Great Lakes and the ore and grain ports of Lake Superior.

Connecting Waterways.—Of critical significance to Great Lakes traffic are the connecting waterways. especially those in which there is a notable change in level irom lake to lake. At Sault Ste. Marie (the "Soo"), passage around the rapids of the St. Marys river, between Lakes Superior and Huron, is provided by canals and locks constructed on both the U.S. and Canadian sides of the river. Lake Michigan, which is connected with Lake Huron by the broad and deep natural channel of the Straits of Mackinac, is also connected with the Illinois and Jlississippi rivers by the Chicago Sanitary and Ship canal, which has a minimum depth of nine feet (see MICHIGAN, LAKE).

In the St. Clair-Detroit river system, connecting Lakes Huron and Erie, improved channels provide a minimum of 25 ft. for downbound vessels and 21 ft. for upbound vessels (*see* SAINT CLAIR RIVER; ST. CLAIR, LAKE). The Welland Ship canal, extending about 27 mi. from Port Colborne, Ont., on Lake Erie, to Port Weller, Ont., on Lake Ontario, provides for transit of vessels between the two lakes. The minimum depth in the canal is 23.5 ft. (see WELLAND SHIP CANAL). A system of canals operated by the state of New York, with federal support, provides free waterway communication between Lake Erie and the Hudson river. Branches of the system connect, with Lake Ontario and Lake Champlain. The minimum depth in the waterway is 12 ft.

From Lake Ontario to the Gulf of St. Lawrence, the St. Lawrence river consists of three segments. The first extends to the mouth of the Ottawa river, a distance of 175 mi., and includes the Thousand Islands, shoals and rapids. The middle segment extends from the mouth of the Ottawa river 95 mi. to the estuary, and the broad estuary is the third segment. Through navigation in the St. Lawrence river is provided by the St. Lawrence seaway development, which was completed in 1959, with a minimum depth of 27 ft. (see ST. LAWRENCE SEAWAY). The canals and channels connecting Lakes Ontario, Erie, Huron and Superior, which had been maintained for several years with a minimum depth of 21 ft. for upbound traffic and aj ft. for downbound traffic, were dredged to 27 ft. following the opening of the seaway.

Timber Resources. — Magnificent stands of timber, principally pine, once covered the upper lakes region, but the virgin forests were destroyed by exploitative cutting between 1870 and 1910. Timber growth is considered the best use for much of the land, and nearly half of the forested area is held in federal and state forests.

Fisheries. — Commercial fishing for iake trout, whitefish, perch, suckers and chub, once an important industry on the lakes. declined seriously after about 1945. The decline was coincident with an invasion of a species of sea lamprey (eel), and measures for control of the lamprey were being undertaken by government agencies in an effort to restore the fish populations of the lakes. (See also FISH CULTURE.)

Pollution. — The use of the lakes for domestic and industrial water supply and for recreational purposes was adversely affected by pollution in some areas. The discharge of sewage, either untreated or inadequately treated, into tributary streams as well as directly into the lakes mas a principal cause of pollution in the more densely populated parts of the region. Various organic and inorganic industrial wastes also were important factors in some areas. Lake Erie. because of its relatively shallow depth and small volume and because of the concentration of population and industrial plants in its watershed, was most heavily polluted. A program of remedial measures, including removal of settleable solids, oxidation of organic matter and reduction of pathogenic bacteria, which was required by law, resulted in a slight decrease in pollution in years of high or normal rainfall. Southern Lake Michigan and some other areas were polluted to a lesser extent, but increasingly effective programs of pollution abatement were needed.

Tourism. — Recreation has developed as an industry of major importance in the region. Cool pleasant summers and numerous lakes in a wilderness setting have attracted tourists and sportsmen. Thousands of vacation cottages have been built along the shores of the Great Lakes and around inland lakes in the region. Vacationists make use of public campgrounds and tourist cabins in the summer, thousands of hunters visit the region during the autumn hunting seasons, and the cold snowy winters attract increasing numbers of winter sports enthusiasts.

For further iniormation on the Great Lakes region, see articles on the various states and provinces bordering the lakes.

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GREAT MOTHER OF THE GODS, the ancient oriental-Greek-Roman deity commonly known as Cybele in Greek and Latin literature from the time of Pindar. She was also known under many other names, some of which were derived from famous places of her worship, for example, Dindymene from Mt. Dindymon.

Cybele is her favourite name in ancient and modern literature, while Great Mother of the Gods, or Great Idaean Mother of the Gods (Muter *Deum* Magna, *Mater* Deum *Magna* Idaea), the most frequently recurring epigraphical title, was her ordinary official designation.

The legends agree in locating the rise of the worship of the Great Mother in Asia Minor, in the region of loosely defined geographical limits which comprised the Phrygian empire of prehistoric times and was more extensive than the Roman province of Phrygia. Her best-known early seats of worship were Mt. Ida, Mt. Sipylus, Cyzicus, Sardis and Pessinus, the last-named city, in Galatia near the borders of Roman. Phrygia, finally becoming the strongest centre of the cult. But the existence of numerous very similar non-Phrygian deities indicates that she was merely the Phrygian form of the nature deity of all Asia Minor. From Asia Minor the cult of the Great Mother spread first to Greek territory. It found its way into Thrace at an early date, was known in Boeotia by Pindar in the 6th century, and entered Attica near the beginning of the 4th century. At Peiraeus, where it probably arrived by way of the Aegean islands, it existed privately .in a fully developed state (that is, accompanied by the worship of Attis [*q.v.*]) at the beginning of the 4th century, and publicly two centuries later. The Greeks irom the first saw in the Great Mother a resemblance to their own Khea, and finally identified the two completely. though the Asiatic peculiarities of the cult were never universally popular with them. In her less Asiatic aspect (*i.e.*, without Attis) she was sometimes identified with Ge and Demeter. It was in this phase that she was worshipped in the Metroon at Athens.

In 204 B.C., in obedience to the Sibylline prophecy which said that whenever an enemy from abroad should make war on Italy he could be expelled and conquered if the Idaean Mother were brought to Rome from Pessinus, the cult of the Great Mother, together with her sacred symbol, a small meteoric stone reputed to have fallen from the heavens, was transferred to Rome and established in a temple on the Palatine (Livy, xxix, 10–14). Her identification by the Romans with Maia, Ops, Rhea, Tellus, and Ceres contributed to the establishment of her worship on a firm footing. By the end of the republic it had attained prominence, and under the empire it became one of the three most important cults in the Roman world, the other two being those of Mithras and Isis. Epigraphic and numismatic evidence prove it to have penetrated from Rome as a centre to the remotest' provinces. During the brief revival of paganism under Eugenius in A.D. 394 occurred the last appearance of the cult in history. Besides the temple on the Palatine, there also existed minor shrines of the Great Mother in the present Piazza S. Pietro, on the Sacra Via on the north slope of the Palatine, near the junction of the Almo and the Tiber rivers, south of the city *(ibid.,* 311–314).

In all her aspects, Roman, Greek and oriental, the Great Mother was characterized by essentially the same qualities. Most prominent among them was her universal motherhood. She mas the great parent of gods and men as well as of the lower orders of creation. Especial emphasis was placed upon her maternity over wild nature. She was called the Mountain Mother; her sanctuaries were almost invariably upon mountains and frequently in caves; lions were her faithful companions. Her especial affinity with wild nature was manifested by the orgiastic character of her worship. Her attendants, the Corybantes, were wild, half-demonic beings. Her priests, the Galli, were eunuchs attired in female garb, with long hair fragrant with ointment. Together with priestesses, they celebrated her rites with wild music and dancing until their frenzied excitement found its culmination in self-scourging, self-laceration or exhaustion. Self-emasculation sometimes accompanied this delirium of worship on the part of candidates for the priesthood.

Though her cult sometimes existed by itself, in its fully developed state the worship of the Great Mother was accompanied by that of Attis (*q.v.*). The cult of Attis never existed independently. There is no positive evidence to prove the existence of the cult publicly in this phase in Greece before the 2nd century B.C., nor in Rome before the empire, though it may have existed in private. The philosophers of the late Roman empire interpreted the Attis legend as symbolizing the relations of Mother Earth to her children the fruits. In this interpretation they were not far wrong, for Cybele and all her kind are embodiments of the earth's fertility.

At Rome the immediate direction of the cult of the Great Mother devolved upon the high priest, Archigallus, called Attis, a high priestess, Sacerdos Maxima, and its support was derived, at least in part, from a popular contribution, the *slips*. Besides other priests, priestesses and minor officials, such as musicians, curator, etc., there were certain colleges connected with the administration of the cult, called *cannophori* (reed bearers) and *dendrophori* (branch bearers). The quindecimvirs exercised a general supervision over this as over all other authorized foreign cults. Roman citizens were at first forbidden to take part in its ceremonies, and the ban was not removed until the time of the empire.

The main public event in the worship of the Great Mother was the annual festival, which took place originally April 4, and was followed next day by the *megalesia*, games instituted in her honour on the introduction of the cult. Under the empire, from Claudius on, the *megalesia* lasted six days, April 4 to 10. and the original one day of the religious festival became an annual cycle of festivals extending from March 15 to 27, in the following order: (1) March 15, *Canna intrat,* the sacrifice of a six-year-old bull, the high priest, a priestess and the *cannophori* officiating, the last named carrying reeds in procession in commemoration of the exposure of the infant Attis on the reedy banks of the stream Gallus in Phrygia. (2) March 22. *Arbor intrat*, the bearing in procession of the sacred pine, emblem of Attis' self-mutilation, death and immortality, to the temple on the Palatine, the symbol of the Mother's cave, by the *dendrophori*, a guild of workmen who made the Mother. among other deities. a patron. (3) March 24, *Dies sanguinis*, a day of mourning. fasting and abstinence, especially sexual. commemorating the sorrow of the Mother for Attis. The frenzied dance and self-laceration of the priests and the self-mutilation of neophytes were special features of the day. The *taurobolium* (*q.v.*) was often performed on this day, on which probably took place the initiation of mystics. (See also CRIOBOLIUM.) (4) March 25, *Hilaria*. All mourning was put off. and good cheer reigned in token of the return of the sun and spring, which was symbolized by the renewal of Attis' life. (5) March 26, *Requietio*, a day of rest and quiet. (6) March 27, *Lavatia*, the crowning ceremony of the cycle. The silver statue of the goddess, with the sacred meteoric stone, the *acus,* set in its head, was borne in gorgeous procession and bathed in the Almo, the remainder of the day being given up to rejoicing and entertainment, especially dramatic representation of the legend of the deities of the day.

The Great Mother is especially prominent in the art of the empire. No work of the first class, however, was inspired by her. She appears usually with mural crown and veil, well draped, seated on a throne and accompanied by two lions. Other attributes which often appear are the patera, tympanum, cymbals, sceptre, garlands and fruits. Attis and his attributes, the pine, Phrygian cap, pedum, syrinx and torch, also appear. In literature she is the subject of frequent mention, but no surviving work of importance, with the exception of Catullus lxiii, is attributable to her inspiration. Her importance in the history of religion is very great, for her cult, like the other mystic worships, at once formed a rival to Christianity and acted as a steppingstone to it. *(See* MYSTERY.)

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GREAT PLAINS. A major flattish land-form area in North America extending from the Mackenzie river lowlands in northern Canada to the Rio Grande in the Big Bend section of Texas, the Great Plains lie directly east of the Rocky mountains and, in New Mexico, of the Basin and Range province. In general, they are about 375 mi. wide and slope gently to the east, where they merge with the central lowlands and the coastal plains.

The eastern border of the Great Plains is readily discernible in only a few places. In Texas the Balcones escarpment, west of Austin, rising to heights of 300 to 1,000 ft., provides a clear break between the Great Plains (there also referred to as High Plains and Edward's plateau) and the coastal plains. A somewhat more subdued escarpment is found in the Coteau du Missouri in North Dakota. Between these two escarpments the eastern border is usually associated with either the 1,500- or the 2,000-ft. contour line. In the United States, these lines lie close to the 97th to 100th meridians, which are also frequently mentioned as border lines.

Below the mountain front on the west the Great Plains have an elevation of 5,000 to 6,000 ft. All major rivers have west-east axes and an average gradient of about ten feet per mile. Prominent streams are the North and South Saskatchewan, Milk. Missouri, Yellowstone, Powder, Little Missouri, Cheyenne, White, Niobrara, Platte, Republican, Kansas, Cimarron, Arkansas, Canadian, Red, Brazos and Colorado rivers.

Much of the plains area consists of gently tilted shale, limestone and sandstone discontinuously mantled by glacial deposits (in the north), loess and alluvial deposits. Although the plains are generally pictured as flat to rolling, conspicuous land forms characterize some of their parts. Among these are the Black hills of South Dakota and Wyoming, the badlands of South Dakota, the sand hills of Nebraska and a series of mountain outliers in Montana and elsewhere. Locally, cuestas, hogbacks, breaks and mesas are sculptured in the sedimentary bedrocks.

Because of limited precipitation, ranging from 10 to about 20 in. a year, grass is the prevailing natural vegetation. Short grass or steppe prevails in the southern plains whereas the cooler temperatures and more effective precipitation in the northern plains support intermediate and tail grasses. In central Alberta and

Saskatchewan the limited but effective moisture also supports broadleaf and mixed broadleaf coniferous forests. Moderate precipitation has meant limited leaching and the soils are usually of superior productivity when supplied with moisture.

Population in the plains area is relatively sparse. It is supported largely by grazing of livestock, dry farming of wheat and the production of sorghums and cotton. Farming under irrigation is expanding. Parts of the plains are well endowed with coal and lignite, petroleum and natural gas.

See Nevin *M.* Fenneman, *Physiography of Western United States* (1931); **W.P.** Webb, *Great Plains* **(1936)**. (W. M. Kn.)

GREAT RIFT VALLEY, a part of the most extensive rift on the earth's surface extending over 50 degrees of latitude from the Jordan valley in southwest Asia to the Shiré tributary of the Zambezi in east Africa. In Africa it is marked by a line of narrow, deep and steep-sided lakes, including Rudolf, Magadi, Natron and Nyasa, by associated volcanic outpourings such as mounts Kilimanjaro (19,340 ft.) and Kenya (17,058 ft.), and in places by steep edges like the Mau and Kikuyu escarpments. A western branch of the Rift valley. extending in a great arc from the northern end of Lake Nyasa, is occupied by Lakes Tanganyika, Rivu, Edward and Albert. See also the Physical Geography sections of AFRICA; KENYA; TANGANYIKA. (R. W. SL.)

GREAT SALT LAKE, in northwestern Utah, U.S.a large body of shallow, briny water, is the most extensive lake of its kind in the western hemisphere and the largest remnant of a Pleistocene lake which overspread the eastern part of the Great Basin (see UTAH). About 83 mi. long and 51 mi. wide, the lake has varied in area—from about 2,200 sq.mi. at a high level in 1873 to 1,500 sq.mi. at a low level in 1940. With an average depth of 10 ft., it had a maximum depth at mid-20th century of 35 ft. and a mean elevation of 4,199 ft. above sea level; it was then a foot lower than at mid-19th century and 12 ft. under the level of 1873.

The salts held in solution are principally sodium chloride and sodium sulfate; after mid-20th century the salinity remained close to 25%, slightly under the point at which salts begin to precipitate.

Few things can live in this saturated salt solution (maintained by evaporation in the face of continued inflow from the Bear, Weber and Jordan rivers). There are some algae, a few flagellates. protozoans and invertebrates, a small brine shrimp and two brine flies. Thousands of tons of salt have been harvested without perceptibly reducing the supply. Stansbury, Antelope arid Fremont islands are used for grazing purposes, the first two being connected with the mainland when the lake is low. Smaller islands and islets are used as nesting sites by white pelicans, great blue herons, cormorants, terns and gulls. A federal migratory bird refuge was established in 1928 at the mouth of the Bear river. Father Silvestre Vélez de Escalante and Francisco Dominguez referred to the Great Salt Lake as early as 1776, though they had not seen it, and for many decades it was reflected on maps of America as a half-legendary body of water, usually named Timpanogos or Buenaventura.

The lake seemingly mas independently discovered in 1824–25 by two trappers, James Bridger and Étienne Provost, and by 1826 other hunters had circumnavigated it. The first formal exploration. by John Charles Frémont in 1843 and 1845, was followed by Howard Stansbury's survey in 1850. The Lucin Cutoff (30 mi. of railway trestlework and fill), constructed across the lake by the Southern Pacific railroad, 1902–03, was replaced in 1957–60 by a dike built at an estimated expense of $49,000,000. There is a yacht harbour at the southeastern shore of the lake, with popular beaches nearby.

See James *E.* Talmage, *The Great Salt Lake, Present and Past* (1900) and Dale L. Morgan, *The Great Salt Lake* (1947). (D. L. M.)

GREAT SLAVE LAKE (ATHAPUSCOW), in Mackenzie district, Northwest Territories, Can., between latitude 60° 50′ and 63° 10′ N. and longitude 108° 50′ and 117° W. and j16 ft. above the sea, is about 298 mi. long, 62 mi. wide and 11,170 sq.mi. in area; it drains by the Mackenzie river into the Arctic ocean. The water is very clear and deep. The shore is indented by large bays, often with rocky slopes that form rugged cliffs fronting East Arm. The western shores are well wooded; the northern and eastern shores are largely barren.

The navigation season is from about mid-June to mid-October, the lake freezing over in winter.

The English explorer Samuel Hearne discovered the lake in 1771. Gold is produced in the Yellowknife and Rae areas. An inland fishing industry (whitefish, trout) was established in 1945 with packing plants at Gros Cap and Hay River. (J. R. M.)

GREAT SMOKY MOUNTAINS. In western North Carolina and eastern Tennessee, U.S., between Asheville and Knoxville, the Great Smoky mountains are the western segment of the high crystalline Appalachians and blend into the Blue Ridge escarpment on the east. The blue smoky haze that covers the region gave the mountains their name.

Originally the domain of the Cherokees, the Smoky mountains were explored in the mid-19th century by the geologists Thomas L. Clingman and Arnold Guyot. The highest segment of the mountains is occupied by the Great Smoky Mountains National park (*q.v.*), which extends 54 mi. between the Little Tennessee river on the southwest and the Pigeon river on the northeast, and is zpproximately 20 mi. wide. Highest peaks in the park area are Clingmans Dome (6.642 ft.), Mt. Guyot (6,621 ft.), Mt. Chapman (6,430 ft.), Mt. Collins (6,188 ft.), Mt. LeConte (6,593 ft.) and Mt. Kephart (6,150 ft.). The mountains are covered by forests, about 40% of which is virgin growth. There is an abundance of rhododendron, mountain laurel, wild flowers and animal life. Gatlinburg. Tenn., serves as park headquarters and offers a wide range of accommodations and services for tourists. A transmountain highway runs from Gatlinburg through Newfound Gap (5,048 ft.) to Cherokee, N.C., which is the site of a Cherokee Indian reservation. (M. C. P.)

GREAT SMOKY MOUNTAINS NATIONAL PARK, in eastern Tennessee and western North Carolina, was established in 1940 to preserve the last remaining sizable area of southern primeval hardwood forest in the United States. The park, 511.678 ac. in extent, contains some of the highest mountains east of the Mississippi river, with Clingmans Dome (6,642 ft.) the tallest in the park.

Summits and ridges are crowned with a forest of red spruce except where open areas—balds—occur. Some of these are grown with rhododendrons (R. catawbiense), which display large purple-pink blooms in the early summer. The forests on lower slopes, traversed by rushing streams, are composed of such trees as hemlocks, silver bell, black cherry, buckeye, yellow birch and tulip tree, the latter sometimes attaining trunk diameters of six feet and larger. Understory trees on lower slopes and in the valleys are flowering dognood, redbud and serviceberry; dense stands of mountain laurel, several species of brilliant-flowered azalea and the white-blossomed rhododendron (R. maximum) form almost impenetrable thickets. Wild flowers of many kinds are abundant in the spring and summer.

A few of the park's more important species of wildlife are black bears, white-tailed deer, foxes, bobcats, raccoons, ruffed grouse, turkeys and many colourful songbirds and insectivorous birds, the latter occurring in greatest numbers while migrating northward in spring.

During pioneer times, many families settled in the sheltered coves and valleys of the area, and a number of their picturesque, primitive farmhouses, barns and a mill are preserved in the park. Cades Cove contains such an exhibit, and there a number of families remain and continue to farm in harmony with certain National Park service regulations. (Dx. B.)

GREAT TREK is the name given to a migration of the Boers from British jurisdiction in south Africa (*see* SOUTH AFRICA, UNION OF: *History*). About 12,000 voortrekkers and their families left Cape Colony between 1835 and 1843.

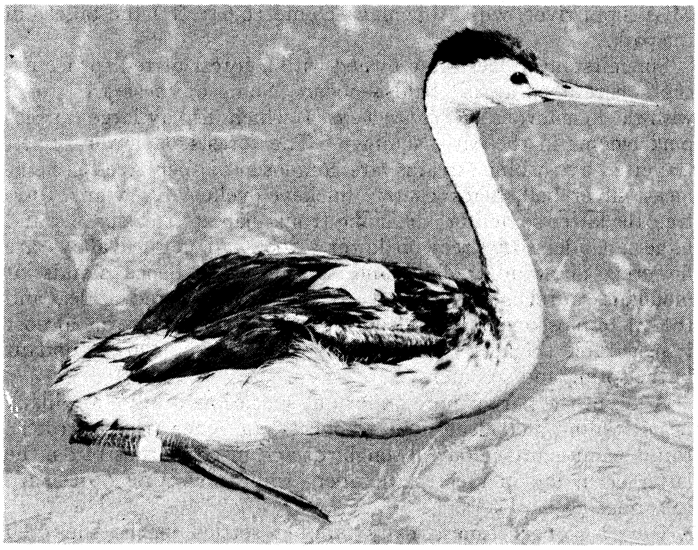
Most of them settled in Natal, but when it was annexed by Great Britain in 1843 many moved across the Orange river and founded the Orange Free State (see ORANGE FREE STATE: *History*) and the Transvaal (see TRANSVAAL: *History*). Both oi these later became Boer republics.

GREAT WALL OF CHINA, a defensive fortification extending about 1,500 mi. from the Gulf of Chihli of the Yellow sea to the gates of central Asia, is the greatest building enterprise ever undertaken by man. Walled frontiers between kingdoms in China date from at least the 4th century B.C., developing from the siege warfare of a people who lived in walled cities. In the 3rd century B.C. the "first emperor of Ch'in"—Ch'in Shih Huang Ti—after uniting China, linked up some already existing walls and built new sections to create the Great Wall, defending China from the Hsiung-nu or Huns on the north. It was built of earth and stone, and its eastern sections were faced with bricks. The Great Wall was frequently modified in later centuries. The sections built in the 15th and 16th centuries—which took in less territory than the "original" Great Wall—were about 30 ft. high and wide enough on top ior a column of troops. Towers about 40 it. high were built at intervals of 200 yd. Not all the outlying walls in Mongolia have been fully traced, mapped and identified as to date. See also CHINESE ARCHITECTURE. (O. L.)

GREAT WAR, THE, 1914–1918: see WORLD WAR I.

GREBE, an aquatic diving bird of the family Podicipedidae, order Podicipediformes, containing several genera including *Podiceps* and *Aechmophorus*. The grebes are generally considered to be among the most primitive living families of birds. As a rule they are weak though fairly rapid fliers. Grebes are distinguished by the rudimentary tail. legs placed far back on the body, flattened shank and elongated toes furnished with broad lobes of skin in lieu of webs, bodily characteristics of adaptive importance to these divers. Although grebes are excellent swimmers. found on coastal and inland waters throughout the world, they are almost helpless on land and take to wing reluctantly. All species have short and close plumage usually some shade of brownish gray above. often reddish markings, white and glossy below.

Most species develop special nuptial adornments in the spring in both sexes, in the form of crests or tufts. and very remarkable mutual courtship ceremonies have been described (*see* COURTSHIP, ANIMAL). In some species, as the great crested grebes (Podiceps



A. WETMORE, U.S. FISH AND WILDLIFE SERVICE

FEMALE WESTERN GREBE (AECHMOPHORUS OCCIDENTALIS) WITH CHICK ON HER BACK

cristatus), this involves the partners facing each other, standing practically erect on the surface of the water. bowing, then dropping to a more horizontal position, and occasionally skittering over the water as if they were walking on the surface.

The nest, usually built among tangled vegetation in shallow waters, consists of a mass of water weeds, in a shallow tray on which the chalky white eggs are laid. The parent covers the eggs before leaving the nest, so that the moist covering, besides screening the eggs from view, provides warmth as a result of its decay. The downy youth, striped black, white and bronn, are often carried about on the parent's back, and if danger threatens, the adult tucks the young under its wings and dives with them.

Of the five European species, P. *ruficollis* is the well-known little grebe or dabchick (*q.v.*), with a wide range over the old world. The great crested grebe (Podiceps *cristatus*) is also a wide-ranging species. The subarctic red-necked grebe (P. *grisegena*) inhabits Europe and America, as does the horned or Slavonian grebe (P. *auritus*). Various other species inhabit North America, among which may be mentioned the western grebe (*Aechmophorus occidentalis*), with a long slender neck and black and white plumage; and the pied-billed grebe (*Podilymbus* podiceps), the best-known grebe in America.

Several more are found in South America, of which the most remarkable is the flightless *Centropelma micropterum* of Lake Titicaca. The common-eared grebe (Podiceps *nigricollis*) breeds over Africa, Europe, northern Asia and western parts of Canada and the United States; four other species of Podiceps occur from Peru to the Falklands and Straits of Magellan. The Mexican grebe (*Podiceps dominicus*), of tropical South and Central America, is a small bird reaching the West Indies and southern Texas; four other species occur in Australia, New Zealand, Malaya and Madagascar. *Podilymbus gigas* is confined to Lake Xtitlan. Guatemala. while *A. major* ranges from Peru and northern Brazil to the Straits of Magellan. (G. F. SS.; HT. FN.)

GREBEL, CONRAD (1498?–1526), Swiss religious leader, the chief founder of Swiss-South German Anabaptism and thus of the Free Church type of Protestantism, was born in Zurich, the son of Junker Jakob Grebel of a prominent patrician family. He received a good humanist education at the universities of Basel, Vienna and Paris, but completed no degree. Returning to Zurich in 1520, he soon became an ardent supporter and associate of Huldreich Zwingli (*q.v.*) in the Swiss Reformation, only to break with him in late 1524 on the issue of the establishment of a free church, separated from the state.

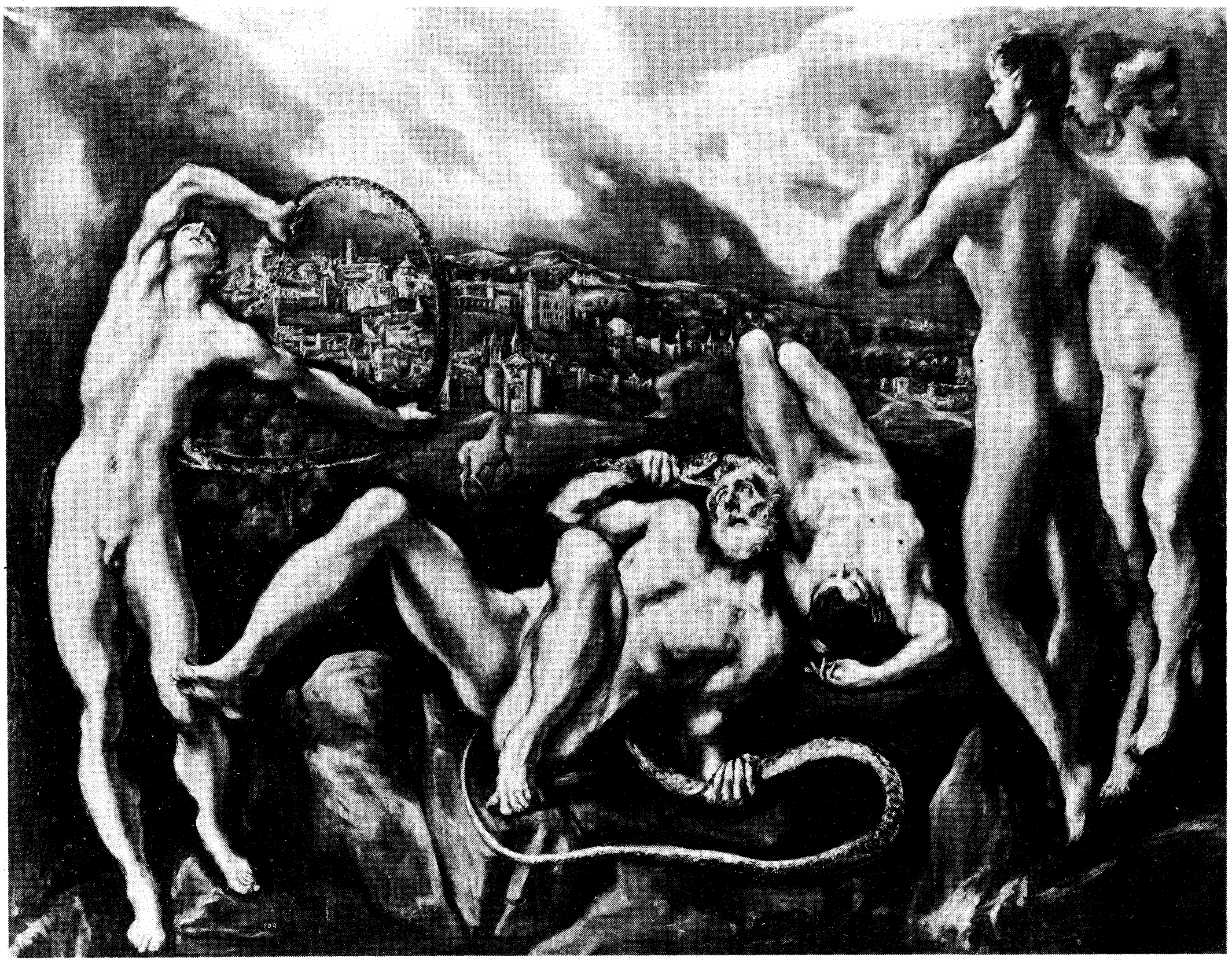
In association with Felix Manz and George Blaurock, Grebel started such a church on Jan. 21, 1525, by performing the first adult baptism in modern history. The group was immediately plunged Into persecution, and Grebel lived a harried life until his death of the plague in 1526 in Maienfeld, Grisons canton. He was imprisoned twice in Zurich for a total of at least six months. He left no writings, but 69 of his letters are preserved in St. Gall. Grebel's major emphases were on the voluntary believers' church, Christian discipleship and holy living, and an ethic of love which included rejection of all warfare. See also ANABAPTISTS.

See Harold S. Bender, *Conrad Grebel ca. 1498–1526, The Founder of the Swiss Brethren, sometimes called Anabaptists* (1950). (HD. S. B.)

GRECHANINOV, ALEKSANDR TIKHONOVICH (1864–1956), Russian composer notable for his religious music and music for children, was born in Moscow on Oct. 25, 1864. From 1881 to 1890 he studied the piano with V. I. Safonov and composition with S. I. Taneev and A. S. Arensky at the Moscow conservatory; from 1890 to 1893 he worked at composition and orchestration at St. Petersburg with Rimski-Korsakov. He soon became known by his songs, his first string quartet (1893) and the first of his five symphonies (1894). His opera Dobrinya *Nikitich* was produced in Moscow in 1903. (The later Soeur Beatrice was produced in 1912 but had to be withdrawn at once on religious grounds.) He composed in all media, producing a great quantity of piano music, songs and choruses, but his music lacks any strong personal stamp. His church music brought him an imperial pension, though his later religious music (from 1912 onward) introduces instruments and cannot be used in the Orthodox liturgy. With the 1917 Revolution he lost his pension and, after several visits to the west, he settled in Paris in 1925. There he published an autobiography. In 1940 he fled to New York, where he died—a U.S. citizen—on Jan. 3, 1956.

See A. Grechaninov, *My Life,* trans. by Nicolas Slonimsky (1952). (G. AB.)

GRECO, EL (1541–1614), properly called DOMENIKOS THEOTOKOPOULOS, one of the greatest and most individual masters of Spanish painting, was born in Crete and trained in Italy. He spent



BY COURTESY OF THE NATIONAL GALLERY OF ART WASHINGTON, D C

"LAOCOÖN" BY EL GRECO. IN THE SAMUEL KRESS COLLECTION, NATIONAL GALLERY OF ART, WASHINGTON, D.C.

the second half of his life in Spain and is known as a Spanish painter. In Italy he was called Il Greco, in Spain Domenico Greco or El Griego, but he is now generally referred to as El Greco. Nothing is known of his early life in Crete, then under Venetian domination, but some of his works suggest that his first schooling was in the Byzantine style of icon painting. The form of the small signed polyptich (Modena gallery, Italy), the vivid colours and the scene of "Moses on Mount Sinai" are of Byzantine origin, while most of the other compositions are derived from Venetian models. There is no evidence of when El Greco went from Crete to Italy but it can be assumed that he was in Venice studying under the aged Titian some time before 1570, when he moved to Rome; for there can be no doubt that he is the artist recommended by the miniature painter Giulio Clovio in a letter of 1570 to Cardinal Alessandro Farnese: "There has arrived in Rome a young man from Candia, a pupil of Titian, who seems to my judgment to have a rare gift for painting. . . ." There is a signed portrait of Clovio by El Greco (Naples museum); he introduced this portrait together with those of Titian, Michelangelo and Raphael, three of the masters to whom he was indebted, in one of his paintings of the "Purification of the Temple" (Minneapolis, Minn.). These and other works executed in Italy are mainly Venetian in style and colour but show a variety of sources. He was influenced by Tintoretto, Paolo Veronese and Jacopo Bassano as well as Titian; in Rome he borrowed from Raphael and Michelangelo and was also affected by the prevailing Mannerist styles.

It is not known why or when El Greco left Italy for Spain; when questioned later in Toledo he refused to reply. Mancini, writing a few years after his death, relates that when it was proposed to repaint some of the nude figures in Michelangelo's "Last Judgment," El Greco's announcement that if the whole painting were demolished he could replace it with one that mould be "decorous and seemly and no worse as a work of art" caused such indignation that he was obliged to leave Rome and retire to Spain. It is. however, probable that he went there with the prospect or hope of employment by Philip II in the decoration of his new palace monastery of the Escorial.

He was first recorded in Spain in Aug. 1577, the date of his contract for altarpieces in S. Domingo el Antiguo, Toledo; there is evidence that he had already been in Madrid. He seems to have made only two paintings for the king, one of which may have been painted before he went to Toledo. The "Adoration of the Name of Jesus" (Escorial; model in the National gallery, London), traditionally called the "Dream of Philip II," has been identified as an allegory of the Holy league, with portraits of Philip II, the pope and the doge of Venice; and though on a much larger scale, this painting is not far removed in style from his later Italian paintings.

The "St. Maurice and the Theban Legion" (Escorial) was commissioned in 1580 for the church of the Escorial, but was rejected for the altar for which it mas painted because it did not please the king.

El Greco appears to have made no further attempt to obtain royal patronage and settled for the rest of his life in Toledo. He was extremely active as a religious artist, whose paintings were much sought by churches and convents. He also painted a number of portraits of church dignitaries and other distinguished persons; his few landscapes and genre compositions and one surviving mythological representation are among the first examples of these subjects in Spanish painting.

In Spain he was known as an architect and sculptor as well as a painter and he designed, if he did not execute, some of the carved altarpieces and their sculptures for which he made the paintings.

It was only after his move to Spain that El Greco developed that highly individual style for which he is famous. Most of his paintings produced in Italy have later been attributed to Tintoretto, Veronese and other Italian artists but his Spanish paintings have never been ascribed to anyone else. Though the transformation of his Italian sources was a gradual process, his early works in Toledo were already distinctive in character. In the "Espolio," which he painted for the cathedral soon after his arrival (1577–79), the elimination of space and dramatic concentration on the figures create a new, highly emotional effect. This painting involved him in a lawsuit concerning the price, in which he was ordered to correct certain "improprieties" in his treatment of the subject, though this was never done.

The "Burial of Count Orgaz," executed in 1586 for the church of S. Tomé, his first entirely independent work, established his fame in Toledo and is still his most celebrated painting. Here all the elements of his Spanish style appear in a composition for which there is no Italian iconographic precedent. The subject is the legend of a local Toledan nobleman of the 14th century who was rewarded for his pious deeds by the miraculous appearance of SS. Stephen and Lawrence to carry his body to burial, in the presence of all the noblemen of the city. The miracle itself is represented in the lower half of the picture in comparatively realistic terms. The frieze of noblemen which forms the background to the burial, the saints and other attendants, have the appearance of individual though stylized portraits, their faces expressing various emotions from contemplation to rapture. Above, the scene in heaven, to which the count's soul is borne by an angel, is in an entirely different language. The elongated figures with floating draperies, grouped in exaggerated postures amid fantastic clouds, the violently contrasting colours and dramatic lighting emphasize the visionary character of the spiritual world.

Later El Greco was to adopt this language for his representations of holy persons on earth as well as in heaven.

His portraiture shows a gradual development from the formal likenesses of his Italian period to an increasingly subjective interpretation. In a number of simple busts and half-length figures (many in the Prado, Madrid), the facial expressions give vivid impressions of personality and temperament. This etiect is in no way diminished by increasing disregard for natural form and conventional modeling. On the contrary, in his late portraits of Cardinal Fernando Niño de Guevara (*c.* 1600, Metropolitan museum, New York) and Fray Hortensio Félix Paravicino (*c.* 1606, Boston)—seated figures in the Renaissance tradition—he achieves his most remarkable effects of likeness with hardly any indication of the structure of the bodies and with a free impressionistic technique that eliminates detailed description.

For his devotional subjects El Greco created types that he hardly ever varied, but his interpretation changed with the development of his style. Thus, several examples of the "Purification of the Temple" (*e.g.,* National gallery, London), based on his Italian compositions of the subject, illustrate the transition from narrative description to symbolical interpretation. His representations of saints, St. Francis in meditation and ecstasy, the repentant St. Peter, St. Mary Magdalene and St. Jerome—like the "Purification" themes of special doctrinal importance to the Counter-Reformation church—become transformed into visionary figures. Rocks, caves or clouds provide mysterious settings and the exaggeration of postures, gestures and facial expressions accentuates the spiritual meaning of the image. The number of replicas of these subjects that exist from his own hand and from his studio shows that they must have enjoyed great popularity.

The painter Francisco Pacheco, who represented the orthodoxy of his time in matters of decorum and aesthetics, proclaimed El Greco to be the best painter of St. Francis of his age.

Among the major accomplishments of his late years was the decoration of the Capilla Mayor of the Hospital de la Caridad at Illescas, dedicated to a miraculous image of the Virgin, for which he designed the altars and probably executed the sculptures as well as the paintings (1603–04, no longer intact). The co-ordination of architecture, sculpture and painting and the unity of subject matter in a composition intended to be seen from a single viewpoint foreshadow principles of Baroque design. In his last paintings, the complete harmony of form and content creates an emotional impact hardly surpassed by later Baroque artists. The distorted bodies in twisted, strained attitudes, seen against the spectral background of Toledo, give direct expression to the physical and mental torment of "Laocoön" (National gallery, Washington, D.C.). The long attenuated figures, whose upward swirling movement is directed by the arbitrary and dramatic lighting, create an impression of a miraculous apparition of the "Assumption of the Virgin" (S. Vicente, Toledo); and the "Opening of the Fifth Seal" (Zumaya, Sp.), in similarly unrealistic language, powerfully evokes the mystic spirit of the ecstatic figure of St. John and of his apocalyptic vision.

The extraordinary originality of El Greco's Spanish style made his paintings a subject of dispute from the beginning. He failed to satisfy the conventional taste of Philip II, whose court painters were mediocre and moderate followers of Italian Mannerism. Yet he won considerable renown in Toledo both as an artist and as a remarkable if strange personality. At the same time he was involved in several lawsuits concerning the orthodoxy of his paintings, and the prices that he demanded. The conventional Pacheco, who visited him in Toledo a few years before his death, described him as "singular in everything as he was in his painting." Shocked by El Greco's opinions on art, particularly his statement that "Michelangelo was a good man who did not know how to paint," Pacheco had to admit that El Greco could not be excluded from the ranks of the great artists. Since his death various legends have been invoked to explain the so-called extravagance of El Greco's style, including a popular local legend that he was mad; in modern times attempts have even been made to prove that he suffered from astigmatism. But this extravagance had its roots in his Greek origin and Italian training, and his development from a minor Greco-Italian painter into one of the greatest artists that Spain has ever known must be attributed to the impact on him of his new environment. The exotic atmosphere of Toledo: a centre of intellectual and religious life, must have been particularly congenial to his own eccentric personality, and his "View of Toledo" (Metropolitan museum, New York) in his late "visionary" style hardly exaggerates the extraordinary appearance of the city. His isolation there from the artistic activities at the court and from modern trends in Italy must also have contributed to his highly original formal development, and the lack of new models as well as Byzantine traditionalism would account for his frequent repetitions of compositions; figures and rhetorical gestures.

Above all, however, his Spanish paintings reflect the atmosphere of fanatical religious zeal in his adopted country and they are particularly close in spirit and expression to the writings of the great Spanish mystics like St. John of the Cross, who was in Toledo when El Greco settled there.

El Greco had a few pupils and assistants, but his style was too personal to be communicated to followers and he remained an isolated figure. Until the end of the 19th century his paintings were practically unknown outside Spain. Since then they have provided a stimulus to many modern painters and El Greco is recognized as one of the world's great artists.

See PAINTING: *Spain.*

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(E. Hs.)

GRECO-TURKISH WAR (1921–22). The origin of the Greco-Turkish War of 1921–22 was the treaty of Sèvres (Aug. 10, 1920), by which among other provisions the Allied powers awarded to Greece eastern Thrace up to the Catalca (Chatalja) line and including Gallipoli, together with the district of Smyrna (Izmir).

On May 12, 1919, the Greeks had already been authorized by the Allied Supreme council to land at Smyrna. In June 1920 the Greeks occupied Bursa and Bandirma on the Sea of Marmara; in October they mere at Yenisehir and Inegol, east of Bursa. Turkey, however, refused to ratify the treaty of Sèvres and from the opposition to it emerged the national revival under Mustafa Kemal Pasha (see MUSTAFA KEMAL ATATÜRK). The situation was complicated by the fact that the Greek elections of Nov 14, 1920. which followed the death of King Alexander returned a royalist majority and led to the withdrawal of Eleutherios Venizelos from politics. On Dec. 20, King Alexander's father, Ring Constantine, who had been forced to vacate his throne by the Allies on June 12, 1917, on account of his pro-German policy, was restored as the result of a plebiscite. His advent to power brought about some disorganization in the Greek army on account of the dismissal of Venizelist officers: the Greek commanders in Turkey, Gen. Anastasios Papoulas and his successor, Gen. Georgios Hadjanestis, owed their positions to their political allegiance rather than to their military capacity. In Jan. 1921 a poorly equipped Greek army started an offensive into Anatolia and took the two railway junctions of Afyon (Afyonkarahisar) and Eskisehir, but was forced to withdraw in April as a result of a Turkish victory.

In July 1921 the Greeks resumed their offensive in order to forestall a Turkish attack. Afyon and Eskisehir were retaken and the Greek advance pressed forward in the direction of Ankara, but it was severely checked by Kemal in September on the Sakarya river, from which the Greeks were obliged to withdraw.

Great Britain and France, meanwhile, showed little unity of policy. The British prime minister, David Lloyd George, favoured the Greeks; but he was greatly hampered by the danger of repercussions in Muslim countries nhere British interests could be affected if too great a measure of support were given to the Greeks. France. on the other hand, was in favour of a compromise with the Turks. On Oct. 20, 1921, France gave up the intention of occupying Cilicia, retaining only the sanjak of Alexandretta (Iskenderun). France. moreover, undertook to supply Turkey with arms. Such sympathy as France had for Greece was weakened when in Jan. 1922 Aristide Briand's government fell and mas succeeded by that of Raymond Poincaré.

The Paris inter-Allied conference recommended on March 24, 1922, an armistice between the two parties. but the Turks under Kemal demanded the total evacuation of Anatolia On Aug 26. 1922, the Turks achieved a great victory at Afyon which compelled the Greek army to withdraw in disorder On Sept. 9, 1922, the Turkish army recaptured Smyrna, where a large part of the Greek population was massacred The Kemalist army was then free to march to the Bosporus, where the French authorities refused to offer resistance to their entry into Istanbul and the British authorities were compelled to follow the French example The armistice of Mudanya, concluded on Oct. 11, 1922, admitted Turkish troops into Istanbul and made provision for renewed peace discussions at Lausanne betneen Turkey and the Allies

The results of the campaign mere important for Greece. A body of officers on the island of Chios led by Col. Nikolaos Plastiras, demanded that Constantine abdicate. Ironically Constantine, forced to abdicate in 1917 under Allied pressure, was now compelied to give nay to his son, George II for having undertaken action with the encouragement of the Allies. On Nov. 28, 1922, the responsible Greek ministers, Dimitrios Gounaris, Petros Protopapadakis, Nikolaos Stratos, Georgios Baliatzis, Nikolaos Theotokis and Hadjanestis, were sentenced to death and executed despite British and French warnings. For Turkey the campaign ended more happily. After protracted negotiations the treaty of Lausanne was signed on July 24. 1923. Greece had to give up eastern Thrace and accept the Maritsa (Evros) river as its eastern frontier, while Turkey obtained Imbros and Tenedos. To some extent future causes of Greco-Turkish friction were removed by the transference of Greek and Turkish minorities to their respective homelands. The sultanate having been abolished on Nov. 1, 1922, Kemal's regime began with the prestige of a great military victory. In Great Britain, Lloyd George's anti-Turkish policy produced a crisis, since it was likely to have repercussions in Muslim areas of the empire and to be criticized by the self-governing dominions, uhom he had not consulted. On Oct. 19, 1922. the Conservative party decided to break the coalition formed in 1918.

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GREECE (Greek Ἑλλάς), a country of southern Europe, comprising the southern peninsular projection of the Balkans, the northern foreshore of the Aegean as far east as the Maritsa river and, except for Imbros and Tenedos, all the main islands of the Aegean, including Crete and (from 1947) the Dodecanese.

PHYSICAL FEATURES

Geology.—Structurally, Greece forms part of the system of folded mountains, thrown up in the Tertiary period, which crosses the old world from the western Mediterranean to the East Indies. In the Balkans these fold ranges consist mainly of sedimentary limestones which were crushed against a resistant central nucleus of hard crystalline rocks, the Rhodope massif. detached fragments of which are seen in the coastlands of Macedonia and Thrace.

The backbone range of central Greece is that of Pindus, which preserves the general north-northwest to south-southeast trend of the Dinaric ranges of Yugoslavia, of which it forms a projection. The Pindus range has a hard core of granites and serpentines, flanked with Cretaceous limestones. From it there diverges eastward, in broad arcs, a series of ranges which form the various promontories of the east coast, and whose lines can be followed out into the several archipelagos of the Aegean. South of the Gulf of Corinth, the general Dinaric grain of the Pindus can be traced again in the promontories of the southern Peloponnesus (Morea), but beyond there these folds make a broad curve. the undrowned fragments of which can be seen in Crete and Rhodes.

After the folding of the mountains. which began in the late Cretaceous period and continued into the Miocene, the topography of the country was vastly modified by rifting and subsidence, processes which still continue on a minor scale and result in earth tremors like those which caused havoc in the Ionian Islands in 1953. This fracture and collapse had various results. In the first place, the rivers of Greece often follow rift valleys, as in the case of the Vardar (Axios) and Struma (Strimon). Second, deep enclosed depressions were formed, which were occupied by lakes. Throughout the Pliocene period these gradually filled with sediment to form wide flat plains, like those of Larissa and Trikkala, often imperfectly drained through a single narrow outlet. Third, the main outline of the coasts was shaped at this time. Where the cleavage ran parallel to the general trend of the mountains, the resulting coast was straight and harbourless, as in Elis. Where, however. the rifting ran across the grain of the folded ranges, long sheltered bays, like the Gulfs of Corinth and Aegina, were the result. Last. the origin of the Aegean sea and its islands must be attributed to the fall of a whole major section of the fold mountains, betneen the eastern shore of the Greek mainland and the west coast of Asia Minor. In the Aegean the depth of the subsidence was greater in the south than in the north. Much of the sea between Lemnos and Thrace is less than 1,200 ft. deep; off the Northern Sporades the sea is at most 5,000 ft. deep; while between the Cyclades and Crete maximum depths of about 8,000 ft. are recorded. The present sea level of the Aegean, therefore, stands approximately halfway between the deepest part of the sea bed and the summit of the highest crests on the mainland. South of Crete, the Aegean "platform" ends abruptly and the sea bed falls to depths of 20,000 ft. or more.

A countereffect of the earth fracture of the Tertiary period was the volcanic eruption that produced the now extinct craters of Patmos, Nisyros and Melos, and that which is still from time to time active on Thera (Santorin). On the mainland, occasional deposits of tuff and lava, as at the cone of Methana, as well as hot springs like those of Lutraki and Thermia, are further signs of vulcanism.

Finally. many details of the coast have been modified. even since classical times. by silting, especially in the deltas of Thessaly.

The peculiar beauty of Greece is found not in the grandeur of its mountains and rivers, but rather in the infinite variety of its scenery and in the intimate juxtaposition of harsh white limestone crags, piedmont terraces with deep-green orchards of olive and fig, dusty plains of sparse thorny pasture and limpid sea of cerulean blue.

Climate. — Summer is hot and dry almost everywhere in Greece, and the mean July temperature at sea level is usually very close to 80° F. The extreme heat is tempered to a small extent in the immediate vicinity of the coast. where a regular sea breeze blows in every afternoon. Temperatures are lower also in the higher mountains of northern Greece which, because of their elevation, enjoy an appreciable rainfall in summer and autumn. Elsewhere! the summer drought is unbroken, and the etesian winds. becoming steadily warmer in their movement southward, parch the earth they pass over. These winds. which belong to the same system as the trades, are gentle. regular and reliable, and summer is the traditional sailing season in the Aegean.

With the break of the rains in late September, conditions change immediately. In winter the belt of eastward-moving cyclonic storms of temperate latitudes shifts southward to include Greece and the other Mediterranean lands. The winds at sea become squally and turbulent, changing direction as each cyclone passes by, and they may make sailing conditions as hazardous as those described by St. Luke in his account of the shipwreck of St. Paul. In Macedonia the north wind from the heavy, cold air mass of the central Balkans is liable to blow with particular force when it is drawn as an indraft down the valleys of the Vardar and Struma into one of the cyclones over the Aegean. At one such time a thermometer reading as low as 14° F. was observed at Salonika. and the nearby gulf had a thin coating of ice. This cold north wind is known as the *bora* and has its counterpart in the *shilok* or warm wind from the south, which on the west coast in the intermediate seasons may quickly heat the local atmosphere as much as 12° F. The difference of temperature between northern and southern Greece is much greater in winter than in summer, and while Athens has a mean January temperature of 46.4" F., the corresponding figure at Salonika is 40.6° F. The west coast. where most of the winter winds blow onshore. has the mildest winters, and Corfu records a mean temperature for January of 50.4° F.

'The amount of rainfall varies markedly over very small distances, according to elevation and exposure. The driest parts are the plains of the east, especially those of Thessaly, where the total annual rainfall is usually less than 15 in. Athens has an average annual fall of 15.4 in.. almost all of which comes between October and March. Salonika, where the summer drought is less extreme, has an average annual total of 21.5 in. The west coast is the wettest part of Greece, for there the winter cyclones strike the mountains squarely after collecting moisture in their passage over the Ionian sea; Corfu has an average annual rainfall of jo.4 in. The winter rains of Greece, being of cyclonic origin, fall in downpours, often divided by long periods of clear days. Much of this torrential rain is lost by immediate seepage and runoff.

Drainage. — Since the rainfall of Greece is very unevenly distributed throughout the year, the flow of its rivers is extremely seasonal, and even in the winter period of high water the flow is irregular and rises with the bursting of each cyclonic storm. In addition, the beds of the rivers are very uneven, as is usual in youthful and little-eroded mountain country; there is a clear contrast between the precipitous upper stretches of streams like the Xliakmon and their lower courses that meander lazily over the old alluvium-filled lake basins or ill-drained deltaic swamps. For all these reasons. the rivers of Greece are of little value for navigation. and they are also very difficult to control for irrigation. The most copious and perennial of them are the Vardar and Struma, which have large catchment basins in the central Balkans, but whose lower sections alone lie in Greece. In addition to these, the chief rivers that enter the Aegean from this country are the Mesta (Nestos), the Aliakmon, the Peneus (Salami-ria) and the Spercheios: the Eurotas of Laconia is the largest stream of the Peloponnesus while Acarnania and Epirus are drained principally by the Achelous. the Arta (Arachthos) and the Kalamas (Thyamis).

An individual feature of the drainage of the limestone districts is the *katavothras* or swallow holes. These are enclosed depressions, formed by subsidence or solution. where the drainage sometimes disappears straight underground and sometimes. when the inflow is heavy. accumulates to form a temporary lake.

The **Peloponnesus (Morea)**.—The Peloponnesus was joined naturally to central Greece by a 4-mi.-wide isthmus. which is now cut by the Corinth canal, linking the gulfs of Corinth and Aegina. The most fertile part of this peninsula is the coastal plain of Pliocene marls and conglomerates in the north and west, the districts of Achaea and Elis where the bulk of the Greek currant crop is grown. The two great alluvial depressions of Laconia and Messenia are oases of fertility on either side of the dry, barren limestone wilderness of Mt. Taygetus (7,897 ft), one of the least peopled parts of Greece. But even in these lowlands the cultivated area is only that which has access to springs of irrigation water from the mountain slopes. Beyond this lies, according to the season, malarial swamp or dusty plain, a type of scenery which occurs throughout all the central part of the third great alluvial lowland of the Peloponnesus. that of Argolis.

The limestone plateau of Arcadia. in the heart of the Peloponnesus is one of the most inaccessible parts of all Greece, and there in ancient times a unique archaic dialect lingered. The open hills carry a very mean pasture, but among them lie occasional tectonic basins that contain some of the best cultivated land of the peninsula. Some, like the basin of Megalopolis. drain outward, in this case to the Alpheus. Others, like the plain of Tripolis (Tripolitsa), are true katavothrus of underground drainage.

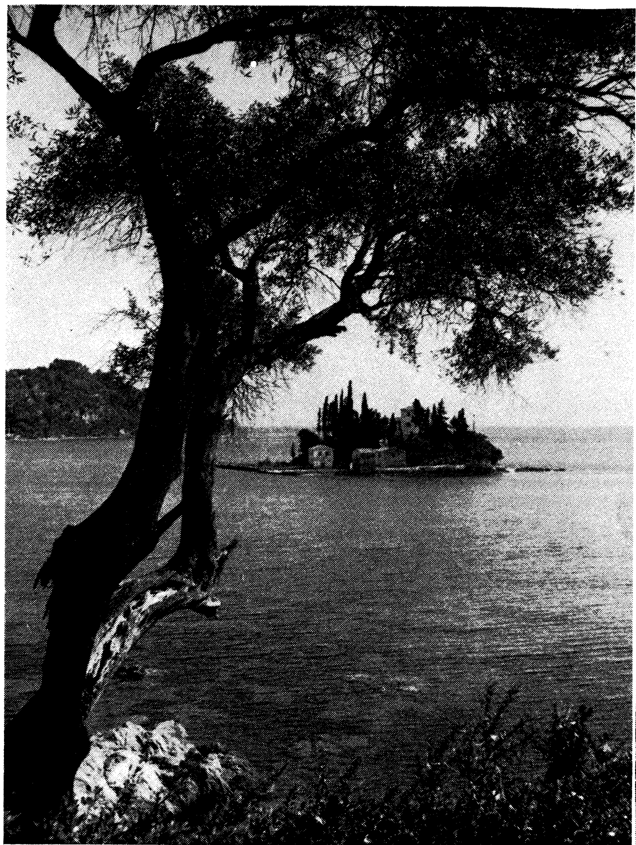
The east coast of the Peloponnesus is deeply indented, and has numerous small natural harbours. The coast of Elis, on the other hand. was formed by a straight fault and has been further smoothed by the deposition of strand flats, through longshore silting. Katakolon is the only good harbour there.

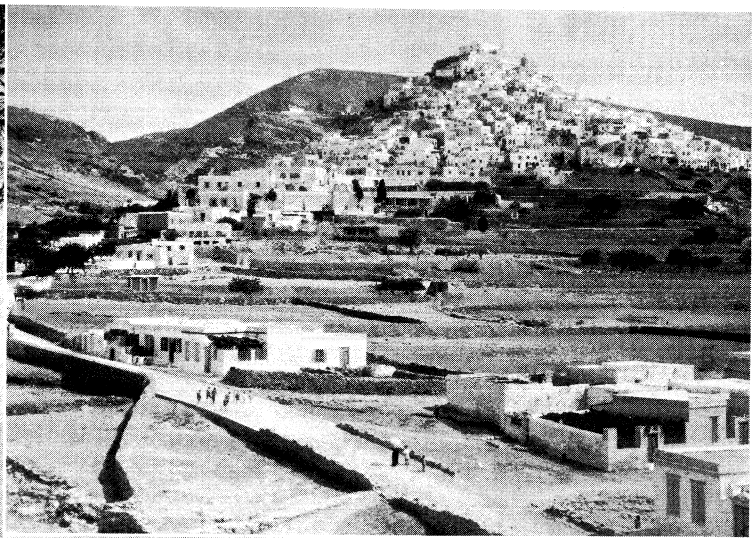
Central Greece.—The central range of Pindus throws off four spurs to the east. The most northerly of these, the Kamvounia range—which some geologists regard not as a fold range but as fragments of the old crust block—runs parallel to the straight faulted coast from Salonika to the Gulf of Volos. It is a discontinuous chain, whose trend can be traced through Olympus (9,550 ft), Ossa and Pelion out into the islands of the Northern Sporades. Skiathos, Skopelos and Skyros. Between this range and the next, that of Othrys, whose line is continued in the Kandelion mountains of northern Euboea. lie the three plains of Halmyros, Trikkala and Larissa. each marking the site of a lake basin of Tertiary times, since filled in with detritus. These last two plains are both drained by the Peneus, which leaves each through a constricted gorge, the lower one being the famous Vale of Tempe, embowered within the forests of Ossa and Olympus.

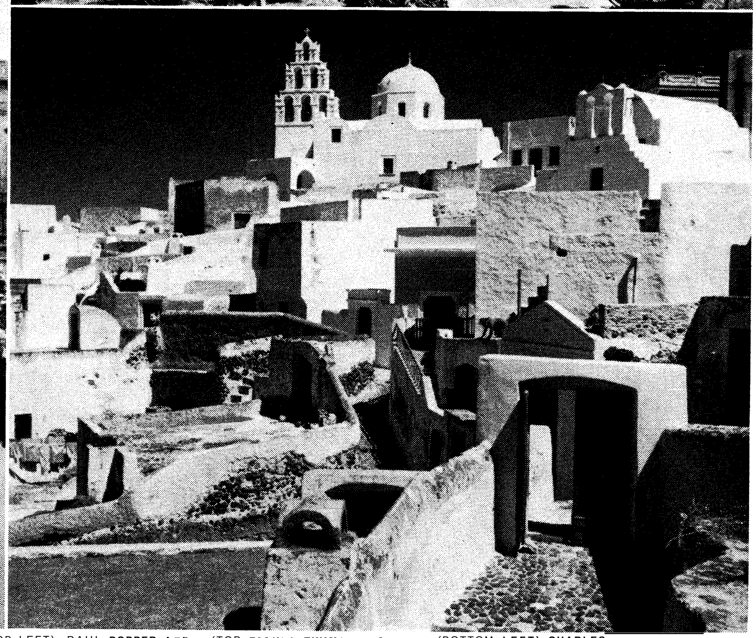
Passing southward, the third range to leave the Pindus is that of Oeta (7.080 ft.), which is continuous with Mt. Oche (Ocha) in central Euboea and which, together with the Othrys range, encloses the alluvium-filled tectonic trough drained by the Spercheios river. The pass of Thermopylae Iies between the eastern tip of the Oeta range and the sea.

Finally, the fourth and most southerly of these subsidiary chains is that linking Parnassus (8,061 ft.), Helicon, Cithaeron, Parnes and Hymettus. Between this range and that of Oeta lie the lowlands of Phocis and Boeotia, drained by the Cephisus and Asopos rivers, These plains, being exposed to the north. have a more continental and extreme climate than Attica, and the olive does not thrive. But thanks to careful drainage the lowland about Thebes has always been good wheat country, and since 1886, when the seasonally fluctuating Lake Copais was drained by the canal of Talenti. much extra fertile farmland has been reclaimed in the plain of Phocis.

The depressions of Attica are among the least fertile basins







BY COURTESY OF (CENTRE RIGHT, BOTIOM RIGHT) GREEK EMBASSY: PHOTOGRAPHS, (TOP LEFT) PAUL POPPER LTD., (TOP RIGHT) EWING GALLOWAY, (BOTTOM LEFT) CHARLES TRIESCHMANN FROM BLACK STAR

VIEWS OF GREECE

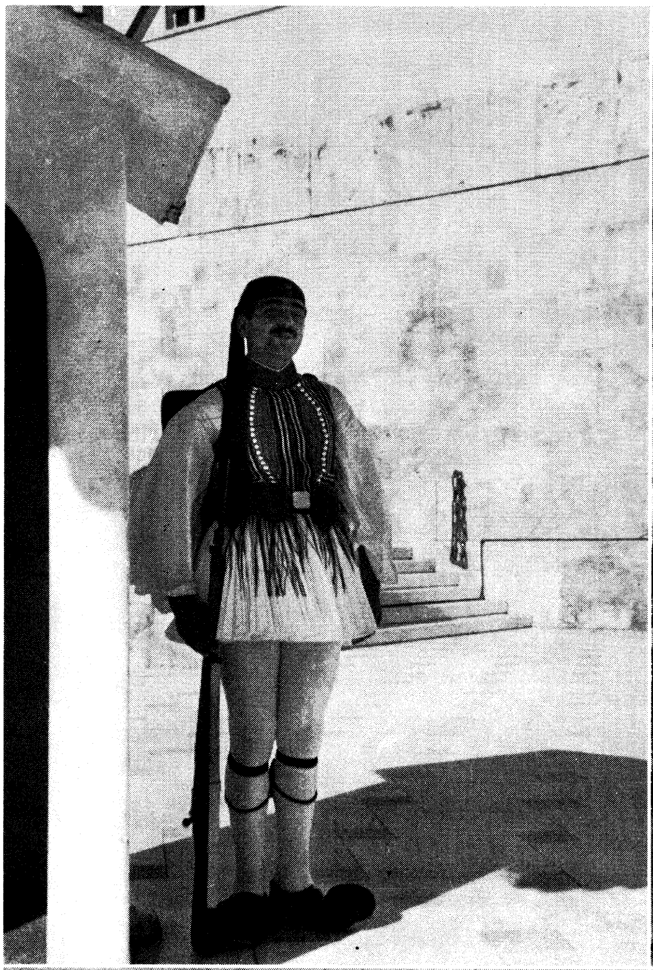
Top left: View from the northwest coast showing Corfu (left) and a smaller island (centre)
Top right: The town of Kastro, built on a conical hill on the island of Melos, one of the Cyclades
Centre right: Academy of Science, Athens
Bottom left: Outdoor cafe in Constitution square, Athens
Bottom right: Scene on Santorin (Thera), a volcanic island of the Cyclades

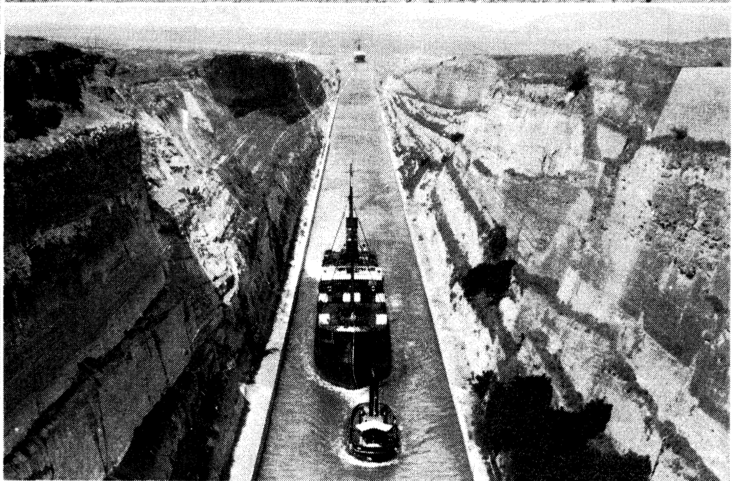
GREECE

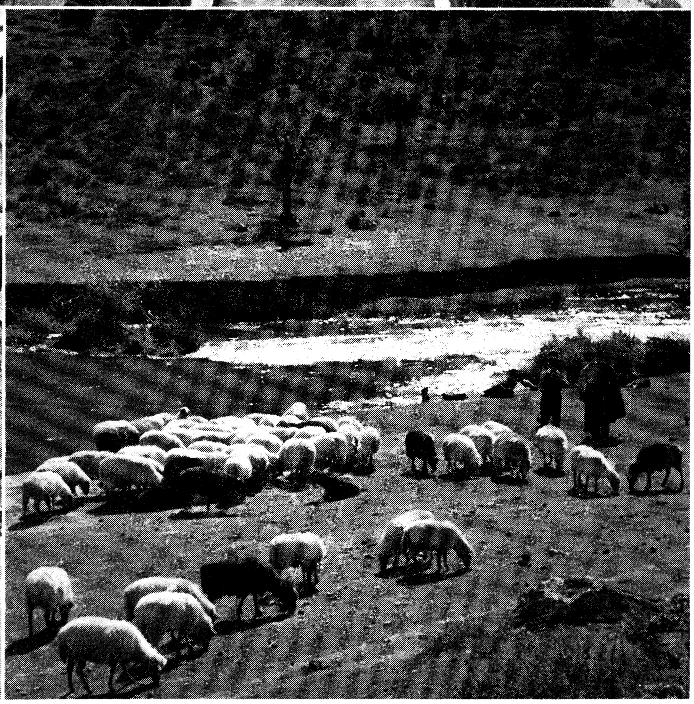

ANCIENT GREECE
English Miles
Roman Miles
Stadia
COLOURING
9000 feet
6000
3000
600
Sea Level
On the same scale
RHODUS
I L L Y R I A
M A R E
I O N I U M
P E L O P O N N E S U S
A R C A D I A
A R G O L I S
M E S S E N I A
L A C O N I C A
Æ T O L I A
A C A R N A N I A
P H O C I S
T H E S S A L I A
Sinus Thermaicus
Sinus Corinthiacus
Sinus Saronicus
Sinus Argolicus
Sinus Laconicus
Sinus Messeniacus
Sinus Cyparissius
MARE MYRTO
Corcyra
Leucas
Cephallenia
Zacynthus
Cythera
ATHENS
SPARTA
CORINTHUS
MEGALOPOLIS


THRACIA
PROPONTIS
Byzantium (Constantinople)
Chalcedon
Chrysopolis
Selymbria
Perinthus (Heracleia)
Bisanthe (Rhædestus) (Rodosto)
Thasos
Samothrace
Imbros
Lemnos
MARE THRACIUM
Tenedos
Alexandreia Troas
Sestus
Abydus
Lampsacus
Parium
Cyzicus
Proconnesus
Arctonnesus
Phrygia
Mysia
Mysia Minor
Abrettene
Abbaitis
Adramyttium
S. Adramyttenus
Lesbos
Mytilene
Pergamum (Bergama)
Teuthrania
Psyra
Chios
Ionia
Smyrna
Sardes
Lydia
Philadelphia (Alashehr)
Tmolus M.
Sipylus M.
Magnesia
Catacecaumene
Mare Icarium
Samos
Icaria
Ephesus
Messogis Mons
Tralles
Laodiceia
Caria
Miletus
Halicarnassus
Sinus Ceramicus
Cnidus
Cos
Calymnos
Patmos
Leros
Peræa Rhodiorum
Rhodus
Cos
Telos
Nisyros
Astypalæa
Amorgos
Naxos
Paros
Myconos
Delos
Syros
Tenos
Andros
Ceos
Cythnos
Seriphos
Siphnos
Melos
Ios
Thera
Anaphe
Scyros
Carystus
Mare Ægæum
Sporades
Cyclades
Longitude East 25 of Greenwich
John Bartholomew & Son Ltd Edinburgh

GREECE







PHOTOGRAPHS. (TOP LEFT BOTTOM LEFT) CHARLES TRIESCHMANN FROM BLACK STAR (TOP RIGHT) NANCY JENKINS FROM BLACK STAR, (CENTRE RIGHT) EWING GALLOWAY, (BOTTOM RIGHT) VAGN HANSEN FROM BLACK STAR

SCENES AND PEOPLE OF GREECE

Top left: Soldier of the royal army on guard duty

Top right: Fishermen of Thasos, an island off the Macedonian coast, bringing in their nets

Centre right: Corinth ship canal, 4 mi. long, joining the Gulf of Corinth and the Saronic gulf

Bottom left: Two-tiered Roman aqueduct at Kavalla, Macedonia. The ancient structure was still used in the 20th century to supply the town with water from Mt. Pangeus

Bottom right: Shepherds of the Peloponnesus grazing their sheep and goats by a stream of central Greece. Their summers are excessively hot, their winter rainfall small and precarious. Athens, however, in the plain of the Attic Cephisus, has the great advantage of a central position easy access to harbours in the Gulf of Aegina and the command of rich and varied resources of timber, pasture. and olive- and vine-groning country, the silver mines of Laurion (Laurium) and the marble quarries of Pentelikon (Pentelicus).

Western Greece and the Ionian Islands.—The southern extremity of the Pindus about Mt Kiona (8,240 ft.) divides Attics and Phocis on the east from Xcarnania and Aetolia on the west, just as the northern Pindus in the region of Mt. Smolikas (8 640 ft.) separates Thessaly irom Epirus The provinces to the west of the main watershed have far fewer fertile basins than those to the east Epirus consists of four parallel limestone ranges, separated by narrow valleys of softer sandstones from which the rivers escape through constricted gorges, like that of the Acheron (Mavropotamos) at Suli. The most extensive fertile plain is the *polje* or basin of inland drainage at Janina (Ioannina) in the mountains, whence a difficult road leads down the Arta valley to the sea. Eastern Aetolia has some eroded Pliocene strata which make fair agricultural country, but the limestone heights of Xcarnania and western Xetolia near the Gulf of Arta are very barren.

The main difference between the provinces on either side of the Pindus range, however. is climatic. On the western side. Epirus in particular is well watered and snow lies on its higher mountains until mid-June. Unlike the rest of Greece, but in common with the central Balkans. the interior of this province enjoys an appreciable rainfall in late surnmer and early autumn, and the olive. which only thrives where there is summer drought, is not found more than about 25 mi. inland from the west coast.

Like the mainland opposite, the Ionian Islands consist of heights of Cretaceous limestone and depressions of softer Pliocene strata, particularly of sandstone. Corfu is fortunate in that, except for the limestone block of Pantokrator in the north, it is composed entirely of these fertile Pliocene deposits and also enjoys a high rainfall. The southern islands are much drier. Cephalonia and Ithaca are almost entirely limestone and have a very broken relief. Leukas (Santa Maura) and Zante (Zacynthus) have steep cliffs to the west, but more gentle slopes leading to the eastern coastal plains.

Macedonia and **Thrace.**—The faults or lines of breakage between the mountain blocks of the coastlands of northern Greece mostly trend northwest and southeast and give their direction. for example, to the lower Vardar, Struma and Mesta; but there are other series of faults. like those that run east and west to form Lakes Koroneia (Langada) and Bessikion. which separate the peninsula of Chalcidice from the rest of Thessaly.

Between the crystalline massifs deep lake basins were left, that became encumbered with detritus in the Tertiary and Quaternary periods. Subsequent drainage and erosion have left a series of terraces. but malarial swamps in the lowest parts of these piains show that the process of drainage is still not complete. These marshes are particularly extensive wherever the main stream leaves the basin through a constricted exit, as in the plain of Serrai on the lower Struma. and in that of Drama, on a tributary. The largest swamps of all, however. are in the Campania, the coastal flats which are being built forward into the Gulf of Salonika by the combined deltas of the Vardar and the Aliakmon.

The three promontories of Chalcidice were islands in the Tertiary period, as is shown by the Pliocene deposits at their roots. These Tertiary deposits also overlie much of the limestone of the Kassandra promontory. the lowest of the three. Those of Longos (Sithonia) and Athos (Akrathos) consist largely of wooded hills of schistose rocks, though there is a steep block of limestone at the tip of Athos.

In western Macedonia. beyond the forested hills of Vermion, lie the high enclosed lake basins of Tertiary deposits of Eordaia, and of Kastoria on the upper Aliakmon. Both these vales are dry and barren. by contrast with the higher valleys of Epirus on the other side of the watershed of Pindus.

The Islands of the Aegean.—The islands of the Thracian sea are all Greek, except Imbros and Tenedos (Bozcaada) which lie in Turkey. Thasos is an ancient mineraliferous massif. like those of the Thracian mainland. Samothrace is of volcanic origin, and its coasts are smooth and harbourless. by contrast with Lemnos which possesses the large strategic anchorage of Moudros.

Lesbos. Chios and Samos are detached fragments. respectively, of the Troad (Troas), the Erythraean peninsula and Mt. Messogis on the mainland of Asia Minor. All are favoured with a mild and temperate climate and palms can be grown in sheltered corners of Chios. But the land surface in all three is rocky, the only extensive areas of fertile soil being in the southern part (Catomeria) of Chios, which consists of limestones of relatively recent formation. In Lesbos, Mytilene, originally an island colony, is the first port, but the deep Gulf of Kallone is the finest natural harbour. The port of Chios is on the east side of the island of that name, opposite the small harbour of Cesme on the mainland.

The Northern Sporades (the "Scattered Islands") continue the structural trend of Olympus, Ossa and Pelion and, like the mainland range, consist largely of crystalline rocks.

Euboea, though a single island. includes projections of two of the mainland ranges, those of Othrys and Oeta, and its rocks range from the fertile Eocene sands and clays of the north through the barren limestone ranges of the centre to the ancient Primary crystalline formations of its southeastern extremity.

The Cyclades (the "Central Islands") were anciently considered to be disposed in a circle about Delos. They are the extreme summits of drowned mountains, in which two main ranges can be followed. The first leads from Euboea through Andros, Tenos, Mykonos, Icaria and Samos to the Mycale promontory of Caria. The second may be traced from Cape Sounion (Sunium) through Kea (Ceos). Kythnos. Seriphos, Siphnos, Kimolos and Amorgos as far as Levitha. Between these two main ranges are Paros and Naxos, which consist of very ancient metamorphic rocks, yielding the marble of the one and the emery of the other. Syros (Syra) and Delos lie slightly south of the main northern arc of islands.

The **Dodecanese.**—This group includes islands of varied geological structure. Kalymnos, Syme and Chalke consist almost entirely of hard gray limestone, which weathers into very poor, thin soil. In Leros, by contrast, fertile Tertiary marls overlie much of the limestone. The southern half of Patmos is the collapsed western rim of an extinct volcano. consisting of purple porphyry, and Nisyros is a complete volcanic cone whose lavas have weathered into a very rich soil Rhodes is the largest of the 12 islands. Its core of hard rocks rises more than 4,000 ft. above sea level and captures a considerable rainfall, while the lower slopes are constructed of weathered marls and sandstones which make good farmland. The remaining islands of the 12 are Kos, Astypalaia, Telos, Karpathos and Kasos. (See DODECANESE.)

Crete.—This island is an extension of the arc of the Dinaric fold mountains. which have here been eroded, invaded by the sea in Tertiary times and later raised again. The landscape is mountainous, most of the island's area of flat land being concentrated in the central plain of Mesara.

In the extreme west. the schistose rocks have weathered into rounded slopes, but the limestone heights of the Lefka Ori ("White Mountains") and Mt. Ida (8,058 ft.) have a more precipitous outline. The north coast, with its alluvial bays, is very different from the south coast, which falls to the sea in steep faulted cliffs. (See CRETE.) (WM. C. B.)

Flora and Fauna.—The vegetation in the different parts of Greece is determined by the climatic and edaphic conditions. In the southern and central regions it is of the Mediterranean type which, to the north and on the higher slopes of the mountains, merges into a central European flora. The main kinds of plant cover are deciduous and evergreen forest and brushwood or scrub. More than half the land surface is under scrub and four distinct types of scrub community can be recognized—maquis, found largely in the Peloponnesus; pseudomaquis, in Macedonia and other northern parts; phrygana in the hills of Attica, the Ionian Islands and the Cyclades; and shiblyak at high altitudes.

The chief plants of the maquis are Spanish broom, strawberry tree, oleander, bay, kermes oak, olive, myrtle and chaste tree

(*Vitex agnus-castus*), whose supple stems are used for making baskets. The tree heath is common except on limestone. Plants of the pseudomaquis include oaks, box, terebinth, juniper, jasmine and cherry laurel. Phrygana consists of scattered bushes, often thorny with gray-green leaves and a resinous aromatic sap, such as *Poterium spinosum, Thymus capitatus,* marjoram, *Cistus,* lavender and *Genista.* Shiblyak is mainly composed of *Paliurus spina-Christi,* smoke tree (*Rhus cotinus*), sumac (*R. coriaria*) and barberry. There is only a very small area in Greece above the tree limit and there juniper and *Daphne oleoides* are the chief plants found. In the lowlands, up to about 650 ft., the flora is of the Mediterranean type consisting of trees, evergreen shrubs and herbaceous plants. A feature of the stony ground in the south and in the islands in spring, and to a lesser extent in autumn, is the brilliant patches of grape hyacinth, star of Bethlehem, asphodel, crocus, fritillary, narcissus, iris, tulip and gladiolus, with annuals, such as anemones and poppies, that make their growth during the winter and die down in the summer. They are succeeded in summer by composites, labiates and other hardier plants.

On the higher slopes bloom *Dianthus, Silene, Verbascum, Thymus* and *Centaurea,* while among the rocks are campanulas, saxifrages, violas, *Potentilla, Sedum, Achillea, Draba,* etc. The river courses are usually stony and bear planes, poplars, willows, chaste trees, oleanders and terebinth. Aleppo and stone pines are characteristic of the northern and western coastal plains.

In the southern and central highlands. and at lower altitudes in the north, where the summer rain and winter cold are greater, deciduous trees (oaks and chestnut in particular) are found on the middle slopes with an undergrowth of sumac, Judas tree, *Ostrya carpinifolia,* wild pear and bay. Above are coniferous forests dominated by the Greek fir (*Abies cephalonica*) and silver fir (*A. alba*) with little or no undergrowth except in the clearings where it is mostly of juniper, hawthorn and small-leaved lime. The clearings and ravines in woods and forests are bright in the spring and summer with crocuses, irises, tulips, fritillaries, asphodels, gentians, etc.

Above 6jo ft. most of the surface is covered by forest and scrub. The woods are of the Mediterranean evergreen type on the lower slopes, mixed deciduous above and coniferous higher still. The Pindus ranges carry oaks and chestnuts and, above them, firs and pines; on Othrys are extensive oak woods; in Attica many of the Aleppo pine forests have been cut down; the higher slopes in the Peloponnesus bear Greek fir and black pine (*Pinus nigra*); beech grows on the higher slopes in the north and chestnuts in southern Macedonia and on the middle slopes of Olympus, Ossa and Pelion. Black pine forms the high forest of Olympus and is common on siliceous soils from about 2,000 to 4,500 ft.

Though by 1954 the fauna of Greece had not been completely studied, many mammals were known to be rare and others very rare. Among the latter are the European brown bear, chamois and red and fallow deer. There is a great variety of birds; and reptiles are common, especially in the Peloponnesus and the Cyclades, but only two of the snakes are poisonous. *See* BALKAN PENINSULA.

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HISTORY: INTRODUCTION

The finer arts and crafts of civilized man, invented in Mesopotamia and in Egypt, were adopted and developed first in Europe by the Minoans of Crete and by the Mycenaeans of Greece during the Bronze Age. The civilizations of these peoples attained a high level before each in turn was overwhelmed. A dark age ensued in Europe. But memories of Bronze Age civilization survived in the rich saga and in the epic poems of which some were finally attached to the names of Homer and Hesiod. These memories played an important part in the Greek renaissance of the 9th century B.C. But a new political, intellectual and social spirit came to birth with the city-state. This spirit was carried to the European shores of the Mediterranean sea and of the Black sea by Greek colonists from the 8th century B.C. onward and to Asia as far as the Indus valley by Greeks and Macedonians in the 4th century B.C. Even when Rome replaced Macedon as the leading imperial power and later fell in turn to barbarian invasions in the 5th century A.D., the Greek civilization which had been a unifying factor in the Greco–Macedonian and the Greco–Roman world lived on for 1,000 years in the dwindling empire of the Byzantines. Once again there was a dark age in Europe. It was enlightened by that rediscovery of the Greek outlook vital to the Renaissance that heralded the end of the middle ages and laid the foundations of modern western civilization. Thus Greek history has a wide scope. It is the keystone of the arch which united east and west, it cast a bridge over two dark ages and has given continuity to man's development in Europe from the Bronze Age to modern times. It is essentially universal and not parochial in interest.

This article covers Greek history in the following three main sections:

(1) *Ancient History,* which includes the Minoan and Mycenaean civilizations of the Bronze Age; the early migrations and colonizing movement of the Dark Age and the Greek Renaissance; the Graeco–Persian wars; the great wars in Greece (the First Peloponnesian War, 460–445, the age of Pericles, the Great Peloponnesian War, 431–404); the city states, 404–354; the Macedonian period; and a summary of authorities on classical Greek history.

(2) *Postclassical and Medieval History,* covering Greece under the Roman republic and Roman imperial rule and the Byzantine periods.

(3) *Modern History,* which traces the history of Greece from its conquest by the Turks in the 15th century to modern times. Sections on the population, government and economy of modern Greece follow.

ANCIENT HISTORY

THE BRONZE AGE

The Minoan Civilization. — The civilization of Ur in Mesopotamia was already mature when the first waves of settlers came by sea from Asia to Greece not later than 3000 B.C. They occupied Cyprus. Crete, some of the Cyclades and the eastern areas of the Greek peninsula, which are warmer and drier than the western. When they arrived, they were familiar with agriculture and seafaring as well as with pastoral life. They were still in the Neolithic stage, for their tools were made of stone and obsidian, a vitreous lava found mainly on the island of Melos. At the beginning of the Bronze Age in Greece, *c.* 2600 B.C. (some scholars subdivide the Bronze Age into a Copper Age and a Bronze Age proper, and date its beginning earlier, *c.* 2900 B.C.), these sparse settlements were reinforced by further waves of settlers, conversant with the use of copper, who probably came from Asia and were similar in race to their predecessors. They were a comparatively peaceful and unwarlike people, for they lived in unfortified villages or hamlets and had more tools than weapons. They developed local variations of culture, but had in common the use or worship of stumpy statuettes which represented a female deity.

In the Neolithic period Cnossus (Knossos) in Crete was an important centre. It controlled the main routes within the island, its port at Amnisus faced the Aegean sea, and its houses soon became considerable in size, with a main room in the centre and a cluster of smaller rooms round it. When the Cretans were reinforced by new settlers at the beginning of the Bronze Age, the skeletons which have been discovered in their two-roomed tombs show them to have had long, narrow skulls and to have been short men and women who averaged just over and under five feet respectively. Quite a different people appeared *c.* 2300 B.C. at Phaestus (Phaistos) in the plain south of Cnossus; they were soon absorbed or eliminated, but they left their memorial in the huge circular buildings where they laid the bones of their dead. Apart from this short-lived intrusion the Bronze Age inhabitants of Crete developed their own culture continuously down to 1450 B.C.

After 2000 B.C. political power was wielded by dynasts at Cnossus, Phaestus and Mallia and finally became concentrated in the hands of the ruler of Cnossus. The central figure of Cretan religion was a female deity, represented in human form, clothed in Cretan dress and attended by priestesses and animal-headed humans. Her cult was associated particularly with sacred trees and with the snake. bull and dove. The furniture of ritual included a three-legged altar. a double axe and twin horns of consecration. There is a temple-tomb near the palace at Cnossus which suggests that the dead rulers received worship as deities. whereas the graves of the commoners are too humble to have been the object of any cult. The Cretans were gifted in painting, gem cutting, metalworking and architecture. Their frescoes reveal a fresh joy in the beauty of the natural world and a love of dancing, boxing and a sport in which boys and girls somersaulted over the backs of charging bulls. Their well-built houses were of masonry usually bonded with timber. and the towns were often laid out on terraced slopes with paved streets and tiers of houses. The great palace at Cnossus was a fine example of monumental architecture with spacious state rooms and numerous storerooms. where the wealth of the realm was hoarded.

Although the palaces and the towns were unfortified and peaceful scenes predominated in the frescoes. the Cretans made excellent daggers. spearheads and rapiers first of copper and then of bronze. and the roads which linked the countryside to the palaces were protected by guard posts. The great wealth of the palaces and the widespread prosperity in the island were due to the profits of trade. protected or exploited by Cretan naval vessels in which a prolonged keel beam served as a ram. In the 16th century *B.C.* Cretan colonies were planted on Cythera. Calymnos and Rhodes. a chain of islands controlling the southern Aegean, and at Miletus on the coast of Asia Minor. Articles of Cretan origin were exported to Egypt. Syria. Asia Minor, the Cyclades and Greece and. further westward. to Lipara and Ischia. The 15th century B.C. brought the greatest prosperity to Crete. Metals, textiles, manufactured goods and natural products were traded between the continents. Egypt. Syria and Troy grew rich as centres of exchange on the mainland. Crete controlled the sea routes toward southern Europe and the west, which were beginning to emerge from barbarism.

The art of pictographic writing had been practised for centuries in the east before it was adopted about the end of the 3rd millennium by Crete. Soon after 1700 B.C. the Cretans invented a linear script with signs for syllables and for numerals on the decimal system. This script has not yet been deciphered. As the people and culture of Crete owed their origins and developments predominantly to the east, it is probable that the Cretan language belonged to an Asian group distinct from the Indo-European group. Philologists see survivals of this Asiatic group in place-names ending in *-ssos* and, *-inthos*, which are commonest in Crete and Asia Minor. Some aspects of Cretan culture, such as the palaces of the dynasts. the worship of deified rulers. the female deity, animal-headed humans and the predominance of peaceful pursuits. are also found in contemporary civilizations of the east; but so many features are peculiar to Crete that the first great civilization on European soil should be regarded as an independent entity. The ancient name of the island and of its people is unknown. Some have identified the island with "Keftiu," whence envoys came to Egypt in the first half of the 15th century B.C. Others have accepted the names which were recorded centuries later by Homer: "Crete. where the race of Minos is" *(Odyssey,* xvii. 523) and its great city "Cnossus where hfinos ruled. holding converse with great Zeus every ninth year" *(Odyssey,* xix. 178). Following Homer. we speak of "Minoan" civilization, and we attribute the legends of the Minotaur, Theseus and Ariadne to the great age of Crete.

After 1450 B.C., when Cnossus had a monopoly of political power in the island and developed a distinct culture of its own in which there are signs of a more militaristic spirit. a new linear script is found at Cnossus and also on the mainland of Greece. This script. unlike the earlier Minoan script. has been deciphered. The language it expresses is Greek. It is therefore certain that at least in the period 1450–1400 B.C. the rulers of Cnossus spoke Greek and presumably were Greeks nho had come from the mainland. They called the place "Ko-no-so" in their new script. which may be called the "Mycenaean" script after the name of Mycenae. which was the chief centre of Greek culture on the mainland. The intrusion of the Greeks marked the beginning of the end of Cretan ascendancy. About 1400 B.C. Cnossus was sacked, and other leading cities of Crete were destroyed within a few decades of that date. The sackers of Cnossus are unknown, but their action opened the way to peoples from the north who were pressing toward the riches of Crete and the near east.

The Mycenaean Civilization.— The early settlers in some of the Cyclades and in the warmer parts of the Greek mainland were reinforced *c.* 2600 *B.C.* by further settlers from Asia and developed their own distinctive cultures. The seafaring peoples of the Cyclades made little models of their ships in lead. They produced beautiful pottery and exported marble vases and figurines. They grew prosperous by carrying the trade of Minoan Crete, whose influence was particularly strong at Melos. Toward the end of the Bronze Age they engaged in raids on Egypt, where they were described, with others. as "the peoples of the sea." Centuries later the Greeks called them Carians. Leleges and Phoenicians — peoples whose affinities were with the coasts of Asia whence the settlers of the early Bronze Age had come (Herodotus. i. 171; Thucydides, i. 8); the most common later name for them. however, was Pelasgians. By virtue of their geographical position they acted throughout the Bronze Age as intermediaries between the Greek mainland and Troy. Asia Minor and Crete. On the mainland the Bronze Age settlers were interested primarily in agriculture. Their largest settlements were made in the plains of eastern Greece south of Rlt. Othrys, but they spread gradually into the western areas. The flat-roofed, rectangular houses of their unfortified villages were built close together and contained reserves of grain stored in large jars. By the beginning of the 2nd millennium the eastern areas had developed separate cultures north and south of the Isthmus of Corinth. Of these, the northern areas traded principally with Troy and with northwestern Asia Minor, the southern area (the eastern Peloponnese) with the Cyclades. While both areas produced fine pottery. the eastern Peloponnese was more advanced in the arts. At Lerna. for instance, a large house was built on a complex plan suitable for a royal residence. and a stone statuette of exquisite workmanship has been found in its debris. It is clear from this and other statuettes that religion was centred on a female deity. If they had been left in peace, the inhabitants of central and southern Greece might have continued to develop a civilization which was similar in many ways to those of the Cyclades and Crete. but in the years after 1900 B.C. they became the victims of aggression.

The districts of northern Greece which lie beyond Mt. Othrys mere not occupied by the settlers who came from Asia at the beginning of the Bronze Age, c. 2600 B.C. The earliest wave of settlers remained in undisturbed possession of Thessaly and continued in the Neolithic stage of civilization until c. 2200 B.C. Their isolation may have been partly an effect of the climate. The Thessalian climate is intermediate between the warm Mediterranean climate of the south and the cold continental climate of upper Rlacedonia. Nor did the Neolithic people of Thessaly penetrate northward in the direction of Macedonia except at Servia (in a low-lying bend of the Haliacmon river): where they founded a small settlement. This settlement was destroyed c. 2500 B.C. by a much cruder people who were evidently nomadic hunters, the first of many groups who soon spread into central Macedonia and Chalcidice and some time later forced their way into Thessaly and occupied the sites of Dimini and Sesklo. These newcomers were quite unlike the earlier settlers of Greece. Their pottery mas roughly made and incised with spiral decorations. They wielded stone battle-axes and they fortified their villages at Dimini and Sesklo with a ringwall. When they adopted a settled life, they built long narrow houses with pitched roofs. entry porches and sometimes apsidal ends. which were suitable for a cold damp climate. Archaeologists have called this type of house megaron, after the Greek word for a long hall. Although the archaeological evidence in northwestern Greece is scanty, it suggests that groups of these newcomers entered Epirus and gradually moved down the western side of Greece as nomad hunters and shepherds. At Servia and at some sites in Thessaly. where they settled among the earlier inhabitants, their worship of the masculine aspect of life is indicated by the use of phallic emblems and male statuettes.

The ultimate origin of these newcomers is uncertain. Their way of life and the climate of the areas in which they settled suggest that they had come through the Balkans, and this suggestion is supported by the appearance of similar houses of an early megaron type in areas near Troy at the time of the first settlement there (c. 2600–2400 B.c.). The most probable hypothesis is that the settlers of Macedonia and of Troy were Indo-European — perhaps the first Indo-Europeans to reach the vicinity of the Mediterranean sea. Another branch, ancestor to the Illyrians, probably reached the Adriatic sea in the same period.

Newcomers disturbed the peace of the Greek peninsula during the middle Bronze Age (c. 1900–1600 B.c.) by irruption and infiltration. They probably entered from the western side of Greece. Early examples of megaron houses have been found at Eutresis in Roeotia, at Lerna and Tiryns in Xrgolis, at Korakou near Lechaeum in Corinthia and at Thermum and Olympia in n-estern Greece. Although they lowered the standard of civilization at first, they brought with them (or coincided with the arrival of) the potter's wheel, on which a fine pottery called hlinyan ware, imitating metal shapes, was made; and they introduced the horse, bones of which have been found in Macedonia in contexts dating to c. 2100 B.C. Similar phenomena occurred at Troy, where new settlers founded the sixth city (c. 1900–1300 B.C.), made Minyan pottery and introduced the horse into Asia Minor.

It is generally agreed that the newcomers of the middle Bronze Age were the first Greek-speaking peoples to reach central Greece and the Peloponnese. Their antecedents are a matter of dispute, but it is probable that they were descended from the Neolithic settlers of Macedonia, of whom a part occupied Dimini and Sesklo in Thessaly. Centuries later Hesiod gave a localized genealogy of the founders of the Greek race which supports this probability. He declared that Thessaly was ruled by Deucalion's descendants. "Hellen the war-loving king and his sons Dorus, Xuthus and Aeolus, delighting in horses." and that their cousins "Magnes and hlacedon, delighting in horses, lived in the area of Olympus and Pieria." The Greek or "Hellenic" race was divided by dialect into three main groups in Hesiod's time—Ionians, Xeolians and Dorians—of which the ancestors were held to be Ion (son of Xuthus), Aeolus and Dorus. The division certainly existed early in the Bronze Age, and it may have begun in Macedonia. Epirus and adjacent areas in the period 2500–1900 B.c., because the Ionians and Aeolians entered central and southern Greece during the Bronze Age but the Dorians in general after the Bronze Age.

When conditions became less troubled in the peninsula, the fusion of the Greeks and their predecessors produced a much more vigorous and artistic civilization than that of the early Bronze Age. This civilization, called Mycenaean, because it was first found by excavators at Mycenae in Argolis, lasted with fluctuating fortunes from c. 16jo to *c.* 1125 B.C. Rule was exercised by dynasties of kings who accumulated wealth on their citadels. At Mycenae the dynasties (Shaft Grave I, Shaft Grave II, Tholos Tomb I, Tholos Tomb II) are numbered by the excavators in accordance with their styles of burial, which were practised at other capitals of the time; and the objects buried with the first two dynasties show that they were Greek. The rulers of the first Shaft Grave dynasty (c. 1650–1600 B.C.) were buried with their weapons and with jewelry of gold, silver, electrum and ivory in tombs at the foot of deep vertical shafts, which were then filled up and marked by upright stone stelai engraved with scenes of war and hunting. The second group of shaft graves (c. 1600–1500 B.C.) was richer still in weapons, jewelry (including amber) and cups of precious metal; horse-drawn chariots were represented on the stelai; and remains were found of a boar's tusk helmet (*i.e.,* a leather cap on which slivers of tusk were sewn for greater protection). Death masks of gold and electrum show that the rulers wore moustaches, and the skeletons are those of a race of men between 5 ft. 6 in. and 6 ft. tall. The first group of tholos (beehive) tombs (*c.* 1500–1400 B.C.) and the second group (c. 1400–1300 B.c.) are examples of skillful architecture. A large circular tomb was excavated in a hillside and roofed over with a great dome (tholos) of conical shape, constructed of masonry blocks carefully wedged and counterweighted, and the whole was then covered with earth and a waterproof layer of clay. The tomb was entered by a walled passage which led to a massive doorway set in the side of the tholos. In the so-called Tomb of Atreus, built *c.* 1330 B.C., the dome is 40 ft. high. The period of the tholos tombs was even more prosperous than its predecessors, but it was followed by a gradual decline during which the rock-cut chamber tomb was in vogue.

At first the more advanced art of hlinoan Crete inspired the Greek peoples, who soon traded direct with Crete and became rulers of Cnossus c. 1450 B.C. The Mycenaean script, designed to express the Greek language by syllabic signs, was probably invented at Cnossus in the 15th century B.C. and taken to the mainland. Greek settlements were planted in Rhodes *c.* 1450 B.c., and Greek traders and exports appeared beside those of Crete at Miletus, in Syria, in Egypt and in the west at Lipara. When Cnossus and other cities of Crete were sacked c. 1400 B.c., the Greeks of the mainland replaced them as the leading naval power in the southern Aegean. They planted settlements in Crete, Cyprus and Cilicia and had trading stations at Ugarit and Poseidium in Syria. Mycenaean pottery, which combined Minoan taste in decoration with greater technical skill and formal design, was exported in large quantities to Syria, Palestine and Egypt. Trade relations were also close with Troy, and Thessaly and lower Macedonia were influenced by Mycenaean culture as they offered ports of call on the sea route to Troy. The absence of hfycenaean imports suggests that the Cyclades (apart from Melos, Thera and Delos) probably preserved a hostile independence. Greeks also settled in the west at Acragas and Syracuse in Sicily and at Oria and Taras in southern Italy. Thus the Greeks became to an even greater extent than the hlinoans of Crete the intermediaries of seaborne trade between Europe and Asia, and a general uniformity of Mycenaean culture prevailed by 1300 B.C. throughout the Ionian Islands (except Corcyra), the Greek peninsula (except Epirus and upper Macedonia) and the islands of the southern Aegean.

After 1300 B.C. Greek trade with Sicily, Troy, Syria and Egypt began to decline. Mycenaean culture lost its uniformity and developed local peculiarities. On the mainland men expected war and violence. Immense fortifications were built to enclose the citadels at Mycenae, Tiryns, Athens and elsewhere, and the slashing sword took the place of the rapier sword. The great palaces, built round a central megaron (of which the finest examples have been excavated at Mycenae, Tiryns and Pylos), were still wealthy, but their subjects in the open suburbs were exposed to attack and arson and declined in prosperity. As conditions worsened, the Greeks turned to piratical raids on Egypt: Cyprus and Caria and finally attacked and destroyed the fortified city of Troy c. 1200 B.C. The Trojan War opened the door to disaster. Barbarians broke into Asia Minor, overthrew the Hittite empire and set in motion a series of great raids by land and sea which destroyed the prosperity of the states in the eastern Mediterranean and brought the great civilizations of the Bronze Age to an end.

Our knowledge of Greek history in the Bronze Age is due mainly to archaeology, which constantly provides new evidence and new problems of interpretation. But we have also two kinds of literary evidence: Greek epic poetry composed from traditional sources before or after 800 B.c.; and contemporary Bronze Age texts in Greece, Asia and Egypt. The literary qualities of the *Iliad* and of the Odyssey are described elsewhere (see HOMER). We are concerned here with the extent to which they represent accurately the setting of the tenth year of the Trojan War and its aftermath. The Iliad (ii. 816–875) gives a "catalogue" of Troy's allies. As they were overwhelmed after the fall of Troy, the source of the catalogue, if historical, was composed in the Bronze Age; otherwise its contents would be fictitious and incorrect. In fact, the names of many allies in the catalogue occur in Bronze Age texts, both Hittite and Egyptian, and this is true also of Troy and its inhabitants (Greek *Troia*=Hittite *Taroisha; Dardanoi*=Egyptian *Dardenui; Ilioi*=Egyptian *Iliunna*). The catalogue of Greek allies (Iliad ii, 485–768) draws a map of political power in Greece and in the islands which mas no longer existing after the Bronze Age but has been fully borne out by excavation. The Greeks as a whole were called *Akhaioi* (Achaeans) and *Danaoi* in the *Iliad;* and these names in the forms *Akaiwasha* (cf. also Hittite *Ahhiyava* for the country of the *Akhaioi)* and *Danauna* or *Denyen* occur in Egyptian documents of the Bronze Age but were not in vogue later in Greece. The *Odyssey* too describes a political situation in western Greece which disappeared at the end of the Bronze Age, and its stories of piracy and raids are typical of the great raids on Egypt in 1192 and 1187 B.C., mhich were recorded in Egyptian documents. The paraphernalia of daily life described in both poems—bronze weapons, boar's tusk helmets, equipment, drinking cups, furniture, metal inlay, etc.—are paralleled by Bronze Age objects and not by those of a later period. The very language of the poems contains dialectal forms which probably derive from a time when Arcadian and Xeolic dialects of Greek were widely spoken, that is, in the late Bronze Age. These and other considerations lead us to believe that not only the *Iliad* and the *Odyssey* but also the great body of saga on which Hesiod and other poets drew were derived in subject matter from the poetry and beliefs of the late Bronze Age. Archaeology has produced parallels for such survival from other parts of the Bronze Age world; for the Babylonian Epic of *Gilgamesh* persisted in Mesopotamia for more than 2,000 years, and some traditions recorded in the Hebrew book of Genesis are found to rest upon historical facts of the Bronze Age.

Contemporary Greek records in the Mycenaean script (the decipherment was still imperfect in the middle of the 20th century A.D.) prove that Greek was the language of the rulers of the palaces at Cnossus and on the mainland c. 1450 B.C. and later; that some at least of the Olympian gods named by Homer were worshipped in Bronze Age Greece; and that some parts of Homer's picture of a feudal society are true to the conditions of the late Bronze Age. The script is mainly scratched on clay tablets, which served as inventory labels for stores. and the tablets have only survived when baked in a great conflagration, Fuller knowledge of this great period of history must depend on further archaeological discoveries and on a progressive decipherment of the scripts. *(See* also AEGEAN CIVILIZATION; CRETE; and GREEK ARCHAEOLOGY.)

THE DARK AGE AND THE RENAISSANCE

The Migrations.—The collapse of Bronze Age civilization was followed by migrations which affected the Mediterranean world and lowered the standard of life for several centuries. Invading bands who probably came from the Danube valley destroyed the settlements in central Macedonia: and the impact of this assault started a great movement of peoples from upper Macedonia and Epirus, areas remote from Mycenaean civilization. It was led by a clan, the Heraclidae, who claimed descent from Heracles and called themselves Achaeans. Their chief followers were Dorians, speaking a broad dialect of Greek, who were brigaded in three tribes, Hylleis, Dymanes and Pamphyli. Many other tribes were associated with them; they too spoke dialects of Greek, grouped by scholars under the title "Northwest Greek." The first invasions in the second half of the 12th century were sufficiently well organized to break down the resistance of the strongest Mycenaean powers. Thessali, led by Heraclidae, forced their way from southern Epirus into southwestern Thessaly, displacing Boeoti who invaded Boeotia (then called Cadmeis). Dorians, led by Heraclidae, migrated from Doris between the Pindus range and Mt. Parnassus, crossed the Gulf of Corinth and broke into the Peloponnese; peoples who spoke the Northwest Greek dialect crossed the western end of the gulf and invaded the western Peloponnese. Once they had overcome resistance, other migrants followed in their wake. Thereafter, as Thucydides wrote (i. 2, 1), "migrations mere of frequent occurrence, the several tribes readily abandoning their homes under the pressure of superior numbers." For when they had pillaged the Mycenaean cities and burned the palaces, the migrating hordes broke up into groups which roamed far and wide and did not accept the unfamiliar conditions of settled life.

Chaos and turmoil continued for two centuries in the Greek peninsula. Only Arcadia, in the mountainous centre of the Peloponnese, and Attica. lying on a peninsula off the main lines of invasion, succeeded in maintaining their independence. Elsewhere the earlier inhabitants mere made subject to the invaders or driven out as refugees. In pursuit of loot, Dorian bands crossed the sea, occupied the southernmost islands of the Aegean and established themselves on the southern part of western Asia Minor. Aeolic-speaking refugees from Thessaly and central Greece ended their wanderings by settling in the northern part of Asia Minor and on the islands of Tenedos and Lesbos. Ionic-speaking refugees fled first to mountainous Achaea and then to Attica, which the Dorians failed to enter by attack from the south. The last of the great migrations from Greece began c. 1000 B.C. when the Athenians launched the so-called Ionian migration, and ended c. 900 B.C. with the occupation of the Cyclades, the central sector of western Asia Minor and the adjacent islands. Meanwhile these and other migrating bands in Asia and Europe had enlarged the area of chaos to include Italy, Sicily and North Africa.

Excavation has exposed the poverty of the dark age in Greece. Men lived in scattered hamlets of hovels. having few material possessions and waging war against one another with the iron weapons which marked the transition from the Bronze Age to the Iron Age. Attica was an exception for a time. Formed into a unified state by Theseus in the late Bronze Age, the people of Attica preserved their Mycenaean traditions as well as their political independence. The city of Athens was strengthened too by the influx of refugees, capable and courageous men. who led the Ionian migration overseas and spread the use of the fine protogeometric pottery which had been evolved in Attica. But, when the migration was finished: the general paralysis of communications on the mainland and in the Aegean affected Athens too, and the city became impoverished by isolation. Conditions were no less difficult overseas in the islands and on the coast of Asia Minor, where the Greeks had established themselves in isolated pockets on narrow coastal strips of land and had to fight for existence against the native peoples and against one another.

The 9th and the 8th Centuries **B.C.**—An oasis of civilization in the near east survived the dark age. Its centre was Phoenicia, Palestine, Syria and Cyprus, where kingdoms such as Solomon's Israel flourished. The Phoenicians maintained their skill as seafarers, traders and artists; they planted Carthage and other colonies in the western Mediterranean; they developed the Phoenician alphabet, in which a separate sign or letter stood not for a syllable but for a consonantal or vowel sound; and they produced finely worked ivories and embroidered textiles. In the 9th century contacts were renewed by Phoenicia and Cyprus with the southern islands of the Aegean, the eastern Peloponnese and Athens. Phoenician ivories were imported and Phoenician letters were adapted to express the Greek language. Several Greek alphabets were in existence by 800 B.C., and intercourse gradually increased among the small communities of the mainland. Another legacy of the Bronze Age was epic poetry orally transmitted by those who still lived in such conditions as obtained during the breakdown of the late Bronze Age. The strongest school of epic poetry was in Ionia, the traditional birthplace of Homer, whose lifetime was put in the second half of the 9th century by Herodotus (ii, 53). Of the works ascribed in antiquity to Homer the *Iliad* is the oldest; some scholars agree with Herodotus' date and others place the poem in the 8th century. The *Odyssey* is clearly later and was probably composed by a diiferent author; even so, it should be dated before 750 B.C., to a time when the western Mediterranean was still unexplored by the Greeks. These great poems and many others, now lost to us, soon became known to the mainland and revealed the religious beliefs, personal ideals and material glories of the Mycenaean world to a population which was slowly emerging from the darkness of the Dorian invasion and its aftermath.

The renaissance of the Greek spirit in the 9th and 8th centuries was a gradual process, and it took place in conditions far different from those of the Bronze Age. Religion played a prominent part. Centres famous in Mycenaean times revived: Apollo again received worship at Delphi from the mainlanders, and Apollo's shrine at Delos attracted the Ionians of the islands. Religious leagues of a regional character, called amphictyonies (or amphictionies), were formed: the northern tribes worshipped at Anthela, the Boeotians at Coronea. some states near the Saronic gulf at Calauria and the Ionians of Asia Minor at the Panionium on the peninsula of

Mycale. Poetic competitions and athletic games were held at such religious festivals, and Olympic games were instituted in honour of Zeus at Olympia in the western Peloponnese. Temples were built between 850 and 750 B.C. at Sparta. Perachora and at Drerus in Crete; and continuity in religion and in architecture was preserved from Mycenaean times at Thermum in Aetolia. where a Mycenaean megaron was superseded by a 10th- or 9th-century temple of megaron type with an apsidal peristyle and this in turn by a classical temple.

A school of religious epic poetry grew up in central Greece. Its leading poet, Hesiod, whom Herodotus regarded as a contemporary of Homer. incorporated many Bronze Age legends in his Works *and* Days but added a strong sense of moral purpose which was characteristic of the mainland in his own day. The Tlzeogony, which was composed considerably later, drew upon Bronze Age traditions and set the Greek pantheon in order.

The political traditions of the Mycenaean world were preserved on the mainland in Attica, where all the citizens belonged to four Ionian tribes and paid a rather loose allegiance to a central government, headed at first by a king and then by magistrates. The refugees from the mainland organized their small states on similar lines when they settled on the islands and the coast of Asia Minor. As the defensible centre in each case was a citadel or polis, these states were called *poleis* or city-states. The Dorians, however, developed a different kind of state in Crete and in Laconia. At the time of the conquest the Dorians reduced the local inhabitants to serfdom and generally did not marry outside their onn circle. During the dark age the Dorian masters split up into small villages (komaz). which tended to fight with one another and nere themselves split by family and tribal feuds (for each district contained members of the three Dorian tribes). Under such conditions the masters might well be overthronn by their serfs. The Dorians of Crete put an end to the internal feuds in their villages by instituting a system of state education Boys were taken from their homes at an early age and trained together until they entered rival troops at the age of 1 j; if they qualified after two years of rigorous discipline, they were admitted to a men's club or mess (andueion) and thereby received the full franchise. Members of a mess fed together and fought side by side during their active life. The troops and messes were maintained by the state, and the members were trained exclusively to serve the state in politics and war; for they formed the "warrior class" in contrast to the "land-\\orking class" of serfs.

Kingship, which was appropriate to large tribal groups. declined in Crete during the dark age, and the villages elected ten executive magistrates to hold office for a year and to supervise the system of state education. A council, which had consisted of heads of clans in the tribal state, was now recruited from former magistrates to form a council of 30 elders, who held office for life. The assembly of citizens elected the magistrates and the elders but had little voice in policy, unless the council was divided in its views.

In Crete there were more than 100 states with such institutions, which agreed never to liberate the serfs in the frequent aars which they waged against one another. As Crete mas geographically self-contained, the energies of their centralized city-states were absorbed within the island, but it proved otherwise on the mainland when Sparta followed the example of the Cretans. In the plain of the Eurotas five Dorian villages combined politically to form the united state of Sparta and to impose much the same system of state education. Under the reform associated with the name of Lycurgus, those who were elected to the messes became full citizens, or Spartiates, at the age of 30 and were called "equals," those who failed to graduate in the state system became "inferiors" with lesser rights. The agricultural land was divided into equal lots, allocated to Spartiate families and worked by state-owned serfs, called helots. Kingship in the form of two royal houses had survived in Laconia, the tno kings claiming suzerainty over all Lacedaemonians (inhabitants of Laconia). In the constitution of the new state the two kings were the military and religious heads, but they had equal powers in the council with 28 elders. who were elected from equals of 60 or more years of age and held office for life. Five magistrates, called ephors, who supervised the state education and the messes, were elected from the equals and held officefor a year; at first they had little importance in the constitution. The assembly of Spartiates elected the elders and the ephors by acclamation. voted on proposals submitted by the council (for it could not initiate proposals itself) and passed decisions which were binding. The Dorian tribal system was replaced for military and political purposes. by five new tribes, each containing the residents of one of the five constituent villages at the time of the reform and thereafter their descendants.

The Spartan state was the first example on the mainland of the famous definition of Xristotle (Politics, 1252^b 28): "the partnership of several villages is the full-grown polis, which already possesses the dimensions of virtually complete self-sufficiency." Its formation was dated by Thucydides (i, 18, 1) toward the end of the 9th century, and it rapidly showed its superiority over its neighbours. (The date and to some extent the character of the reform associated with the name of Lycurgus are much disputed; for the view given here see *Journal* of *Hellenic Studies,* lxx, pp. 42–64 [London, 1950].) The warrior class of Sparta enforced the kings' suzerainty by reducing all Lacedaemonians to dependent status: the Perioeci (people of the vicinity), as they were called, henceforth obeyed the dictates of Sparta and served in the army, retaining only limited powers of internal self-government. The Lacedaemonian army then annexed Nessenia after 20 years of war (c. 740–720 B.C.) ; the best land was allocated to Spartiates and worked by Messenian serfs, and the hill people became Perioeci. Two other Dorian states grew, as did Sparta, out of constituent villages in the 8th century, namely Corinth and Megara. They conducted an indecisive war with one another for control of the Corinthian isthmus. But a new outlet was found for their energies in colonization.

The Colonizing Movement **and** Its Effects.—The pioneers of Greek colonization were the Ionians of Asia Minor. When life became more peaceful, they soon felt the pinch of over-population; for they held only a small foothold on the coast and could not overcome the vigorous peoples of the interior. Led by the Milesians. they sailed into the Black sea and planted their first colonies on its coasts m the first half of the 8th century. The Ionians of Chalcis and Eretria in Euboea opened up the west by planting colonies on the island of Ischia in the bay of Naples and at Cumae on the mainland opposite in the middle years of the 8th century. They were the first also to colonize Sicily. The Ionians of the islands were among the early colonists on the northern coast of the Aegean and on the island of Thasos. Although the Dorian states of the mainland came later, they founded the strongest colonies: for example, Syracuse, Corcyra, Apollonia Illyrica, Ambracia, Leucas and Potidaea founded by Corinth; Byzantium and Chalcedon founded by Megara; Taras (Tarentum) founded by Sparta; and Cyrene founded by Thera. The spate of colonization continued until c. 550 B.C., by which date hundreds of colonies were planted on the northern Mediterranean coast and islands from Spain to the Hellespont (except in the inner Adriatic), on all shores of the Black sea and on the African coast between Egypt and Carthage. The limits to the areas of colonization were set by the rival sea powers Etruria, Phoenicia and Egypt.

The Greek colony was a small independent unit, a replica and not a servant of its founder's original city; it was a polis in its own right, an apoikia or "settlement far from home." Thus the great variety of city-state institutions! alphabets, calendars! festivals and so on was perpetuated overseas in innumerable small states. Because the colonists aimed to establish a self-sufficient community, they went out in search of fertile land; but they chose sites in most cases which were suitably placed for trade. They were able to establish themselves at the expense of less civilized and less well-organized peoples by virtue of intelligence and fighting power; for they came usually in longboats of 50 oars, seized and fortified a small island or strong point and used their superiority of weapons and defensive armour to win good land. The Greeks adopted little from the natives of the sites that they colonized. Their colonies were rather outposts of a Greek civilization which was racially and culturally exclusive, but from them spread those hellenizing influences which transformed Europe during the Greek and Roman periods.

The Greek states of the homeland sent out their colonists for a variety of reasons. Sometimes they wished to rid themselves of surplus population or political malcontents, but they usually had their own positive interests in mind. The earliest colonies were planted to tap the trade in metals: and others were set up in areas rich in wheat, tunny fish or animal products. The colonies could thus trade with the homeland and particularly with the founding city. The commercial character of Greek colonization was so marked that the agricultural states of the homeland (the central Greek states. including Attica and the bulk of the Peloponnese) sent out no colonies, whereas the leading commercial states; such as Miletus. Chalcis. Eretria and Corinth. founded the largest number of flourishing colonies.

As the colonies were planted, Greek trade increased steadily. The traffic by sea, ranging from the shores of the Caucasus to Spain. had its centre of exchange at the Isthmus of Corinth. The merchantmen. being unable to tack against the mind, sailed along the coasts and islands, taking advantage of the onshore and offshore winds rather than venturing across the open seas. The Corinthians. c. 600 B.C., constructed a roadway (diolkos) for hauling vessels and cargoes across the four-mile span of the isthmus; Corinthian shipwrights invented the go-oared longboat; and the strategic position of its colonies, combined with its own wealth and naval power, gave the city of Corinth a strong hold on the western trade. The expansion of Greek trade within the colonial areas coincided with a period of close relations with Syria, Phoenicia and Egypt, The traffic which began in the 9th century revolutionized Greek ceramic art in 750–700 B.C., when the formal but austere dignity of geometric pottery gave way to the orientalizing style of polychrome painting and imaginative decoration. The new style was developed first in Crete, Corinth and Laconia and later in Athens and Ionia, but it spread rapidly throughout the Greek world, the potters of Corinth holding the lead until 550 B.C. Greek traders were active in the eastern Mediterranean, where stations were established at Naucratis in the Nile delta and at Poseidium near the mouth of the Orontes in Syria. Greek troops were employed as mercenaries by the kings of the east.

The Tyrannies.—Prosperity brought political troubles in its train. The traditional loyalties of the tribal state with its constituents — tribe (phyle), brotherhood (phratry) and clan (genos) —were centred in the racial units and were based upon the agricultural landowning system. The claims of birth were now upset by the claims of wealth. The first effects were seen among the aristocratic leaders. whose solidarity of interest was disrupted. At Corinth. where the Racchiadae were the ruling clan. Cypselus, the son of a Bacchiad woman. seized power and set up a "tyranny" which mas maintained by him and his descendants from *c.* 657 to c. 582 B.C. His example was followed at Sicyon, where tyranny lasted for a century, and at Megara, where it was short-lived. The tyrants were not social revolutionaries but self-seeking aristocrats. who increased their own revenues by keeping the citizens at work and promoted the trade and prestige of their states with remarkable success. When they fell, they left a legacy of political bitterness. from which oligarchy emerged once more triumphant. In these Dorian states the existence of the serf class also acted as a brake against social revolution. In the Ionian states. where all men were citizens. the tyrants at Ephesus and at Miletus. for example, overthrew the aristocratic order but failed to establish a stable government; and on their fall a period of faction ensued between oligarchs and democrats.

Solon. — The troubles which attended sudden prosperity were sometimes solved by "law-givers" or arbitrators. The most famous of these. Solon of Athens. was appointed in 594 B.C., at a time when the wealthy were entitled under the laws of debt (1) to tie bankrupt debtors to the land and exact one-sixth of the produce and (2) to sell off a second category of debtors as slaves. The explanation of these two categories of debtors is disputed: the first probably comprised members of Athenian clans. who were prohibited by law from alienating land owned by the clan: the second was probably composed of *orgeones* (that is to say, members of guilds), who were Athenians originally by naturalization and not by blood and owned alienable goods. Solon liberated both categories. forbade the tying or selling of bankrupts and made new laws of debt. He then carried a constitutional reform to safeguard the poor from oppression. He instituted a people's court of appeal in the Heliaea; there anyone could initiate a case. and the appeal from the ruling of a magistrate or the verdict of a phratry or clan court was judged by a panel drawn by lot from all citizens, however poor. He divided the people into four classes according to income and ruled that candidates for state offices should belong to this or that class; he thus eliminated the aristocratic principle of birth, which had hitherto been important in candidature for office. He left the constitution much as he found it (annual magistrates elected by the people; the council of the Areopagus, the members of which nere elected for life from the former magistrates; and an assembly or ecclesia), but he nominated 400 members to serve for ten years on a new council or boule, which was to act as a steering committee for the assembly. Solon was a true arbitrator: he gave to each section of the state those powers which he considered it fit to wield He enunciated for all citizens freedom of the person, equality before the law and a say in election and government, but he left the mass of real power in the hands of the Areopagus council and the wealthy class in the state. which was in the main the aristocracy of birth. He also took an important step to widen the economic basis of a country which was mainly agricultural and had stood aside from the colonizing movement: he invited craftsmen from other states to settle in Athens and to receive the franchise. Further, he reformed the standard of the currency so that Athens could enter the commercial orbit of Corinth on favourable terms.

Currency and Coinage. — During the expansion of the Greek states, 750–550 B.C., commercial exchange was lubricated by the adoption of currency from Lydia in Asia Minor, where a lump of electrum (a natural alloy of gold and silver, in which the proportion of gold is variable) was guaranteed at a definite price by the king of Lydia and stamped with his emblem of state. a lion's head. Most of the Greek states which engaged in commerce were coining in silver before 600 B.C., and the circulation of fractional currency in place of barter made it possible to accumulate mobile wealth more rapidly. Credit, usury and banking soon followed. and the foundations were laid of an active capitalism which has distinguished Europe from the east for many centuries.

The Conflict Between Greece and Persia

The Persian Advance and the Growth of Sparta and Athens. — The expansion of the Greek states was favoured by external circumstances. No great power overshadowed the Mediterranean area in the period 750–550 B.C. The civilized states of Asia Minor, Syria. Egypt, Carthage and Etruria were less aggressive and less capable than the Greeks, and no really great wars broke out between the Greek states theinselves (the conflict that involved the largest belligerent coalitions was the Lelantine War between Chalcis and Eretria and their several allies). The situation changed when Cyrus the Great incorporated Lydia in the Persian empire c. 546 B C.; and his successors reduced every state from the Mediterranean coast of Asia to the Indus valley and Egypt also. In 514–513 Darius I led the forces of the Persian empire across the Bosporus into Europe, marched north against the Scythians beyond the Danube and withdrew discomfited; but he retained control of the northern Aegean coast. conquered some Greek islands off Asia Minor and the Hellespont and received the submission of the king of Macedon In 500 the Persians were preparing to advance into the Aegean, where they were invited to intervene at Naxos in the Cyclades.

The Peloponnesian League. — The Greek states of the mainland took no steps to help the Greeks of the Asian coast and the islands when they were overrun by Persia. The Spartan government uttered diplomatic threats. but remained. no less than the others. immersed in its own affairs. By j46 B.C. Sparta had become the strongest power in Greece. a Messenian revolt (*c.* 640–620) had been put down; the rival military power of Xrgos had been defeated; and a military coalition known as the Peloponnesian league or, more accurately. the Spartan alliance, had been formed. As leader of a coalition Sparta had many attractions to offer, including a stable constitution, a superb standing army and a sound agricultural economy—(having banned the introduction of coinage, the Spartans had very little commercial interest, and they had no hunger for land). The Spartans' record moreover was good, in that they had deposed tyrants in some states and supported conservative government in general. Any state which joined the military coalition contracted a defensive alliance with Sparta, agreed to serve under Spartan command in time of war and undertook to provide help against the seris; and the contracting state received in exchange the protection of the leading military state against any aggressor. Having initiated this policy *c.* 550 B.C., Sparta brought almost all the Peloponnesian states, apart from Argos, into this coalition before j10.

Peisistratus and the *Peisistratids*.—Athens grew in power under a tyranny. When Solon retired, there was a long period of party striie which ended finally in the seizure of power by Peisistratus about j46 B.C. He and his sons ruled Athens until 510 with a firm and consistent policy which brought the prosperity envisaged by Solon. Athenian pottery outstripped Corinthian and established a long-lasting supremacy for black-figure and red-figure wares. Under Peisistratus, Athens became one of the leading centres of commercial exchange, had very close relations with the Ionians, planted settlers on the Thracian Chersonese, on Lemnos and Imbros and held Sigeum in the Troad, thus securing some grip on the approaches to the Hellespont. After Peisistratus died in 528 or 527, the advance of Persia weakened the Athenian position. Two friendly tyrants. Polycrates of Samos and Lygdamis of Naxos, fell from power. and Darius annexed the Chersonese and threatened Lemnos and Imbros. Athens moreover became embroiled in 519 with Boeotia. where a league of city-states had grown up under the leadership of Thebes and was trying to force Plataea into membership. When Athens made an alliance with Plataea. Thebes and Athens came to blows, and Athens was victorious. This success caused alarm to the other Greek states. In 514 Hipparchus, one of Peisistratus' sons. n-as assassinated by two Athenians, Harmodius and Aristogeiton. In 510 Sparta, aided by Athenian exiles. used force to expel from Athens the leader of the Peisistratids, Hippias, who fled to Persia. Athens was now enrolled in the Peloponnesian league: which included Boeotia and other states in central Greece.

Cleisthenes.—Liberation did not bring peace to Athens. The aristocrats who had been ousted from authority or banished by the tyrants now struggled with one another for power. But the common people and especially the town dwellers, to whom the tyrants had brought prosperity. were a new factor in the situation; for they had gained some political experience in working the constitution and the laws of Solon under the tyrants. who kept the real control in their own strong hands. A returned exile, the aristocrat Cleisthenes of the Alcmaeonid clan, who was losing the struggle against his peers, espoused the cause of the commons. His rivals called in a Spartan garrison to occupy the acropolis in 508 B.C. The Athenians rose in disgust, forced the garrison (commanded by a Spartan king. Cleomenes I) to withdraw from Attica and authorized Cleisthenes to set up a constitution.

Cleisthenes' aim was to cut away the political power of the clans which made the rivalry of the aristocrats so dangerous and to give the guildsmen a part in the administration of the state. He therefore made residence instead of race the basis of the electoral system and replaced the four racial tribes with ten new tribes of residents in "demcs" (about 170 areas similar in size to small parishes). As he wanted the new tribes to cut across (1) the local influence of the clans which owned big estates and (2) the sectional interest of the town as opposed to the country, he constructed each new tribe out of demes usually not contiguous one with another and drawn in equal proportion irom town, coast and inland. Having broken the racial principle (as the Spartans had done in their reformj. Cleisthenes made tribal membership hereditary after 507 B.C. Each new tribe provided a military contingent; elected a general (strategus) and lesser officials annually; and for a council of state provided 50 members annually: selected by lot irom candidates elected by its own demes in proportion to the population of each deme. The new council or boule of 500 members, inheriting the powers of Solon's council of 400, prepared all business for the assembly, carried out routine administration and was divided by tribe into ten committees of which there mas always one, elected by lot, in permanent session for a tenth part of the year. Although Cleisthenes ensured the electoral and political rights of the commons, he left the constitution in the hands of the experienced class. The council of the Areopagus, as guardian of the constitution and the laws, had the right to veto a decree of the assembly and tried cases of treason. The chief magistrates (the nine archons) were still elected by the people en masse from members of the two richest classes, and the 500 councilors had to be members of the top three classes, who had passed a scrutiny (*dokimasia*) by the outgoing council. There were thus sufficient checks on the assembly's sovereignty to make the constitution a balanced one, "admirably adapted to promote unanimity and preserve the state" (Plutarch, *Life* of Pericles, 3).

Athens and the Peloponnesian League, *506–500*.—The constitution was soon tested. In j06 B.C. the Spartans advanced to Eleusis with their Peloponnesian allies, while Boeotian and Chalcidian armies invaded northern Attica at two points. The Athenians concentrated their army at Eleusis. But the Corinthians, who disapproved of an attack on Athens, left the Peloponnesian ranks, and this precipitated a quarrel between the two Spartan kings, who had equal powers of command. A deadlock resulted, and the whole Peloponnesian army went home. Athens then trounced the forces of Boeotia and Chalcis separately. annexed the best land of Chalcis and planted 4.000 Athenian settlers on it. Aegina then made an alliance with Boeotia and sent a strong fleet to ravage the coast of Attica. The Athenians approached Persia for help. but, when they were ordered to accept Hippias as tyrant, broke off negotiations. Meanwhile Sparta was dealing with the problems raised by the fiasco of the recent invasion of Attica. A law was enacted whereby the two Spartan kings were forbidden to serve together, except in Laconia. Next, anxious to deprive Persia of a gambit for entering Greece, the Spartans brought Hippias over from Asia and promised to restore him as tyrant. They then asked their allies to send delegates to a conference at Sparta and explained their plan; but the Corinthian delegate protested, the others followed suit and Sparta acquiesced in the decision.

This conference not only saved Athens but also crystallized the organization of the Peloponnesian league. Thereafter, whenever a defensive alliance with Sparta was invoked. Sparta convened the delegates of the allies and explained the position. The delegates then voted: each state having one vote, whether the body of allies was to go to war; the decision of the majority, being binding on the minority, was reported to Sparta, which voted separately in the state's own assembly. If the two equal bodies—the congress of allies and the Spartan state—concurred, a common policy was adopted; otherwise no action was taken by the Peloponnesian league as a whole. 'This was a realistic procedure. which recognized that the agreement of Sparta was indispensable to the league.

The Ionian Revolt.—The Greek states of the mainland thus were iar from united in 500 B.C. when Persia accepted an invitation to intervene at Naxos. A member of the Persian royal house and a Greek called Aristagoras, who had been appointed tyrant of Miletus by Persia, tried to take Naxos by surprise in 499 and failed. Afraid of Persian resentment at this failure, Aristagoras made plans to raise the Ionian states in revolt. He resigned his tyranny at Miletus and persuaded the other states to depose their pro-Persian tyrants. Then he applied to Sparta for help. Sparta was already committed to enmity with Persia, but saw that the Spartan army, which counted 10,000 men at full strength, could do little or nothing to hold the narrow coastal fringe of Asia Minor against the vast resources of Persia. Sparta therefore refused. Aristagoras, however. went on to Athens, and the Athenian assembly gave him a squadron of 20 ships. thus earning the gratitude of the Ionians and the hostility of Persia. The only other help was five ships sent by Eretria.

The Ionian states that had deposed their tyrants decided in 498 to tight ior their independence against Persia. It was a remarkably courageous decision; for the resources of Persia were vast and individually the Ionian states were puny by comparison. At first they held the initiative; for the Persians had to muster the fleets of their subjects in Cyprus, Phoenicia and Egypt. But the Ionians started by marching inland. n-here they burned Sardis but failed to capture the citadel. The Greek cities of the Bosporus and of the Hellespont rose in sympathy, thereby cutting off the Persian forces in Europe and opening the way for supplies from the northern coast of the Black sea. Most of the Carians. who were good soldiers. joined the revolt. Finally the Greek states in Cyprus attacked the Phoenicians in the island. Instead of co-ordinating their allies and sailing to Cyprus. the Ionians allowed Persia to take the initiative in 497. At this stage the Athenians sailed home. Two Persian army groups operated in Asia Minor, and a third was transported by the Phoenician fleet to Cyprus. where the Ionians brought them to battle on land and at sea. Although the Ionians were victorious at sea, the Persians kept the initiative by land and recovered the whole of Cyprus in 496 B.C. In Asia Minor one Persian army group reduced some Greek states in the area of the Hellespont. but the other group was finally annihilated by the Carians late in 496. During the winter of 496–495 the Ionian states sent deputies to a conference at the Panionium to make an agreed plan. They decided to raise no army but manned 353 ships. each contingent serving under its own captain. When the captains entrusted the command of the fleet to one of their number, the seamen mutinied. Meanwhile Persia raised a larger fleet. which moved up the coast with an army in support and offered a free pardon. if the Ionians would capitulate; but the offer was refused. In midsummer of 495 a naval battle was fought at Lade. in which some Ionian squadrons fought well but others fled without engaging. The Persian fleet was decisively victorious, and by the summer of 493 the last of the rebels was reduced. (The chronology is disputed; for this account see Historia, iv. p. 385 [1955])

The Ionian revolt was not in vain. It showed the Greeks of the homeland that resistance to Persia was not hopeless and that co-ordinated policy, unified command and sea poner nere of the first importance. The Persians too learned a lesson. When the) had meted out punishments. they permitted democratic government in the Ionian states, ordered them to keep the peace nith one another and demanded tribute in accordance nith a just assessment. This politic settlement was successful. The Ionians stayed quiet while the Persians re-established their authority in Europe as far as Macedonia in 492 and raised forces in 491 to punish Xthens and Eretria

The policy of Athens had fluctuated during the revolt. When it ended in failure. the Athenians began to fortify their naval base at the Peiraeus on the advice of Themistocles. who advocated resistance to Persia ; and they sought a *rapprochement* with Sparta In 491, Persian agents visited the Greek states and demanded earth and water. the tokens of submission Several states medized (*i* e , joined the Medes and Persians). One of them. Aegina nas still at nar with Athens. At the request of Xthens. Sparta compelled Aegina to re\ oke this submission to Persia in 491, but Aegina attacked Athens in the following year and was only held in check by Athens with the aid of Corinth. (The chronolog} is disputed: for this account see *Historia,* iv. p. 385 [1955].) Nevertheless, Athens could now count on the help of Sparta

The Persian Wars in Greece.—A strong Persian expeditionary force sailed across the Aegean in 490 B C All the islands in its path submitted except Euboea \ here Carystus and Eretria resisted but were quickly reduced. The Persian commanders, taking the advice of Hippias, landed unopposed at Marathon; supplies were ferried over from Euboea, and the plain was suitable for their cavalry, which was far superior to any Greek cavalry When the Athenians learned of the landing, they sent a runner Philippides (or Pheidippides), to inform Sparta (he reached Sparta. 140 mi. away, on the next day) and met in assembly to discuss strategy. On the proposal of Miltiades. nho was general of a tribal contingent. they sent their heavy infantry to Marathon There the Athenian commander. Callimachus. pitched his camp on the foothills where the Persian cavalry could not deliver an attack. and watched the Persian infantry drawn up along the shore. For a few days neither side moved. The Athenians numbered about 10,000 men and were reinforced by 1,000 Plataeans. The Spartans promised to send an army when they had completed the festival of Apollo, but that would not be for a week or more.

Marathon.—Miltiades had had considerable experience of Persian warfare. As ruler of the Thracian Chersonese. he had seen the army of Darius in 513 and followed the events of the Ionian revolt from close quarters. He therefore appreciated the fighting qualities of both sides at Marathon. The Greek heavy infantryman. the hoplite. wore defensive armour of bronze (helmet. breastplate and greaves). whereas the Persian infantryman more a bonnet. a padded or scale-clad tunic and close-fitting trousers. The Greek weapons were a bronze shield, a six-foot spear and a sword, whereas the Persian had a wicker shield, a shorter spear and a sword. Miltiades knew that despite inferior numbers the Greek infantry would have a chance of defeating the Persian infantry at close quarters. Infantry tactics were similar on both sides; for the men fought in a solid line, several ranks deep. The Greeks, however: were more experienced : hoplite warfare had been practised since 700 B.C.. and the Athenians and Plataeans were seasoned soldiers. The Persians were a picked but composite force with far less tradition of infantry fighting. Miltiades, therefore, advised his fellow generals to attack as soon as opportunity offered. The votes of the ten generals were equally divided. and the casting vote lay with Callimachus, a civil magistrate (archon polemarch). He sided with Miltiades. Even so, each general had one day of operational command in turn. Those who had sided with Miltiades gave him their days, and it so happened that Miltiades commanded on the day of the attack. The circumstances which made the attack possible are not explained by Herodotus, the historian of the Persian Wars. and the following account is a reconstruction which is controversial.

While the armies waited. Miltiades advanced his position into the plain by felling trees and making stockades at night. until he was only a little more than a mile from the Persian infantry lines. The large force of Persian cavalry, perhaps 5,000 strong, maneuvered in the plain by day but needed water and pasture at night; these were best found at that time of year (September) in the springs and marshes at the far end of the Marathon plain. One night near dawn some Ionians serving with the Persians came to the stockades and said, "The cavalry are away." Miltiades drew up his men, strengthening the wings and thinning out the centre of the line, hurried across the plain in the dawn and charged the Persians at the double. Bitter fighting ensued. The Athenian centre was pushed back. but the weight and superior armour of the wings prevailed and both wings then turned inward and attacked the Persian centre from both sides. Once the melee of the infantry battle had started, the Persian cavalry could not intervene effectively. and the Greeks drove the enemy down to the sea, where their fleet took them off.

As the Persian fleet stood out toward Euboea, the Athenians on the battlefield saw flashes from a shield inland. The flashes were evidently a signal; for the fleet changed course and headed for Athens. Suspecting that the supporters of Hippias intended to surrender the city, the Athenians managed by a forced march to reach Xthens just before the fleet entered the bay of Phalerum. A landing was now impossible. The Persian fleet sailed for Asia. Next day the Spartan vanguard arrived and marched to Marathon to study the arms and tactics of the Persians. The Athenian dead, 192 in number. were buried where most of them had fallen. The burial mound still marks the spot. The Persians had lost 6,400 men and much of their prestige.

Preparations for War, 490–480.—Darius was now determined to invade Greece in force. But a revolt by Egypt: Darius' death in 486 B.C. and the reduction of Egypt by Xerxes, his successor, delayed the offensive until 480. Although the Greek states had ample warning, most of them made no preparations until the last moment. Athens showed more foresight. Rliltiades led a fleet of 70 ships into the Aegean to secure the Cyclades against Persia. He was wounded in an unsuccessful attack on Paros and was later condemned on a charge of misconduct. He died of his wound soon afterward. The offensive was then abandoned, but the Athenians made political preparations for the future. The aristocratic leaders. who were related to Hippias, and perhaps also other leaders favoured appeasement or collusion. Even the advocates of resistance differed in their strategy, because some trusted in their victorious army and others in their comparatively inexperienced and small navy. The decision lay with the assembly from meeting to meeting, but there was a grave danger that the mood and, therefore, the policy of the assembly might fluctuate if it were to be exposed to the oratory of rival leaders. It was essential to make a lasting choice in good time. The means were found in ostracism —a procedure which may have been devised by Cleisthenes but was used now for the first time. If the assembly decided without debate to hold an ostracism, each citizen scratched the name of the man he wished to expel on a piece of pottery (ostrakon) and returned it at a later meeting. If the pieces of pottery exceeded 6,000, the man whose name headed the poll was banished for ten years but retained his property and citizenship. Between 488 and 482 ostracism was used frequently (thousands of ostraka have been found in the excavation of the Agora in Athens). Victims were Peisistratid and Alcmaeonid leaders and finally Xanthippus, son-in-law of Cleisthenes, and Aristeides. a colleague of Miltiades at Marathon. By this effective method the assembly selected Themistocles, the advocate of a naval strategy, as its leader for the war against Persia and authorized him in 483-482 to devote an unexpected yield from the state-owned silver mines to the building of warships. In 480 the victims of ostracism were recalled. The fleet then stood at zoo vessels and Themistocles mas in charge.

Another problem at Athens was the machinery of command in the field. The preliminaries at Marathon had made this obvious. In 487 the assembly deprived the civil magistrate of his military functions and changed the procedure for appointing the nine chief magistrates. The demes now elected 500 candidates, of whom nine were selected by lot, scrutinized by the council and appointed. The ten generals were the only officials still appointed by direct election. They became the most important figures in Athens at a time when a war for survival was imminent. (See STRATEGUS.)

Effective resistance depended less on Athens than on Sparta. Whereas Athens was hemmed in by enemies (Thebes and Aegina), Sparta led a powerful military coalition and had shown prowess by inflicting a severe defeat on Argos *c.* 495 B.C. When Xerxes sent envoys to ask all Greek states except Athens and Sparta for earth and water, Sparta held a Greek congress late in 481, at which delegates of about 30 states agreed to enter into alliance against Persia and to terminate all wars with one another. Argos, Crete and Syracuse were invited to join the alliance. Their refusal was reported when the delegates met in the spring of 480 at the Isthmus of Corinth. The problem of co-ordinating 30 states was solved by the statesmanship of the Spartans and their allies. who formed the bulk of the coalition. Each state. Sparta included. cast a single vote at a congress of delegates and agreed to obey a majority decision. The congress entrusted the command by land and sea to Sparta, decided the general lines of allied strategy, raised and allocated men and money, conducted diplomatic negotiations and threatened medizing states and persons. The member states of the congress entitled themselves "the Greeks" (Hellenes). Thus for purposes of defense a Greek league came into existence and evolved an efficient machinery of allied co-operation.

Artemisium and Thermopylae.—In the spring of 480 B.C., Xerxes entered Europe with a vast army, supported by a large fleet. His chief problems were supply and transport. He had laid some dumps in advance but depended mainly on the fleet; which was therefore tied to the army. The means of transport in a country without roads were pack horse and oxcart. Indeed the army advanced at so sluggish a rate that Xerxes brought the Greeks to battle on land only once in 480, and that was on ground chosen by them. The congress of the Greek league wanted to inflict a defeat on the Persian fleet, which would halt Xerxes' advance. They therefore posted the Greek fleet at Artemisium in northern Euboea and a holding force of 6,000 or 7,000 hoplites at the pass of Thermopylae on the mainland farther down the Euboic channel. The fleets fought indecisively on three successive days. The Greeks had sufficient success to encourage them in view of their inferior numbers, but their base on the island became unsafe when the Persian army turned the position at Thermopylae. There the hoplites proved far superior in hand-to-hand combat, and the Spartan king Leonidas and his 300 Spartiates showed the spirit of free men by fighting to the death.

Salamis.—The congress of the Greek league chose the island of Salamis, off the Bay of Eleusis, as its next naval base and fortified the neck of the Isthmus of Corinth. Central Greece was left defenseless. Thebes joined the Persian forces, as Thessaly had already done, but the Athenians took to their ships on the advice of Themistocles, abandoned Athens to fire and pillage and let the council of the Areopagus represent the state during the emergency, while the people were dispersed as refugees. The political decision of the Greek congress was unpopular from the outset with some of the captains who had to put it into effect. The Greek fleet of 380 warships was faced by a Persian fleet which had replaced its heavy losses in storms off Thessaly and Euboea and now mustered about 1,400 ships (for the numbers of ships involved. as well as for other controversial matters connected with the battle of Salamis, see the full discussion in the *Journal* of Hellenic *Studies,* lxxvi, p. 32 ff. [1956]). When the Persian fleet conducted a reconnaissance off the eastern exit of the Straits of Salamis, the division of opinion flared up on the council of captains over which the Spartan commander, Eurybiades, presided. Many captains wished to withdraw their national contingents and defend their homes in the Peloponnese, for they were afraid of being bottled up and annihilated in the Straits of Salamis and the Bay of Eleusis. The decision lay with Eurybiades, but Themistocles did not wish the future of the Greek navy to hang on the Spartan's judgment. He sent a message that evening to Xerxes, saying the Greeks were divided and about to disperse and that he, Themistocles, was friendly to the Persian cause. The advisers of Xerxes, remembering the Greek dissensions at the battle of Lade, thought the message credible. and Xerxes acted upon it. He sent 200 ships that night to close the western exit from the Bay of Eleusis, off Megara, landed picked troops secretly on an island at the eastern end of the straits and kept the main fleet under oar all night, patrolling the open water outside the eastern exit. Meanwhile the Greek captains wrangled into the small hours, until Aristeides brought a report that the western exit was being closed by the enemy. Withdrawal was now impossible. The Greek command made its plans, aided by the captain of a ship from Tenos who deserted and gave details of the Persian dispositions.

The Greeks were experienced in naval warfare. Their ships were vessels of a uniform type, the trireme, driven in battle by 170 oars and designed for ramming. They were more stoutly built and therefore lower and slower than the Phoenician galleys. which were designed for boarding tactics and carried more marines. The first problem for the Greek command mas to offset their smaller numbers by drawing the Persian fleet into the straits. As dawn broke, the Greeks embarked at their bases halfway up the straits and rowed off northward out of sight. The Persian fleet, seeing them disappear, thought they were in flight and rowed into the straits. Then the Greeks returned in battle order to the narrowest part of the waters, maneuvered under oar to create favourable circumstances for ramming and went into the attack at the crucial moment. The Phoenician squadron. in the van, suffered heavy losses, and the leading files were driven back onto those which were still advancing. Then the Greek ships, encircling the scene of confusion, rammed repeatedly with a sure aim, until the Persian ships capsized and the sea was covered with wreckage and corpses (Aeschylus, *Persae,* lines 417–421). As a west mind rose, the Persians hoisted sail and fled to Phalerum. having lost the pick of their fleet. Next day Xerxes, who had watched the battle from the mainland, did not renew the engagement; for although his fleet was still far superior in number, he saw no hope of prising the Greek fleet out of its strong position.

Plataea and Mycale.—The Greek victory at Salamis halted the Persian advance in September, the end of the campaigning season.

Xerxes himself returned to Asia with his fleet and part of his huge army, but his general Mardonius wintered in central Greece with a formidable army. Despite Athenian, Plataean and Megarian pressure, the Greek congress at first kept its army at the Isthmus of Corinth and its fleet at Aegina to conduct a co-ordinated defense; if necessary; but it passed to the offensive on both land and sea in late summer, 479 B.C. Mardonius, having tried in vain to detach the Athenians from the Greek cause by diplomacy and then by ravaging Attica, withdrew his army of perhaps 150,000 men as the Greeks advanced. He chose his ground in the Boeotian plain below Plataea. There the Persian cavalry dominated the plain and the Greeks stayed on the foothills. where they soon ran short of supplies and water; for nearly 40.000 hoplites and 70,000 light-armed troops were dependent on pack horses traversing Mt. Cithaeron. One night in August the Spartan regent Pausanias ordered a general withdrawal, which was disrupted by the obstinacy of a Spartan officer who stayed at his post. Dawn found the Greek units scattered. Mardonius advanced at once, concentrating his best infantry against 10.000 hoplites of Sparta and 1,500 hoplites of Tegea. who were isolated from the main Greek army.

Pausanias kept his troops in hand, until he judged the moment ripe. Then he led his Spartans and Tegeans downhill at the charge. They overwhelmed the Persians with their superior weight, longer weapons and disciplined array, killed Mardonius and pursued the fugitives to their stockaded camp so closely that the cavalry could not intervene. The Greek centre was driven back from the plain; but the Athenians. 8.000 strong under Aristeides, defeated the Thebans. joined Pausanias and stormed the camp. By nightfall the bulk of the Persian army was destroyed. Meanwhile the Greek fleet. commanded by the Spartan king Leotychidas. drove the Persian fleet to the Asian mainland at Mpcale. Leotychidas landed his sailors and marines farther up the coast. destroyed the Persian fleet and inflicted very heavy casualties on a supporting army. The Ionians and Aeolians at once rose in revolt. The Persian invasion thus met with final disaster.

The Greek Offensive.—As Persia had vast resources. Xerxes was likely to attack again. The best method of hindering him was to punish the medizing states, to cut the communications between Europe and Asia and to keep the Phoenician fleet out of the Xegean. Late in 478 B.C. this was almost achieved; for Thebes had been punished and Thessaly invaded, and the navy under Pausanias had captured most of Cyprus and occupied Byzantium. But the revolt of the Ionians and Aeolians raised a difficult problem. Sparta and the other Peloponnesians still thought (as in 498) that Ionia could not be defended and therefore advised the Ionians and Aeolians to leave Asia. Athens. however. appreciating the nature of sea power, believed that Ionia could be protected and could help to protect the Aegean from the Phoenician fleet. The divergence of opinion between Sparta and Xthens was also based on self-interest. Having lost a considerable proportion of their best troops at Thermopylae and Plataea, the Spartans wished to husband their manpower for the suppression of the helots and the strengthening of the Peloponnesian league. The chief asset of Athens was the fleet; for Attica was ruined, and the walls, of Xthens were being rebuilt against the wishes of Sparta. If Athens could win the leadership of the Ionians of the islands and of Asia Minor, a mass of power comparable to that of the Spartan alliance would be created. Xthens then played a skillful hand. In 479, after the victory at Mycale, the Athenian squadron under Xanthippus joined the Ionians in capturing Sestos in the Hellespont. In 478, when the Spartan Pausanias became unpopular and mas recalled. the Ionians offered the command of the Greek navy to the Athenian captain. Aristeides. Athens accepted and Sparta acquiesced. They had combined to defeat Persia in the past and were both under oath to maintain the principles of the Greek league.

The Confederacy of Delos.—An offensive and defensive alliance was contracted by Athens with each of a number of Ionian states separately in the winter of 478–477; these Ionian states did not necessarily make alliances with one another. Xthens (with a fleet of 200 triremes) was thus the centre and leader of the coalition, but undertook to respect the autonomy of the other members. The allies met regularly at Delos in a synod, where each state had one vote and a majority vote was binding; the Athenian state took its own decisions separately. If the synod and Athens agreed, a joint policy was formed by the coalition. which was known in Greek as "Athens and the allies" and goes now under the loose title of the Confederacy of Delos. It resembled the Peloponnesian league closely? except that the alliance was offensive. The allies accorded to Athens the command at sea, a half-share of any booty and important executive powers: *e.g.*, Athens decided which states should contribute money and which states ships and assessed the amount in each case. Athenian officials kept the accounts of the allied fund, which was placed in the temple of Apollo and Artemis at Delos. and Athenian commanders had disciplinary powers over the troops which each state had to supply in addition to money or ships. The coalition won a series of successes against the Persians in Europe and Asia, which culminated in an attack on a Persian army and a navy of 350 ships mustering at the Eurymedon river in Pamphylia *c.* 466 B.C. Under the command of Cimon. the Athenian fleet of zoo ships, carrying about 5,000 hoplites. and the allied squadrons, amounting to 100 'ships and carrying parties of marines and archers, sank 200 enemy vessels. forced a landing and defeated the Persian army. The policy of Athens was triumphantly vindicated.

Cimon and Sparta.—During these years Athens had to watch its relations with Sparta. Themistocles, who had deceived Sparta while the walls of Athens were being rebuilt, and Aristeides and Xanthippus, who brought the Confederacy of Delos into being, were in favour of democracy and hostile to Sparta. but the people put their trust in Cimon, a friend of Sparta. and in the council of the Areopagus, which had proved its excellence during the year of emergency. Themistocles was ostracized and then banished; he died in the pay of Persia. The Areopagus maintained friendly relations with Sparta. Athens was also careful to have the allies' agreement on matters of external policy and was probably supported by a majority vote of the Delian synod in forcing Carystus to join the coalition and in compelling Naxos, which had seceded, to rejoin on less favourable terms. But Cimon's victory of the Eurymedon created a new situation, because the allies were now safe from Persian attack and the last Persians in Europe were about to be expelled. In 46j B.C. Athens demanded from Thasos a share in certain possessions on the Thracian coast. As this demand infringed their autonomy. the Thasians seceded from the Confederacy of Delos. Xthens attacked Thasos. which was reduced by 462 B.C. and forced to rejoin the confederacy as a dependent state: the Thasians were compelled to surrender their fleet, dismantle their walls. give up their mainland possessions and, thenceforward. contribute money to the allied fund.

The policy of Athens alarmed the Spartans, who secretly promised help to Thasos. But a terrible earthquake in 464 killed many Spartiates, and the helots rose in revolt. Sparta obtained help from its allies, including Athens. but in 462–461, while the Athenian army was in Messenia. the democratic leaders. Ephialtes and Pericles, carried a reform at Athens which ended the ascendancy of the Areopagus and installed a democratic constitution. Sparta dismissed the Athenian army with ill-concealed mistrust. In 461 the Athenian assembly ostracized Cimon and entered into alliance with Argos and Thessaly, the medizing states, which were the enemies of Sparta on the mainland. The period of co-operation between Sparta and .Athens, which had led Greece to success against Persia. was now at an end.

Greek Civilization during the Persian Wars.—Greek beliefs, as expressed by Homer and Hesiod, had much in common with the Bronze Age. The physical universe. for instance. was held to be a sphere, the upper half airy and light and the lower dank and dark. with the earth a flat disk floating midway between the two halves on the waters of the "underworld" and rimmed all around by the great river of Ocean. Matter was original. at first chaotic and confused but then of its own volition orderly and arranged The gods were secondary in time, resident some in the heavens, some in the underworld, but unable to change the conditions of material existence. Men. created by the gods. were subject not only to the material world but also to the caprice of gods who were at odds among themselves. These beliefs formed the background of the Babylonian epics (especially the Epic of *Gilgamesh*) and of early Egyptian religion, but they led to a state of fatalistic despair and superstitious terror, in which men became subservient to the magical incantations of an authoritative priesthood. The Greeks, however, retained a faith in man's free will, moral purpose and independent judgment: the legendary hero Achilles chooses to. fight because he has his own standards of conduct and accepts the prospect of an early death. Likewise, they attributed the same qualities to the superhuman beings of their mythology: Prometheus chooses to give fire to man and accepts eternal suffering. But the consequences of such acts of free will do not lie solely within man's or god's control: they are subject to the immutable laws of physical life—heredity, disease, death and so forth. When Orestes murders his mother to avenge her assassination of his father, no man or god can prevent the onset of insanity.

Faith in free will, in moral purpose and in independent judgment had important political consequences. The Greeks despised the oriental subjects of the Persian monarchy. They defended the free city-state to the death. Solon told the Athenians that they were individually responsible for the internal relations of their society and that Athena, the goddess of their state, would be their guardian in the external fortunes of international and material life. Therefore he laid down a plan for social justice which the Athenians might implement of their own free will but which he would not enforce by seizing power. The colonizing movement and the wars against Persia and Carthage (see SICILY) made the Greek states more conscious of their common heritage and strengthened their belief in the benignity and power of their gods, over whom Zeus presided. Religious faith was strong; Olympia, Delphi and Delos became international centres which influenced the far-flung world of small city-states. Pindar expressed the orthodox piety, moral principles and personal ideals of the Greek world at the time of the struggle with Persia and Carthage. Aeschylus, who fought in the Persian Wars, saw Zeus as the governor of the nations who regulated the consequences of man's free will in accordance with his divine justice. He wrestled with the problem of God's relations with the physical laws of matter—with death, disaster and insanity. In his last trilogy, the *Oresteia* (458 B.C.), he brought the gods of light and the gods of darkness into harmonious agreement to use the immutable laws of physical life for the advancement and well-being of the human race.

The remarkable achievements of the city-state were due to a solidarity of feeling among the citizens, which sprang from the qualities that we associate with family life. Religion played a very important part in it. The gods of the state presided over the festivals of tribe. brotherhood and clan and required the full loyalty of all their members. The citizens expressed their gratitude in temples and in statues of the gods, and the plays of Aeschylus were enacted at a religious festival in honour of Dionysus. The common sense of obligation which united so many states in resistance to Persia was strengthened by the religious sanctions of the Panhellenic oath taken at the Isthmus of Corinth and Plataea. Yet this solidarity was beginning to split by 461 B.C. Sparta and Athens were on the verge of a war which might divide the Greek world. There were outbreaks of party strife within individual states, where the conflict of rich and poor weakened the traditional loyalties of tribe and clan. A new philosophy of life was growing up in the more sophisticated society of Ionia, where the individual man advanced the claims of individualism and denied the divine right of moral and religious restraints in society. The very independence of the Greek spirit was in danger of losing its sense of purpose and undermining its own achievements.

(*See* also GRAECO-PERSIAN WARS.)

THE GREAT WARS IN GREECE

The First Peloponnesian War, 460–445.—In Athens. after the political power of the Areopagus was overthrown, the council of 500 and the assembly controlled all legislation and enacted all decrees of state without let or hindrance. The constitution became a full democracy, a direct government by the majority of the people (*demokratia*). The council prepared the agenda for the assembly, directed the magistrates and heard charges of treason. The people's courts gave a final decision, except in such matters of religious observance as were left to the Areopagus. The assembly had an unrestricted competence, except that any proposal which conflicted with the established laws could be impugned by any citizen and held up until a people's court gave a ruling. The limits set on candidature for office by Solon and Cleisthenes were swept away in 457 B.C., so that the poorest citizen became eligible for all magistracies, except those which carried religious or financial responsibilities. The ordinary man was directly involved in all aspects of political life to an extent unthinkable in a modern European state, and the majority had a deep devotion and enduring loyalty to the tenets of the revolution.

Democracy at Athens was confident and aggressive from the outset. The people engaged in war on two fronts in 460 B.C., endeavouring to break up the Peloponnesian league and to detach Egypt from the Persian empire. As Sparta was weakened by the helots' revolt and the Egyptians fought well against Persia, Athenian energy and courage achieved remarkable success in the first years of the so-called First Peloponnesian War. The navies of Athens and the confederates defeated the Peloponnesian navies, captured Aegina and controlled the Gulf of Corinth from bases set up at Naupactus and Pegae. At the same time they protected the long lines of communication to Egypt and maintained an expeditionary force, which held the Persian garrison of Egypt under siege. Even when the Spartans operated in Boeotia, the Athenians and their allies, who included Thessaly, Argos and Megara on the mainland, raised an army of 14,000 hoplites and held the enemy to an indecisive battle at Tanagra, with heavy losses on both sides, in 457. In the same year Athenian forces overran Boeotia and took civilian hostages from Phocis and Opuntian Locris. Athens established, or favoured the establishment of, democratic governments in these mainland states, in the hope that they mould remain loyal. The city of Athens itself was made almost impregnable—so long as Athenian sea power lasted—by long walls of thick masonry linking it to the Peiraeus.

The Rise of *Pericles*.—The tide of Athenian success turned when Persia invaded Egypt with huge forces and made a separate peace with the majority of the Egyptians. Confident in their sea power, Athens and the allies continued to operate on the Nile, until the Persians diverted its waters, captured the fleet and annihilated a relieving squadron in 454. The sea power of the Delian confederacy was suddenly crippled. The confederate states. already disgruntled by Athens' self-seeking policy: resented their losses in Egypt, and many of them in the southeastern Aegean rebelled from the confederacy. At this time the leading statesmen in Xthens were Pericles, author of the democratic reform and enemy of Sparta, and Cimon, victor of the battle of the Eurymedon and friend of Sparta, who had been recalled from ostracism. Their policies were diametrically opposed except in regard to Persia. The people wisely used Cimon to negotiate a truce with Sparta for five years (451–446) and appointed him to command a fleet of zoo ships. which won several decisive victories over the Persians in the eastern Mediterranean in 450 and 449. Cimon, however, died during the campaign. For other purposes the people put their trust in Pericles. His policy was to complete a process which had already begun, the conversion of the confederacy into an empire and the application of democratic principles at Athens.

In the winter of 454–453 B.C. the fund of the confederacy was transferred from Delos to Athens. The vast sum of 8,000 talents, accumulated mainly from booty, passed technically into the keeping of Athens but effectively into the possession of the Athenians, who appointed Pericles to supervise the monies. Then, while the Persian fleet was being held in Cyprus and Cilicia, the rebels in the Aegean were quickly reduced; for. having been ordered in the past to contribute money, instead of ships, they had no fleet. They were given harsh treatment. Xthens installed a garrison, set up a "democratic" council appointed in the first instance by Athenian commissioners (episkopoi) and exacted an oath of loyalty from each councilor and sometimes from each citizen, which ensured that anyone violating his oath could be summarily executed. Athenian cleruchies were also planted to picket the confederacy.

(A cleruchy was a settlement in which each settler had an allocation or kleros of land and retained his Athenian citizenship.) Before 478 B.C. cleruchies had already been established on Lemnos, Imbros. the Thracian Chersonese, at Sigeum and Salamis; and soon afterward Scyros had been conquered and a cleruchy placed there. Now, between 450 and 446, the Athenians made their imperial purpose clear. They confiscated the best land of some of the "confederates" (*e.g.*, Andros and Naxos) and gave it to cleruchs, who acted as a deterrent against revolt and provided bases for naval operations. In addition Athens made the use of Athenian currency, weights and measures obligatory for all confederates.

On seizing the fund of the confederacy Athens became rich overnight and so could afford a more extravagant democracy. Pericles instituted state pay for those who rendered political and other services. Jurors, councilors, officials and troops—20,-ooo men in all, according to Aristotle—mere soon in receipt of modest payments. Pericles asserted that the poorest citizen should thus be enabled to serve the democracy. His rivals accused him of political jobbery; for they believed he mas buying votes with stolen money. In 451 B.C., on the proposal of Pericles, Athenian citizenship was resrricted to those who were of Athenian parentage on both sides. Thus Athens became racially exclusive, at the expense mainly of the confederates. By closing the citizenship during the very process of empire building the Athenians showed themselves less wise than the Romans were later to prove.

While the truce held with Sparta, Athens made peace with Persia, probably in 448 B.C. The treaty, known as the peace of Callias, marked the successful conclusion of the Greek war against Persia. Under its terms the freedom of the Greeks in Asia was recognized, and the contracting parties—the Athenians and their allies and "the Great King"—agreed not to intervene in one another's territory and waters. Athens tried to represent this treaty as a Panhellenic triumph and invited all states which had been in the ambit of the Persian invasion to attend a conference at Athens, to restore the temples burned by Persia and to plan a general peace throughout the Greek world. Yet the offer of peace talks came strangely from the aggressors in the First Peloponnesian War, who were busily converting the Confederacy of Delos into an empire for themselves. When the Spartans and their allies made no response, the other invitations were canceled.

Pericles had at least extricated his country from war on two fronts. After 448 B.C. the Athenians could concentrate their efforts against Sparta. On the surface they were strong. They had complete control of Aegean resources, as well as great wealth and an unrivaled fleet; they had Megara, Boeotia and Locris in subjection. Phocis as an ally and Achaea. Naupactus and Troezen on their side; and they had alliances with Leontini in Sicily and with Rhegium in southern Italy. Only goodwill was lacking. Puppet governments euphemistically called "democracies," Xthenian garrison troops and Athenian monopoly of policy deceived no one who had experienced them. Early in 446. when the truce was about to expire. refugees from Boeotia, Locris and Euboea defeated Athenian troops in Boeotia and forced Athens to evacuate that country. Then the states in Euboea revolted. As soon as Pericles crossed to Euboea with an army. Megara revolted. The Peloponnesian league's army was already on the road to Attica. Pericles brought the Xthenian army back to Attica. while the Boeotians and the Peloponnesians combined their forces near Eleusis. Then, at the very moment when the superior strength of Sparta was about to be applied, the Spartan king in the field, Pleistoanax. withdrew his army and went home. He was fined on a charge of having taken bribes from Pericles. Meanwhile Pericles reduced the whole of Euboea in a rapid campaign. In the winter of 446–445 a treaty of peace "for 30 years" was concluded between Athens on the one side and the Spartans and their allies on the other.

The terms of the Thirty Years' treaty recognized the Xthenian empire and the Peloponnesian league. Sparta left Aegina and Naupactus under Athenian control. and Athens abandoned Achaea, Troezen and Megara to the Peloponnesian league. The beneficiaries of the treaty were the two coalitions, and the prospects of its duration rested on the balance of power between them. Therefore Argos, as a strong military power, was to be kept neutral; but any other state could join either group at any time and enjoy the terms of the Thirty Years' treaty. It was a statesmanlike attempt to secure a lasting peace. There were provisions for the freedom of the seas and for arbitration in case of disputes. Peace and prosperity reigned for 15 years thereafter throughout the eastern Mediterranean. Yet these were years of preparation for war; for the peace between Sparta and Athens rested not on goodwill but on a balance of power which was becoming more and more precarious. The Spartans indeed, having no capital for new enterprises, had little hope of expansion and were content to husband their military strength within the bastion of the Peloponnese and to maintain the freedom of the western seas across which corn and goods were imported. Athens, on the other hand. had the capital and the spirit to expand; and Sparta felt that Athens was only waiting for a suitable opportunity to return to the attack.

Periclean Democracy and Imperialism, 445–431.—In the years of peace Athens decided future policy. The choice was between Cimon's successor, Thucydides son of Melesias, and Pericles. Thucydides stood for a qualified democracy, for co-operation with Sparta and for alliances with the Aegean Greeks; Pericles stood for a full democracy, for enmity with Sparta and for imperialism in the Aegean. Thucydides was ostracized in 443 B.C. Those who shared his views lay dormant until the revolution of 411.

The full democracy had such faith in Pericles that it acknowledged him to be the first citizen in the state, elected him annually as senior general and made him responsible for the great reserve fund on the acropolis. He owed his position to financial honesty, intellectual vision and force of character, not to any cabal or party. Indeed the policies of the democracy knew 'no party organization. He made the city of Athens beautiful by building the Parthenon and the Propylaea on the acropolis from public funds. He brought prosperity to the citizens by increasing sea-borne trade. by annexing land for cleruchs and by granting pay for service at home and in the empire. He claimed that the democracy was a model to all men. It gave to its citizens equality and freedom in speech, in law, in politics and in education; it provided full employment. good economic conditions and also humane treatment for resident aliens and slaves; and it combined these blessings with a constitution under which the individual citizen was directly involved in forming policy and in managing all aspects of administration. The Periclean democracy engendered an ardent loyalty in which idealistic principles and material interests frequently coincided.

Pericles consolidated the empire. Civilian hostages were deported from unruly subject states to Athens. Cleruchies were planted, for instance, at Chalcis and at Histiaea in Euboea and colonies of Athenians and their subjects at Amphipolis in Thrace and on the coasts of the Black sea. Between 445 and 431 there was only one incident which threatened the stability of the empire. Ordered to accept Athenian arbitration in a dispute with Miletus. the Samians stood on their rights as voluntary members of the "alliance"; for they still had their own fleet. Pericles then occupied Samos and administered the usual punishment: a '.democracy" supervised by a garrison and commissioners, the surrender of civilian hostages and a fine for disobedience The Samians revolted, hoping for help from Persia and Sparta; but their hopes proved vain. and they capitulated after a lengthy siege in 439. Athens made them surrender their fleet. demolish their fortifications, give hostages and pay the cost of the war (1,276 talents) in installments over a number of years. The only state which revolted in sympathy. Byzantium, capitulated after the fall of Samos. The empire was securely held. But, as Pericles said later, it was held under a tyrannical rule which Athens could not remit without danger (Thucydides ii, 63).

Sparta and Persia were prepared to tolerate the Athenian empire so long as their onn interests were not affected. But domination of the Aegean and the Black seas had not satisfied Athenian ambitions or apprehensions. Athens gained a strategic base in the west by helping Xcarnania to defeat Ambracia. a colony of Corinth, and then contracting a close alliance with Acarnania and Amphilochia (c. 437 B.C.). The appearance of an Athenian fleet in the

Ionian sea alarmed the Peloponnesians and especially Corinth. But Corinth mas not deterred on that account from quarreling with Corcyra, originally a Corinthian colony and now a considerable naval power. Sparta tried in vain to persuade Corinth and Corcyra to accept arbitration. They went to war in 435. The Corcyraean fleet of 120 triremes was victorious; but Corinth and some friendly states. many of which were members of the Peloponnesian league, mustered a fleet of 150 triremes in 433. At this stage Corcyra asked Athens for an alliance. The issue for the Athenians was clear: if they wished to preserve the general peace under the Thirty Years' treaty, they would refuse to help Corcyra; if they wanted to fish in troubled waters, they would grant an alliance at the risk of endangering the general peace. The assembly hesitated. On the first day of debate the majority was against an alliance. but on the second day it voted an alliance on the advice of Pericles. Corcyra seemed a prize worth having: the accession of its fleet would alter the balance of naval power decisively, and the Corcyraeans controlled the coasting route from the west to the Peloponnese. The Athenians combined audacity with cleverness. They granted Corcyra a defensive alliance, which was not a breach of the Thirty Years' treaty, and sent *only* ten ships. hoping perhaps that the prestige of Athens would halt Corinth and that the smallness of the force would not frighten the Peloponnesians as a whole. When the ten ships were already on the way to Corcyra, they sent 20 more; they may have learned that Corinth was about to attack and hoped that the 30 Xthenian ships would by their superior seamanship give the Corcyraean fleet an advantage. But the Athenian commanders were given orders to engage only if the Corinthians were about to force a landing on Corcyra.

In Sept. 433 B.C. the Corinthians and their allies defeated the Corcyraeans in the sputhern channel. but broke off the action when the ten Xthenian ships engaged to prevent a landing. The Corinthian fleet returned to the attack in the evening; but the fortuitous appearance of the other 20 Athenian ships from the south at this crucial moment caused the Corinthian fleet to withdraw and sail homeward. Athens now had bases on Corcyra, in Acarnania and at Naupactus and the assistance of the battered Corcyraean navy and. in the winter of 433–432, began to put pressure on Corinth and on Megara as an ally of Corinth. Potidaea, an old Corinthian colony in Chalcidice, was ordered to break off relations with Corinth and to dismantle its sea walls. Economic sanctions were imposed against Megara, whose commerce was excluded from all ports of the Athenian empire. Potidaea revolted. and the Corinthians and their Peloponnesian friends placed "volunteers" in the city before it was invested by Athens. Sparta, reluctant to engage in war against a naval power or to terminate the Thirty Years' treaty without legitimate grounds, was playing a waiting game; but Corinth. Megara and other states made a *démarche* to Sparta, claiming that Athens' aggression had violated the treaty and invoking the defensive alliance on which the Peloponnesian league was based. The Spartan assembly then held a debate. The decision mas taken by a large majority that Athens had violated the treaty. The Spartans reported this decision to the congress of allies which met and concurred. Thus the two organs of the Peloponnesian league decided to go to war unless Athens was prepared to retract. Abortive negotiations ensued. Then Sparta delivered an ultimatum: peace would continue only if Athens recognized the independence of the Greek states. Pericles spoke in the decisive debate at Athens. He advocated war and the assembly supported him. Their decision was that Athens would accept an offer of arbitration but not any ultimatum from Sparta. Negotiations ceased in the winter of 432, and Thebes. a member of the Peloponnesian league, committed the first act of war by delivering a treacherous attack on Plataea, an ally of Athens: in the following spring. The historian Thucydides saw the fundamental cause of this war in the growing power of Athens together with the growing apprehension of Sparta. He appreciated at the outset that it would be a great war, because it was likely to end in the destruction of one party or the other.

The Great Peloponnesian War, 431–404.—The course of the war is described elsewhere (*see* PELOPONNESIAN WAR, THE). In the Archidamian War (431–421) each side began with superior strength on its own element, and ten years of fighting increased the margin of superiority. Vet neither side could apply its superiority with decisive effect. Sparta could not force Athens to battle, or breach the impregnable walls; and the Peloponnesians, unable to campaign far afield or for long periods because they lived on their own agricultural produce, failed to exploit the advantage which the Spartan commander Brasidas gained in Chalcidice by raising Athens' subjects in revolt. The Xthenians held the seas with their navy. but their warships could not impose a complete blockade on Peloponnesian merchantmen; and their sea-borne raids, effective though they were, did not serve as a prelude to an invasion of the Peloponnese. All this, according to Thucydides. was foreseen by Pericles, who expected a long war of attrition and thought that Athens would prove more buoyant than Sparta. On the whole he was correct. The Athenians lost more than one-third of their manpower in the plague and in action, they had to demand three times as much tribute from their subjects and they spent more of the financial reserve than they had expected; but in 421, when the peace of Nicias (so named after the general who guided Athenian policy) was made, they had complete control of almost the whole empire, a great navy and the means of recouping their finances rapidly. Sparta suffered less loss of life than Athens, but was shaken internally by the revolts of the helots; and the allies, especially Megara and Corinth, were impoverished and embittered. Sparta's control of the Peloponnesian league was very shaky in 421, and Argos seemed after a generation of neutrality to be a strong rival in military and political matters. The peace terms of 421 included the restoration of all places (except Plataea, Nisaea and some Corinthian possessions in the northwest) and of all prisoners captured in the mar and an undertaking to submit to arbitration all disputes between the Athenians and their allies on the one hand and the Spartans and their allies on the other.

Pericles had originally gone to war in order to break the Peloponnesian league, the basis of Sparta's power in international affairs. The peace of Nicias provided a great opportunity for doing so by diplomacy, operating from strength. But Pericles had died in 429 and Athens was disunited. A worthy successor might have united Athens. created a block round Athens and Argos and used the Athenian army to lead a coalition against an isolated Sparta. Alcibiades tried but failed. The failure was the fault not so much of one man as of the Xthenians collectively. They did not make a decisive choice between Alcibiades and Nicias. and their indecision lost them the chance of winning the peace. When war broke out again, the same indecision brought the Sicilian expedition to disaster (415–413) and crippled Athens' recovery later. On the other hand the Spartans kept their unity and their power of decision. The victory over Argos and Athens at blantinea in 418, the re-formation of the Peloponnesian league and the winning of the war at sea by Persian money and Peloponnesian manpower were due to Sparta's tenacity and leadership. The hard necessities of war broke the political front at Athens, ruined the state's finances and brought the navy and the empire to an end in 404 B.C. They also strained the strength and warped the judgment of Sparta and undermined the loyalty of the Peloponnesian allies. Moreover the naval position in which the Spartans found themsell-es at the end of the war was one which they could not afford to maintain. The Greek states from the Aegean area to Sicily were torn and weakened by war and dissension. Persia and Carthage were the gainers. Without striking a blow they extended their field of political influence. while the Greeks were wearing one another down.

Greek Civilization, 458–404.—As fear of Persia receded, the city-state became the centre of existence. Whereas Aeschylus (525–456) had studied the relations between God and man in human history, Sophocles (*c.* 496–406) was concerned with relations between man and the city-state. in which God's purpose for man was revealed: the ideal qualities of the characters Oedipus and Antigone in his tragedies were seen in relation to their obligations to the state. Devotion to the state reached its highest level at Athens in the period between the wars. when prosperity and confidence reigned. The Parthenon and Propylaea were built by a people who felt an undivided affection for the city and for the goddess of the city, the maiden Athena. The principles of the democracy were expressed in an ideal form by Pericles. whose vision captured the imagination of his contemporaries and inspired the leading writers of the period—Sophocles, Thucydides and Aristophanes—even on occasions when they criticized the real Athens of the Peloponnesian War. It was an age of great intellectual and emotional power. Men carried principles to their logical conclusion in architecture. sculpture, drama and politics. At the same time they respected "the unwritten laws" of moral and religious restraint which gave a true balance and proportion to their art and to society. Athena and the gods of the family were not abstractions but demanded of their worshippers the highest standards in loyalty and nobility. The Periclean period at Athens was the acme of the Greek city-state. The light of the Greek genius was focused with brilliant intensity on the life of the polis—but only for a short time; for the lens was soon starred by disaster.

The Peloponnesian War broke the strands of traditional religion in Athens. The centres of family worship were lost when the Peloponnesians ravaged the countryside and refugees poured into the city. The horrors of the plague, the disaster at Syracuse and the final shock of utter defeat broke men's faith in the favour of the gods. The state was split by revolution. Citizens killed one another in civil war. and party loyalties took precedence over patriotism. Alcibiades was typical of many young Athenians whose intellectual ability was devoid of any religious scruple or moral principle, and their conflict with the older generation who remembered the days of Pericles is vividly portrayed in the comedies of Aristophanes.

The effects of the war on Athenian society were heightened by the teaching of the sophists, who came from other parts of the Greek world and spread new ideas in the crowded city. Their lectures were stimulating and exciting. They covered the whole range of human thought with remarkable versatility and originality. Although individual sophists laid new foundations for philosophy and conduct. the general trend of their teaching mas rationalist in method and agnostic in conclusion. Traditional religion in their view was the child of convention. and natural law indicated that might is right and that the individual pursues his own interest. Speculation in physics seemed to support this view. for Democritus reduced the operations of the universe to an interaction of atoms which were governed by some impersonal "necessity" or natural law. if not by random "chance." hfedicine. too, emancipated itself from religion. "This disease." wrote Hippocrates of epilepsy (the so-called "sacred disease"). "is no more sacred than other diseases. . . . Its origin is in heredity . . . and its cause lies in the brain, as is the case with all the most serious diseases."

The divine right of the city-state mas severely shaken not only in Xthens but throughout the Greek world, of which Xthens was the cultural capital. The centre of interest was shifting toward the individual. Euripides portrayed the transition in his plays. They show the tragic consequences for the individual of war, tradition and conventional religion. His Hecuba, *Medea*, *Orestes* and *Hippolytus* are psychdlogical studies of the individual woman or man who is not confined within the limits of the city-state. His dramas, therefore, have a modern quality. Aristophanes represented both sides of the conflict. He made fun of the diehard traditionalists and challenged Athens' right to empire and men's justification of war; but he also pilloried the sophists and those who accepted the worst side of their teaching. He deno'unced the self-seeking individualists and the psychologists who rated human desires above moral restraint. In the end he gave his allegiance to his ideal picture of Athens and to the service of the city as it was despite its faults. Socrates was the only Athenian among the sophists. He questioned the assumptions of his pupils in all matters of religion. ethics and belief and professed to know only that he knew nothing. This stage of his teaching created many agnostics, who lost their traditional bearings and found refuge in individualism. But Socrates carried others forward to a new belief in the ultimate verities of goodness, truth and understanding; and his own life of humility in the service of philosophy inspired them to follow his example. R'hen Athens had fallen, Socrates was put on trial "for not worshipping the gods whom the state worships, for introducing religious innovations and for corrupting the young men." He was found guilty of the charge. When he was sentenced to death. he refused to ask for mitigation of sentence. He died because city-state tradition was strong. but his martyrdom proclaimed the individual's right to free thought and belief. Thus a rift was opening between political life and personal philosophy, which Plato later described so simply: "A man who really fights for nhat is right must lead a private. not a public. life, if he hopes to survive. even for a short time" (Apology, 32a).

The City States, 404–354: Independence or Combination?

The Spartans and their allies had fought for the independence of the Greek states R'hen they won, it was expected that several hundred independent states would emerge from the dismembered Athenian empire. But independence mas not necessarily the panacea for international troubles. Its effect was seen in Sicily where victory over Athens in 413 B.C. had left the Greek states free to engage in party strife and to fight against one another and the resulting chaos was exploited by the Carthaginians, who had added most of the Greek states to their empire by 404. The states of Greece and the Aegean area were already torn by civil strife and harboured strong animosities toward one another; and the Persians were more dangerous neighbours than they had been since the battle of the Eurymedon. It was clear to a few political thinkers, such as Isocrates, that Greek civilization could be preserved not by the untrammeled independence but by the co-operation and combination of the Greek states. On the other hand the politicians and the electorates were concerned primarily with the narrower issue of their own survival and expansion, often at the expense of neighbouring Greek states, and they were reluctant to enter any combination which limited their own freedom of action. Many wars were waged in the 4th century B.C. to decide whether independence (*autonomia*) or co-operation (*symmachia*) in various forms should be the guiding principle of Greek international affairs.

Sparta and the Movements for Independence, 404–371.—During the last stage of the Peloponnesian War the Spartans were liberating the small states in the Aegean. They naturally supported pro-Spartan parties. which were oligarchical rather than democratic in outlook; and Spartan troops were left to assist their parties in maintaining power. The Spartans moreover were winning the naval war on Persian subsidies and had agreed in return to surrender the Greek states of Asia Minor to Persia; and they saw that they would be able to break this agreement safely only if the small states of the Aegean were kept firmly in the Spartan bloc. Nor was their position easy on the Greek mainland. The allies had been critical of Spartan leadership and resentful of Spartan demands, and they had their own ideas about the fate of Athens. Corinth, Thebes and others wanted to annihilate Athens as the aggressor in two great wars. but Sparta managed to obtain a majority vote in the congress of allies for the policy of preserving Xthens as a satellite in the Spartan bloc. An oligarchic government (the government of "the 30," commonly known as the Thirty Tyrants) was therefore installed in the presence of Spartan forces. Thus the end of the war in 404 saw Sparta fully launched on an attempt to hold the "liberated" states and Xthens under a system of combination which showed many familiar features of imperialism. The wartime allies of Sparta. who were members of the Peloponnesian league, naturally felt alarmed for their own liberties when they saw the policy of Sparta in the Aegean.

The first reaction came at Xthens. The oligarchs were particularly ruthless in killing and exiling their enemies (for instance, the men who had overthrown the oligarchy of "the 400" set up by the revolution of 411), and they soon had to call in a Spartan garrison. The leaders of the exiles obtained help from disgruntled members of the Peloponnesian league (especially Thebes. Megara and Elis), established themselves in a frontier fortress on Mt. Parnes and went on to capture the Peiraeus. where the democratic element was strongest. They defeated'the oligarchic forces and the Spartan garrison troops in a pitched battle at Munychia in

May 403 and made preparations to attack the walls of Athens. Late in the summer Sparta intervened. There mere by then three factions in Attica: the extreme oligarchs held Eleusis, the moderate party was defending Athens and the extreme democrats were attacking Athens from the Peiraeus. The arrival of a Peloponnesian army ended the fighting and Sparta made a new settlement: Attica was split into two states, one centred on Eleusis and the other on Athens. The Spartans counted on the animosity between oligarchs and democrats to keep the states separate, but the democratic tradition of Athens soon asserted itself. In 401 Xthens swallowed Eleusis, and Attica was unified under a democratic regime, which had the good sense to carry out all its formal obligations to Sparta.

Cyrus the Younger and Agesilaus.—Meanwhile there was a similar reaction to Spartan policy in the Aegean. Sparta broadened the basis of the oligarchical governments in the Aegean states, but insisted that they should follow Sparta in foreign policy and pay tribute to maintain a Spartan navy. The issue with Persia was still undecided, because Cyrus, the Persian viceroy in Asia Minor, was friendly with Sparta and did not take over the Greek states. In the spring of 401 B.C. Cyrus mustered a large army of local peoples and hired 14,000 Greek mercenaries: told Sparta of his plan to seize the Persian throne from his brother. Artaxerxes II Mnemon, and asked for Spartan aid. The Spartans in the past had always refused to commit themselves to war against Persia in Asia Minor, but now decided to give naval support to Cyrus and thereby accepted the risk of war with Persia. It was a bold decision, because Sparta's control of the Aegean states and of the Greek mainland was far from strong. Cyrus was defeated and killed at Cunaxa in Mesopotamia. and Sparta made an alliance with Egypt (which was in revolt) and sent out an expeditionary force in 400 B.C. to defend the liberty of the Greek states in Asia Minor. The adventures of the Greek mercenaries whom Cyrus had engaged gave Sparta some encouragement; for they proved themselves far superior to Persian infantry in battle and in skirmishing and they fought their way from Mesopotamia to the Black sea (the retreat is the subject of Xenophon's *Anabasis*). Sparta held the initiative for five years. The Spartan infantry raided far and wide inland and collected much booty. but it failed to capture strongholds and was harassed by the Persian cavalry. The navy was at first under separate command and operated independently. Then, in 396, the Spartan king Agesilaus went out with reinforcements and was given command of the army and navy. Agesilaus; however. raided inland and did not emulate the strategy of Cimon, who had shown that it was essential to hold the southern corner of Asia Minor and to defeat or contain the Phoenician fleet.

The Corinthian War and the King's Pence.—The Greek states had little sympathy for Sparta in the war against Persia. Even those in Asia Minor which had supported the naval operations of Athens in the 5th century were alienated by Sparta's method of conscripting and requisitioning and by the use of mercenary soldiers, freed helots and Peloponnesian troops whose chief interest seemed to be booty. The islanders disliked the oligarchical governments which Sparta supported and lacked confidence in the Spartan admirals. The mainland states were more afraid of Sparta than of I'ersia. For the Spartans had also abused their position in the Peloponnesian league by launching attacks on Elis in 400 and 399 and by treating the country as Athens had treated Thasos in 462. When Agesilaus went out in 396, Corinth. Thebes and Athens sent no contingents. and it was known that Athenians were entering Persian service in the fleet which an Athenian naval officer. Conon, was commanding. In the summer of 395 the Boeotian league broke away from the Peloponnesian league, attacked Phocis in contravention of Sparta's orders and made an alliance with Athens. At this time a Persian agent toured the dissentient states of the mainland and gave subsidies to anti-Spartan leaders at Thebes, Corinth and Argos. The first attack by Sparta on Boeotia failed. Corinth. Argos and many of the states of central Greece joined the insurgents in 394, and Sparta recalled Agesilaus and his expeditionary force from Asia, because major operations on two fronts were impossible. The Persian navy then launched its offensive, defeated the Spartan navy decisively at Cnidus in Aug. 394 and sailed into the Aegean sea, expelling pro-Spartan oligarchs and tyrants from the islands.

This war of independence, called the Corinthian War, was inconclusive on land. The insurgent states failed to evolve a centralized system of command. and the Spartan army defeated all its rivals. Agesilaus fought his way from central Greece through Boeotia and brought his army into the Peloponnese. A stalemate ensued with heavy fighting at the isthmus. where Corinth and Argos held a strong defensive position. At first these two states formed a union under which each had reciprocal rights in the other's territory; later Argos annexed Corinth. The decision in the war lay with the Persians. At first, in 393, they let Conon help Athens to rebuild the long walls (which had been demolished under the peace terms of 404) and to form a small fleet, but after 390 their attitude changed as the Athenians tried to regain some of their Aegean empire and to assist Cyprus. then in revolt from Persia. Sparta held on to the Hellespont and even attacked the Persians and the small Athenian fleet with some success. Persia's support was then switched to Sparta, and Athens was soon blockaded by a Spartan fleet operating from Aegina (387). In 386 all Greek states accepted the terms of a peace which was guaranteed by Sparta and Persia and called either the peace of Antalcidas (from the name of the Spartan negotiator) or the Icing's peace. The Greek states in Asia Minor. Clazomenae and Cyprus were to be subject to Persia, and all other Greek states were to enjoy independence, except Lemnos, Imbros and Scyros which were to be Athenian possessions. Persia undertook to attack any Greek state which refused to accept the peace "by land and sea; with ships and money."

Confident in the support of Persia, the Spartans interpreted "independence" in their own interest. They broke up every example of combination to which they could apply force. The Boeotian league was dissolved. so that each state there should be "independent." and Corinth was separated from Argos. Mantinea was forcibly split up into five "independent" villages in 384 B.C. The strong Chalcidian league was dissolved by Sparta in 379 after three years of fighting. The Spartans also interpreted independence in the sphere of internal government in each state as the rule of an oligarchic regime. They captured Thebes by treachery and replaced the democrats with pro-Spartan oligarchs; and they forced Phlius to capitulate after a long siege and gave the oligarchs a free hand. Sparta pursued a policy of "divide and rule" under the empty mask of independence. The members of the Peloponnesian league were controlled by intimidation; Sparta's own subjects were held down by oligarchic governments and by garrisons where they were needed; and Persia, Macedonia and Dionysius I, tyrant of Syracuse. were Sparta's allies. Those who suffered under this rule learned the truth of the Spartan saying: "We cheat boys with dice and men with oaths." Rut the basis of Spartan power was dangerously small. The Spartiates were a very small minority in the Spartan state itself, and the oligarchic parties in other states were a minority in each state. Sparta relied ultimately on the force of arms wielded by several thousand men in order to hold down most of the Greek states.

The War *of Independence, 379–371: Leuctra.*—The fight for independence began in 379 B.C. Seven exiles returned to Thebes at night and led a successful revolt. Sparta promptly isolated the area of trouble, but a Spartan officer made a foolish and unsuccessful attack on Athens, which caused such indignation that Athens made an alliance with Thebes. Two years of fighting ensued, and then the allies captured the passes over Mt. Cithaeron and kept the Spartan army out of Boeotia. Sparta then took the offensive by sea against Athens. which was building up a naval coalition. The Spartans suffered a series of defeats, but fought on at sea until a split developed between Athens and Thebes. At this stage Persia appeared again on the diplomatic scene. In 371 the representatives of Persia. Sparta and Athens, together with those of their allies, agreed to make peace on the principle of "independence." under which garrisons were to be withdrawn and general disarmament was to be carried out. The Spartans took the oath on behalf of their own city and its "allies,!' but the delegates of Athens and those of the allies of Athens, including Thebes, took the oath individually. The Theban delegates then asked to be recognized as acting for the Boeotian league, but Sparta refused to permit this. Thebes uithdrew from the peace. The Spartan army entered Boeotia before the Thebans could muster their allies in Boeotia and forced a decisive battle at Leuctra. The Thebans uere outnumbered. but they had a general of genius in Epaminondas, who appreciated the Importance of striking at the enemy's strongest point. He therefore massed his men 50 deep against the Spartan right wing, where the Spartan king Cleombrotus and the Spartiate troops were stationed, and charged at the double. The massed Thebans killed 400 Spartiates and routed all the rest of the enemy before the Theban centre and right wing came into action. The military reputation on which Sparta's supremacy had been founded was broken irretrievably, and the Spartan empire was destined to collapse rapidly and completely.

The Second Athenian Confederacy and the Boeotian League — During the war of independence from 379 to 371, Athens and Thebes developed new and important ideas in the field of combined action by a number of states. Athens published the charter of a confederacy in March 377. In this, Athens undertook to respect the independence of any ally which entered the confederacy under a defensive alliance: specifically, Athens promised not to exact tribute, not to introduce a garrison, not to meddle with internal government and not to revive any territorial claims against an ally. The constitution of the new confederacy resembled that of the Delian one. Each allied state cast one vote at the congress of allies, and a majority decision was binding on them all; the Athenian state, however. stood outside the congress as a separate entity and took its own decision on any matter of mutual interest. If both bodies reached the same decision, the confederacy as a whole acted upon it. In such an event Athens was entrusted with full executive command and disciplinary powers in the field; but an ally could seek redress through the congress of allies sitting as a deliberative or judicial body. The allies also controlled their own treasury recruited by contributions from members on an assessment by the congress. and Athens made grants in money and ships from the state treasury. Athens and the allies formed a joint court to pass judgment on any person who broke the charter of the confederacy. Thus machinery was created uhereby a group of states could combine in a common policy of defense and each state had precise safeguards for its own independence. In 376 Athens defeated Sparta in a naval battle off Naxos, and in the next few years the confederacy attracted about jo states which revolted from Spartan rule in the Aegean and the Ionian seas. The Athenians set them a fine example by taxing their own resources heavily and providing the bulk of the fleet.

Thebes had alnays been the leading spirit of the Boeotian league. The numerous states of Boeotia had been grouped in the past into 11 wards, each of which had returned 60 councilors to form a strong central government, sitting at Thebes, and had contributed its quota of money, troops and generals (boeotarchs). Thus the federal state of Boeotia had adopted a system of proportional representation, such as is common in modern Europe. But the Thebans of 379 B.C. regarded indirect government as oligarchical. When they liberated the states of Boeotia from Spartan rule, they created a democratic assembly of Boeotians. meeting at Thebes, in which policy was determined by direct vote. The executive officials-councilors. magistrates. army commanders, etc — were elected by the wards, reduced in number from 11 to 7. Thebes and its dependencies. nhich together formed three of the seven wards. played a predominant part in the league and supplied the ablest boeotarchs and the best hoplites in the war of liberation. The Boeotian league was particularly well designed for small states in an agricultural area of limited extent and its success in overthrowing Sparta led many other states to emulate its constitution.

The second Athenian confederacy and the Boeotian league, as associations of free states, contrasted themselves with the imperial systems of Sparta and Syracuse under Dionysius I. The pressure of Carthage on Sicily had created a situation in which Dionysius had succeeded in establishing himself as tyrant or dictator at Syracuse in 405, and his subsequent achievements made a great impression on the Greek world. He enlarged Syracuse far beyond the normal size of a city-state by destroying other states and deporting their population into his territory, and he amassed great armaments by ruthless confiscation of capital resources and by hiring mercenary troops in large numbers. His cosmopolitan forces conquered those Greek states of Sicily which lay outside the Carthaginian zone and also many Greek states in southern Italy, and he planted colonies on the Adriatic coasts and islands. Syracuse became the capital of an empire which was bound to the mill of Dionysius and enjoyed commercial supremacy in the Greek west. In 371, when the Spartans were defeated at Leuctra. the dictator mas at the height of his power. Men admired his success but did not reckon the cost in terms of political morale and human degradation. The example of Dionysius may well have inspired Jason of Pherae in Thessaly. Jason had made himself tyrant of his own city-state and, by the end of 373, had forced the other Thessalian states to obey the commands which he issued as "ruler of Thessaly" or *tagos*—a title that had been in abeyance for many generations. In 371 Jason had the finest cavalry force and the largest mercenary army in Greece and was drawing substantial revenues from the peoples of Thessaly. These examples of the voluntary and the forced association of states into a powerful group aroused interest and alarm. They were studied by Isocrates, who preferred the voluntary association (as he argued in his *Panegyricus)* but believed that some sort of forced association might be better than internecine wars between individual states.

The Attrition of the Leading Powers, 371–355.—Although Athens and Thebes proclaimed similar principles, they were separated by a dislike born of many frontier disputes and two great wars. More recently, Athens had seized Oropus, a frontier post, and Thebes had destroyed Plataea and subjugated Thespiae. Therefore when the Thebans asked their Athenian ally for help after the battle of Leuctra. Athens made no answer but invited all Greek states to a conference. Athens' proposal was that the Greek states should ally themselves individually with the second Athenian confederacy as a whole and maintain the terms of the peace of 371 with the backing of Persia. This proposal was accepted by almost all the Greek states. But the diplomatic triumph of Athens did not arrest the revolt of the Peloponnesian states from the rule of Sparta. Democrats seized power in many states. Those in Mantinea and Tegea founded an Arcadian league in the spring of 370 and invited the Boeotian league to assist it in the autumn. Meanwhile Thebes had been watching Jason, who had come south to help Thebes immediately after the battle of Leuctra but had taken the opportunity to seize Thermopylae on his return and to strengthen his net of alliances. Fortunately for Thebes, Jason was assassinated in the summer of 370. The Boeotian league then formed a strong coalition of central Greek states which included Euboea and Acarnania, hitherto members of the Athenian confederacy. The forces of this coalition, led by two boeotarchs, Epaminondas and Pelopidas, and those of their allies. the Arcadian league. Elis and Argos, ravaged the whole of Laconia and liquidated the Peloponnesian league forever. In 368 Epaminondas returned to strengthen his allies. In the course of his two Peloponnesian campaigns. Messene was fortified as the capital of the liberated Messenians and Megalopolis was built as the federal capital of Arcadia. These successes alarmed Athens, who took the radical step of making an alliance with Sparta and later with Sparta's ally Dionysius of Syracuse and tried in vain to halt the progress of Boeotia by defending the isthmus. where Corinth and other states which were afraid of Argos sided with Sparta and Athens.

The Boeotian Ascendancy, to 362.—Boeotia was the leading land power for a decade. This state's democratic federalism was widely imitated. Leagues with sovereign assemblies and federal magistrates on a cantonal basis were formed in Thessaly and Aetolia, as uell as in Arcadia; and other federal states—Phocis, Acarnania and Achaea—nere brought into alliance with Boeotia. Epaminondas advocated a liberal attitude toward the federal states and accepted the oligarchic governments of the member states of the Achaean league in 366 B.C., but the Boeotian assembly replaced them with democratic governments and installed garrisons to keep them in office. Pelopidas extended Boeotia's influence in the north, intervening successfully against Athenian interests in Thessaly and Macedonia. When Athens and Sparta sent envoys to Persia for help, Pelopidas won the favour of Artaxerxes II and tried to impose a "King's peace" on the Greek states in 366. The terms were "independence" for all states, and Athens was ordered to withdraw her fleet from the Aegean sea.

The confidence of the Athenians had been shaken by Boeotia's victories, and they knew that their confederates disliked the alliance with Sparta and Dionysius. There was now the further danger that Boeotia and Persia might launch a naval offensive. The Athenians therefore began in 366 to convert the confederacy into an empire. They captured Samos off Asia Minor, Sestos and Crithote in the Chersonese, Pydna and Methone in Macedonia and Potidaea, Torone and other cities in Chalcidice. They did not admit these cities to the confederacy but occupied most of them with cleruchies and used them as naval bases. They also made a treacherous and unsuccessful attack on Corinth and allied themselves with Alexander, tyrant of Pherae, in Thessaly and with Arcadia in the Peloponnese. The Boeotians pressed their advantage, defeated Alexander (they lost Pelopidas in the process) and then launched a naval offensive, probably in 363, under the command of Epaminondas. His fleet of 100 triremes sailed unchallenged to the Bosporus, where Byzantium and other members of the Athenian confederacy joined him in attacking Athenian corn ships sailing for the Peiraeus. But continuous warfare from 378 had exhausted the finances of Boeotia, and Epaminondas returned home without exploiting his success. Affairs in the Peloponnese demanded his attention. The Arcadian league had broken away from the Boeotian coalition, attacked Elis, seized Olympia and appropriated the funds of the temple of Zeus. This act of sacrilege split the Arcadian league, and a Boeotian force became involved in a fracas between Tegea and Mantinea. Epaminondas invaded the Peloponnese in 362 with forces drawn from Boeotia, Thessaly, Euboea. Locris and Aeniania. He was joined at Tegea by troops from Argos. Sicyon, Messenia and part of Arcadia. The decisive battle took place near Mantinea, where the armies of Mantinea, Sparta, Athens. Elis and Achaea held a defensive position. Epaminondas outmaneuvered his opponents, overwhelmed the Mantineans and Spartans and was mortally wounded at a critical moment. The Boeotians and their allies halted. Soon after peace was concluded on the *status quo*.

The League of States. — The Greek states were exhausted by war after war and by the vicissitudes of party strife. In the winter of 362–361 all mainland states except Sparta formed a league. They promised to maintain a general peace among themselves, to settle disputes by negotiation and to protect members of the league against aggression by "a general alliance," that is, by collective security. Their aims for all member states were strength, prosperity and peace. They probably set up a federal congress, a court of justice and a central treasury; and they passed a resolution as "the Greeks" in which they refused to join a group of satraps who were in revolt from Persia. The attempt to form a league of Greek states was short-lived, because the leading states continued to form military coalitions among the members. Athens made alliances with Arcadia, Achaea, Elis, Phlius and the Thessalian league, and Boeotia sent troops into Arcadia in 361. The Athenians moreover pursued their imperialistic policy by punishing those "confederates" who had joined Epaminondas in 363 and by undertaking operations of war in Euboea, Thessaly, Macedonia, Corcyra. Thrace and the Hellespont.

The Social War and the Sacred War to 354. — Athens was strained to the utmost in 357, when Mausolus, satrap of Caria, supported the revolt of Chios, Rhodes. Cos and Byzantium from the confederacy. In the Social War (*i.e.*, "War of the Allies"), as it was called. the Athenian fleet was defeated in 356, and threats by Persia caused Athens to make a peace in 355, under which the independence of the rebels was recognized. Meanwhile a so-called Sacred War had broken out in central Greece: provoked by menaces from Boeotia against Phocis, the Phocians under the leadership of Philomelus confiscated the treasure of the temple of Apollo at Delphi, hired thousands of mercenary soldiers and defeated the citizen levies of Boeotia, Locris and Thessaly early in 354. The collapse of the great powers on the mainland was almost complete. Xenophon wrote with justice that after the battle of Mantinea "even greater confusion and indecision" descended upon the Greek states. In the west. too, there was anarchy and chaos The empire of Dionysius I collapsed when exiles returned to attack his son and successor Dionysius II and drove him off to Italy. The leader of the liberators. Dion. was murdered in 354 B.C., and civil war raged in Syracuse.

Political and Economic Troubles. — Although the first half of the 4th century B.C. was racked by war, it was a period of widespread prosperity. Trade flowed in increasing volume from the outer parts of the Greek world — Spain and Massilia, the Adriatic coasts. Thrace and the Crimea, the eastern Mediterranean and Cyrenaica. At the same time Carthage and Persia accumulated large capital reserves. Athens was the leader of Greek commerce, but was rivaled in the 4th century by many states which engaged in sea-borne trade and acquired capital resources Culture, too, was widely diffused. The Attic dialect and alphabet, Attic commercial law and Attic town planning were becoming characteristic of many parts of the Greek world. Any considerable city had its theatre, civic centre and gymnasium. whether in Sicily, Italy, Greece, Asia or Cyrenaica. Trade in books was beginning, and Greek manners were spreading into the hinterlands of the continents. Banking, marine insurance, commercial treaties, mortgaging and so on were fully developed. Isocrates spoke of a "Greek" culture, as we may speak of a European culture and it was based on a prosperity which was expanding in spite of the spasms of war.

Prosperity made the states feel more constricted than ever by the narroa confines of their territories. They fought with their neighbours, to defend or extend their lands — Sparta with Arcadia, Arcadia with Elis, Corinth with Argos, Athens with Boeotia — and they fought to secure the seaways along which their exports and imports traveled. The distribution of wealth within the states was an even more potent cause of war. Capital accumulated rapidly in the hands of the wealthy. Because direct taxation was imposed only in times of emergency, the gap between rich and poor tended to increase apace. unless a revolution led to a redistribution of property. In a moderate democracy the poorer classes, which usually were in the majority, viewed the rich with suspicion and laid on them many "liturgies" or voluntary offices which were costly to discharge. A dividing line existed too between those who had some capital and those who had none, the *aporoi*. As Aristotle pointed out, the granting of doles to the poor at Athens, for instance, was a palliative and not a solution; he advocated the making of capital grants which would raise a poor man above the line and start him in some business (*Politics*, 1320a 35), but few states had the resources and none the will to do so. The antagonism between rich and poor was reflected in the swing from oligarchy to democracy. which was given additional impetus by the imperialistic or "liberating" po ers who exploited the internal situation in another state for their own advantage. It was made more dangerous in some states by the presence of large slave or serf populations and of foreign mercenary soldiers, as well as by the proximity of aggressive neighbours. The situation in Sicily as described in a Platonic letter is an extreme case: "There is never any end. What seems to be an end always links on to a new beginning. The circle of strife is likely to destroy both factions utterly. the faction of tyranny and the faction of democracy, and the Greek language will almost die out in Sicily as it becomes a province of Carthage or of Italy."

The stresses and strains which beset the city-state from within and from without weakened the solidarity and loyalty of the citizen body and favoured the growth of individualism. Life mas becoming more specialized. Lawyers. financiers, philosophers, merchants and farmers, for instance, concentrated their energies on one pursuit and played less part in public life than they had done in the 5th century. War was often conducted by mercenary soldiers and mercenary rowers; leading generals of city-states, such as Chabrias. Iphicrates and even Agesilaus, hired themselves out to serve Persia, Cyprus or Egypt. Finance was becoming more and more the sinews of uar, and citizen levies diminished in importance and to some extent in quality. Corporate religion began to decline. Great temples were still built, but more attention was given to secular and civic buildings. Tragedy lost its religious inspiration and followed the lead given by Euripides toward psychological drama. Political comedy was changing gradually into a comedy of social manners. where chance placed individuals in ridiculous situations! and prose developed at the expense of poetry. Sculpture lost something of its idealism and gained in sensual beauty, in sentiment and in realistic portraiture. Philosophy was concerned with the soul or mind of man rather than with his conduct in the state. When Plato envisaged the ideal city, he appreciated that the philosopher would be reluctant to become a ruler.

Although the Greek world was troubled by so many rapid changes. it remained immensely vigorous in action and fertile in ideas. Greece was unrivaled in commercial capitalism. in the understanding of agriculture and of finance and in the skillful practice of the art of war. The greatest philosophies and the noblest prose of antiquity were created in this period, and sculpture and painting reached a high level of perfection. But the political problem remained unsolved. Greek thought was still conditioned by the nationalism of the city-state. Plato and Aristotle analyzed the defects of contemporary politics with remarkable insight. They believed that a more enlightened education and the intelligence which it would produce might reform the city-state from within, and they both gave a picture of an ideal city-state in which the effects of capitalism would be controlled by the authority of state laws. But each state was envisaged as a separate entity and divorced, as far as possible, from contacts with its neighbours. Isocrates had a more practical outlook. He also believed in the value of education. but he saw that interdependence was more important than independence in the crowded world of the city-states. Practical politicians and the electorates behind them devised many forms of association which met some of the new needs of interdependence: complete merging of city-states by force or by agreement, the growth of federal systems with a common citizenship (sympolity) or with an exchange of citizenships (isopolity); sharing of monetary or commercial advantages; organization of large and efficient coalitions based on collective security; and even the formation of a league of states. But at the same time each city-state pursued an independent policy and often an imperialistic policy. as soon as it had reaped the temporary advantages of membership in an association. The liberal principles of the second Athenian confederacy and the Boeotian league did not withstand the temptations of success. The Greek world was exhausted and leaderless in 354 B.C., when a new power was growing in the north.

THE MACEDONIAN PERIOD

The area which we now call Macedonia was inhabited in the 4th century B.C. by peoples of Greek, Illyrian and Thracian stock. The Macedonians proper held the coastal plain at the head of the Thermaic gulf and had more Greek blood than their neighbours of upper Macedonia. Their royal house claimed descent from Heracles, son of Zeus, and the kings were recognized as Greek by the presidents of the Olympic games early in the 5th century. They claimed suzerainty over the cantons of upper Macedonia which had their own royal houses, but they were seldom able to exercise an effective suzerainty. Kingship in Macedonia proper and in the cantons of upper Macedonia, like that of the Heroic age in the Homeric poems, was hereditary within one family and constitutional. The king owned all land and conducted all affairs of state in war and peace at his own discretion. He chose his own "companions" from the nobles of the land to advise him and serve with him in battle. They had a personal "kinship" with the king which enhanced his claim on their loyalty. The Macedonian people elected the king. tried cases of treason in which the king was a litigant and had power to depose him by their vote. They derived their land and citizenship from the king and owed him personal service. taxes and dues. They had no substratum of serfs or slaves, and as freemen they consorted on easy terms with the king and his companions. The feudal institutions of Macedonia proper and of upper Macedonia were unlike those of the city-state and were regarded as barbaric by the Greeks.

As Greek manners spread inland, they were canalized by the royal house. Greek culture was adopted by the court and Macedonia traded with the sea po ers of the Aegean, but the march of Greek political ideas which led to the growth of city-states in Thessaly was successfully resisted by the Macedonian kings.

The Rise and Triumph of Macedonia. — Although Macedonia proper and the cantons of upper Macedonia were not closely united *c.* 360 B.C., they had a common interest in contending with their aggressive neighbours in Illyria. Paeonia and Thrace and with the Greeks who attacked them from Chalcidice or Thessaly or from the Aegean sea. In 359 the Illyrians killed the king. Perdiccas III. and 4,000 Macedonians in battle and annexed the western part of upper Macedonia. Athens, then still very powerful. Paeonia and Thrace were ready to invade and divide the country. The infant son of Perdiccas was elected king; and Philip, a brother of Perdiccas. was appointed regent Having lived as a hostage at Thebes in the period of Epaminondas and Pelopidas. Philip at the age of 22 had a thorough knowledge of Greek warfare and diplomacy as well as of the methods of the Balkan peoples. He bribed his enemies in Paeonia and Thrace to keep the peace and concentrated his troops against a pretender, Argaeus, who landed with the support of 3,000 mercenary soldiers. sent by Athens, late in 359. Philip defeated the pretender. He let the mercenaries go free and made peace with Athens, which was then at war with the revived Chalcidian league and desired to capture Amphipolis. In 358 he subjugated the Paeonians, defeated the Illyrians decisively and won the support of Illyria's southern neighbour, Epirus, nhere he married Olympias, daughter of the Molossian king. These remarkable successes led the Macedonians to elect him king as Philip II. He now exercised effective suzerainty over upper Macedonia and began to incorporate the leaders of the cantonal royal houses into the ranks of his companions.

Philip's Alliance with the Chalcidian League.—The chief threat to Macedonia came from the Greek states. Fortunately for Philip, the Chalcidian league, in which the principal state was Olynthus, was at war with Athens over Amphipolis, an independent state supported by the league. In the spring of 357 B.C., Philip boldly laid siege to Amphipolis. When Athens was asked by Amphipolis to send a garrison to its aid, Philip made a secret pact to give Amphipolis to Athens, if Athens gave him Pydna, a city on the Macedonian coast which was an ally of Athens. The Athenian bases at Potidaea and Torone in Chalcidice kept the Chalcidian league occupied, while Philip prosecuted the siege and captured Amphipolis. He pronounced Amphipolis independent, attacked and took Pydna and negotiated with the Chalcidian league for a defensive alliance; for Athens was now engaged in the Social War, and the Chalcidian league became the strongest power in the northwestern areas of the Aegean. The alliance was consummated with the cession of a rich territory called Anthemus to the league; and Philip captured Potidaea and gave it to the league as well. As both powers mere at war nith Athens, they agreed under the terms of their alliance not to treat separately with the common enemy. But Philip was anxious not to embitter Athens and therefore let the Athenians depart from Potidaea without ransom. In 356 he advanced from Amphipolis to help Crenides, a Thasian settlement, against the Thracians. Crenides received Macedonian settlers and gave Philip access to the gold and silver mines of Mt. Pangaeum, from which he later derived a revenue of 1,000 talents a year. Athens organized a coalition of the kings of western Thrace, Paeonia and Illyria. Philip attacked them one by one. In Aug. 356 the Illyrians mere defeated. Philip's horse won a race at the Olympic games, and Olympias gave birth to his first son, Alexander.

Philip advanced his power along the Thracian coast and captured the last Athenian base on Macedonian territory. Methone, in 354 But his main task in these years mas to consolidate and develop his kingdom. He absorbed the royal houses of upper Macedonia into his entourage and chose young nobles to act as royal pages He increased the prosperity of Macedonia by a trade pact with the Chalcidian league and by building roads and founding colonies in the interior. Pella, the capital, was a thriving inland port; and Crenides, renamed Philippi. brought him gold and silver from which he minted coins on the Thracian and Attic standards. The Macedonian cavalry, headed by the companions, was the traditional arm of the country, and Philip raised the Macedonian infantrymen or "foot companions" to a high pitch of efficiency by regular training. As he advanced his frontiers he annexed some territories and created new Macedonian citizens—some of them of Greek extraction—by granting them land in his enlarged realm. He was forming a national territorial state, capable of expanding its territory and citizenship in a way unknown to the Greek city-state. At the same time he represented himself to the city-states as an upholder of Greek ideas. He placed the heads of Heracles and of Zeus on his coins. He set up a copy of the treaty with the Chalcidian league at Delphi. He entered Thessaly to help the free states against the tyrant Lycophron of Pherae and he captured Pagasae for them in 354 before Athens was able to come to its relief. When the opportunity came to intervene in the Sacred War, he was careful to represent himself as the champion of Apollo.

Onomarchus and Philip in *Thessaly*.—In central Greece Boeotia defeated the Phocians under Philomelus in the latter part of the year 354 B.C., but a new Phocian leader, Onomarchus, rallied his countrymen, hired more mercenaries and made alliances with the tyrants in Thessaly against the free states, which invoked Philip's aid. Onomarchus defeated Philip and his Thessalian allies twice in 353 and then turned to inflict heavy losses on Boeotia, which was the natural but probably not the formal ally of Philip. Onomarchus now ruled from Mt. Olympus to the Corinthian gulf, and was the ally of Athens, Sparta, Corinth, Megara, Achaea and other states. Nevertheless Philip attacked him in Thessaly in 352, defeated his army of 500 cavalry and 20,000 infantry and inflicted almost 10,000 casualties; Onomarchus himself was killed; the remainder escaped to an Athenian fleet which lay offshore in support. This resounding victory caused the tyrants to capitulate. Philip allowed them to withdraw, reorganized the Thessalian league to include all Thessalian cities and accepted election as its president with command of its forces and some claim on its revenues. In the summer of 352 he led the Macedonian and Thessalian forces to Thermopylae, but he found the pass defended by the Phocians and their Athenian, Spartan and Achaean allies. He withdrew at once and switched his attack to Thrace. In 351 his eastern frontier was at the Hebrus river, and he was on good terms with Byzantium and with Cardia. enemies of Athens.

Eubulus and Demosthenes in Athens.—During these years there had been considerable fighting in the Peloponnese and unrest among the island states in the Aegean. Athens had recovered steadily from the effects of defeat in the Social War, thanks to a policy of refusing invitations to join in adventures in the Peloponnese or to intervene in party struggles in the Aegean. The democracy had become more extreme after 404, the council losing many of its pou-ers to the assembly and to the people's courts and the orators gaining greater influence in the assembly. The process was checked in 354 when a conservative politician, Eubulus, was elected chief commissioner of the theoric fund (money reserved for the relief of the poor) for four years and the commissioners were authorized to control general expenditure. During his tenure a law was passed whereby surplus revenue went into the theoric fund and could only be diverted into the military fund by a decision of the assembly. As the poor commanded a majority, they now had a financial interest in preserving the peace so as not to divert money from the theoric fund and were less ready to engage in adventurous wars than in the past. But Eubulus and the assembly were not pacifist: they sent expeditionary forces to counter Philip at Methone, Pagasae and Thermopylae; and they acquired the Chersonese and sent cleruchs to Sestos in 353–352. The chief opponent of Eubulus was Demosthenes, a brilliant orator, who advocated an adventurous policy in the Peloponnese. Rhodes and Thrace but did not denounce Philip as the chief enemy of Athens until he delivered the speech known as the First Philippic, probably in 350 B.C.

The Fall of *Olynthus*.—Chalcidice was the key to any offensive against Macedonia. Eubulus negotiated unsuccessfully with the Chalcidian league late in 352 B C.. and Philip forced the issue in 349 by asking the league as his ally to surrender two pretenders to his throne. The Chalcidians refused and treated separately with Athens, which was a breach of their alliance with Macedonia. Athens granted an alliance and sent 2,000 mercenaries and 38 triremes. Philip remained inactive until the sailing season ended. Then he took a number of Chalcidian cities by storm or negotiation and started a rising against the pro-Athenian governments in Euboea in Jan. 348. As Euboea lay on the sea route to Chalcidice, Athenian forces were sent there rather than to Chalcidice; but these forces suffered such reverses that Athens recognized the independence of Euboea and paid a large sum to ransom prisoners in July. Meanwhile Philip reduced all Chalcidice except Olynthus, to which Athens had sent a further force of 4,000 mercenaries and 18 triremes. A third force of 2,300 citizen troops and 18 triremes was held up by northerly winds. It arrived to find Olynthus in Philip's hands. Philip razed the city to the ground and incorporated Chalcidice in his realm.

The End of the Sacred War.—Before the Athenians had recovered from the shock of defeat in Euboea and in Chalcidice, Philip offered peace and alliance. Athens was in a weak position, because Phocis was now failing in the Sacred War. and Thessaly, Boeotia and Euboea formed a strong group. Even Demosthenes, who had criticized Eubulus and denounced Philip in the Olynthiac speeches, supported negotiations with Philip as a necessary step in extricating Athens from the Sacred War. An interruption occurred in the winter of 347–346, when Sparta and Athens tried to seize Thermopylae, but the plan miscarried. Peace and alliance were concluded between Macedonia and Athens in July 346 (the peace of Philocrates) ; but opinion in the Athenian assembly was divided, Eubulus and Aeschines proposing to implement the alliance and Demosthenes trying to prevent its implementation. Philip and his allies, with the exception of Athens which refused to send a contingent. invaded Phocis and received the capitulation of the Phocians. The Amphictyonic council, guided by Philip, made a settlement which was merciful by Greek standards: the Phocians were disarmed, their towns were split into villages and they had to pay an indemnity to Apollo. The two votes of Phocis on the council were transferred to Philip, and he was elected president for the Pythian games in Sept. 346. Athens refused at first to acknowledge Philip's position. But the Amphictyonic council demanded an apology, and Athens apologized after a debate in which Aeschines was shouted down and Demosthenes emphasized Athens' isolation and the need to avoid a rupture with Philip and his allies.

Demosthenes' Policy of Resistance.—Between 346 and 340 Philip increased his control of the Balkan area by a series of campaigns and negotiations. He controlled Illyria as far north as Scodra (the modern Shkoder or Scutari in Albania), Epirus. Thessaly through the Thessalian league (of which he was elected president for life) and Paeonia and Thrace through vassal kings. His alliances reached as far as the Getae on the lower Danube. the Greek cities on the Black sea and the lesser states in the Peloponnese. The Aetolian league allied itself with him *c*. 343. The kingdom of Macedonia was becoming unified by economic prosperity and military success. and the subject peoples in the Balkan area were secured by military colonies, economic development and the prestige of the king himself. The very strength of Macedonia forced the Athenians to decide between Aeschines and Demosthenes in the assembly and in the people's courts. They chose the policy of Demosthenes and won the alliance of other states which were apprehensive of Macedonia: Corcyra, Ambracia, Leucas, Corinth. Achaea, Messenia, Byzantium, Abydos, Chios, Rhodes and Euboea, which sent delegates to a conference at Athens in March 340 B.C. and agreed in principle to participate in a war against Philip. Demosthenes was crowned for his services to the state.

Philip had hoped to win the Greek states by diplomacy. But the triumph of Demosthenes ended those hopes, and there was now a danger that Athens would find an ally in Persia, which had put down a series of revolts and held the Asian side of the Bosporus. Philip laid siege to Perinthus in the summer of 340 B.C. and then to Byzantium, as these cities had refused to implement their alliance with him; and he sent a letter of complaint to Athens which rescinded the treaty of alliance with Macedonia. Help was sent to Perinthus and Byzantium by Persia and Athens, which contracted an alliance, and by Athens' other allies. Philip raised the siege, conducted a campaign as far as the mouth of the Danube and fought his way through the Triballi in northern Thrace. In 339 his friends on the Amphictyonic council offered Philip the command of their forces in a new Sacred War against the Locrians of Amphissa. Philip accepted. When his Macedonian and Thessalian forces reached Cytinium in Doris, he sent envoys to ask the Boeotian league to join him in accordance with the alliance. Demosthenes led Athenian envoys to Thebes and offered a favourable alliance to the Boeotian league, under which Athens would pay two-thirds of the expenses of war and serve under Boeotia's command in the field. The assembly of the Boeotian league voted for alliance with Athens and denounced the existing alliance nith Philip. The allies occupied strong defensive positions. They refused all overtures for peace which Philip made, and it was clear that Philip could only overcome their opposition by force.

Philip's *Victory at Chaeronea, 338* B.C.—The Macedonian army was an unknown quantity to the citizen levies of Boeotia and Athens; for it had fought on Greek soil only in Thessaly and then against the mercenary troops of Onomarchus. The Macedonian cavalry was far superior to that of the allies: the heavy cavalry, wearing protective armour and equipped with shield, s ord and lance, operated in wedge-shaped formations for close fighting; the light cavalry, armed like Greek cavalry with javelin and sword, was designed for skirmishing. The infantry carried a pike twice as long as the Greek hoplite's spear, fought in less close order and were more flexible in maneuver. and the phalanx or line of battle was supported by units of specialized light infantry. In the summer of 338 B.C. Philip broke through the allies' position north of Amphissa, which was held by 10.000 mercenary troops. He offered in vain to negotiate with the citizen forces of Boeotia and Athens. A decisive battle mas fought at Chaeronea between about 35,000 Greek hoplites and about 30.000 Macedonian infantry. Philip, commanding the right wing of the phalanx, made a bold maneuver of withdrawal which drew the Athenians opposite him out of their position. As the Greek line moved to its left to maintain contact, a gap opened near the right wing, into which the young prince Alexander charged at the head of the companion cavalry. At the same time Philip delivered his attack. Both wings of the allied army were destroyed or captured; the centre broke and fled. Philip did not launch his cavalry in pursuit, as he had done with deadly effect in other battles. Boeotia capitulated and was treated as a treacherous ally; the league was disbanded and oligarchic government mas installed at Thebes, where a Macedonian garrison occupied the acropolis. The Athenians accepted terms, under which they lost what had been left of the second Athenian confederacy, but kept Lemnos, Imbros. Scyros. Delos and Samos and entered into alliance with Macedonia. Philip entered the Peloponnese and was honoured by every state except Sparta, which proudly refused him entry but could not prevent his marching to Gythium in southern Laconia. The military might of Macedonia was triumphantly demonstrated with a minimum of bloodshed.

Greece under Philip and Alexander. — The enemies of Philip had always claimed that he would follow the path of Greek imperialism and destroy or enslave the city-states which he conquered. Isocrates, who was now 98 years old. wrote a letter to Philip in which he urged him to end the period of mad imperialism. to bring the Greek states into an association of goodwill and to declare war on Persia. Nor was this an old man's fantasy. Isocrates had seen the ceaseless wars for hegemony in Greece and the consequences of social unrest, and he had observed Philip's ability to win the support of Thessaly and his enlightened generosity in victory. Demosthenes, on the other hand, found that generosity inexplicable. He distrusted Philip and Macedonia at the moment and for the future. because he was the advocate of untrammeled independence for his city-state. Athens.

Philip chose the way of co-operation. At his suggestion the Greek states of the mainland (except Sparta). together with many island states. formed a Greek league, which was ratified in 337 B.C. at Corinth and is now called the League of Corinth. The states undertook to keep the peace among themselves and to use military sanctions against any aggressor; to respect the constitution and liberty of one another and to unite in suppressing piracy and brigandage; and to refrain each in its own state from any executions or revolutionary procedures uhich were contrary to the existing laws. Each state elected a number of delegates, proportionate to its military and naval strength, who sat on the federal organ of government, "the council of the Greeks." All states were bound by the council's decisions. which were taken on a majority vote and covered all matters of federal government, including issues of foreign policy. At its first meeting the council entered into an offensive and defensive alliance for all time with "Philip and his descendants." decided to conduct a war against Persia and elected Philip to be commander of its armed forces and chairman of the council during the war, citing him as "a benefactor of Greece" The council then approved the presence of Macedonian garrisons in Thebes. Chalcis. Ambracia and Corinth and called up contingents for the war against Persia.

The settlement of Greece was certainly statesmanlike. It went much further than the league of 362 B.C. had gone to arrest the endemic troubles of the Greek states; and war with Persia would provide an outlet for their energies and surplus populations. Alliance with Macedonia did not amount to incorporation in a Macedonian empire. Philip avoided that step. It is uncertain whether he acted as a Greek with an interest in Greek affairs, as an enlightened statesman who wanted a strong union of powers against Persia, or as a hypocrite who preferred to dominate by appearing to unite his potential enemies in a Greek league. In any event the league held firm until Philip was assassinated in 336 B.C. It then elected his son and successor, Alexander III, to command its forces. The same year saw the completion of a federal system in Sicily, where Timoleon had defeated the Carthaginians and established a moderate form ot government in the Greek states.

The conquest of Persia by Alexander the Great and the army of the Greek league is described elsewhere (*see* ALEXANDER III, *THE* GREAT). We are here concerned with events in Greece. Before the expedition set out, Thebes rose in revolt, in 336 B.C. and again in 335. Alexander pardoned the first offense and gave Thebes an opportunity to retract from the second revolt. But Thebes remained obstinate. Alexander then stormed the city with his own troops and with those of the Boeotian states which were hostile to Thebes. The punishment of the rebels was referred to the council of the Greek league, which condemned the population to slavery and allotted its lands to neighbouring states. Alexander executed the sentence. He could and should have prevented the council from passing such a sentence; for the liquidation of Thebes was interpreted as an act of Macedonian imperialism. He showed generosity toward Athens and other states which had helped to instigate the revolts of Thebes and also toward Demosthenes and other statesmen who had received subsidies from Persia. but the confidence which Philip had hoped to create between Macedon and Greece was destroyed almost irretrievably.

In the opening years of the campaign against Persia (334 *et seq.* B.C.) Alexander respected the position of the Greek league. Island states were enrolled as members of the league, and a check was imposed on party strife and on revolutionary procedure. On the other hand the Greek states in Asia Minor were probably treated as part of Alexander's kingdom; for each nas given a treaty by Alexander, and Greek and barbarian alike were governed by his regulations. So long as the Persian fleet stayed at sea. Sparta acted openly as the enemy of Macedon. and Athens not only instituted conscription for young men but also intrigued with Persia. When the Persian fleet aas disbanded, Sparta used Persian money to hire a large mercenary army, raised Elis. Achaea and part of Arcadia in revolt and invited Athens to join in the fight for independence. But Athens refused. The coalition nith 2.000 cavalry and 20,000 infantry, defeated one Macedonian army and attacked Megalopolis but was broken up in the autumn of 331 by Xntipater. Alexander's deputy in Macedonia, who reinforced his army with contingents from the Greek league. The fate of Sparta and the rebellious states was entrusted by the council of the Greek league to Alexander. He forced Sparta to enter the league and made the rebels pay an indemnity to Megalopolis.

During the rest of Alexander's lifetime the Greek states made no move. The central issue in their party politics was the attitude to be shown toward him. In 330 B.C. Demosthenes won his case in Athens with his speech "On the Crown" in defense of Ctesiphon, whom Aeschines was prosecuting for having proposed that a crown should be given to Demosthenes after the battle of Chaeronea; and Aeschines left the country. A steady stream of exiles flowed from the Greek states to Asia. until Alexander decreed in 324, probably with the agreement of the Greek league, that all exiles should be reinstated. The states even granted Alexander "godlike honours" at his own request—some with gratitude and some with mockery. Greek envoys, wearing crowns in his honour, waited upon him at Babylon just before he died in 323 B.C., at the age of 32.

Macedonia and the Greek States, 323–224.—The conquests of Alexander in Asia brought great prosperity to the eastern Mediterranean. The accumulation of capital reserves enabled Athens to equip a large fleet and to improve the city's defenses, and other states on the mainland of Greece benefited from the years of peace. The wealthy class in most states favoured good relations with Macedon. The democratic leaders were afraid of a coup *d'état* by the wealthy and resented the restrictions on foreign policy which had been imposed by the League of Corinth. So long as Alexander lived and conquered, they complied reluctantly with his wishes. But the news of his death and of the quarrels between his generals gave the democratic leaders some hope of throwing off the alliance with Macedon. Large forces of Greek mercenaries were under arms: 8,000 men, commanded by an Athenian, Leosthenes, were at Taenarum in Laconia and 23,000 men were marching homeward from the east. The Athenian people decided to go to war. They engaged Leosthenes and his mercenaries and formed an alliance with the Aetolian league, but most of the Greek states—especially those which had reason to fear Athenian ambitions—opposed this policy or at least refused to co-operate. The allies began the Greek War, as they called it, (it is alternatively called the Lamian War) with an army of about 30,000 men. They seized Thermopylae in Oct. 323 B.C. and blockaded a Macedonian army under Antipater in Lamia throughout the winter. Meanwhile an Athenian fleet of 170 ships sailed to the Hellespont but gained no allies. In 322 three Macedonian armies were operating in Thessaly and two Macedonian fleets held the northern Aegean. Superior numbers enabled Antipater to defeat and split the Greek allies. Athens surrendered unconditionally in Sept. 322. A year later the Aetolian league accepted moderate terms from Antipater, who was anxious to settle affairs and to intervene in Asia.

The lessons of the Greek War were clear. Athens was unable to unite the Greek states because of their mistrust and the forces of Athens and Aetolia alone were far inferior to the massive armies of the Macedonians. Antipater abandoned the policy of co-operation. Treating Athens as a traitor, he exacted an indemnity for the war, placed a garrison in Munychia to control the Peiraeus and Athens and disfranchised the poorer class, so as to leave only 9,000 citizens as the electorate for an oligarchic government. The assembly passed sentence of death on the democratic leaders who had instigated the war. Demosthenes committed suicide. Antipater set up pro-Macedonian oligarchies in the Peloponnesian states and installed Deinarchus, a politician from Athens, to act as Macedonian governor of the Peloponnese. The freedom of Athens and of the Peloponnesian states was at an end. They were now subject to a Macedonian protectorate, which dictated their form of government and made them keep the peace.

From 320 to 275 B.C. the states of the mainland were involved in the wars of the Diadochi ("successors") of Alexander, who fought for power and ended by dividing the Macedonian empire into a number of fairly stable monarchies. During these troubled years the Greek states were important to the rival kings and generals because they were able to provide troops and taxes. The policy of co-operation was applied for the last time in 303 by Demetrius Poliorcetes, who revived the League of Corinth and treated the Greek states as allies. Otherwise the Macedonians kept control, whatever their protestations may have been, by setting up puppet governments and imposing garrisons. In Athens, for instance, Antipater's son Cassander in 317 placed Demetrius of Phalerum at the head of an oligarchic government under the protection of a Macedonian garrison; and this situation lasted till 307. The council of the Areopagus received many of its traditional powers, the rich were freed from the liturgies (public duties) imposed by the democracy and a strong control was set on all legislation; but behind this façade Demetrius of Phalerum was a tyrant who ruled with Macedonian support. The state which made the boldest bid for independence was Sparta, whose successful revolt, in 280, was joined by Elis and by some states in Arcadia and Achaea but not by rivals of Sparta in the Peloponnese. But the very success of this revolt made Sparta's allies suspicious and uneasy and they fell away when Sparta attacked the Aetolian league and suffered heavy losses. In 275 the Antigonid dynasty was finally established on the Macedonian throne.

Between 275 and 224 the strength of the Macedonian kingdom in Europe was weakened by the attacks of Pyrrhus of Epirus (d. 272) and by the intrigues of Ptolemy II of Egypt and other Hellenistic monarchs. The Greek states obtained a greater measure of independence. The most vigorous peoples were those of the hill country who developed the federal system. The Aetolian league had been organized as a league of cantons with a democratic assembly on the model of the Boeotian league since 370, and it had never been subjugated by Macedon. Now it expanded its territory by incorporating other states, which retained their own citizenship but assumed Aetolian citizenship under an act of sympolity, and it granted an exchange of citizenships with more distant states under an act of isopolity. The Aetolian assembly, which met twice a year, decided on policy and elected for the year a general who presided over the assembly and commanded its armed forces; and routine administration was carried out by a council, of which the members were elected by the cantons in numbers proportionate to their military strength. The general and his advisers, acting as a committee, were entrusted with wide powers, because the assembly met so rarely; and a man could be re-elected to the generalship only after an interval of some years, lest he become too powerful and autocratic. By 224 the Aetolian league, having defeated its rival, the Boeotian league, included within its sympolity the core of central Greece from coast to coast and counted among its close allies by isopolity such states as Cephallenia and Chios. Just as the democratic city-states of the previous century had been, the Aetolian league was aggressive and warlike.

The Achaean league had been disbanded in the period of Macedonian domination. It formed again on a democratic basis c. 280 B.C., with an assembly of citizens over 30 years of age and a representative council of deputies. From c. 200 B.C the assembly's powers declined. It met jointly with the council at irregular intervals to decide major issues. The predominance of the council made the policy of the Achaean league less adventurous than that of the Aetolian, and the member states had a greater degree of independence, rarely exchanging their citizenship by an act of isopolity. The number of annual generals of the league was reduced from two to one in 255. Then the general acted as president of the assembly and commander of its forces and shared with a small committee of officials the exercise of a strong executive authority; and the same man could be elected general in alternate years. This feature in the league's democratic constitution enabled Aratus of Sicyon to hold office every other year and gain a strong position of leadership. Aratus had a fanatical hatred of the tyrants whom Macedon supported, and he drove them out of city after city until by 228 the Achaean league comprised almost all states in the Peloponnese except Elis, Messenia and Sparta.

The greatest city-states of the past led a rising against Macedon in 267 or 266 B.C. This was the Chremonidean War (so named after the Athenian leader), in which Athens and Sparta, in alliance with Ptolemy II of Egypt, proclaimed themselves champions of the liberty of the Greek states. But few of the states joined them. The Athenians fought gallantly, but were starved into surrender by the superior forces of Macedon in 262. They did not become independent again until 229; after this, they preserved their freedom by a policy of neutrality.

The Spartans lost their allies and remained a second-rate power, without Macedonian intervention, until 227 B.C., when they saw themselves threatened by the expanding Achaean league. Sparta indeed had been crippled, ever since the battle of Leuctra, by the small number of Spartiates, or full citizens, who ouned sufficient land to pay their contributions to the messes. In 227, however, a Spartan king. Cleomepes III. changed the situation by revolutionary methods: he abolished debts and confiscated all land, which he redistributed in lots to increase the citizen body. Having thus enlarged his army and announcing a program of social revolution, Cleomenes attacked the Achaean league and detached so many of its member states that its general. Aratus, called on Antigonus Doson. king of Macedon, for help in 224.

The Coming of the Romans.—Between 224 and 205 B.C. Macedon struggled to regain a dominant position in Greece. As the price of help to Aratus, Antigonus Doson took over Corinth and founded another Greek league. This was similar to Philip II's League of Corinth and included the leagues of Thessaly, Phocis, Boeotia, Euboea, Epirus, Acarnania and Achaea. As the elected commander of the league's forces, Antigonus cornered and defeated the Spartans at Sellasia in 222, entered Sparta and canceled the measures of Cleomenes. When Xntigonus died, in 221. Philip V succeeded to the throne of Macedon. He helped the members of the new Greek league against the Aetolian league, Elis and Sparta in another so-called Social War (220–217). which was indecisive. At the peace conference the Aetolian delegate spoke of "the cloud rising in the west," namely Rome, nhich had gained control of a part of the Illyrian coast and Corcyra in 229 and sent envoys to the Isthmian games at Corinth's invitation in 228. When the outbreak of the Second Punic War was followed by a series of Roman defeats, Philip allied himself with Carthage (21j) and tried in vain to oust Rome from the Illyrian coast. Rome raised Philip's Greek enemies—the Aetolian league, Elis. Sparta and Messenia—against him in 21 2; the Romans were about to invade Africa when fighting ended in Greece in 20j without any clear gain for either side.

The period from 20j to 146 was marked by the advance of Rome. Some Greek states called upon Rome for help, as they had called upon Persia and Macedon, but they learned to their cost that the Romans had neither gratitude nor scruple where their desire for power was involved. The Romans' first step was to defeat Philip V (battle of Cynoscephalae, 197 B.C.) and to confine him to Macedonia; they were helped in this by the Aetolian and Achaean leagues, Athens, Rhodes and Pergamum. It was now the Romans, not the Macedonians, who proclaimed that the Greek states were to be independent. They used Greek and Roman troops to enforce the transfer of Argos from Sparta to the Achaean league. Also, Rome gave the Aetolian league less territory than it claimed. The Roman army left Greek soil in 194, but the Aetolian league countered by inviting the Seleucid king Antiochus III into Greece. Antiochus came, in 192, but the Romans and Philip V of Macedon drove him out and reduced the Aetolian league to impotence. The Romans then defeated Antiochus at Magnesia, on the other side of the Aegean, in 189, deprived him of Asia Minor west of the Taurus mountains and announced the freedom of the Greek cities there in 188.

Meanwhile Rome's ally, the Achaean league led by Philopoemen, was extending its territory; Sparta, which had been brought into the league in 192, tried to secede; but Philopoemen was able to enforce the annexation of the state in 188. after a number of leading citizens had been massacred. A few years of uneasy peace were marked by complaints which the Greek states made to Rome against one another and against Macedon. Then, in 171 the Romans ordered Perseus, the successor of Philip V of Macedon, to disband his forces. Perseus refused and Rome attacked. The Greek states played little part in the war. They watched the almost complete annihilation of the Macedonian army (battle of Pydna, 168 B.C.) and the dismemberment into four republics of the kingdom which had towered over them for two centuries. The Greeks too were given a taste of Roman methods: in Epirus, where sympathy with Macedon had been shown in two wars, the Roman army destroyed 70 towns and deported 150,000 men as slaves; although the Achaean league had declared for Rome, 1,000 leading citizens were deported to Italy; and Aetolia was weakened by Roman troops which helped the pro-Roman party in a civil strife. Even so, the authority of Rome was flouted. Then, in 148 a Roman army annexed Macedonia as a province; and in 146 another army defeated the forces of the Achaean league—Boeotia, Euboea, Phocis and Locris. This time the consul L. Mummius made an example of Corinth: the men were massacred, the women and children were enslaved and the city was razed. Rome ordered the disbanding of all leagues and the replacement of democracy by oligarchy in a number of states and announced that any breach of the Roman regulations would be punished by death. Thus the liberties of the Greek states mere finally and completely abrogated.

During the period of Macedon's supremacy the centre of economic prosperity shifted to Asia Minor and Egypt, but the Greek states remained prosperous, especially those north of the Isthmus. War was more humane until Rome entered the field, and it caused little disruption of trade. The instability of Greek politics was due to the widening gap between rich and poor and to the growth of slave populations, which reduced the unskilled free worker to the minimum level of subsistence. The danger of social revolution was always present. It caused the rich to band together and to lean on the support of Macedon or Rome. whereas the democrats sought to overthrow the rich and to gain new territories. The leagues grew in response to the challenge of the greater states of the Macedonian world, but they pursued their policy as rivals and not as unifiers of Greece, until disaster engulfed them and the weaker single city-states. Greek culture became more uniform, but Athens was still the centre of sophistication and philosophy. It was in Athens that Menander wrote his comedies, which depicted social life in a city with kindly wit and perfect style. The schools of Plato and Aristotle were rivaled by four sects which concentrated on the problems of individual happiness—the Sceptics, the Cynics. the Epicureans and the Stoics Individualism was now fully emancipated from the strands of city-state religion. Greek culture made great strides in medicine. mathematics, astronomy. botany, hydrostatics and technical subjects; it excelled in scholarship and in those varieties of prose and poetry which depend on the precise and imaginative mind of the scholar; and it was magnificently portrayed in sculpture and painting. But Greek culture was gradually losing the distinction that it had derived from the city-state and was fitting itself for the long life that it was to enjoy as the culture of educated men in an urban setting within the framework of the Roman empire.

Authorities for Classical Greek History

Our knowledge of the Bronze Age is derived from archaeological excavation (see AEGEAN CIVILIZATION) and from the poems attributed to Homer (*q.v.*). For the period of the Greek renaissance from the 9th century onward we rely on archaeology and on the remains of epic (see HESIOD), lyric and elegiac poetry. Political and military history begins with the works of Herodotus and Thucydides (*qq.v.*), who painted some of the background of the great wars which they described so brilliantly. Contemporary inscriptions and coinage have survived from the 6th century B.C. onward in increasing quantity; they check the accuracy of ancient historians and supplement their accounts in an infinity of ways. For the 4th century the contemporary history of Xenophon (*q.v.*) is filled out by the fragments of Ephorus and Theopompus, who were themselves the ultimate source of later works composed under the Roman empire—the Lives of Plutarch (*q.v.*) and the Library of Diodorus Siculus (*q.v.*). The whole body of classical literature, architecture and art provides the rich background against which the historical data are marshaled, and understanding of Greek politics owes most to the 4th-century orators and philosophers—Isocrates and Demosthenes, Plato and Xristotle.

For the Hellenistic period the scholar draws on a mass of contemporary inscriptions, coins and material remains, but with the outstanding exception of Polybius (*q.v.*) the works of contemporary historians have survived only in fragments. The career of Alexander has been preserved for us by a Roman governor, Arrian (*q.v.*), whose account rests on sources contemporary with Alexander and is supplemented by Diodorus Siculus and by Quintus Curtius Rufus. Our information about the Greek mainland from 323 to 146 B.C. is drawn mainly from Diodorus Siculus, Polybius, Plutarch's *Lives* and Livy; and an insight into social manners is afforded by the comedies of Menander (*q.v.*).

See also separate articles on subjects of special interest, for example, GREEK ARCHITECTURE; GREEK ART; GREEK LAW; GREEK LITERATURE; and GREEK RELIGION.

The contributions of the ancient Greeks in various fields are covered in detail in key articles such as PHILOSOPHY, HISTORY OF; LOGIC. HISTORY OF; OLYMPIC GAMES and SCULPTURE.

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POSTCLASSICAL AND MEDIEVAL HISTORY

Greece under the Roman Republic.— After the collapse of the Achaean league the Roman senate appointed a commission to reorganize Greece as a dependency of Rome. Corinth, the chief centre of resistance. was destroyed; the national and cantonal federations were dissolved, commercial intercourse between cities was restricted. and the government was transferred from the democracies to the propertied classes, whose interests were bound up with Roman supremacy. Some favoured states like Athens and Sparta retained their rights as *civitates liberae,* the other cities continued to enjoy local self-government but probably were subjected to payment of tribute. General powers of supervision were entrusted to the governor of Macedonia. The internal disorder which remained over from the previous political revolutions was checked by the historian Polybius, whom the senate deputed to mediate between the litigants.

Greece was seriously disturbed during the first Mithradatic War (88–84 B.C.). Many of its cities sided with Mithradates, whose success in detaching the Greeks from Rome is to be explained partly by the way in which his agents incited the imperialistic ambitions of cities like Athens, partly by his promises of support to the democratic parties. The result of the war was disastrous to Greece. Apart from the confiscations and exactions by which the Roman general L. Cornelius Sulla punished the disloyal communities, the extensive and protracted campaigns left central Greece in a ruinous condition.

During the last decades of the Roman republic oppressive exactions by officials were not unknown. Still greater was the suffering produced by the rapacity of Roman traders and capitalists. Sicyon had to sell its most cherished art treasures in order to satisfy its creditors. A further hindrance to Greek prosperity was the diversion of trade which followed upon the establishment of direct communication between Italy and the Levant The coastal districts and islands suffered considerably from swarms of pirates who freely plundered the chief trading places and sanctuaries; *e.g.* Delos in 69 B.C. This evil came to an end with the suppression of piracy in the Mediterranean by Pompey (67 B.C.), who settled some of his captives on the desolated coast of Achaea.

In the conflict between Julius Caesar and Pompey the Greeks provided the latter with a part of his excellent fleet. In 48 B C. the decisive campaign was fought on Greek soil, and the resources of the land were severely taxed by the requisitions of both armies. Though Caesar treated the country quite leniently after his victory at Pharsalus. the Greeks supported the cause of Brutus after Caesar's assassination; but they were too weak to render much service. They subsequently passed into the hands of Marcus Antonius, who imposed further exactions to defray the cost of his wars. The levies and requisitions which Antonius made in 31 B.C. for his campaign against Octavian (the future Augustus) exhausted the country so completely that, after the battle of Actium, Octavian had to take prompt measures to avert a general famine. The depopulation which resulted from the civil wars was partly remedied by the settlement of colonists at Corinth and Patrae by Julius Caesar and Octavian; on the other hand, the foundation of Nicopolis by the latter merely had the effect of transferring the people from the country to the city.

Roman Imperial Rule; **Augustus** to Diodetian.— In his reorganization of the provinces of the Roman empire Augustus incorporated Thessaly with Macedonia and converted the rest of Greece into the province of Achaea under the control of a senatorial proconsul resident at Corinth Several states, including Athens and Sparta, retained their rights as free cities. The provincials were encouraged to send delegates to a synod at Argos to consider the general interests of the country and to uphold national sentiment. The Delphic amphictyony was revived and extended so as to represent in a similar fashion northern and central Greece.

Economic conditions did not greatly improve under the empire. Although new industries sprang up to meet the needs of Roman luxury and Greek marble, textiles and table delicacies were in demand, the only cities which regained a flourishing trade were the partly Italian communities of Corinth and Patrae. Commerce languished in general, and the soil was mainly abandoned to pasturage. Such wealth as remained was amassed in the hands of a few great landowners and capitalists; the middle class continued to dwindle; and many persons became dependent on doles and largesses.

Seeing no future before them, the European Greeks were content to dwell in contemplation amid the glories of the past; and national pride was fostered by the undisguised respect with which the leading Romans treated Hellenic culture. To perpetuate this culture, the Greeks continued to set great store by classical education, and in Athens they possessed one of the chief universities in the Roman empire. At the same time the Greeks had so far lost their warlike qualities that they supplied scarcely any recruits to the army; and they retained too much local patriotism to crowd into the official careers of senators or imperial servants. Although in the 1st century A.D. the astute Greek man of affairs and the *Graeculus esuriens* ("hungry little Greek") of Juvenal abounded in Rome, both these types were mainly derived from the less pure-blooded population beyond the Aegean. The influx of Greek rhetoricians and professors into Italy during the 2nd and 3rd centuries A.D. was balanced by the large number of tourists who came to Greece.

In A.D. 15 the Greeks petitioned Tiberius to transfer the administration to an imperial legate. This new arrangement was sanctioned, but lasted only till A.D. 44, when Claudius restored the province to the senate. The years 66 and 67 were marked by the long visit of the emperor Nero, who wanted to display his artistic accomplishments at the various festivals: in return for the flattering reception accorded to him he besto ed freedom and exemption from tribute upon the country (this favour was speedily revoked by the emperor Vespasian). Important material benefits were conferred by Hadrian, who made a lengthy visit to Greece: besides erecting public works in many cities. he relieved Achaea of arrears of tribute and exempted it from various imposts; and he fostered national sentiment by establishing a new pan-Hellenic congress at Athens.

In the 3rd century Greece again experienced danger from foreign invasions. Already in 170 the Costoboci from beyond the Danube had penetrated into central Greece and sacked Eleusis before being broken up by the local militia. In 253 a Gothic army unsuccessfully besieged Thessalonica. In 268 the province was overrun by Gothic bands in collusion with a Herulian navy; these captured Athens and advanced as far south as Sparta; but a new landing in the north was defeated by the emperor Gallienus, and the victories of the emperor Claudius II in 269 put an end to the immediate danger. (W M.; X.)

The Early Byzantine Period.— After the reorganization of the empire by Diocletian at the end of the 3rd century, Achaea occupied a prominent position in the diocese of Moesia. Under Constantine the Great, Macedonia was a diocese of the prefecture of Illyricum and was subdivided into the eparchies of Thessaly, Achaea (including some of the Ionian and Aegean Islands), Epirus

Vetus (including Corfu and Ithaca) and Crete while the other Greek islands formed an eparchy of the diocese of Asia. A complex hierarchy of imperial officials was introduced and the system of taxation elaborated so as to yield a steady revenue. The levying of the land tax was imposed upon the *dekaprotoi* ("ten leading men") who, like the Latin *decuriones*, were entrusted henceforth with the administration in most cities. The tendency to reduce all constitutions to the Roman municipal pattern became prevalent.

Although the elevation of Constantinople to the rank of capital in 330 was prejudicial to Greece, which felt the competition of the new centre of culture and learning and had to part with numerous works of art to embellish it, the general level of prosperity in the 4th century was rising. Commercial stagnation was checked by a renewed expansion of trade consequent upon the diversion of the trade routes to the east from Egypt to the Euxine and Aegean seas. Agriculture remained depressed, and many small proprietors were reduced to serfdom; but the fiscal interests of the government called for the good treatment of this class, whose growth at the expense of the slaves was a step in the gradual equalization of the entire population under the central despotism. This prosperity received a sharp setback in a series of unusually severe earthquakes in 37j.

The emperors of the 4th century attempted to stamp out by edict the old pagan religion, but except for the decree of Theodosius I by which the Olympic games were interdicted (394). these measures had no great effect and indeed were not rigorously enforced. Paganism was long to survive in Greece—particularly in the Laconian mountains. The sure footing gained by the Christian Church in Greece in the course of the 4th century was strengthened by the judicious manner in which the clergy, unsupported by official patronage and often out of sympathy with the Arian emperors, identified itself with the interests of the people.

The schools of Athens in the 4th century still retained much of their prestige, and the Cappadocian fathers. for instance Basil of Caesarea. went there for their classical studies. In the 6th century Justinian forbade pagans to teach philosophy in Athens; and there appears to be no evidence that this work was taken over in Athens by Christian scholars. who seem at this time to have been attracted to the more flourishing schools of Gaza and Alexandria. But even if the schools of Athens declined in the early middle ages, there is ample evidence that the Byzantines prized their Hellenic tradition. Although they called themselves *Rhomaioi* ("Romans") and were proud of their Christian orthodoxy, they never forgot their ancient Greek culture. Greece itself, however, was for a long time an obscure and neglected province, with no interests beyond its church and its commercial operations, and its culture declined rapidly.

Barbarian invasions, meanwhile, continued. The incursion of the Visigoths under Alaric (395–396) was accompanied by a systematic devastation that crippled Greece for decades (the arrears of taxation that resulted were remitted by the emperor Theodosius II in 428). Vandal pirates raided the country in 466 and in 47j. The Ostrogoths under Theodoric were in Thessaly in 482. The Huns reached the Isthmus of Corinth in their invasion of j40 and Thermopylae in that of jj8. The early part of the 7th century saw Greece invaded by hordes of Avars and Slavs; and numbers of Slavs settled in parts of Greece (though the country was never completely slavicized, as J. P. Fallmerayer maintained).

From the **Isaurians** to the **Angeli,** 717–1204.—The emperors of the Isaurian dynasty in the 8th century continued the reorganization of the provinces into themes which appears to have been initiated by the 7th-century Heraclian emperors and subsequently extended to the rest of the empire. By the end of the 10th century Greece was divided among the themes of Hellas, the Peloponnese, Nicopolis, Dyrrachiuin. Cephalonia and Thessalonica, with the maritime themes of Samos and of the Aegean Sea. (Crete had its own governor, but from the early part of the 9th century to 961 it was in Moslem hands.) During the iconoclast controversy which raged intermittently from 726 to 843 Greece showed itself to be a strong supporter of the traditional use of icons—notably in 727 and in 823, when revolts broke out.

After the final renunciation of iconoclasm by the imperial government (843) and the establishment of the strong Macedonian dynasty (867), the Greek themes shared in the prosperity of the rest of the empire and had a flourishing economic life—particularly through the silk industry centred in Corinth and Thebes. In spite of imperial restrictions, the landed magnates (*e.g.*, the Sgouri of Nauplia and the Cantacuzini of Messenia) built up large family estates in Greece as elsewhere. Northern Greece was open to attack from the Bulgars late in the 9th and early in the 10th centuries, but by 1018 the Bulgarian empire had been conquered by the Byzantines. Thessaly was occupied by nomad Vlachs at the end of the 11th century and became known as Great Walachia. Greece was also attacked from time to time by the ambitious Normans of southern Italy. Robert Guiscard took Durazzo in 1082, whence his army advanced into Thessaly before it was driven out by Alexius Comnenus. In 1147 the army of Roger II of Sicily sacked Thebes and Corinth and took back to Palermo spme of the Byzantine silkweavers from these flourishing centres of the industry.

The **Late Byzantine** Period.—With the crusaders' conquest of Constantinople in 1204 (*see* CRUSADES) and the subsequent establishment of a Latin empire, Greece was split between Latin conquerors and Byzantine aspirants to the imperial throne. In the north the Greek despot Michael Angelus Comnenus set up an independent kingdom consisting of Epirus, Aetolia and Acarnania; and the Epirote rulers for a time enlarged their territory and hoped to regain Constantinople. But when Constantinople fell to the rulers of Nicaea, Epirote territory and authority d indled; and by 1340 what remained had either become part of the restored Byzantine empire of the Palaeologi or fallen to the Angevins of Naples or to the Serbs. In the middle of the 15th century. after being overrun by Serbs and Italians, this territory was conquered by the Ottoman Turks Thessalonica, Thessaly. with central and southern Greece and the islands were divided among the Latin conquerors after the Fourth Crusade, and a number of feudal principalities uere set up. In the north the kingdom of Thessalonica was granted to Boniface of Montferrat. but it soon fell, first to Theodore. despot of Epirus, uho took the title of emperor in 1223, then to the Byzantine emperor of Nicaea. John III Vatatzes, in 1246. After changing hands several times in the 14th and early 15th centuries Thessalonica was captured by the Turks in 1430.

The duchy of Athens (Attica and Boeotia) was granted as a fief by Boniface of Montferrat to the Burgundian Otto de La Roche, whose family kept it until 1308. It fell to the Almogávares (*q.v.*) in 1311. These Almogávares, otherwise known as the Grand Catalan company had entered Byzantine service as mercenaries on the conclusion of peace between the French and the Aragonese in Sicily (1302). They soon quarreled with the Byzantines, however, and moved southward. Walter of Brienne, who had become duke of Athens on the extinction of the house of La Roche. engaged their services next. but quarreled with them in turn; whereupon they defeated him in battle. Settling on his lands, they set up their own form of government in the duchies of Athens and Neopatras, with Aragonese princes from Sicily as their dukes. This Catalan–Aragonese domination lasted until 1388. when it gave way to the Florentine lord of Corinth Nerio Acciajuoli, nho in 1391 acknowledged Amadeo of Savoy as prince of Achaia and called himself "lord of Corinth and the duchy of Athens and Neopatras." The duchy of Athens mas ruled by the Acciajuoli family (apart from a period of Venetian domination, 1395–1402) until it was conquered by the Ottomans in 1456–58.

The most flourishing Frankish principality in Greece was that of Achaia, or the Morea (the Peloponnese), under the Villehardouin family. It was originally a fief of Boniface of Montferrat and was granted to William of Champlitte, whom in 1205 Pope Innocent III called "prince of the whole province of Achaia"; but by 1209 it was held direct from the Latin emperor by Geoffrey of Villehardouin with the title of prince. The Frankish rulers found the Byzantine system of granting land in *pronoia* (*i.e.*, to the care of someone) not dissimilar from their own grants in fee and came to terms with the natives. who were allowed to hold their lands in return for military service to the conquerors Toward the end of the 13th century, the splendid Frankish civilization of the Morea began to deteriorate William of Villehardouin prince of Achaia, had already been decisively defeated by Michael VIII (Palaeologus) at the battle of Pelagonia (1259) and been forced after three years' captivity, to cede the Moreot strongholds of Mistra, Old Maina and Monemvasia (1262). The Palaeologi subsequently regained much more of the territory, which was reorganized in the 14th century as the Byzantine theme of the Peloponnese and governed by despots, usually members of the imperial family, with their centre at Mistra (still famous for its buildings and frescoes, the last flowering of Byzantine civilization). In 1381, hon ever. another band of mercenaries, the Navarrese company, took possession of a considerable area in the west in the name of Jacques de Baux, a claimant to the Frankish principality; and from 1383, when Jacques died, the Navarrese themselves ruled there till 1430, when they were overthrown by the Palaeologi. In the 15th century. however, there were renewed Turkish attacks. which the new Byzantine fortification, the Hexamilion across the Isthmus of Corinth, failed to stem, and Thomas and Demetrius Palaeologi were finally conquered by the sultan Mohammed II in 1458–60.

Venice long retained its Greek conquests. The partition of 1204 and subsequent acquisitions had given it a number of scattered possessions of strategic and economic value, ruled directly or by nominees or by special arrangement. The more important of these were: the Ionian Islands (*q.v.*); Modon (1206), Coron (1206), Argos (1388). Nauplia (1388) and Monemvasia (1464) in the Morea; Crete (1204); and interests in the island of Euboea (shared with the Veroneae family Dalle Carceri), as well as in numerous other islands and in the duchy of the archipelago. This last was organized under the leadership of the Venetian Marco Sanudo, who captured Naxos as early as 1204–05. By 1207 more than two dozen islands were held either by him or as fiefs from him, and henceforth the Latin archipelago was dominated by Venetian families such as the Sanudi and the Ghisi, the Barozzi and the Crispi. Venice held Nauplia and Monemvasia until 1540, Crete until 1669 (two strongholds there till 1715) and the Ionian Islands until 1797.

The Frankish conquest brought the establishment of a Latin ecclesiastical hierarchy, though the native Greek priests were left undisturbed and the higher Byzantine clerics continued to exist side by side with the Latins, though they often resided in Constantinople. It vigorously stimulated economic and cultural life in Greece and, on the whole. was accepted by the indigenous majority. It also evoked a revival of Hellenic patriotism among Greek leaders and thinkers in the Byzantine despotate of the Peloponnese. In particular, the humanist Georgius Gemistus Pletho (*q.v.*) put forward utopian plans for the new constitution based on Plato's republic, but such attempts to revive Greek political life could not stave off the Ottoman conquest.

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MODERN HISTORY

Greece Under the Turks (1453–1821).—The Turkish conquest of Greece (Tourkokratia) is conventionally dated from 1453, when Constantinople was captured by the sultan Mohammed II and the last Byzantine emperor, Constantine XI, fell with his capital. In fact this date is no more than a symbol and a convenient average, for the greater part of the territory of the empire was already in the hands of the Ottoman Turks, and of the remainder, some parts remained outside Ottóman control for generations and even centuries longer.

At Trebizond, on the Black sea, a so-called Greek empire survived till 1461; on the mainland, the despotat of Epirus outlived Constantinople in independence for a generation; and many of the islands fell to the Ottomans only in the following centuries—Rhodes in 1523, Cyprus in 1571, Crete in 1669 and Tenos in 1715. The Ionian Islands almost entirely escaped Turkish occupation But even those parts of Greek territory which escaped or delayed Turkish occupation were scarcely ever independent. The alternative was generally subjugation to the power of Venice, which proved generally more unpopular than that of the sultan. When Venice gained control of the Peloponnesus by the peace of Karlowitz (1699), the Turks were able to recover it within 20 years with the ready acquiescence of the Greek population.

The comparative popularity of Turkish rule during the first centuries of the occupation was due to a number of contributory causes. In the first place, the rule of the early sultans was able and strong; at least it kept at bay the predatory powers of the west. collectively known to the Greeks as Franks. who had shown, by diverting the fourth crusade to Constantinople in 1203. that their fellow feeling for Christendom was barely skin-deep. In the second place, the doctrinal schism of Christendom had reached a degree of bitterness in the 15th century sufficient to make Mohammedans actually more welcome to Orthodox Greeks than the Catholics of Rome: and there were those who held that the fall of Constantinople was no more than the just due of the emperor and of the patriarch who had accepted reunion with Rome, on humiliating terms. at the council of Florence in 1439. Mohammed II therefore astutely appointed Gennadius, the surviving leader of the party that had opposed reunion with Rome. to be patriarch under his rule. with full confirmation of his rights over the Orthodox community in return for their political obedience; and such tolerance toward Christians, who were, like the Ottomans. "people of the book," was in perfect accord with Mohammedan principle.

In the third place. Ottoman rule was not initially oppressive in its incidence on the subject communities, at least in the golden age of the empire (whose apogee is generally identified with the reign of Soliman the Magnificent, in the middle of the 16th century). The Greeks in particular enjoyed freedom in two important spheres, apart from the practice of their religion. and these were interconnected, both in preserving the continuity of their national consciousness and in leading eventually to the struggle for independence.

One of these was freedom of trade, an occupation which the Turks traditionally looked down upon in comparison with the profession of arms and which enabled the Greek mercantile class to build up simultaneously contacts abroad, wealth. a tradition of independence and a merchant fleet which could in the event be readily converted to warlike purposes. The second great freedom was that of education in the Greek language. which went hand in hand with the freedom of the church. The importance of this factor in the conservation of Greek individuality needs no emphasis; the schoolmaster, the priest and the poet were the makers of the Greek revolution.

Next among the reasons why the Greeks acquiesced so readily for so many generations in the Turkish occupation was the nature of the Ottoman political system; but since it was this also which led ultimately to the struggle for independence, it is the least simple element in the story. The system was based on the traditions of the Turkish tribes' nomadic past, adapted to more settled conditions, but the system never fully assimilated the conception of fixed geographical frontiers or that of the nation-state. The one constant factor was the centralization of all power in the hands of the sultan, from whom alone all rights emanated. His empire was divided for administrative purposes into provinces under governors of his own nomination, of which Greece was distributed among six; but all the land remained the property of the sultan, who could dispose of it as he wished in fiefs allotted to Turkish settlers (usually loyal military adherents), or permit his non-hfoslem subjects to live on it on payment of a land tax. There grew up piecemeal exceptions to the system. however. Some important garrison towns were subordinated directly to Constantinople instead of to the provincial governor; some areas achieved a special status (Chios, for instance, becoming a private appanage of the empress-mother of the sultan); and other areas, because of their inaccessibility, were left virtually to their own devices (*e.g*, parts of Crete and of the Pindus mountains and some of the smaller islands). A varying measure of local autonomy in the administration of justice was also tolerated, especially in the Peloponnesus.

At the height of its power. Ottoman rule was not inhumanly oppressive. Its defect was that it was arbitrary and unpredictable, being too dependent on the character of individuals, especially on that of the sultan at the top. The Greeks' principal obligations were to pay the capitation tax (kharaj), which simply entitled them to remain alive in the sultan's dominions, the land tax, the tax on commerce and occasional special levies according to their circumstances and way of life; and to contribute male children (about one out of five on average) to the sultan's private service, to be brought up as janissaries (*q.v.*). The last was a cruel practice (though not always to the worldly disadvantage of the Greek children, who might rise through it to great heights), and it was abolished beiore the end of the 17th century. The taxes, however, were not in themselves exorbitant by modern standards. The vice of the system was that the Greeks received no rights—not even the 'elementary rights of justice and security—in return. The result was, on the one hand, that they turned increasingly to their own resources to manage their own affairs (especially to the priests and to the leaders of their own communities. known as prokritoi or primates); and. on the other. that in many areas lawlessness became endemic. in the form of the *klephtai* (brigands) and the scarcely more law-abiding *armatoloi* (men-at-arms or *gendarmes*) whom the Turkish government indiscriminately licensed to put down the brigands. Finally, the Greeks had one other course open to them in the ramshackle system which Ottoman administration became when the days of the great sultans were over; this was to penetrate and to usurp the system themselves, by climbing the rungs of power which the corps of janissaries and other opportunities opened to them. By the 18th century they had done this so successfully that four of the great offices of state (dragoman of the Porte. dragoman of the fleet and voivode or governor of each of the two Transdanuhian provinces, Moldavia and Wallachia) had become virtually Greek preserves. The Greeks who infiltrated the administration system in this way formed a distinct colony at Constantinople. known as the Phanariotes (from the Phanar, the quarter in which they lived).

All these factors contributed in different ways to the state of affairs which eventually made the liberation of Greece possible. But they took long to work in this direction. partly because the system was not generally felt to be sufficiently oppressive except in passing spasms. and partly because the contributory factors were to some extent contradictory in their operation. There was little common sentiment between the sophisticated Phanariotes of Constantinople and the priests and peasants of central Greece or the brigands in the mountains.

Such manifestations of opposition to Turkish rule as occurred up to the 18th century were as spasmodic and unpurposeful as Turkish oppression. Greek uprisings were generally in response to deliberate and unscrupulous provocation by external powers in the course of great wars fought for no interest of the Greeks, and the latter were then generally the victims of both sides. At the naval battle of Lepanto in 1571, for instance, between the Turks and the forces of Don John of Austria, Greek islanders were by force of circumstances serving in both fleets; and mainland Greeks who rose in revolt at the instigation of Don John were simply put down without mercy by the Turks and without help from their allies. In the following century, the invasion of the Peloponnesus by the Venetian general Francesco Morosini (whose guns were responsible for the destruction of the Parthenon at Athens in 1687) aroused not a spark of enthusiasm among the Greeks; and the return of the Turks to the Peloponnesus in the following generation was accepted as the lesser evil.

It was not until the intervention of the Russians in the 18th century that a serious revolt was promoted on Greek territory; and again the motives were unconnected with any real demand for national independence. Meanwhile, the influential Greeks of Constantinople were in effect pursuing quite a different policy of their own, which was not to disrupt the Ottoman empire but to take it over as a going concern.

The Rising of *1770* and *the* Beginnings of Nationalism.—The rising in the Peloponnesus in 1770 is virtually the beginning of modern Greek history. It was precipitated by the empress Catherine the Great of Russia as a diversion in one of the recurrent Russo-Turkish wars; but for the first time it struck a spontaneous response from the Greeks (especially the Peloponnesians) and thus came near to success.

The Russian claim to interfere in Greek affairs rested ostensibly on the possession of a common religion, which the tsars regarded themselves as entitled to protect, and on the inheritance of the Byzantine tradition as a result of the 15th-century marriage between the niece of the last emperor of Constantinople and the grand duke Ivan III of Muscovy, the first Russian to call himself tsar. In practice. the real motive lay in the advantage that a Russian liberation (which meant annexation) of Greece would give the tsars over the Ottoman rulers, by opening a backdoor to Constantinople.

The Greeks. however, welcomed the approaches of the tsar's agents for reasons of their own. In the Peloponnesus society was relatively advanced and ripe for self-rule and, being relatively well populated, that area suffered more than most from the land hunger which resulted from the rule that no land could pass from Turkish into Greek possession. The conjunction of a politically conscious and aggrieved upper class with a landless and therefore lawless lower class led naturally to a revolutionary mood.

The revolt of 1770, prepared and incited by Russian agents, took the Turks by surprise and was at first successful. But Russian help was late and inadequate (having to come by sea round Europe and through the Mediterranean); and, with the help of a bloodthirsty army of Albanians, the Turks eventually suppressed the rising in the Peloponnesus, the only area in which it reached serious proportions. The Russians quickly abandoned the Greeks in order to pursue the war with Turkey elsewhere and brought it to a relatively successful conclusion in the treaty of Kuchuk Kainarji (1774). An ambiguous clause in this treaty gave the Russians a right "to make representations" on behalf of the sultan's Christian subjects at Constantinople, and this provided the excuse for all future Russian interventions in Greek affairs.

After about nine years of barbarous repression by the Albanian forces of the sultan. the Peloponnesus recovered a normal level of existence and prosperity. But when Catherine the Great tried again in 1786 to provoke a similar rising against the Turks, the Peloponnesians had naturally learned their lesson too well to respond. The only response came from elsewhere. The inhabitants of Suli (Souli), in the province of Southern Albania, rose against the sultan and were savagely suppressed by the provincial governor. Ali Pasha, from his capital at Janina. The Russians again abandoned their allies, but this time the consequences were more pregnant for the future. Ali Pasha's appetite was whetted by success, and within 30 years he carved out for himself a large semi-independent slice of the sultan's empire, seriously weakening the strength and cohesion of the whole. This remarkable figure unwittingly played a large part in making possible the Greek revolution of 1821 (see Ali [called the Lion of Janina]).

Between the risings of 1770 and of 1821 history underwent a great change which decisively shifted the balance in favour of the Greeks. The American and French Revolutions, the rise and fall of Napoleon, the conflict of the great powers in the near east, the outbreak of nationalist revolutions as far away as South America and as near as Serbia, the weakness of the Ottoman empire as revealed by the virtual secession of Ali Pasha, the incitements of European liberals and poets, not only foreign (such as Lord Byron) but also native (such as Rhigas Pheraios). and the awakening of a national consciousness by native scholars (such as Adamantios Korais) as well as by merchants, politicians and priests all contributed to the outburst of 1821. The one factor that played relatively little part in bringing about the revolution was immediate Turkish oppression. It was rather the enfeeblement and relaxation of tyranny that fed the appetite for liberty, as it was the apparently imminent dissolution of the Ottoman empire that offered the opportunity of escape.

But the positive motives at work among the Greeks were dangerously confused. The aspirations of the different classes and regions were unreconciled. The Greek aristocrats of Constantinople. of the Transdanubian provinces and of the tsar's court had little in common with the peasants, priests and brigands of central Greece or with the wealthy merchant families of the islands; and no reconciliation had been attempted, or was possible, between those who looked to Russia, to England. to France or even elsewhere for patrons of Greek independence. The result was much confusion in the years of war (1821–29).

All the great powers had a more or less definite interest in Greek affairs by 1821. In Russia there mere considerable Greek colonies, including that at Odessa which in 1814 founded the Friendly society (Philiki *Etaireia*) with the express object of promoting a Greek revolution; and there were also highly placed Greek officials. including the tsar's foreign secretary Count Ioannis Capodistrias and his aide-de-camp Prince Alexandros Ypsilantis. The Austrian empire was hoping to encroach eastward and southward as the Ottoman empire disintegrated and was seeking to play the same role in the northern Balkans that Russia sought to play in Greece. England and France alternated in intrigue throughout the near east during the Napoleonic Wars. wooing Ali Pasha, the sultan and the dissident Greek leaders with arms, money and promises by turns. The fate of the Ionian Islands was typical of the whole complex of forces at work. They were taken by the French from Venice in 1797 and then occupied in turn by the Russians (1799), by the Turks (1800), by the French again (1807) and by the British (1814) in the space of 20 years; and one of their dependencies. the mainland port of Parga, mas even ceded to Ali Pasha by the British in 1817. From all such manoeuvres of power politics, the Greeks were simply the sufferers; but experience was teaching them how to take advantage of these rivalries. The Ionian Islands. under British control, were a haven where armed irregulars from the mainland could take refuge under pressure. Russia provided a base from which the Philikz *Etaireia* could mature its plans, as well as a school of statecraft where Greeks could learn their political trade Vienna was another haven of refuge and intrigue for Greek *émigrés*. The French were still reckoned the greatest soldiers of Europe even after Waterloo; and the fall of Napoleon released many military adventurers from whom the Greeks (as well as the Turks and Egyptians) could learn the art of war. Added to this was the newborn European liberal prejudice in favour of freedom. which provided the Greeks with money, arms, propaganda and philhellenes to fight at their side. Only the opportunity of revolt was needed. and this was finally provided by the open rebellion of Ali Pasha against the sultan Mahmud II in 1820. While the Turks were preoccupied with this dangerous threat, the Greeks in their turn rose in March 1821.

For the events of the ensuing seven years see GREEK INDEPENDENCE, WAR OF; NAVARINO, BATTLE OF.

The First Phase of Independence (1829–64).—Although Navarino made the independence of Greece a certainty. another two years pdssed before the fighting ended and nearly five before the new state took shape. Among the great powers, Navarino was not the end of a war but in effect the beginning of a new one. The sultan proclaimed a holy war (jihad) in Dec. 1827, and Russia declared war on Turkey in April 1828. France and Great Britain, who had striven for six years to avert this climax, reluctantly withdrew their ambassadors from Constantinople. It was not until the Russian armies had almost reached Constantinople that, by the treaty of Adrianople (Sept. 1829), the sultan formally accepted the independence of Greece as prescribed by the treaty of London (July 1827). which the battle of Navarino had been fought to enforce. From this date all the great powers and other contestants finally resigned themselves to the two complementary facts that Greek independence could not be reversed and that it did not entail the general dissolution of the Ottoman empire. Europe settled down with a new equilibrium of the near east.

Neither the boundaries nor the constitution of the new Greek state were yet settled. however. During the Russo-Turkish War of 1828–29 desultory fighting continued on the Greek mainland, almost neglected by the preoccupied powers, and even the army of Ibrahim Pasha remained at large in the Peloponnesus until a French expeditionary force was sent there in 1828 to ensure its withdrawal. While the conference of London debated at its leisure what should be the limits of the new state (varying from a minimum area, the Peloponnesus alone, to a maximum area bounded on the north by a line drawn from Volos to the Aspropotamos [Achelous]), the Greeks set about enlarging their territory uell beyond both the minimum and the maximum and lobbying to secure the addition of important islands such as Samos and Crete. They were helped by the military skill of British free lances, such as Sir Richard Church and Frank Abney Hastings (*qq.v*), as well as by the sympathetic connivance of French regulars, to install themselves well to the north of the Gulf and Isthmus of Corinth on both the western and eastern flanks of the Greek mainland during 1828–29, though they could not recover strongly held fortresses such as Athens. Foreign-born Greek leaders, such as Alexandros Mavrocordatos and Dimitrios Ypsilantis, also now played a notable part in consolidating Greek expansion, as well as popularizing Greek ambitions in terms familiar to the European courts; and above all, Count Ioannis Capodistrias (see KAPODISTRIAS IOANNES ANTONIOS, Count), formerly the tsar's foreign secretary, who had been elected provisional president of Greece by the third national assembly (April 1827) and arrived to assume office in Jan. 1828. conducted Greece's foreign affairs with the utmost skill and devotion

Capodistrias and His Successors—In his personal aspirations Capodistrias was less successful. He had a clear but autocratic idea of the way to run his new country, a strong, centralized government aith the last traces of local self-government suppressed; and without actually suggesting that his position should be made permanent. he clearly regarded himself as irreplaceable. Meanwhile the great powers, represented by the conference of London, cautiously sought a more orthodox settlement.

At the time of Navarino. they still had in mind a ruler of Greece who would remain the sultan's vassal. The treaty of Adrianople, by confirming Greece's unqualified independence, made this impossible and early in 1830 the throne of Greece was offered to Prince Leopold of Saxe-Coburg (the futute king of the Belgians, uncle of the future Queen Victoria), who at first accepted. Capodistrias, however, subtly hinted to him that the terms of the offer mere inadequate to ensure Greece's viability, and he withdrew his acceptance. Capodistrias continued his presidency while another candidate was sought, and he grew steadily more unpopular. not with the ordinary people, who benefited by his firm rule. but with the "primate" families (such as Koundouriotis of Ydra [Hydra] and Mavromikhalis of Maina) who had expected to inherit the Turkish feudal system under their own mastership, with the liberal-minded constitutionalists (led by Mavrocordatos, who refused to take office under the president) and with most of the irregular leaders of the war (except Theodoros Kolokotronis, who loyally supported Capodistrias and became his licensed tax gatherer, on characteristically unorthodox principles). To the natural dissensions of the Greeks were added the intrigues of the three official resrdents. Russian, British and French, who mere appointed to look after their countries' interests in Greece from 1828.

The end of Capodistrias' unequal struggle with confusion came on Oct. 9, 1831. when he was assassinated at Nauplia (the first capital of Greece) by two members of the Mavromikhalis clan. He was succeeded by a triumvirate consisting of his brother Agostino (Avgoustinos) with two of the wartime leaders, Ioannis Kolettis and Kolokotronis; but anarchy soon supervened. Agostino fled the country in April 1832, and Kolettis and Kolokotronis each tried to establish a government of his own (the former supported by Mavrocordatos, and each supported by a private army of irregulars). The chaos was mitigated only by the continued presence of a reduced French force to keep order in the Peloponnesus, until at last the conference of London reached its final decision, which was embodied in a convention signed on May 11, 1832 (but dated May 7, because the British government had meanwhile fallen in the crisis of the Reform bill). By this convention Greece was established as an independent kingdom, under the protection of Great Britain. France and Russia with its northern boundary from the Gulf of Volos to the Gulf of Ambracia. and including some of the Aegean Islands (but not Crete or Samos, for which

Capodistrias had fought in vain). Louis I of Bavaria, who was also a party to the convention, accepted the Greek throne on behalf of his 17-year-old son Otto (*q.v.*) who arrived at Nauplia on Feb. 6, 1833, and endeared himself by at once adopting the Greek national costume and the Greek spelling of his name, Othon. He was accompanied by three Bavarian advisers, as well as by a garrison of Bavarian troops to replace the French; and for the next ten years the government of Greece was virtually a Bavarian monopoly.

Otho.—The accession of King Otho (as he is usually called in English), backed by a generous loan from the protecting powers, was looked upon as the beginning of a new golden age for Greece. There were certainly agreeable episodes to record in the immediately following years: the transfer of the capital from Nauplia to Athens (1834); Otho's coming of age (1835) and marriage to Amalia of Oldenburg (1836); the foundation of the University of Athens (1837); and the establishment of diplomatic relations with Turkey (1839). But they were no more than episodes, and the political background was more ominous.

There were constant disorders in different parts of the kingdom, chiefly the result of discontentment of the wartime leaders who had been set aside in favour of Otho's new Bavarian administrators. There were major outbreaks of brigandage on the mainland in 1834–36 and again in 1839, and in the latter year conscription was first instituted. There was a revolt in Crete in 1841, a year after the island had been restored from the Egyptian province of Mohammed Ali to the direct rule of the sultan Abd ul-Mejid; and although this was juridically no business of the new Greek kingdom, it was one of many incidents that helped to remind the Greeks that only a small part of their racial and religious kinship was under independent rule.

Above all, there was resentment of the alien and untactful rule of the Bavarian clique led by Josef Ludwig, Count Armansperg, who was in effect absolute ruler of Greece from 1834 to 1837, though his title mas changed from "president of the regency" to "archchancellor" when Otho came of age. It was not until Dec. 20, 1837, that a Greek. Konstantinos Zographos, was first appointed as the king's chief minister, and even thereafter the Bsvarians continued to hold the ministry of war and to penetrate the administration effectively at many levels.

Resentment came to a head in 1843. On the night of Sept. 2–3 the royal palace was surrounded by a rebel force led by veterans of the War of Independence, whose chief demands were the removal of the Bavarians and the establishment of a constitution. It was a typically Greek revolution, conducted almost without bloodshed, with much ebullient good humour and almost no bitterness (except against the Bavarians) and with a strong streak of conservatism and personal affection for the king. As soon as Otho had given way he became a national hero and the occasion a national holiday. A national assembly was convened (attended significantly by representatives from the unliberated areas of Thessaly, Macedonia and Epirus) which drew up a constitution providing for a lower house (*vouli*) and a senate (yerousia) This constitution, to which the king took his 'oath in March 1844, remained in force for 20 years.

There followed a period of domestic quiescence, marred only by disagreeable episodes in Greece's foreign relations. With Great Britain there were a number of points of friction which did little credit to the protecting power. The British government was entitled to claim, as it vigorously did, the payment of interest on the international loan in 1847, as well as compensation for losses arbitrarily inflicted on British subjects (including the philhellene historian George Finlay and the Gibraltar Jew Don Pacifico); but hardly to enforce the claims, as Lord Palmerston insisted on doing in Jan. 1850, by ordering the Mediterranean fleet to blockade Piraeus (Peiraeeus) and openly hinting an intention to annex two minor islets alleged to have formed part of the Ionian Islands. Palmerston's undignified conduct nearly brought down the government in which he was foreign secretary; he narrowly averted a vote of censure by one of the most celebrated speeches of his career. The British claims were reduced and met, but Otho came out of the episode with greatly enhanced prestige for his courageous refusal to be bullied. Unfortunately this success led him into a more foolhardy act of defiance four years later and to a passionate devotion to the cause of Greek irredentism known as the "Great Idea" (Megali Idea).

In the Crimean War the British and French sided with Turkey against Russia. Imprudently, but for obvious reasons, the Greeks sided with Russia, and Otho took the lead with strong popular support in an attempt to enlarge Greece's territory. There had been no major breach of the peace between Greece and Turkey for 25 years, though brigandage and frontier incidents had led to a brief rupture of diplomatic relations in 1847. Now the Greeks seriously set about trying to conquer Thessaly and Epirus. In Jan. 1854 they entered Epirus and defeated the Turks at Peta; in Thessaly they had little success. The Turks sent an ultimatum to Greece in March and began to expel Greeks from Smyrna and Constantinople in reprisal. In May British and French troops were landed at Piraeus to enforce Greek neutrality, and the occupation lasted until 1857. Greece's frontiers thus remained unchanged and its appetite unappeased. Otho, too, as the leader of Greek irredentism and the victim of the great powers' disciplinary action. reached the height of his popularity.

At the same time Greece's relations with Great Britain were exacerbated by the question of the Ionian Islands. which had been left under British protection by the treaty of Nov. 5, 1815. The national feeling of the Greek inhabitants of the islands had reached a dangerous intensity, which produced a serious rising on Cephalonia in 1849. Their future now became fortuitously connected with the unhappy end of Otho's reign. Otho misused his popularity to behave autocratically at home, while distracting his subjects with the prospects of fresh acquisitions of territory abroad. Despite a succession of patriotic Greek prime ministers, including several heroes of the War of Independence (Mavrocordatos. Kolettis, Kitsos Tzavelas, Georgios Koundouriotis, Konstantinos Kanaris), the king never fully accepted the role of a constitutional monarch. Opposition to him grew, first breaking out in a mutiny in the garrison of Kauplia in Feb. 1862.

This was suppressed, but by October trouble was again brewing. While Otho and Queen Amalia were on a tour of the Peloponnesus, the revolt began in Aetolo-Acarnania on Oct. 19 and spread to Athens on Oct. 22. Otho arrived back in his naval frigate on the following day to find a provisional government in power under Dimitrios Voulgaris, which had proclaimed his deposition and also its intention to maintain the monarchy. Otho never set foot in his capital again. The protecting powers recognized that the Greeks were acting within their rights in deposing their monarch and set about the search for a successor. More than a year passed before the right man was chosen.

It was at this point that the future of the Ionian Islands became bound up with the question of the Greek monarchy. For nearly half a century the British government had argued that its protectorate over the islands was essential to its security in the Mediterranean, though they had played no strategic role in events since the Napoleonic Wars. As recently as May 7, 1861. the chancellor of the exchequer, W. E. Gladstone (who had served briefly in the islands as lord high commissioner extraordinary in 1858–59) had stated that "it would be nothing less than a crime against the safety of Europe" to cede the islands to Greece. Yet exactly 18 months later. on Dec. 8, 1862. the British cabinet decided to renounce the protectorate in favour of Greece, and by the end of the year the decision was widely known to have been taken. (It has even been contended that the prime minister, Lord Palmerston, had personally reached this decision before the fall of Otho, that he offered the islands to Otho on condition that he would refrain from all provocation of Turkey, but that Otho refused.) In Greece the widespread knowledge of this new intention contributed to a characteristic revulsion of feeling in favour of Great Britain, which startlingly expressed itself in a plebiscite on the succession conducted in Dec. 1862. Out of 244,202 votes, 230.016 were given to Queen Victoria's second son. Prince Alfred, whom the British government had already officially declared ineligible, as being a member of the ruling family of one of the three protecting powers.

Various candidates of other powers were similarly ruled out.

Finally the search ended with the choice of the 17-year-old William, second son of the heir to the throne of Denmark. On June 5, 1863. representatives of the three powers and Denmark signed a protocol in London recognizing his election (which the Greek assembly had enthusiastically carried two months earlier) to the vacant throne on the explicit understanding that the Ionian Islands would be ceded to Greece.

The treaty of cession was signed in London on Nov. 14, 1863, by representatives of Great Britain, France. Austria. Prussia and Russia (the powers which had established the protectorate) and confirmed by a further treaty between Greece and the three protecting powers (Great Britain. France and Russia) on March 29, 1864. The new king. who took the title "George I of the Hellenes" (his predecessor had been "king of Greece"), had arrived in Athens on Oct. 30, 1863. and the British evacuation of the Ionian Islands was completed by the following June.

The New Monarchy (1863–1924).—The half century of King George I's reign (1863–1913) was an epoch in itself in modern Greek history. an epoch in which Greece grew to the status of a power in its own right (even if still a minor one) instead of a semi-dependent ward of other powers (though the "protectorate" of Great Britain. France and Russia nominally lasted till 1919). The period was notable for the most considerable (but not the last) increases of Greek territory. Thessaly, most of Greek-inhabited Epirus and Macedonia, Crete and the majority of the Aegean Islands (except the Dodecanese) were added to the kingdom of the Hellenes. These advances were not achieved without setbacks, which mere chiefly due to political instability at home; and the seeds were sown of troubles that were to bedevil the future—notably those of the constitutional dispute between supporters and opponents of the monarchy and those of mutual hostility between Greece and other successor states of the Ottoman empire (chiefly Bulgaria and Albania), which previously had either not existed or been separated from Greece by the surviving extension of Turkey in Europe. Nevertheless, it was also in this period that Greece produced its first two statesmen of recognized European eminence: Kharilaos Trikoupis (1832–96) and Elevtherios Venizelos (1864–1936). These two men differed from their numerous rivals not in the fervour of their support for Greece's expansionist claims, which were the main political issue of the period, but in the wisdom with which they recognized that the country needed sound administration in support of them.

On his accession, the new king inherited a legacy of political confusion bordering on anarchy and even violence. A succession of ministries came and went during his first year. But a clean break with the past came with the inauguration of the new constitution. to which he took his oath in Nov. 1864. It was highly democratic. It abolished the senate, replacing it with a council of state appointed by the crown (abolished in its turn a year later); it established elective local government; and it defined the position of the king, which was in effect that of a passive instrument of the will of the people.

This system came to be described, by an inversion of the usual term, as a "monarchical democracy" (*vasilevomeni* dimokratia); and there is a happy irony in the phrase, since dimokratia is also the Greek for "republic." King George I operated this constitution conscientiously and successfully for 47 years, until it was revised in 1911. He was also luckier than his predecessor in not being accompanied by a foreign garrison; and although he had Danish advisers in his train, the most unpopular of them, Wilhelm Carl, Count Sponneck, left Athens in 1865. Greece was at last truly free—free to becomegreat.

The Cretan Rising, 1866.—Though relative tranquillity was restored at home. the new reign's troubles abroad began soon. In 1866 the Cretans rose in revolt against Turkish rule, which in its decline had become truly oppressive. The sultan. Abd ul-Aziz, sought not only to suppress the revolt but to transfer Crete back to Egyptian rule. A self-constituted Cretan assembly retorted by proclaiming its union with Greece, and although the king and government could not afford the risk of accepting the decision, many volunteers went from the mainland to support the islanders in arms.

The Cretans appealed to the great powers, of whom Great Britain alone was opposed to the solution of a plebiscite. In particular. European opinion was stirred by the heroic end of the monastery of Arkadi. whose abbot blew it up with the garrison and its attackers together rather than surrender alive. Though the revolt was crushed, the intervention of the powers obliged the sultan to grant administrative reforms, which mere embodied in the organic statute of 1868.

The Cretan problem, which was to be virtually coextensive with George I's reign, was thus shelved again. The sultan took his revenge on the Greeks two years later by creating in 1870 the Bulgarian exarchate, a separate ecclesiastical organization for Bulgaria, independent of the Greek Orthodox patriarchate which had been for so many centuries the unifying force of the Ottoman empire's Christian subjects.

The Russo-Turkish War, 1877–78.—The second crisis of the new reign mas precipitated by the Russo-Turkish War of 1877–78. As in the Crimean War, many Greeks saw in it an opportunity to acquire Thessaly, if not Epirus and Crete as well. But a coalition government, in which Trikoupis was foreign secretary, held them in restraint, in the well-grounded expectation that the great powers would sympathetically consider Greek claims at the peace settlement.

Russian victories. however, swept aside these restraints. The government fell. and its successor was only withheld from armed intervention by British mediation and by the collapse of Turkish resistance in Jan. 1878. In the treaty of San Stefano (March 3, 1878) between Russia and Turkey. Greece's territorial claims were ignored in the interests of creating "Greater Bulgaria" as a Russian satellite, with access to the Mediterranean and practically the whole of Macedonia incorporated in it.

The other powers refused to accept this settlement, which was upset by the Conference of Berlin (June 1878); but still Greece received no satisfaction, beyond an injunction to the sultan Abd ul-Hamid II to reach an agreement with King George for the modification of their common frontier. The fulfilment of this injunction was dragged out until 1881, when a conference at Constantinople finally defined a new frontier between Greece and Turkey from the southern slopes of Mt. Olympus in the east to the Arachthos river in the west, giving Greece the greater part of Thessaly and a small corner of Epirus. It was in 1878, after the rejection of the treaty of San Stefano, that Great Britain secured the right to occupy Cyprus (which it did not formally annex until 1914), in return for a guarantee given to Turkey that its Asiatic provinces should be untouched.

Trikoupis.—Between the acquisition of Thessaly in 1881 and the next great foreign crisis in 1896, the domestic scene in Greece was dominated by Trikoupis. He became prime minister early in the '80s and remained in power, with brief and generally unfortunate intervals, until his final resignation in Jan. 1895. During this period great advances were made in Greece's domestic administration. Roads and railways were extended. the merchant navy was expanded, brigandage was virtually suppressed and the financial administration was put on a sound basis which attracted the confidence of foreign investors. But this progress was subject to abrupt setbacks whenever Trikoupis' chief rival, Theodoros Diliyiannis. a crafty but hotheaded parliamentarian, succeeded in replacing him.

One such damaging occasion was shortly before the crisis provoked in Sept. 1885 by the Bulgarian annexation of Eastern Rumelia (part of the territorial expansion which in 1878 Bulgaria had briefly gained at San Stefano and lost again at Berlin). Public opinion in Greece demanded compensating gains at Turkish expense. and Diliyiannis mobilized the army and navy. A brief war broke out between Bulgaria and Serbia, but the great powers intervened before Greece could begin hostilities against Turkey, and by the familiar method of a naval blockade Great Britain compelled the Greek government to abstain and to demobilize in May 1886. Diliyiannis' government fell, and Trikoupis returned to power. He dealt competently with the financial setback caused by Diliyiannis' militant policy and retained the confidence of the king and people for nearly seven years. Even after Trikoupis' party had been defeated in a general election in 1890 (largely for having adopted a pacific policy in one of the recurrent Cretan crises in 1889). the king reappointed him prime minister in 1892, after dismissing Diliyiannis for incompetence. This was the boldest constitutional step of George I's reign.

***Crete** and Macedonia,* 1896–1912.—It was after Trikoupis' death (in April 1896), when Diliyiannis was again prime minister, that the next major crisis in Greece's foreign affairs occurred, again over Crete. The chronic bitterness between Cretans and Turks broke out in violence and bloodshed at Canea, the administrative capital, in May 1896.

This time it was Diliyiannis' turn to exercise restraint and to accept Turkish promises of reform. But these were not carried out, and the deteriorating situation culminated in a further outbreak of violence at Canea in Feb. 1897. Diliyiannis announced that Greece could no longer remain indifferent and sent an armed force to annex the island. Thereupon Great Britain, France, Russia, Italy. Germany and Austria proclaimed an international protectorate and also landed troops. The familiar intervention of the great powers exasperated Greek public opinion to the point of demanding general war on Turkey; and in March 1897, while the expedition to Crete was still indecisive, the crown prince Constantine put himself at the head of the Greek forces in Thessaly in readiness for war. Hostilities were at first limited to skirmishing by irregular bands; but Turkey declared war on April 17, and Greece was defeated in a brief and humiliating campaign ***(see*** GRAECO-TURKISH WAR, 1897). Peace was eventually signed in Dec. 1897. on milder terms than at first seemed probable. Greece naturally had to withdraw from Crete. which remained under the occupation and protection of the great powers, and minor modifications were made to the northern frontier in Turkey's interest, but the indemnity originally demanded was reduced from £T10,000.000 to £T4,000,000. The prestige of the royal family suffered severely, until a characteristic reaction set in after an attempt to assassinate the king in Feb. 1898.

The repulse of Greek claims to Crete and Macedonia was looked upon as no more than temporary, and the two territories largely occupied political attention in Greece for the next 15 years, until the chance of a final settlement came. In Crete the disturbances of 1896–97 even represented a slight immediate advance for the Greek cause. The protecting powers (reduced to four by the withdrawal of Germany and Austria) proclaimed the administrative autonomy of the island; and after a further outbreak of violence in Sept. 1898 (in which the British vice-consul at Herakleion [Iraklion] and a number of British soldiers were killed) they insisted that all Turkish troops should leave the island and invited Prince George of Greece (the king's second son) to become high commissioner under the nominal suzerainty of the sultan. Prince George arrived in Crete in Dec. 1898, originally for a term of three years which was eventually prolonged till 1906. His tenure was unfortunately marred and. finally, terminated by a dispute with a group of Cretan politicians, led by Elevtherios Venizelos, who seceded in March 1905 to set up a "provisional government" of the island at Therison.

Prince George was replaced in 1906 by Alexandros Zaimis, a former prime minister and one of the most eminent, popular and respected statesmen of modem Greece, under whose auspices Venizelos became the leading figure in the Cretan administration. Tranquillity and order were so effectively restored that in July 1908 the great powers felt justified in beginning the withdrawal of their forces from the island.

At almost the same date, an event took place at the other end of the Greek world which entirely upset the powers' calculations. This was the Young Turks' revolution, which set up the Committee of Union and Progress at Salonika, the principal town in Macedonia. Having first compelled the sultan Abd ul-Hamid to restore the lapsed constitution of Turkey, the committee then deposed him in 1909 and effectively ruled the Ottoman empire in the name of his successor Mohammed V; but toward the Christian minorities it pursued a forceful and hostile policy that resurrected all the Greeks' latent fears for the future of Macedonia. Since the end of the 19th century a state of undeclared civil war between Greek, Bulgarian and Turkish irregulars had prevailed in Macedonia. somewhat like the situation in southern Greece before the War of Independence. The Young Turks' revolution now worked a widespread transformation in the whole Balkan scene. It brought together Greeks, Bulgars and Serbs in the common interest of frustrating the "Ottomanization" of Macedonia; it provoked the Cretans yet again to declare the union of Crete with Greece in Oct. 1908 and to send a delegation (including Venizelos) to Athens to give effect to their decision; and it led to the formation in the Greek army of the Military league (May 1909) in imitation of the Committee of Union and Progress. Although the Greek government pursued the juridically correct course of disowning the Cretan proclamation of union. the Military league succeeded in forcing many of its wishes on the king, including the dismissal of his sons from military and naval commands and the summoning of Venizelos to Athens in an official capacity in Jan. 1910.

From March 1910, when the Military league dissolved itself on the completion of its task, Greece moved swiftly to the climax of the Balkan Wars. A national assembly was elected in August. at Venizelos' instigation, to revise the constitution, but when it proved unamenable to his wishes, Venizelos, having become prime minister for the first time on Oct. 18, dissolved the assembly and held a second election'in December. From this election, which gave him a large majority, dated his extraordinary ascendancy over the Greek political scene.

His revised constitution was promulgated in June 1911; his peace was made with the royal family (the crown prince Constantine being restored to high command by the creation of the new post of inspector general of the army); the election of a chamber of deputies under the constitution of 1911 gave Venizelos a majority of five to one in March 1912; and he was ready to set about the creation of the Balkan league, which was to destroy the Ottoman empire in Europe. Still, however, he would not admit the Cretan representatives to the new chamber until he was ready and strong enough to face the consequences.

The Balkan Wars, 1912–13.—During the summer of 1912 treaties were concluded between Bulgaria and Serbia and between Bulgaria and Greece; Serbia and Greece had no conflicting interests and no formal alliance as yet. In October the three govemments presented joint demands to Turkey for reforms in Macedonia, which were unacceptable. Turkey declared war on Bulgaria and Serbia on Oct. 17. Venizelos at last admitted the Cretan representatives to the chamber and declared war on Turkey on Oct. 18. The First Balkan War ***(see*** BALKAN WARS, 1912–13) lasted seven months, interrupted by an armistice (December-January) for peace negotiations in London, in which Greece participated without formally accepting the armistice. The war was a tremendous success for the Balkan allies, not least for Greece, whose armies captured Salonika, Preveza, Parga and Janina in succession, besides the acquisition of Crete, Samos and other islands. Constantine, who fully redeemed his reputation as a commander, succeeded to the throne on March 18, 1913, when King George I was assassinated in Salonika.

Salonika was the point of friction between the allies, of whom the Bulgars at least also hoped to acquire it. Even before the defeat of the Turks was complete, Greece and Serbia began to negotiate a treaty of alliance specifically against the danger of attack on either by their ally, Bulgaria. The First Balkan War was terminated on May 30, 1913, by the treaty of London, which virtually abolished the Turkish empire in Europe. Among other dispositions, it ceded Macedonia to the Balkan league as a whole and left the disposition of the Aegean Islands to the powers. Two days later, the Graeco-Serbian treaty was signed, and within a month the Second Balkan War had begun with a Bulgarian attack on the two allies on June 30.

The Second Balkan War, in which Rumania joined Greece and Serbia, ended in a rapid defeat of the Bulgars and a considerable recovery of lost ground by the Turks. It was ended by the peace of Bucharest on Aug. 10, 1913. Bulgaria was treated generously and still. retained part of Macedonia and an outlet to the Aegean sea in western Thrace.

The fate of other areas liberated from Turkish rule by the upheaval of the two Balkan Wars was still not completely settled even when World War I broke out a year later. For instance, the Greeks continued to claim northern Epirus, part of the newly created state of Albania; the Turks refused to withdraw from several of the Aegean Islands; and the Italians remained in the Dodecanese, which they had occupied on an ostensibly temporary basis in 1912. Relations between Greece and Turkey remained bad, and the Balkans seemed to be again on the brink of another convulsion when the outbreak of World War I in Aug. 1914 merged their parochial problems in the great upheaval of Europe.

World War I and Asia *Minor*.—World War I opened up a bitter difference between the king and Venizelos that lasted beyond their lifetimes and divided Greeks for a generation into royalists and republicans. The cause was that the two men and their advisers disagreed on the likely course of the war and consequently on the interpretation to be put on the Graeco-Serbian treaty in the event of Bulgaria's joining the Central Powers in hostilities against Serbia (who was from the first an ally of the Entente). Venizelos believed in and hoped for a victory of the Entente. Constantine was more uncertain of the outcome and therefore preferred neutrality, with a sympathy toward the Central Powers. The Greek general staff, especially the chief of staff, Col. Ioannis Metaxas (later prime minister). in the main supported the king with their military judgment. Though the crisis was not reached until Sept. 1915, when Bulgaria mobilized to attack Serbia, the two attitudes were clear from the start, when in Aug. 1914 the king assured the German emperor William II (whose sister Sophia he had married) that he. though officially neutral, was on Germany's side in sympathy; and two weeks later Venizelos gave the Entente to understand that his sympathies were wholly with them and that Greece would enter the war on their side if Turkey did so against them. Turkey in fact entered the war against the Entente in Nov. 1914, which was also the occasion of the British annexation of Cyprus.

At this juncture the king's will prevailed, supported as he was by his chief of staff, and he was able both to keep Greece neutral and to retain Venizelos as his prime minister. The struggle between Venizelos and the general staff came to a head in March 1915, when the king dismissed his prime minister rather than accept the resignation of Metaxas. In Venizelos' place the king nominated Dimitrios Gounaris, who unfortunately chose to represent Venizelos as motivated by spite against the royal family. Gounaris retained power even after a general election in June had given Venizelos' party (the Liberals) a small majority. Venizelos was recalled to office only in August and dismissed again in October, but in the interval there had occurred the decisive events of Bulgaria's mobilization to attack Serbia, Greece's countermobilization and the arrival at Salonika of Allied forces on Venizelos' invitation. To restore the situation the king appointed Zaimis prime minister, with instructions to repudiate Greece's obligations under the Graeco-Serbian treaty on the grounds that they applied only to "a war between one of the allied states and a single other power," not to a general European war. Even Great Britain's offer to cede Cyprus to Greece did not sway the new government, and it was soon withdrawn. Greece remained neutral; the king dissolved the pro-Venizelist chamber; and the Liberals abstained from the new elections of Dec. 1915 in protest.

Neither Venizelos nor the Allies took further drastic measures against the king's government until after the discreditable surrender of Ft. Rupel, on the Bulgarian frontier, to the Germans and Bulgars in May 1916. There then followed a series of increasingly strong Anglo-French ultimatums and, in September, Venizelos' secession from Athens to Crete, whence he proceeded to Salonika to set up a rival government. Although the Allies' terms were repeatedly met by King Constantine's successive governments on paper, they grew steadily stiffer (especially after Dec. 1, 1916, when Allied troops landing at Piraeus were fired on by the king's troops as they approached Athens); and they culminated on June 11, 1917, in a demand that Constantine should leave the country, which he did the next day. His second son Alexander succeeded him (the crown prince George being both unwilling and unacceptable to the Allies). On June 26 Venizelos returned to Athens from Salonika as prime minister, and on June 29 Greece declared war on the Central Powers. Greek troops were not in action on the Macedonian front until May 1918, but they played a distinguished part in the final offensive in September and contributed an army corps to the French expedition into the Ukraine in December. Venizelos' subsequent triumph at the conference of Paris (*q.v.*) was the climax of his achievement.

As early as Jan. 1915 the Entente had tried to tempt Greece into the war with the promise of territorial gains on the coast of Asia Minor. Venizelos exacted fulfilment of this promise, and the Allied supreme council in Paris authorized the landing of Greek troops at Smyrna in May 1919. This was the beginning of disaster both for Venizelos and for Greece. He himself spent too long for his own good away from Athens, achieving diplomatic triumphs; securing, for instance, the treaties of Neuilly and Shvres (*qq.v.*), terminating the war with Bulgaria and with Turkey respectively; the agreement with the Italian foreign minister T. Tittoni (July 1919) on the terms of cession of the Dodecanese (*q.v.*) to Greece; an extension of the Greek area of occupation in Turkey (July 1919), almost an agreement on the cession to Greece of northern Epirus (which only Pres. Woodrow Wilson opposed); and, not least, the admiration of all the Allied representatives. But within two years the greater part of this edifice had collapsed. In Sept. 1920, on returning to Athens, Venizelos dissolved the chamber; in October King Alexander died; in November Venizelos was defeated at the polls; in December Constantine was restored to his throne on the crest of a wave of emotion; and in the following year the occupation of Smyrna developed into a catastrophic war with the resurgent power of Turkey under Mustafa Kemal. The Greeks, ill-advised or imperfectly restrained by imprudent western politicians, launched a general offensive in Asia Minor in March 1921, which was defeated and then, in July, obstinately renewed. By September they were in full retreat.

In October the prime minister, Gounaris, appealed to the British government to intervene, while at the same time the French government entered into an accord with Mustafa Kemal. The British government, being itself disunited on policy in the near east, was unable to rally its allies to a common policy, and by 1922 Greece's position was desperate. In Aug. 1922 the Turks launched a final devastating offensive, which drove the Greeks out of Asia Minor and almost totally destroyed Smyrna in September. The remnants of the Greek army rallied on the island of Chios under Gen. Nikolaos Plastiras, who put himself at the head of an antiroyalist revolution. Constantine, blamed for the disaster, left the throne to the crown prince George, and six of his principal ministers and generals (including Gounaris) were court-martialled and shot under Plastiras' orders.

There followed one of the most erratic and unhappy periods in modern Greek history. The war with Turkey was finally liquidated by the treaty of Lausanne (July 24, 1923), which superseded the unratified treaty of Shvres. An agreement for the compulsory exchange of Moslem and Orthodox populations between Greece and Turkey under the supervision of a commission of the League of Nations, following the similar Graeco-Bulgarian agreement of 1919 (which, however, was on a voluntary basis), left Greece with a more homogeneous population, but also with nearly 1,500,000 refugees to assimilate. The country's troubles were aggravated by an incident on the Graeco-Albanian frontier in Aug. 1923, which led to an Italian bombardment of Corfu and to the imposition of a heavy indemnity by the League of Nations, and by an abortive military rising in Macedonia in October, the promotion of which was attributed to the retired chief of staff, General Metaxas, and other royalist officers.

General Plastiras' revolutionary committee accordingly asked the young king, George II, to leave the country (which he did in Dec. 1923) while the future of the monarchy was decided. Anxious to restore constitutional government, the committee held elections on Dec. 16, which were won by the Liberals. The committee then resigned, in Jan. 1924, and after a brief tenure of office by Venizelos (who resigned in February) a republic was proclaimed on March 25 and confirmed retrospectively by a plebiscite on April 13. Adm. Pavlos Koundouriotis, scion of a family famous in the War of Independence and himself a hero of the First Balkan War, became first president.

The Republic (1924–35).—The new republic made an uneasy start, marred by friction with all its immediate neighbours to the north and also with the great powers. The British minister had actually been withdrawn after the execution of the six royalist leaders. Little more than a year after the republic's proclamation, and before it had a constitution, power was seized on June 26, 1925, by Gen. Theodoros Pangalos, one of the few soldiers who had been successful in the recent war with Turkey; and on Jan. 3, 1926, he assumed dictatorial powers. Koundouriotis resigned and was replaced by the dictator himself after a travestied election. Pangalos was an eccentric though not a brutal ruler, but his methods were dangerous and had virtually precipitated a war with Bulgaria in Oct. 1925, which only the intervention of the League of Nations forestalled. He held power only until Aug. 22, 1926, when he was deposed by another military coup d'état, led by Gen. Georgios Kondylis with the support of Col. Napoleon Zervas at the head of a semiautonomous force called the Republican guard. Kondylis hastened to restore normal government. He dissolved the Republican guard with some bloodshed in September; he restored Koundouriotis to the presidency; he organized elections in November; and after a coalition government had taken office under Zaimis, he retired from the scene. With some reconstructions, the same government held office until May 1928, and in the meantime a new constitution (which re-established the senate) was promulgated on June 3, 1927. The occasion of the government's fall was a crisis precipitated by the return from abroad of Venizelos, after several years' absence, in March 1928. He became prime minister on July 3, dissolved the chamber a week later and won a large majority at the general election in August.

Venizelos then held office for nearly four years (until May 1932), during which time he was largely successful in restoring normal relations with all Greece's Balkan neighbours. In Oct. 1928 an agreement was signed with Yugoslavia (which had denounced the Graeco-Serbian alliance of 1913 in Nov. 1924) to negotiate all outstanding differences; in November a convention was signed with Albania; and in the same month a Greek minister was sent to Sofia for the first time since the war. There followed negotiations with Bulgaria on compensation for the property of exchanged populations in Jan. 1929; a treaty of friendship with Yugoslavia in March 1929; treaties of conciliation and arbitration with Hungary and with Austria in 1930; and a final settlement of outstanding differences with Turkey in June 1930. At the end of Oct. 1930 Venizelos paid an official visit to Ankara (Angora). Meanwhile the League of Nations' Refugee Settlement commission had wound up its work at the end of 1930. The republic (of which Zaimis had been elected president in succession to Koundouriotis in Dec. 1929) had begun to appear stable and accepted. But beneath the surface there were still hostile currents.

A financial crisis in 1932 weakened Venizelos' position. His government finally fell over two measures which showed that the constitutional quarrel was not dead. One was to change the electoral system to that of proportional representation, the other to restrict the freedom of the press, which the royalists, under the leader of the so-called Popular party, Panayiotis Tsaldaris, were alleged to be abusing. After two short-lived governments (the second again under Venizelos), a dissolution and a general election followed in September, under the system of proportional representation.

The result was to elect many small groups (including the Communists) with no clear majority for any party. Tsaldaris formed a precarious coalition which fell in Jan. 1933. Another general election in March 1933 (by majority voting) gave Tsaldaris a sufficient lead to form a stable government, and it was this government which crowned Venizelos' work by signing a Balkan defense pact with Rumania, Turkey and Yugoslavia in Feb. 1934. But by the following year a state of near deadlock had been reached between the two principal parties, Tsaldaris' Populists and Venizelos' Liberals, the latter of which controlled the senate while the former controlled the chamber. A bitter battle was fought before the two agreed on the re-election of Zaimis as president in April 1934. The real issue was becoming increasingly plain: it was the Populists' intention to restore the monarchy.

The Monarchy Restored.—In March 1935 an abortive coup d'état was staged with the object of putting Venizelos in power and frustrating the royalists. Its failure was the end of Venizelos' career and made the restoration of King George II a certainty. Kondylis, who put down the rising, was made deputy premier; and after a general election in June, he took part in a coalition government of the right wing under Tsaldaris. After internal disputes about the restoration of the monarchy (which were procedural rather than substantive) Kondylis himself became first prime minister and then regent. He organized a plebiscite on Nov. 3, which approved the restoration of the monarchy; and King George was back in Athens by the end of the month. The constitution of 1911 was restored in place of that of 1927.

But the settlement was still uneasy. At a general election in Jan. 1936 the balance rested almost evenly between a Liberal and Republican group led by Themistoklis Sophoulis in succession to Venizelos and a right-wing coalition of the parties of Tsaldaris and Kondylis and the tiny group led by Metaxas, the former chief of staff. Between these two coalitions the balance was held by 15 Communists. A succession of deaths in the first half of 1936 left Metaxas the only possible prime minister, and on Aug. 4, 1936, he converted his position into that of a dictatorship, with the king's consent, in order to forestall the threat of a Communist coup d'état under cover of a general strike, which had been fixed for the following day.

Metaxas' blow to the constitution and, especially, the king's acquiescence in it reopened bitter feelings between royalists and republicans, but probably saved Greece from anarchy. There followed four years of severe but efficient government, leading up to Greece's entry into World War II in Oct. 1940.

World War II.—The Fourth of August, as Metaxas' regime was called, produced administrative efficiency, a sound currency and adequate defenses, at the expense of some constitutional liberties and of the whole parliamentary system. It was ferociously hostile to the Communists (and to others arbitrarily designated as such) but otherwise benevolent and not unpopular. Metaxas had been expected by many to side with Germany and Italy in the world struggle which was already developing. His military training was German, and so was the sense of discipline which he tried to impose on his individualistic people; and his judgment in World War I had set him at variance with the western Entente. In fact, however, he sought first to strengthen the Balkan pact inherited from Venizelos, which was extended by a nonaggression treaty with Bulgaria in July 1938; and second, to avoid provoking any power, especially Germany. He was anything but timid toward Italy, against whom Greece had joined in voting sanctions in 1935. He accepted a British guarantee of Greece's frontiers in April 1939, after Italy's annexation of Albania, but he remained neutral on the outbreak of World War II and continued so even after an Italian submarine had sunk a Greek cruiser at Tenos in Aug. 1940. On Oct. 28, 1940, however, the Italians forced Greece into the war by invading the country from Albania.

The Greek army under Metaxas' chief of staff, Alexandros Papagos, drove back the invaders with astonishing success and had occupied about a quarter of Albania before the Germans joined in the attack on Greece (*via* Bulgaria and Yugoslavia in April 1941). The country was then rapidly overrun; and a small British expeditionary force, which had reached Greece in March 1941 in fulfilment of the guarantee of 1939, was driven off the mainland by the end of April and off Crete a month later.

By this time Metaxas had died (Jan. 29), his successor had committed suicide and King George II and his new government (under Emmanouil Tsouderos) had gone into enforced exile. Tsouderos' government in exile lasted three years (till April

1944), but had no real power.

The German-Italian occupation of Greece lasted until Oct. 1944, though for the ,final year it was exclusively German. It was marked by appalling suffering and great heroism. The Germans found three successive traitors or dupes to make prime minister, but few others like them among the people. Resistance began with passive nonco-operation, which developed into sabotage and the formation of guerrilla bands in 1941–42 and culminated on Nov. 25, 1942, with the capture and destruction of the Gorgopotamos railway viaduct by a force of Greek guerrillas and British parachutists. This was the only occasion on which the two principal guerrilla forces, the Communist-controlled E.A.M.-E.L.A.S. (National Liberation Front and National Popular Liberation army) and Gen. Napoleon Zervas' E.D.E.S. (National Republican Greek league), effectively co-operated in action. At other times they frequently fought each other, though not without undertaking independent actions against the common enemy.

In a major series of civil conflicts lasting from Sept. 1943 (immediately after the surrender of Italy to the Allies) to the summer of 1944, E.A.M.-E.L.A.S. eliminated all its political and guerrilla rivals except Zervas and set up a provisional government in the Greek mountains which by implication disowned both the king and his government in exile. A mutiny in sympathy occurred among the Greek troops outside Greece in April 1944 (when Tsouderos resigned); but after this had been suppressed and a precarious peace had been restored among the guerrillas in Greece, the two rival governments were brought together in a coalition under Georgios Papandreou, a former Venizelist Liberal. Accompanied by a small British force. his government returned to Athens as the Germans withdrew from Greece in Oct. 1944, but disintegrated a few weeks later when the Communist members of the coalition refused to accept its orders to disband their guerrilla force. A bitter civil war broke out in Athens on Dec. 3, which the British liberating forces intervened to suppress with great difficulty, after E.A.M.-E.L.A.S. had overrun virtually the whole of Greece except a few square miles of Athens and Salonika.

The Communist Rebellion.—The Communists accepted defeat and the disbandment of their forces at the conference of Varkiza in Feb. 1945. Apart from casual brigandage and clandestine subversion, they respected the Varkiza agreement for nearly two years. Meanwhile a period of political reconstruction followed, under the regency of the archbishop of Athens. Damaskinos, in place of the king, who had reluctantly agreed not to return to Greece until a plebiscite had been held on the monarchy. Many governments succeeded each other rapidly before elections (under British, French and U.S. supervision) were held in March 1946. The Communists abstained, and a strongly royalist majority was returned. A plebiscite followed in September and duly restored George II (who survived only until April 1, 1947, when his brother Paul succeeded on his death). But Greece's postwar troubles were once more only beginning. There were now three Communist-controlled countries on the northern frontier, and the U.S.S.R. evidently still hoped to annex Greece to its orbit. The presence of British troops in Greece was unsuccessfully challenged as a threat to peace by the Soviet delegate at the first meeting of the United Nations Security council in Feb. 1946; and Greece's relations with the neighbouring states were constantly on the Security council's agenda thereafter. The climax was the appointment of a United Nations' commission in Dec. 1946 to investigate border incidents.

Within the following months full-scale guerrilla war was reopened by the Communists, who had gone underground in 1946. The commitment of defending Greece became too much for the British troops and the British taxpayer, and it was taken on by the U.S. government, with the announcement of the so-called Truman doctrine on March 12, 1947. Massive financial and material help from the U.S. came only just in time. for by the end of 1947 large areas of Greece were in Communist hands again, and on Dec. 24 the Communist leader Markos Vafiades proclaimed a provisional government in the northern mountains.

Reconstruction and Recovery.—The rebellion dragged on throughout 1948. The Communists gained control of large areas, and carried off thousands of families (including children) behind the "iron curtain." The war was not ended until 1949, when the defection of Yugoslavia from the Soviet bloc closed an important stretch of Greece's northern frontier to the rebels. On Oct. 16, 1949, the Greek Communist broadcasting station announced the end of open hostilities (though subversion and espionage continued). The task of reconstruction was put in hand largely with U.S. funds and under U.S. guidance, but the continual change of governments inhibited progress. The election of March 1950 reversed the trend to the right of 1946 and resulted in a coalition of the Liberals and the left centre under N. Plastiras. The coalition was unstable, and after frequent reshuffling of cabinets, another election was held in Sept. 1951.

A few weeks earlier a new phenomenon had entered the political field. Field Marshal Papagos (the first Greek ever to hold that rank). who had led the Greek army against the Italians in 1940 and against the Communist rebels in 1949, resigned as commander in chief and formed a new political group, the Rally (*Synagermos*). It won the largest number of votes, but not enough to enable Papagos to govern alone, and he refused to enter a coalition. The result was another year of unstable government under his opponents until in Nov. 1952 another election was held, this time under the system of majority voting (last used in 1935). The Rally was overwhelmingly successful, so that at last Greece was able to dispense with a coalition government. Papagos became prime minister and set about accelerating the reconstruction of the country with characteristic thoroughness but without proceeding to the nonparliamentary methods of his dictatorial predecessor Metaxas. By the end of 1955, though still in need of U.S. assistance and in spite of a disastrous series of earthquakes in 1953–54. Greece was well advanced in its postwar recovery.

The Greeks could now at last assume a more considerable role in world affairs. The Dodecanese were finally ceded to Greece by Italy under the peace treaty of Feb. 1947. The admission of Greece into the Council of Europe in 1949 and into the North Atlantic Treaty organization in 1951 (formal entry, Feb. 1952) confirmed that it was now a European power. Papagos was welcomed on his visits to Italy. Germany. France and Spain, as were King Paul and his queen in the United States. A Greek contingent took part in the Korean war (1950–53). On Aug. 9, 1954, at Bled, Yugos., Greece signed a treaty of alliance with its ancient enemy Turkey and with Communist Yugoslavia.

Only one serious point of friction remained, with Great Britain over the sovereignty of the British colony of Cyprus. The campaign of the Cypriote Greeks for union (*enosis*) with Greece mas adopted by Papagos' government in 1954. The Greek claim soon spoiled the harmony between Turkey and Greece. The Turkish government took the view that, in the event of Britain's withdrawal, the island should return to Turkey. A British-Greek-Turkish conference, which gathered in London to find a solution to the dispute, ended in deadlock on Sept. 7, 1955. (*See* CYPRUS.)

The death of Papagos (1883–1955), which occurred on Oct. 4, deprived the country of its outstanding personality, and soon revealed disintegrating tendencies within the Greek Rally. Konstantinos Karamanlis (1907–   ), who as minister of public works had earned himself wide popularity, formed a new government. A new election was held on Feb. 19, 1956. Karamanlis' National Radical union, a new government party, won 161 of 300 seats in the chamber of deputies, the opposition being divided into seven different groups, including a crypto-Communist one.

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(C. M. WE.)

POPULATION

The population of Greece. less than 1,000,000 in 1829, steadily increased, by territorial expansion, the influx of refugees from other countries and natural causes. (See Table I.)

TABLE I.—Area and Population

Year of census	Area in square miles	Population	Difference: in numbers	Difference: Per cent	Density per square mile
1821*	18,341	938,765	—	—	51.18
1828	18,341	753,400	−185,365†	−19.75	41.07
1870	19,381‡	1,457,894	+704,194	+194.38	75.22
1879	19,381‡	1,679,470	+221,576	+15.20	86.66
1889	24,552§	2,187,208	+507,738	+30.23	89.08
1896	24,552§	2,433,806	+246,598	+11 27	99.13
1907	24,399‖	2,631,952	+198,146	+ 8.11	107.87
1920	58,222¶	5,531,474	+2,899,522	+110.17	95.01
1928	50,133♀	6,204,684	+673,210	+12.17	123.76
1940	50,133♀	7,344,860	+1,140,176♁	+18.37	146.51
1951	51,182□	7,630,587	+285,727	+ 3.89	149.09
1961◇	50,547	8,357,526	+726,939	+ 9.53	165.34

*Population calculated restrospectively on the basis of the census of 1828. †The drop in population reflects the loss of life during the War of Independence (1821–28). ‡The Ionian Islands were annexed in 1864. §Thessaly and Arta were annexed in 1881. ‖A small strip of territory in Thessaly was ceded to Turkey in 1897. ¶Macedonia, Epirus, Crete and the eastern Aegean Islands were annexed in 1912–13; and Thrace, Imbros and Tenedos in 1919–20. ♀Eastern Thrace, Imbros and Tenedos were ceded to Turkey in 1922. ♁The increase in population between 1920 and 1940 reflects the influx of refugees from Asia Minor and subsequent exchanges of population. □The Dodecanese mere annexed in 1947. ◇Preliminary.

By mid-20th century the average birth rate was 25 per 1,000 and the average death rate 10 per 1.000; during the German occupation of 1941–44, however, the death rate rose to 26 per 1,000.

The distribution of population by geographic regions, according to the census of 1961, is shown in Table II.

TABLE 11.—Population by Geographic Regions, 1961

Regions	Area in square miles	Population
Mainland:		
Central Greece (with Euboea)	9,508	2,805,875
Peloponnesus	8,132	1,090,822
Thessaly	5,395	694,461
Macedonia	13,109	1,887,650
Epirus	3,511	351,167
Thrace	3,295	356,708
Total, mainland	42,950	7,186,683
Islands:		
Ionian Islands	873	212,277
Crete	3,218	482,021
Aegean Islands	3,506	476,545
Total, islands	7,597	1,170,843

The population of the municipal district of the capital, Athens, was 621,741 according to the census of 1961, but greater Athens, which includes the suburbs of the capital as well as its port of Piraeus, had a total population of 1.837.041. Other large towns (1961 pop.) are Salonika (Thessalonike) with 377,026: Patras with 94,758; Volos with 67,314 (mun.); Kavalla with 44.406; Iraklion (Candia) with 64,492; Larissa with 55.733; Kalamata with 38,077; Serrai (Seres) with 39.804; Drama with 32,328; Canea with 38.268; Ioannina with 36,295; Komotine with 29,731 (1951 pop.); and Corfu with 27.431 (1951 pop.). The urban population was 36.8% of the total in 1951, the rural population 63.2%.

Languages.—Although there are small groups of Turkish-speaking Moslems in western Thrace and Slavonic-speaking pockets in Greek Macedonia, 96% of the population speaks the Greek language (*q.v.*), which is the mother tongue of 93% of the population (some being bilingual persons who, in addition to their mother tongue spoken in the home, habitually use Greek). The largest foreign-language group is the Turkish, which numbered about 130,000 in 1951.

Religion.—The Eastern Orthodox faith is the established religion in Greece, 96.5% of the population belonging to that church. Of the remainder, the largest single group is Moslem. The Church of Greece is administered by the Holy synod, which consists of the archbishop of Athens and primate of all Greece as chairman and 12 metropolitans assisting him.

There are 71 dioceses throughout the country, each presided over by a metropolitan. Although inseparably united from the point of view of dogma with the Church of Constantinople (where the ecumenical patriarchate has its seat), the Church of Greece is completely autocephalous. Religious toleration and freedom of worship are guaranteed by the constitution, but proselytism is forbidden and punishable by law.

Education.—Primary education is free and compulsory for all children bet een the ages of 6 and 14 years; in the year 1953–54 there were 9,939 primary schools (public or private), attended by 980,036 children and staffed by 20,442 teachers. Secondary education is provided at gymnasia, which are separate for boys and girls in the big towns but mixed in the smaller towns and villages. Children who have a school-leaving certificate from a primary school may enter a *gymnasium* after passing an entrance examination. Tuition is for six years and is completed by a school-leaving examination. There are also commercial and technical schools in the category of secondary education. In 1953–54 public and private secondary schools together numbered 661, with 218,929 pupils and 6,815 teachers.

For higher studies there are two universities, one in Athens (founded in 1837), with 4,397 students in 1952–53; and one in Salonika (founded in 1925), with 2,261 students. Athens also has the National Technical university ("Polytechnic"; 1,348 students in 1952–53), the High School of Economic and Commercial Studies (2,144; *cf.* 1,108 in 1951–52) and the High School of Political Sciences (1,561). Teachers are trained at 14 training colleges, which had an average annual, attendance of 3,000 in the 1950s.

The ministry of education is also responsible for the preservation and upkeep of ancient monuments of all periods. for the upkeep and functioning of museums and for the supervision of excavations. It has a department of arts, responsible for music and the graphic arts; a department of letters, responsible for theatres, motion pictures. libraries and public records; and a department of churches, responsible for ecclesiastical and religious matters. Great Britain, the United States and France maintain schools of archaeology in Athens. The British council maintains an institute and library, as do Italy, the German Federal Republic and Sweden.

GOVERNMENT, ADMINISTRATION AND DEFENSE

Constitution.—Greece has a written constitution. in the drafting of which the French and U.S. constitutions, as well as British constitutional practice, were largely drawn upon.

During the struggle for independence (1821–32) the representatives of the Greek people, in their national assemblies. made various attempts to evolve a constitution and to organize a state; but all these efforts were of an ephemeral nature. as the persons who framed the constitutions were theorists trying to copy the U.S. and French models while at the same time imposing elaborate checks on the executive without taking realities into account.

From the establishment of the monarchy in 1832, Otho I as "king of Greece" ruled for ten years without a constitution at all but with the assistance of a regency council and of a senate. There was a growing opposition to this "absolutist" regime, however, and a bloodless revolution led by General Demetrios Kallergis in 1843 forced King Otho to agree to the convocation of a national assembly mandated to draw up a liberal constitution.

The constitution of 1844 provided for an elected chamber of deputies and a senate nominated by the crown. The king still retained wide powers, including the right to veto legislation, to appoint and to dismiss ministers and to dissolve the chamber.

In 1862 King Otho was dethroned by another bloodless revolution. and a fresh national assembly was convened to draw up a new and more liberal constitution. This assembly offered the crown to Prince William of Denmark, who became "George I, king of the Hellenes" in 1863 and established a lasting dynasty.

The constitution of 1864 abolished the senate, leaving the chamber of deputies as the sole legislative body. It also laid down that "all powers are derived from the nation and are exercised in the manner prescribed by the Constitution," thus establishing the principle of a popular monarchy (or "crowned democracy" as it is known in Greek legal parlance). It remained in force until 1911, when it was revised to form what is known as the constitution of 1911. Under this new constitution, the main prerogatives of the crown were left intact, so that the king still had the right to appoint and to dismiss ministers and to dissolve parliament; but constitutional practice demanded that after an election the king should entrust the leader of the majority with the formation of a government and that in the event of the government's being defeated by a vote in the chamber and resigning, the king should entrust the leader of the next strongest party in the chamber with the formation of a government.

After the abolition of the monarchy and the establishment of a republic in 1924, a new republican constitution was promulgated in 1927. This remained in force until the restoration of the monarchy in 1935, when the constitution of 1911 was brought back into force.

Greece's first parliament after World War II (elected on March 31, 1946) had a mandate to revise certain "nonfundamental" provisions of the constitution. A constitution drawn up by an all-party parliamentary commission was ratified by the chamber on Dec. 22, 1951, and was promulgated on Jan. 1, 1952. The main provisions of this constitution, which consists of 112 articles, are as follows:

Articles 1 and 2 prescribe that the Eastern Orthodox Church is the established religion of Greece; that the exercise of all other religions is tolerated, with the limitation that there shall be no proselytism directed against the established church; and that the Church of Greece is autocephalous.

Articles 3–20 constitute what may he termed the Greek "Bill of Rights." They prescribe equality before the law, immunity irom arbitrary arrest, habeas corpus, ireedom of assembly and of association, the inviolability oi the home, the freedom of the press, compulsory free state primary education, etc. As revised in 1951, article 11 of the constitution of 1911 was amended by the addition of a clause making it illegal for civilservants to strike. Article 14 was also amended so as to give judicial authorities the right to confiscate a newspaper if it openly incites to sedition.

Articles 21–28 relate to the form of government and to the prerogatives of parliament.

Articles 29–44 define the authority of the crown, the most important of the royal prerogatives being that the king appoints and dismisses his ministers, is supreme commander of the armed forces and has the right to dissolve parliament (but must simultaneously order the holding of elections within 45 days of the dissolution of parliament and the reconvening of parliament within 90 days of its dissolution).

Articles 45–53 relate to the succession and to regency and prescribe that the Greek crown and its constitutional rights are hereditary and vested in the dynasty of King George I, males having priority in the order oi succession; that the heir to the throne must belong to the established church; and that in the king's absence abroad the duties of regent are exercised by the crown prince (if of age) or, in the event of there being no crown prince or of his not being of age, by the queen.

Articles 54–76 prescribe parliamentary procedure and the prerogatives of parliament, including immunity, qualifications and disabilities of deputies.

Articles 77–81 relate to ministerial responsibility and provide for the impeachment of ministers by the chamber.

Articles 82–86 lay down that the council of state (*symvoulion* epikrateias) is the supreme court in matters of administrative law and has the power to examine the legality of ministerial decrees, acting as a court of justice in cases of administrative law and hearing the appeals of private citizens against the validity of acts by ministers or other public authorities.

Articles 87–98 relate to the judiciary and make provisions for its independence, judges of the higher courts being appointed for life and other members of the judiciary being irremovable unless convicted of a criminal offense. They also lay down that courts oi law shall sit in public and that the jury system shall be maintained

Articles 99–112 are of a general nature and provide for the permanency of civil servants, for the election of municipal councils by universal suffrage and for all able-bodied Greek citizens being liable ior military service; they also specify certain constitutional guarantees for foreign capital invested in Greece.

The chamber of deputies meets in Athens and is elected every four years. There is universal suffrage, women having been given the vote in 1952. Voting is obligatory and secret. The electoral system is not prescribed by the constitution, but is regulated by statute.

Local Government. — The Greek administrative system is very largely modelled on the French system. For administrative purposes the country is divided into 9 departments and 51 nomoi or prefectures. There is a governor general (who is a full cabinet ministerj of Northern Greece with headquarters in Salonika and governors general of Epirus, of Thrace, of Crete and of the Dodecanese. Governors general and nomarchs (prefects) are appointed by the government.

The peninsula of Mt. Athos (*q.v.*) in Khalkidiki (Macedonia) forms a self-governing community and enjoys a privileged status. Though administratively forming a part of the Greek state, it is subject to the spiritual jurisdiction of the ecumenical patriarchate in Constantinople and is governed by the Holy Community, which consists of representatives of the 20 monasteries situated in the peninsula.

Municipal government, with elected mayors and urban and rural councils, was established in Greece in the middle of the 19th century and is indeed part of the constitution. Municipalities and communes have the right to raise certain taxation subject to the approval of the ministry of the interior, but the general expenses of the provincial services are defrayed by the state budget. Municipal elections are held every four years.

Civil Service. — The civil service is composed of established permanent officials, who are irremovable except by decision of a ministerial disciplinary council, and unestablished officials who are removable by decision of the minister. There are no permament undersecretaries at the ministries, their place being filled by secretaries-general who change with the government. The secretary-general is the senior official after the minister, some of whose authority is delegated to him.

Justice and Police. — Article 87 of the constitution laid down that "justice is administered by judges appointed by the King according to the law." The supreme court is the Areios Pagos, which consists of two divisions, civil and criminal. There are 11 courts of appeal, which can hear both civil and criminal cases, and 58 courts of first instance. with a criminal court at the seat of each. There are also 350 courts of the justice of the peace and 47 magistrates' courts. Each court (with the exception of the last two categories) has its district attorney. In addition there is the council of state (*symvoulion epikrateias*), whose function has already been described.

The administration of justice is supervised by the minister of justice. Procedure follows the French model; *i.e.*, the investigating officer examines the evidence and interrogates witnesses and, if he decides that there is a prima facie case, sends the file to the district attorney, who then decides whether a charge shall be formulated. If a charge is made, the case is heard in open court, the district attorney representing the crown and the accused being represented by counsel.

There are two bodies of police, the town police (*astynomia poleon*) and the gendarmerie (chorophylaki). Both come under the administrative control of the ministry of the interior. The police were reorganized by a British police mission after World War II.

Labour and Social Legislation. — Greece ratified and put into effect the Washington convention on the 8-hour day and the 40-hour week; and the right to annual holidays with pay was established in 1945 throughout industrial, commercial and public-utility concerns. Engagements and dismissals are regulated by law, and industrial health and safety are also regulated by legislation.

Social insurance is highly developed, and there are a large number of mutual benefit institutions established by the various trades and professions. In 1939 the state established an autonomous central fund (Idryma Koinonikon Asphaliseon or I.K.A.) to provide relief in case of sickness, old age and unemployment, to which other funds have gradually been affiliated. Contributions to the funds vary; for example, to I.K.A. the worker pays 1% of his salary to cover sickness benefit and another 1% to cover his pension, while the employer contributes 5% and 3% respectively.

The Greek trade-union movement numbers more than 2,000 different unions, with a total membership of about 250,000. Largely thanks to the mediating efforts of the British T.U.C. immediately after World War II, the Greek General Confederation of Labour was reconstituted and affiliated to the I.C.F.T.U.

Defense. — The guerrilla operations of 1946–49 necessitated the maintenance of a much larger army than the normal peacetime establishment, and the international defense obligations subsequently assumed by Greece (which adhered to the North Atlantic treaty in Feb. 1952 and signed the tripartite alliance with Turkey and Yugoslavia at Bled on Aug. 9, 1954) did not allow any substantial reduction.

A large proportion of the cost involved was undertaken by the United States and by Great Britain. but defense expenditure still accounted for more than 40% of the Greek budget in 1954–55.

The ultimate responsibility for defense matters rests with the ministry of national defense, which has its own general staff. In addition to the minister of national defense, who exercises over-all supervision and control of defense matters, there is an under-secretary of national defense and an over-all general staff of national defense.

Military service is compulsory. liability beginning in the 21st year of age and lasting until the 50th. The normal term of service is 24 months, followed by 19 years in the first reserve and 10 years in the second.

Effectives of the armed forces totalled 140,000, including 11,000 for the navy and 12,000 for the air force. The land forces are organized in three army corps, in addition to a separate command known as A.S.D.A.N. (higher military command of Attica and the Islands) which has the same status as an army corps and is based at Athens. In 1954 the army comprised ten divisions, with an independent commando brigade.

The navy, in 1954, comprised the cruiser "Elli" (8,856 tons, formerly the Italian "Eugenio di Savoia"), 3 fleet destroyers, 14 frigates, 4 submarines. 7 gunboats, 4 mine sweepers. 1 training ship, 14 motor mine sweepers, 2 mine layers, 16 launches, 8 oilers, 2 repair ships, 10 landing ships, 21 landing craft, 1 salvage vessel, 6 transports, 3 lighthouse tenders, 5 water carriers and 10 fleet tugs. The main base is at Salamis and the main dockyard at Skaramanga.

The air force consisted of fighter squadrons, light bomber squadrons, transport squadrons and reconnaissance squadrons. The main bases are at Therme (formerly Sedes, near Salonika), Larissa, Eleusis and Dekeleia (formerly Tatoi, near Athens).

ECONOMY

Agriculture. — Although only 25% of the land is suitable for cultivation — 15% is forest or woodland and the remaining 60% barren or rocky — Greece is essentially an agricultural country, with more than 55% of the population directly engaged on the land. The country is far from self-sufficient in food, however, as only about one-half of the wheat and one-quarter of the other cereals consumed are home-grown.

The paucity of arable land inevitably resulted in the intensive cultivation of what may be termed luxury products, such as tobacco, currants, etc., which bring relatively high prices on the international market. Tobacco alone normally accounts for about 40% of the total value of the country's exports.

Tobacco is grown mainly in Macedonia, in Thrace and in the Agrinion district of central Greece. The cultivation of the vine is mainly concentrated in the Peloponnesus (especially in the narrow belt of lowland along its northern and northwestern coast line) and in some of the islands (notably Crete). The chief areas for wheat are Thessaly, Macedonia and Thrace, maize being grown mainly in Epirus. After grain, the olive is the most important crop (Greece is the third largest producer in the world); it is grown mostly in the low-lying coastal areas and in the islands, especially Corfu.

The problem of providing a means of livelihood for 1,500,000 destitute refugees from Asia Minor after the disastrous campaign of 1922 and the subsequent exchanges of populations was partly solved by the agrarian reform of 1924, when large estates were expropriated and broken up for settlement by the refugees. The second stage of this redistribution of land came in 1952, when provision was made in article 104 of the revised constitution for the compulsory expropriation of all estates exceeding 65 ac. for settlement as small holdings by landless peasantry. The average holding is very small, amounting to about $1\frac{1}{2}$ ac. of arable land to each peasant. Table 111 shows the yield of the principal grain and other food crops.

TABLE 111. — Agricultural Production
(in metric tons)

Crop	1935–38	1950–53	1954	1955
Wheat	768,000	1,057,500	1,218,500	1,336,000
Barley	197,000	225,250	231,350	224,000
Oats	116,000	135,750	149,290	156,000
Rye	55,000	54,500	50,770	54,000
Maize	255,000	246,000	258,480	288,000
Rice, paddy	2,000	57,000	89,660	61,000
Olive oil	112,700	101,625	108,780	115,000
Olives	...	559,000	553,000	496,000
Currants	158,200	78,725	75,500	...
Sultanas	28,600	33,900	38,000	...
Wine	372,700	399,400	455,020	371,000
Fresh grapes	79,500	122,000	122,410	...
Citrus fruit	53,100	147,275	194,000	...
Dried figs	28,600	23,700	27,000	...
Potatoes	148,200	414,925	452,210	438,000

For the period 1935–38 the average annual volume of exports of tobacco amounted to 45,300 metric tons out of a total crop of 61,000. Figures for annual exports of tobacco for the period 1951–54 were 43,600 tons, against a total crop of 59,800 tons. Greece's main tobacco market is Germany, which before World War II absorbed most of the annual crop. The decline in exports in the immediate postwar years was due to the partition of Germany and to a change in taste toward Virginia blend; hut by 1953 the exports were almost as large as before the war, and the annual crop was also restored to its prewar quantity.

Livestock. — Although the German and Italian occupation of 1941–44 and the guerrilla war of 1946–49 played havoc with the livestock of the country, the animal population was almost restored to its prewar level by 1953, as shown in Table IV.

TABLE IV. — *Livestock*

Type	1938	1951	1952	1953
Horses	363,183	292,222	305,000	315,000
Mules	183,609	174,524	193,000	200,000
Asses	404,379	466,947	475,000	492,000
Cattle	1,041,487	915,067	945,000	976,000
Sheep	8,138,772	7,325,997	7,784,000	8,254,000
Goats	4,356,120	4,003,492	4,139,000	4,510,000
Pigs	429,748	635,791	587,000	603,000
Chickens	11,944,551	10,010,546	10,506,000	10,615,000

Fisheries. — Greek waters abound in fish, and there tvas considerable expansion of the fishing industry between World Wars I and II as a result of the refugee influx of many experienced fishermen from Asia Minor. In World War II the industry was shattered when most of the fishing craft were requisitioned or otherwise lost; but most of the losses were later made good with Marshall plan aid, and the introduction of more efficient methods of fishing and a modern refrigeration plant caused production to rise from 35,000 tons in 1938 to 45,000 in 1951 and then (after falling to 43,000 in 1952) to 52,000 tons in 1953.

The acquisition of the Dodecanese Islands in 1947 doubled Greece's sponge-fishing fleet and led to a considerably increased sponge harvest (63,836 kg. in 1953).

Mining. — Greece has a wide variety of mineral deposits, although all of them are not fully exploited. These deposits include iron ore (of high content), iron pyrites (in Argolis), emery (in Naxos), copper, zinc, lead and silver (at Laurion), manganese, aluminum, antimony, magnesite ore (Euboea), lignite (reserves estimated at 10,000,000 tons), sulphur, bauxite (around Delphi), etc. (See Table V.)

TABLE V.—*Mineral Production*
(in thousands of metric tons of ores or concentrates)

Mineral	1929	1938	1948	1951	1952	1953
Iron	253.0	338.6	—	52.8	158.3	88.3
Lead.	44.8	14.9	1.9	4.9	5.6	6.5
Zinc.	29.0	10.3	5.7	8.4	9.0	11.2
Antimony. . . .	0.14	—	—	5.8	2.8	5.0
Chrome	24.2	42.5	1.5	25.3	32.2	36.8
Bauxite	6.3	179.9	44.3	163.7	284.9	328.2
Iron pyrites . . .	133.4	244.0	19.3	181.3	194.7	237.3
Magnesite. . . .	84.0	168.2	11.1	60.9	79.4	107.0
Lignite	156.5	108.0	125.4	191.9	251.1	444.5

Manufacturing Industries.—As it has few raw materials (with the exception of cotton) and is obliged to import almost all its fuel, the country does not lend itself greatly to large-scale industrialization. On the other hand, the availability of cheap skilled labour (especially after the exchanges of populations) made possible a rapid expansion of such industries as there were, notably in the textile branch. Industry is concentrated in Attica, where there is a relatively cheap supply of electric power and where Piraeus offers excellent port facilities. With the exception of a small number of big concerns. the average industrial enterprise is usually a family affair employing a very small number of persons. In April 1951 there were in all 82.674 manufacturing and handicraft establishments employing 318,686 persons, including only 272 establishments with 100 persons or more.

Electricity.—The installed capacity rose between 1950 and 1954 from 236,000 kw. to 397,000 kw. (including 58,000 kw. from hydroelectric power stations). Production rose between 1929 and 1954 from 102,000,000·kw.hr. to 1,176,000,000 kw.hr.

Communications.—There are two main railway networks in the country: the Greek State railways (S.E.K.), which connects Athens with Salonika and the main towns in continental Greece; and the Piraeus-Athens-Peloponnesus railway (S.P.A P.), which connects the capital with the main towns in the Peloponnesus across the Corinth canal.

Widespread damage was caused to the roads, railways, bridges, ports and telegraphs during World War II and the guerrilla war that followed. At the end of World War II the Corinth canal—which connects the Ionian and the Aegean seas—was blocked by the retreating German forces. Largely because of U.S. and British economic aid, most of the damage mas made good by 1954. The Corinth canal had been reopened to shipping in 1948; about 14,500 mi. of road mere back in use; more than 1,600 mi. of railway had been fully restored (only 41j mi. were usable in Oct. 1944); and 1,384 destroyed or damaged bridges had been completely rebuilt or repaired. In 1954 there were 12,892 motor cars, 19,171 trucks

TABLE VI.—*Volume of Foreign Trade*
(in dr. 000,000)

Item	1938	1948	1950	1951	1952	1953*	1954*
Imports	14,761	1,822,275	2,141,134	5,974,974	5,193,013	7,156	9,901
Exports	10,149	469,864	451,591	1,526,201	1,798,407	3,396	4,556

*New drachmas.

TABLE VII.—*Distribution of Foreign Trade*
(in 000 U.S dollars)

Country	Imports from			Exports to		
	1952	1953	1954	1952	1953	1954
United Kingdom . .	34,326	31,808	36,601	19,353	16,299	19,255
Egypt . .	926	959	1,271	2,903	3,737	3,692
United States . .	75,730	47,557	45,857	15,200	15,875	15,122
France	27,347	21,317	21,748	10,481	7,775	11,109
Western Germany . .	41,986	39,830	4,652	35,944	32,002	37,108
Switzerland . . .	2,855	3,123	51,276	2,389	1,933	2,289
Italy	40,903	46,988	10,830	7,558	11,619	19,497
Netherlands . . .	8,861	7,366	2,172	2,235	2,805	3,809
Turkey	4,883	8,559	13,415	3,013	2,886	1,246
Sweden	13,405	10,435	11,763	2,849	1,810	1,371
Austria	6,793	6,545	15,942	4,302	5,052	4,694
Belgium	20,220	13,379	5,503	766	676	862
Yugoslavia . . .	2,643	6,211	2,941	850	5,507	2,298
Finland	3,446	3,609	...	4,182	2,418	3,205

and 5.446 buses. The national air line (T.A.E.), which links Athens with the principal towns and islands, transported in 1953, in 8,072 flights, 43,718,944 passenger-km. and 1,198,119 ton-km. of freight and mail.

Merchant Shipping.—Since ancient times the Greeks have been a seafaring people. The mainland has a long coast line and the islands are widely scattered. so that the most practical means of communication is by sea. The Greeks have thus come to assume a pre-eminent position as sea carriers, and their economy has benefited considerably from this.

The Greek merchant fleet numbered 335 ships (494,000 tons in all) in 1920; 577 (1,837,31j) in 1939; 121 (508,000) in 1945, after losses in World War II; 138 (501,593) in 1946; and 309 (1,242,075) in 1954. In addition to ships registered under the Greek flag, a considerable volume of Greek-owned tonnage is registered under foreign flags, mainly Panaman, U.S., Liberian and British. The total number of Greek-owned ships under Greek and foreign flags in Dec. 1953 was 1,162, with a total tonnage exceeding 7,000,000. In 1953 goods loaded in Greek ports amounted to 770,000 metric tons and goods unloaded to 2,983,000 tons.

Foreign Trade.—The volume and the distribution of foreign trade are shown in Tables VI and VII.

National Finance.—During the first half of the 20th century Greece had to contend with a series of events and circumstances that completely disrupted its economy, placed gigantic burdens on the people and necessitated considerable aid from abroad to keep the country from collapse. The influx of nearly 1.500,000 destitute refugees in the 1920s created vast economic problems. The successful strides made toward restoring the economy to a healthier state were halted by World War II and the guerrilla war of 1946–49, which once again shattered the country's economy and caused widespread destruction of its natural resources and brought about the grossest inflation that Greece had ever known, with the gold sovereign changing hands at dr. 170,000,000,000,000 in 1944.

TABLE VIII.—*Budgets*
(in new dr. 000,000; year endina June 30)

Item	1950–51	1951–52	1952–53	1953–54*	1954–55*
Revenue	4,863.5	5,740.4	7,929.9	10,231.1	12,069.0
Expenditure . . .	6,072.5	6,612.0	6,632.0	9,200.0	10,361.9

*Estimates.

The introduction of a new drachma in Nov. 1944 with a value of 50,000,000,000 old drachmas to 1 new drachma meant in effect the wiping out of the drachma savings of the whole nation. The rate of exchange in relation to the pound sterling went through a series of readjustments (dr. 600 to £1 in Nov. 1944; dr. 2.000 in June 1945; dr. 20,000 in Jan. 1946: dr. 32,000 in Sept. 1948; dr. 42,000 in Sept. 1949; dr. 84,000 in April 1953) until the three zeros were dropped in May 1954 and the rate was fixed at dr. 84 to £1 and dr. 30 to the U.S. dollar.

With a prewar foreign debt of about £75,000,000 still outstanding, the country found itself completely destitute at the end of World War II. The United States and Great Britain were quick to appreciate that only immediate and extensive economic aid could keep Greece from utter collapse, especially as the Communist guerrilla war made necessary the maintenance of a large army on a war footing and the expenditure of large sums of money on defense. When the British government announced in March 1947 that its own economic difficulties made it necessary to terminate its commitments in Greece, the United States took over financial responsibility for the country with the pronouncement of the Truman doctrine on March 12, 1947; and by June 1953, Greece had received more than $2,500,000,000 in foreign aid. This aid enabled the Greeks to persevere in their efforts toward restoring the country's economy. These efforts culminated in a budget surplus for 1953–54. (See Table VIII.)

See Kingdom of Greece, *Statistical Summary of Greece* (Athens, 1954). (S. L. H.)

GREEK ARCHAEOLOGY. The liberation of Greece (1821–29) made the scientific and thorough exploration of her ancient remains possible to many such scholars as Böckh and

Foucart, the epigraphists; Newton, the discoverer of the Mausoleum; Penrose and Dorpfeld who revealed the wonders of Athenian architecture; Brunn and Furtwangler, Ross and Beulé. To-day a well organized Greek archaeological service is actively engaged in preserving and conserving antiquities, and there are American, Austrian, British, French, German and Italian archaeological schools in Athens devoted to the same object in collaboration with the Greek authorities.

Use of Subject. — The genius of the Greek people laid down for the whole western world the foundations of the study of literature, art, philosophy and science, including geometry, astronomy and mathematics, and such subjects as zoology and botany. The Greek histories we possess, both those of Greek writers themselves and those produced by modern scholars based on wider sources of information, deal in the main with political affairs, and hardly touch on the culture of this gifted people from whom our civilization is derived. Political history is apt to describe exclusively political manoeuvres, diplomatic and internal, the personalities of statesmen and generals, and the progress of campaigns and battles. The material circumstances of life, public and private, are rarely discussed and the general tendency of culture at any given period and the various influences which affected it are seldom taken into consideration. Yet the trend of thought in all forms of art, the fashion for a particular type of beauty, the popular style of the age, are essential factors in building up the moral character of a people. The basic information for most of the elements necessary for this study is to be obtained from a proper use of archaeological evidence. The sources for Greek archaeology lie in two spheres, the literary and the material. From the literature of ancient Greece we derive information about the social, political and economic life of the Greeks and some also about the material surroundings of their life. But literature, except a few authors such as Pausanias who travelled in Greece about the time of Hadrian, did not consciously aim at describing this life for us. The descriptions and allusions given were meant for a public already well familiar with such life from personal experience, and therefore are of comparatively little value unless they can be checked by comparison with the actual objects. It is the function of archaeology to supply the material objects so far as they can be found and identified, and to interpret them.

Excavations. — Except in certain cases where temples such as the Parthenon or the Temple of Apollo at Bassae have, though sadly damaged, stood erect from those days to the present, or fortifications such as those of Messene or Aegosthena have similarly survived the assaults of man and time, the materials for Greek archaeology have to be recovered by excavation from the earth which has covered and so preserved them. Objects may be found by casual excavation by farmers tilling their lands, or by deliberate excavation intent on recovering the treasures of the past. Many important objects have been revealed accidentally by the builder or even by the fisherman's net as in the case of the bronze youth from Marathon. Most has been revealed by deliberate excavation, the only correct method, but it must be scientific, because all excavation is in a sense destruction. The very act of digging and of removing objects from the ground destroys their context. For instance a group of vases and jewellery found together in a tomb tell its story; they date each other, and give a picture of the culture of their age. If, however, the jewellery be removed without keeping the pottery with it or at least taking proper note of it, that jewellery like the Aegina treasure in the British Museum can tell us hardly half its story. Similarly a nest of vases found under the foundations of a temple gives a terminus post quem for its building, but if the vases are removed and no observations made as to their position and relationship their value as historical evidence is lost. Thus many of the objects exhibited in museums are archaeologically dumb because they have been found either in the operations, usually illicit, of a professional excavator who digs for plunder to supply the cabinets of collectors or museums, or in the excavations of irresponsible archaeologists. Never was the urgent need of patience, accuracy, and detailed observation more conspicuously demonstrated than in the case of the excavation of the sanctuary of Artemis Orthia at Sparta where thousands of small objects of all periods were found around the ruins of a temple and its altar. It was only the skilled restraint of the archaeologists, who slowly removed the earth almost inch by inch, that unravelled the complicated stratification, and gave us not only the history of one of the most important Spartan temples, but also an invaluable record of the culture of Sparta through 600 of the most momentous years of its existence. The change of soil, the various materials used in building, and all apparently minute points must be constantly watched and this record of the stratification if not made by the excavator can never be made by another and so irretrievable damage may be done. A carelessly conducted excavation is even more disastrous than the burning of a library, for the archaeological evidence it has destroyed can never be replaced.

Objects Found.--Objects from excavations may be found in the ruins of ancient temples and sanctuaries, or in those of public buildings such as theatres or colonnaded market-places, or fortifications, or in those of private houses, or in tombs, perhaps the most fruitful source of all. Tombs are more apt to yield complete objects, temples and public buildings yield inscriptions, and both they and houses produce quantities of fragmentary small objects of everyday use which give us the stratification of culture on any particular site. In this way the evidence obtained from tombs and that from temples or inhabited sites supplement each other.

HISTORY OF EXCAVATION

Scientific archaeological exploration of ancient Greek remains was rather long delayed, though a French expedition had undertaken some researches at Olympia in 1829. Some of the earliest archaeological expeditions worked on the coast of Asia Minor among the Greek colonies rather than on the sites of the motherland. Thus Newton's work at Halicarnassus and Cnidus which enriched the British Museum with the remains of the Mausoleum and the Demeter of Cnidus and Wood's patient search for the Artemisium at Ephesus, though among the earliest excavations carried out with definite scholarly aims, belong rather to Asia Minor than to Greece.

German. — Not till 1875, however, were the great German excavations at Olympia begun, under a special treaty with the Greek Government. This expedition under the leadership of Curtius, Adler and Treu, after six arduous campaigns, revealed what was left of the temples and other buildings of the Panhellenie sanctuary of Olympia. Rich finds rewarded the efforts of the excavators, the pedimental sculptures of the great temple of Zeus, the Winged Victory by Paeonius, and greatest treasure of all, the Hermes of Praxiteles, the only undoubted original by one of the greatest masters of Greek sculpture. These sculptures, whose date is indisputable, are of unrivalled value for the history of Greek art. Since then German expeditions have done important work at several other sites. At Thera the ancient town has been cleared and gives an excellent picture of an island community in the latter part of the classical age, while rich tombs of the early iron age were also found. At Athens the theatre of Dionysus was excavated and also a large part of the Dipylon cemetery, providing much fresh information about Athenian funeral customs. After preliminary campaigns in the early cemeteries of Samos, most useful for the light thrown on early Ionian art, especially the vases, the famous temple of Hera there has been laid bare and the history of another of the sacred sites of Greece is being made known. This and similar work on the temples of Aphrodite and Aphaea at Aegina has yielded valuable facts towards the study of architecture, and the results of the complete excavation of the Aphaea temple now enable us to study in their right context the famous sculptures from it at Munich.

Greek. — Greece has taken a foremost part in the rediscovery and preservation of her treasures, and apart from many minor researches has carried out several major excdvations — the Acropolis at Athens, at Eleusis, the Amphiaraeum by Oropus and at Epidaurus. The history of the Acropolis was entirely rewritten by the results of excavation. The successive stages of the Parthenon and the temples planned to precede it on the same site, the earlier Propylaea, and the old Athena temple all show

how closely the architectural monuments of the prime of Athens are to be co-ordlnated with the history of the city herself. Fresh fragments of the sculptures of the Parthenon were found, but the most surprising artistic find was the hoard of statues damaged and overthrown in the Persian invasion of 480 B.C., which had been subsequently used to fill up a hollow during rebuilding. These, though damaged are at least unrestored originals, and show by the plentiful traces of bright painting still extant on them how the Greeks intended their sculptures to appear. A fundamental date for the history of Greek vase painting was another of the more important facts determined. At Eleusis the Hall of Mysteries was discovered and the progressive enlargement of this and of the sacred enclosure indicate both the gradual increase of culture and prosperity in Greece during the 6th and 5th centuries B.C., and the growth of the importance of the shrine itself. Many important sculptures and inscriptions were found. The Amphiaraeum and Epidaurus were the centres of cults connected with healing, but the latter is the more important as the central shrine of Asclepius himself. Here the whole sanctuary has been cleared with the theatre and all the subsidiary buildings. Valuable architectural results were obtained, and sculptures illustrating the style of Timotheus, a leading artist of the 4th century, with many historical inscriptions, and others giving interesting details about visitors to the shrine and their cures. This whole group of buildings with the theatre, accommodation for patients, gymnasium and music-hall gives a vivid picture of the life of a Greek spa during the first two centuries after Christ. The central sanctuary of the Aetolians at Thermon has been cleared and valuable material for the history of the development of architecture was unearthed and many important inscriptions. At Lycosura in the ruins of the temple were found the greater part of a colossal group by Damophon, a leading sculptor of the 2nd century B.C.

French. — The French school has excavated Delphi, the seat of the famous oracle of Apollo, which has produced sculptures of the first rank, such as the bronze charioteer, a masterpiece from the hand of an artist still unknown, and the marble frieze of the Cnidian treasury, a gem of archaic art. Besides these, the innumerable "treasuries" and shrines, the theatre and other buildings have added much fresh material for the study of architecture, and an immense harvest of inscriptions. At Delos the French have cleared the sanctuary of Apollo with its many temples and colonnades, but the complicated nature of the site makes the unravelling of its history rather difficult. A large part of the Hellenistic town has been cleared with its streets, houses, warehouses, port and theatre, and this combined with the sacred associations of the site, gives a panorama of the active life and trade of this town, a sanctuary of Panhellenic renown and a free port, the great entrepôt of the Aegean, especially for slaves. As the island itself produces little or nothing to sustain the life of even a small population and water is scarce, provisions of all kinds must have been extensively imported. Among other sites where French explorers have worked is Tegea, where the temple of Athena Alea has been excavated and some heads and other fragments of the pedimental sculptures have been recovered. These, though battered, are originals from the hand of Scopas, a master of the 4th century, a contemporary and rival of Praxiteles.

American. — The Americans, now about to undertake the arduous project of excavating the agora of Athens and the other buildings sacred and profane around it, have previously concentrated their efforts on Corinth, the most flourishing commercial city on the Greek mainland next to Athens itself. In 146 B.C. Mummius overthrew all its buildings except the temple of Apollo, some columns of which still stand. The Americans have cleared a large part of the Agora and a short length of the road leading to the port of Lechaeum, and have identified the theatre and other public buildings. The excavations show how complete was the rebuilding that took place when Caesar sent a colony to the site and how thorough was the destruction by Mummius. The elaborate arrangements for the water supply of the city have been revealed in the fountains of Peirene and Glauke. The former which dates back to the 6th century emphasizes the importance attached by the tyrants to making proper provision for this essential for the well-being of their subjects. The ruins of Corinth indicate that this too was a prosperous city, and that the site was eminently adapted by nature for a trading centre. An American expedition also excavated the Heraeum, the national sanctuary of Argos. This site was continuously occupied from the early bronze age till late classical times, and was especially rich in finds of the archaic period of art that illustrate the varied influence notably those from the east, affecting Greece at that date. The architecture of the temple rebuilt after a fire in 423 B.C. and of the other buildings in the precinct forms an interesting contrast to Attic work of the same date; in addition a few interesting sculptures were discovered.

British. — The first British excavation was that of Megalopolis, and apart from the problems involved in the architecture of the theatre and the Thersilion, the council chamber of the Arcadian confederacy, the results hardly came up to expectations. Otherwise apart from valuable contributions to Aegean archaeology by excavations in Crete, at Mycenae, in Melos and in Thessaly, the great excavations of the British school have been at Sparta. Here the classic sanctuaries of Artemis Orthia and Athena Chalcioecus and of Helen and Menelaus have been discovered, and entirely new light has been thrown on Spartan art which now appears to have been extremely flourishing in the archaic period when oriental and Ionian influence were much in evidence. In later times only the growth of a narrow military policy stifled the natural Hellenic tendency towards artistic expression in all the accompaniments of life. The tracing of the walls has determined the size of the city and the excavation of the theatre and the innumerable inscriptions of the early imperial period show that Sparta flourished under the Pax Romana as a provincial capital.

Other nations have taken an active part in excavations in Greece. The Austrians have been at work in Elis, the Dutch at Argos, the Danes at Lindos, the Czechs at Samothrace and the Swedes at Calaureia, while the latter and the Italians have specially distinguished themselves in Aegean archaeology.

SEVEN BRANCHES OF ARCHAEOLOGY

Greek archaeology subdivides naturally into seven branches. These are: —

I. Topography. — This is naturally linked with geography and consists in the exploration of Greek lands and the noting of the ancient ruins they contain, the observation of their natural resources, and finally the co-ordination of the results of such research with the knowledge of the country to be derived from ancient writers. This sifting of the evidence forms the basis of our knowledge of the political and historical geography of Greece. A full understanding of the physical aspects of the country and its natural products, mineral or other, coupled with as full a survey as is possible of the ruins of ancient towns and hamlets, is essential to enable us to picture the land where the drama of Greek history was played, and art and literature had their birth. A classic example of topographical work is Leake's *Travels* in *Northern Greece* and a modern work of the same type is Stahlin's *Das Hellenische Thessalien,* while Frazer's monumental *Commentary on Pausanias* is the outstanding instance of an attempt to stabilize our knowledge of Greece by the correlation of archaeological and literary material and of ancient and modern topography:

II. Epigraphy.-The study of ancient inscriptions which may vary from a grave inscription of a few words to lengthy laws or decrees and fall into two large groups: (A) Inscriptions proper, by which we mean words inscribed on monuments or objects to denote their purpose, often mentioning the name of the deity or person concerned. These subdivide into: (1) Epitaphs, perhaps the largest class of all; these can be of historical importance, as, for instance, the epitaph of Dexileos, an Athenian cavalryman who fell in the Corinthian War about 395 B.C.; (2) Dedications, varying from the official dedication of a building to a word or two scratched on a small bronze offered to a god. The serpent column from Delphi (now in the Hippodrome at Constantinople) recording the names of the Greek cities that won the battle of Plataea against the Persians, and the bronze Etruscan helmet dedicated by Hieron, king of Syracuse, at Olympia after the battle of Cumae (now in the British Museum) show the historical value of such inscriptions. The fragments of the metrical dedication of the Athenians celebrating their victories over Boeotia and Chalcis in 506 B.C. is a useful check on the accuracy of Herodotus who quotes it. Most of the inscriptions celebrating victories at games, such as the famous inscription of Damonon of Sparta, who boasted that he and his son had won more races than anyone else, fall into this class. (3) Honorary inscriptions, such as the lines inscribed on the bases of statues erected to persons like Alexander and Hadrian, or those recording honours granted by a State to citizens or to natives of other States, when the honours usually consisted of the right to a front seat at festivals and *proxenia* and certain exemptions and immunities. (See INSCRIPTIONS.) (B) Documents both public and private or, on another classification, sacred and profane. These subdivide into: (1) Treaties and alliances, such as the treaty between Athens, Mantinea and Argos, which corrects the text quoted by Thucydides; (2) Laws such as the famous laws of Gortyn, which from their archaic language and their legal contents rank high in importance; (3) Decrees of the State or letters from kings, Roman emperors, or some other authority, regulating the affairs of subordinate States, such as the decrees of Eressos about tyrants which were confirmed by letters of Philip Arrhidaeus and Antigonus; (4) Financial records such as the famous tribute lists which form the basis for the study of Athenian finance in the 5th century, or the records of the treasures of the temple at Delos; (5) Building inscriptions such as those of the Erechtheum at Athens which give important architectural details; (6) Lists of names such as those recording the manumission of slaves, some of which from Athens give interesting information about trades, and lists of soldiers killed in battle or of ephebi; (7) Boundary stones recording political boundaries, the limits of sacred areas and the bounds of private property, the last including mortgage stones which give the name of the mortgagee and the amount of the mortgage. Among miscellaneous inscriptions come the potsherds scratched with the names of politicians which were used in voting at an ostracism in Athens. Several of these bear the name of Themistocles himself, others that of Xanthippus, the father of Pericles, and yet others the name of the great political opponent of Pericles, Thucydides the son of Melesias, whose ostracism in 444 B.C. left Pericles free to carry out his policy.

III. **Numismatics,** the study of Greek coins, which includes complicated subjects such as metrology, weight standards, the ratio of the metals to one another as well as the classification of the coins themselves and their study as original objects of art.

IV. **Architecture,** the study of Greek construction which has had a profound influence on subsequent building. Apart from the great temples such as the Parthenon at Athens and all the smaller shrines, there are hundreds of ancient buildings of more secular use, such as the Propylaea or gateway to the Acropolis at Athens, the Stoa of Attalus in the market of Athens, and the theatres, colonnades, and other buildings to be found on every important Greek site. With them can be grouped fortifications and private houses. The study of the gradual development of Greek architecture, and the methods by which the ancients overcame the problems confronting them, provide lessons of the greatest value to modern architects. True, of many Greek buildings little more than the foundations exist, but a study of these and of the fallen blocks of the superstructure enables us to reconstruct the building on paper even if only in part, and the evidence of a single stone when observed by the trained eye may lead to important results. Thus the discovery of the foundations of a building is of the greatest assistance in visualizing it.

V. Ceramics, the study of ancient pottery, which has in recent years been highly developed. Broken pottery is the commonest of all objects found on an ancient site, and is intrinsically the most worthless, and therefore for the archaeologist in many ways the most valuable, for it is unlikely to be stolen or to be forged. Whole vases found in tombs have of course a market value, but these may have no archaeological value if removed from the ground by illicit or irresponsible excavators. Thus on the excavation of an ancient site it is a *priori* probable that the latest pottery will be found near the surface and the oldest deepest down, and so on. (See STRATIGRAPHY and SEQUENCE DATING.) Thus by careful excavation stratum by stratum the archaeologist can obtain a stratified sequence of the potsherds from any given site. These can be dated by the evidence of inscriptions or by that previously obtained from other sites, and thus provide a ceramic history of the site in question and a test by which buildings and other objects can be dated in their turn, and they even serve to correct false impressions or ideas that have hitherto held the field. A classic instance of stratification is the "Persian Stratum" on the Acropolis of Athens which consists of damaged objects used as filling on the restoration of the buildings on the Acropolis after the destruction of Athens in 480 B.C. The study, too, of the pottery that prevails in a given stratum shows the commercial and cultural influences prevailing at that period and throws light on the economic or political orientation of the city where it is found, and on the social customs and the prosperity of its citizens. There are of course pitfalls for the unwary or the inexperienced. The strata are not always laid down on mathematically level ground, but may slope down the side of a mound. The earlier strata may be dug into in laying the foundations of a later building and so be partially disturbed, but proper observation of this enables the later building to be more nearly dated. Again, when the accumulation of debris over a long period of years has made a mound, the site may be levelled for later constructions by cutting off the top and throwing down to the sides as was done at Troy by the builders of the gth, or Graeco-Roman city. Further, when in early days a particular type of pottery has been very commonly used on a site the soil becomes so full of fragments of it that every later stratum can hardly help containing a few pieces. This sometimes leads to error, as occasionally attempts are made to date a building by the earliest objects found in it. As a rule unless there are special circumstances to be taken into account a building, tomb or whatever it is should be dated by the latest object found.

Greek pottery divides into the following groups: —

Neolithic. — This in turn subdivides into that found on the mainland and that found in Crete. (See AEGEAN CIVILIZATION.)

Bronze Age, which has three divisions: Early, about 3,500–2,200 B.C.; Middle 2,200–1,600 B.C.; Late 1,600–1,100 B.C.; and the pottery of these three periods is further subdivided according to the regions where it is found as Minoan, Cycladic or Helladic. Under Middle Minoan comes the pottery formerly called Kamares ware, under Early Helladic Urfirnis ware, under Middle Helladic Minyan ware and Matt-painted ware, and the pottery called Mycenaean is to be classified according to its provenance as Late Minoan, Late Cycladic or Late Helladic. Each of the three divisions of the Bronze age has further chronological subdivisions. (See AEGEAN CIVILIZATION.)

Early *Iron* Age. — The pottery of this period is still far from well known and is marked by the gradual predominance of geometric ornament, by the introduction of new shapes, by a different quality of paint, and in general by an artistic decadence which so often coincides with an improvement in the material concomitants of life.

Geometric Pottery. — By goo B.C. the Iron Age was well established in Greece and the geometric style of ornament predominated. This is sometimes known as Dipylon pottery, because it first became known from vases found in the cemetery outside the Dipylon gate at Athens. About 800–750 B.C. the geometric style began to modify under the influence of oriental motives derived through the Greek colonies on the coast of Asia Minor and Cyprus, and probably, too, through contact with Phoenician traders. This modification is known as Phaleron ware from the site of its first discovery. Then about 750 B.C. what is known as Proto-Corinthian pottery had a great vogue. This consists of small vases delicately made with fine linear ornamentation carefully designed and often combined with friezes of animals and warriors, well and minutely drawn. These vases are called Sicyonian, from the view recently advanced that they were manufactured there. They are, however, the forerunners in many respects of the next great phase of Greek pottery.

Orientalizing.—Towards the end of the 8th century B.C. oriental influence which had gradually permeated the geometric style became the chief characteristic of Greek pottery. Just as the geometric style, though uniform, had many local variations all over Greece according to the circumstances of the place of manufacture and of the quality of the clay employed, so now the orientalizing style throughout the Greek world produced a great number of local styles, and many of these have not yet been definitely placed. The style flourished more in the islands and along the Asiatic littoral where we find Aeolic, Clazomenian, Milesian, Samian, Rhodian, Delian and Melian wares. Even Naucratis had a special fabric of its own, and on the mainland we have Corinthian, Chalcidian, Boeotian, Attic and Laconian wares. Many of these local wares, like the Boeotian and the Laconian developed on their own lines in the succeeding periods, but never attained to any great importance, for Attic pottery eclipsed the rest of the Greek fabrics and became the great standard. It seems to have been extensively exported, especially to Etruria, where its products found a ready market among the Etruscan nobles. Thus Attic pottery from the 6th century onwards is the great centre of Greek ceramics, and we have two main styles: (1) Black-figured ware in which the designs are painted in black on the red ground of the vase and picked out with incisions and with added purple or white paint. This ware flourished during the 6th century, and shortly before 500 B.C. gave way to another style which was practically its converse; (2) Red-figured ware, in which the ground is painted black and the designs are reserved in the red colour of the vase, while details are rendered with black lines. These last two classes of pottery, from the elegance and beauty of their drawing, rank more as paintings than as pottery. With them must be grouped a contemporary ware in which the designs were painted on a white ground. Particularly noticeable are the white *lekythoi* which were made specially to be placed in graves and decorated with unfixed paint. These provide us with some of the best Greek paintings and drawings known.

With the degeneration of the red-figured style in Attica at the close of the 5th century the Greek colonies in Italy took the lead and produced quantities of large vases decorated in a florid and over elaborate style. In Greece itself the red-figured wares gave place to less pretentious vases intended more for use than as works of art. Good pottery covered with the excellent black glaze which was the secret of the Attic potters, was produced in great quantities, but the ornament was limited to incisions assisted by simple patterns in white paint laid on the black surface. Certain simple forms of white grounded ware were still made, but ordinary designs of flowers, fruit, musical instruments and the like were the sole decoration. The principal decorated ware from the 4th century onwards was moulded pottery which includes a large class of vases usually known as Megarian bowls. These are often covered with a uniform black glaze which is seldom of good quality and in later examples tends to be thin and grey. The decoration at first consisted of figure subjects as on the earlier black and red-figured wares, and Homeric subjects were specially popular. Designs based on the acanthus, shells, scales and other motives popular in Greek decorative art are common and figures of Erotes are often added. With these comes a class of black pottery ornamented with moulded medallions or figures applied to the surface. Here the motives employed are usually figures of maenads, satyrs, and other Dionysiac subjects, amazons and gods and goddesses. Moulded wares became popular in Italy as Arretine pottery and so spread throughout the Roman world as "Samian Ware" (now usually called terra *sigillata*) which was the characteristic tableware of the first two centuries of the Christian era. Two probable reasons may be assigned for the decay of Greek pottery after the 5th century. The general increase of wealth and luxury due to the renewed intercourse with the riches of Asia especially after the campaigns of Agesilaus and Alexander, inspired the upper classes, the patrons of the vase painters, with the fashion of using silver plate for their tables. At the same time the new age of adventure beginning in the 4th century caused a change in art which was henceforward practised more for its own sake than as the means of ennobling objects of ordinary domestic and social use.

VI. Sculpture, which properly comes under art and embraces all forms of plastic and toreutic, and can be subdivided into the following groups: (1) Sculpture proper, which is limited to figures carved in the round or in relief by the artist direct from the stone or marble. A minor branch is gem engraving in which subjects are carved either in intaglio or in cameo directly on the stone; (2) Modelling, which applies to figures small or large modelled in clay intended as independent works of art or else as models for large figures to be executed in marble or bronze. The votive terra-cotta statuettes which are found in such numbers in excavating Greek sanctuaries and tombs, though usually cast in moulds, fall into this class and so do the well-known Tanagra and similar figurines which were made in moulds for funeral furniture; (3) Metal casting especially bronze, the favourite material for many of the greatest Greek sculptors. Polyclitus for instance worked principally in this technique. A subdivision of this group is jewellery made by casting in gold and silver small objects which were then fitted together to make earrings, necklaces, and other ornaments; (4) Metal chasing, which is practically confined to the precious metals; (5) Carving in materials other than stone or marble, which is usually restricted to small objects such as statuettes of ivory, but in the earlier days of Greek art according to the literary evidence there were statues of wood which have not been preserved.

VII. Painting.— We have nothing left of the frescoes or easel pictures of the great masters of Greek painting like Polygnotus or Apelles and a history of Greek painting has to be constructed mainly from the literary sources. The vase paintings, however, of the Attic black and red-figured styles and of the white grounded vases supply much beautiful and valuable material for estimating the style and manner of the Greek painters. The painted grave stones from Pagasae which are not earlier than the 4th century represent industry rather than art, but still provide-useful evidence as to methods and technique.

None of the seven branches of Greek archaeology are absolutely independent for they often over-lap each other. Inscriptions may be found on buildings, on statues, on vases and on coins. Coins themselves, being struck from engraved dies in intaglio approach one of the subdivisions of sculpture, and ceramics and vase-painting are also closely connected. Famous statues, too, were often imitated in coin types. Then topography and study of the ancient remains from the geographical point of view take into account practically all the other branches. Thus a hoard of coins containing a large number of bronze coins of a city, the site of which is doubtful may solve its identification. Still every Greek archaeologist, though he naturally specializes in one or two branches only, should have a sound working knowledge of the others.

CHRONOLOGICAL DIVISIONS

In addition to the seven great branches which divide Greek archaeology according to subject, there are two chronological divisions, the pre-historic and the historic. It is hard to say where the first ends and the second begins, but for practical purposes the division may be put at 776 B.C., the Greeks' own traditional date for the first Olympiad and the beginning of their chronology.

Prehistoric.— The prehistoric age subdivides into the usual periods: Palaeolithic, Neolithic, Bronze Age, Early Iron Age. The Palaeolithic Age is not yet established for Greece, though a few isolated palaeoliths are reported. The Neolithic and Bronze Ages are described under AEGEAN CIVILIZATION. The Early Iron Age is a natural evolution from the last phase of the Bronze Age affected by the infiltration of external elements, probably northern, which the Greeks described as the Dorian Invasion or the Return of the Heracleidae. It is characterized by the use of the "geometric" pottery mentioned above, iron swords of a Danubian type, bronze safety-pin brooches often with spiral ornaments, bronze figurines of animals, long bronze pins and sometimes ivory plaques and figurines. This culture is not that of a particular

AUTHENTICATED NEWS

TEMPLE RUINS AT THE ANCIENT SACRED SITE OF DELPHI, ON THE SOUTHERN SLOPE OF MT. PARNASSUS, GREECE

tribe or people, but of a phase in the evolution of Greek art, for in the civilization of a people community of inspiration is more important than community of race. Early in the 8th century a great increase in oriental influence due partly to Phoenicians and Etruscans and partly to the Greek colonies in Asia Minor inaugurated the orientalizing period of Greek art and here the historic age begins.

Historic.—With this, the classical age, our outlook is different. In the time of unwritten history or legend archaeology itself is history, because the incidents of a people's life are reflected in its material remains. In other words prehistoric archaeology is a manuscript from which history can be deciphered. On the other hand in the classical age history is written. Archaeology then becomes an illuminator and interpreter of history and is best studied under its separate branches described above. (See GREEK ARCHITECTURE; GREEK ART; POTTERY AND PORCELAIN; INSCRIPTIONS; NUMISMATICS; PALAEOGRAPHY.)

RELATIONS TO OTHER COUNTRIES

Greek archaeology is not complete in itself, because inevitably it impinges upon the archaeology of the countries that are the neighbours of Greece. Man is a social animal and lives by contact with his own kind. Archaeology is one way of studying the material results of the contact of man and man. Similarly no race can live for long in a state of complete isolation and the result of the contact between one race and another is reflected in their archaeology which thus provides a means of gauging the extent of the influence of one race upon another. For pre-historic times there is archaeological evidence that Greece was in contact with surrounding races. The marked influence which Egypt and Crete exerted upon each other is well known. So we find connections between the Aegean civilization and Palestine, Cyprus and Asia Minor, where Troy is the classic example. Northwards there are clear evidences of intercourse between prehistoric Greece and Macedonia and the Danubian and Carpathian areas. Westwards there are hints of relations with Italy, and the Aegean civilization (*q.v.*) touched Sicily and Sardinia. So no true student of the Aegean civilization can appreciate its full value without considering its neighbours and in chronology the Egyptian connections are of vital importance. With the beginning of the classical period and the dawn of history the relations of Greek archaeology naturally became more intricate. The connection with Egypt and Asia Minor still remains and there is great uncertainty as to the amount of the debt of Greece to Phoenicia during the orientalizing age. These contacts are of the utmost value for chronological questions. Northwards again Macedonia, Thrace, and the Danubian and Euxine districts become of genuine historical importance through their contacts with Greek archaeology. The dating of the monuments in those regions is due in large part to our knowledge of Greece. For the Adriatic the same holds true and further west in Italy the case is far stronger. Sicily and southern Italy were studded with Greek colonies and their relations with the indigenous cultures provide a reflex of their relative importance and also most useful chronological comparisons, and Etruscan archaeology is throughout illuminated by our knowledge of Greece. Sardinia, the east coast of Spain and the south coast of France were fringed with Greek colonies, and so Greek archaeology illustrates these with great profit to history. These instances show how important it is not to allow the detailed study of Greek archaeology to exclude all view of any other. Two further points of the utmost importance for study of human development occur for note. When Alexander overran the Persian empire and through Macedonia made Greece mistress of the Near East he spread Greek culture which is illustrated by hundreds of monuments throughout the East as far as the borders of India. The influence of Greece on Asia is revealed by Greek archaeology and it was upon this union of East and West that the foundations of Christianity were laid. Secondly, when Rome became mistress of the Mediterranean the culture she adopted was that of Hellenistic Greece, the very culture which Alexander and his successors had propagated. Greek archaeology reveals this to us in the houses of Rome and Pompeii and the adoption by Rome of Hellenistic culture, which Greek archaeology verifies, assisted the rapid growth of Christianity under the Roman empire. Constantine's official adoption of Christianity was one of the greatest landmarks in world history and Greek archaeology helps in no small measure to appreciate why and how this change was inevitable.

MUSEUMS

The materials for the study of Greek archaeology are housed in various museums all over Europe and in America. The museums of Greece take precedence because their contents are mainly the product of scientific excavations and have not lost their contexts and the sculptures they contain have not suffered from restoration. The National museum at Athens is famous for its sculptures, vases, bronzes, the Acropolis museum for archaic sculptures, the Epigraphical museum for inscriptions. The museums of Olympia, Delphi and Delos house the great finds from the excavations of those sites and that of Candia contains the finds from Cnossus and Crete in general. Other important museums in Greece are those at Thebes, Volos (for paintings), Samos (for sculptures), Nauplia and Corinth (both for prehistoric pottery), Sparta (for Spartan art), Thera, Corfu, Chalcis, Thermon and several others. In Italy Rome leads the way with the Museo delle Terme for sculpture, the Vatican for sculpture and vases, the Capitoline museums for sculpture and the Villa Giulia for vases. At Naples the National museum has unrivalled sculptures, as also has the Uffizi at Florence, where in the Museo Archeologico are Greek objects found in Etruria. The museums of Palermo for sculpture, Syracuse for vases, Taranto for vases and terra-cottas are important, and there are many other museums with Greek objects all over Italy. In France the Louvre is the principal museum with great treasures of Greek art. In Germany there are many museums. Berlin has in the State museums fine sculptures and vases and in the Ethnological museum Schliemann's finds from Troy. At Munich the Glyptothek contains the Aegina pedimental figures and other sculptures and the Museum für Antike Kleinkunst contains valuable vases. Dresden (Albertinum), Cassel, Heidelberg, Hildesheim and other German towns have good collections. In Great Britain the British Museum in London has the Elgin Marbles and a fine series of vases, the Fitzwilliam museum in Cambridge and the Ashmolean at Oxford have vase collections, too, and the latter a fine prehistoric collection as well. In Turkey the Constantinople museum has good sculptures and some of the finds from Troy, and in Egypt the Alexandria museum has a good collection of objects illustrating the later stages of Greek art. In Denmark at Copenhagen the Ny-Carlsberg Glyptothek has sculptures and the National museum vases. In Holland the Scheurleer museum at The Hague and the Leyden museum, and in Belgium the Musée du Cinquantenaire at Brussels have good vases and terra-cottas. In Russia the Hermitage museum at Leningrad has sculptures and vases, and several of the south Russian towns such as Odessa have good collections from the Greek colonies on the Black Sea. In America the Metropolitan museum in New York and the Museum of Fine Arts in Boston both have good collections of sculpture and vases, while the university museums at Baltimore, Philadelphia, and Harvard have useful collections.

BIBLIOGRAPHY.—The publication of the results of research in all seven branches of Greek archaeology and of the material yielded by excavations is catered for by a large number of periodicals in the principal countries of Europe and in America and by the issue by specialists and others of learned monographs treating some particular section of the whole field. The principal periodicals are: in Greece the *Ephemeris Archaiologike,* and the *Archaiologikon Deltion;* in Austria the *Jahreshefte* of the Austrian Archaeological institute, in France the *Revue Archdologique* and the *Bulletin de Correspondance Hellénique;* in Germany by the *Jahrbuch* of the German Archaeological institute, the *Athenische Mitteilungen,* and many others; in Great Britain by the *Journal of Hellenic Studies* and the *Annual of the British School at Athens;* in Italy by the *Monumenti Antichi* of the Accademia dei Lincei and the *Annual* of the Italian school at Athens; and in the United States by the *American Journal of Archaeology.* The monographs dealing with special aspects of Greek archaeology fall into three classes: (1) Monumental collections or catalogues of a particular class of object, such as the great Corpus of Greek inscriptions *(Inscriptiones Graecae)* issued by the Berlin academy or the *Corpus Vasorum Antiquorum* published under the auspices of the *Union Académique Internationale* and scientific catalogues of famous museums such as the German catalogue of the Vatican sculptures and the British catalogue of the Capitoline collections and the British Museum catalogue of Greek coins. (2) Comprehensive publications of the objects found in great excavations with full and scientific commentaries such as the German pubhcations of the excavations at Olympia, Thera and Aegina; the French publications dealing with Delphi and Delos which are still in progress; and the Greek publications dealing with Epidaurus and the Acropolis at Athens. (3) Monographs on particular topics which range from handbooks of the usual type for students, such as the histories of Greek sculpture by E. Gardner, Overbeck, Collignon, and Picard, to scientific monographs of the first class which lay the foundations for the study of a particular subject. Here we can class in topography Woodhouse's *Aetolza;* in epigraphy Cavaignac's treatise on the *Trésor d'Athènes;* in numismatics Svoronos' *Nomtsmata ton Ptolemaion;* in architecture Penrose's *Principles of Athenian Architecture,* and the American monograph on the Erechtheum; in Ceramics Beazley's books on Attic black and red-figured vases; in sculpture Joubin's *Sculpture Archazque,* or Furtwangler's *Masterpzeces* and in painting Pfuhl's *Meisterwerke Griechischer Zeichnung und Malerei,* and the great portfolios of plates of sculpture and of portraits published by Bruckmann of Munich. *See* also A Michaelis, *Anczent Marbles in Great Britain* (1882), and *A Century of Archaeologzcal Discoveries* (1908); J. P. Droop, *Archaeological Excavation* (1915). (A. J. B. W.)

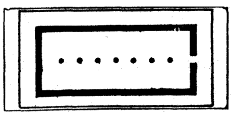
GREEK ARCHITECTURE, in this article, refers to the architecture of Greece from approximately 1100 B.C to A D. 300. The historic periods, conventionally known as Greek, during and after the dark ages of invasions, displaced populations and colonization, through the Graeco-Roman period, will be covered here. The earliest prehistoric phase of Greek civilization in the later part of the Aegean period continued the earlier non-Greek phase and therefore will not be discussed *(see* PREHELLENIC ARCHITECTURE). Furthermore, only the historical evolution of Greek architecture as a whole will be traced, leaving the analysis of the orders for discussion elsewhere (see ORDER)

To the Greeks fell the role of inventing the grammar of conventional forms on which all subsequent European architecture was based. The materials at their disposal, wood and stone as well as mud, induced them to adopt a post-and-lintel system, as in Egypt (see EGYPTIAN ARCHITECTURE), instead of massive walls and vaults, as in Mesopotamia. However, for molding their supports they chose conventional rather than naturalistic forms, therein resembling their Aegean predecessors; particularly Greek mas the patient genius with which they perfected every element, rarely deviating from the forward path to invent new forms or new solutions of old problems. This conservative adherence to older types led to such masterpieces as the Parthenon (*q.v.*) and Erechtheum (*q.v.*).

This article is divided into the following sections:

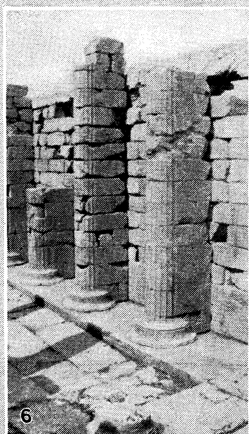
1. Primitive Period (1100–600 B.C.)
2. Archaic Period (600–500 B.C.)
3. Transitional Period (500–450 B.C.)
4. The Culmination at Athens (450–400 B.C.)
5. Fourth Century (400–300 B.C.)
6. Hellenistic Period (300–100 B.C.)
7. Graeco-Roman Period (100 B.C.–A.D. 300)

1. Primitive Period (1100–600 B.C.).—While Greek domestic architecture began with the Dorian invasion, monumental religious architecture first appeared in the 9th century. Mere open areas with altars (Aegina, Sparta, Ephesus) no longer sufficed when gods were represented in large images, requiring special temples. The houses of men furnished the patterns: from the circular nomadic hut developed the horseshoe or apsidal plan (Eretria, Gonnoi), the oblong plan with curved walls (Thermon) and eventually the normal straight-sided oblong, the axis running east and west. and the entrance always at one end. A porch



FROM DINSMOOR, "THE ARCHITECTURE OF ANCIENT GREECE" (BATSFORD)

FIG. 1.—TEMPLE AT NEANDRIA



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EXAMPLES OF DORIC TEMPLES

1. Temples at Paestum; at the right the so-called Basilica, really an archaic temple (c. 540 B.C.). At the left the so-called Temple of Poseidon (c. 460 B.C.), showing heavy transitional proportions relieved by numerous flutes; one of the best preserved of Greek temples (for interior see fig. 5)
2. Temple of Apollo at Corinth (c. 540 B.C.), showing the seven standing columns, with sturdy archaic proportions, monolithic shafts, and high architrave (frieze and cornice missing). View from interior, with Acrocorinth in background
3. Temple of Zeus at Olympia (c. 465–457 B.C.); Libon of Elis, architect. East front (restored), showing heavy proportions as at Paestum because of its transitional date and colossal scale, the effect being relieved by pediment sculpture (the shields are Roman additions). Overthrown by earthquakes, little now existing above the platform level
4. The Parthenon on the Acropolis at Athens (447–432 B.C.); Ictinus and Callicrates, architects. The masterpiece of the Doric style, with the lighter proportions of the culminating period. This west front is nearly intact apart from the loss of the pediment sculptures; the flank colonnades were partly demolished by bombardment in 1687 (for interior see fig. 7)
5. Interior of the Temple of Poseidon at Paestum (see fig. 1), showing the usual Doric treatment with superposed tiers of heavy Doric columns to support the ceiling
6. Interior of the Temple of Apollo at Bassae (c. 450–420 B.C.); Ictinus, architect. This shows the later scheme of employing single tiers of slender Ionic columns to support the ceiling, even though the temple is Doric externally
7. Interior of the Parthenon (see fig. 4) from the west, with the internal colonnades (in two tiers as at Paestum) and walls and parts of the flank colonnades blown out by the explosion. The dark patch of pavement in the distance is the site of the gold-and-ivory statue

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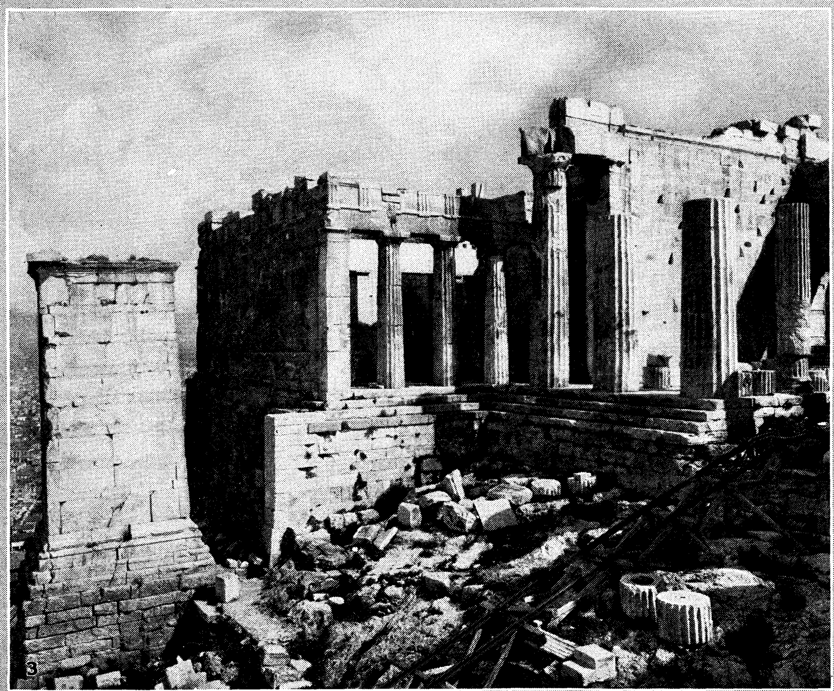
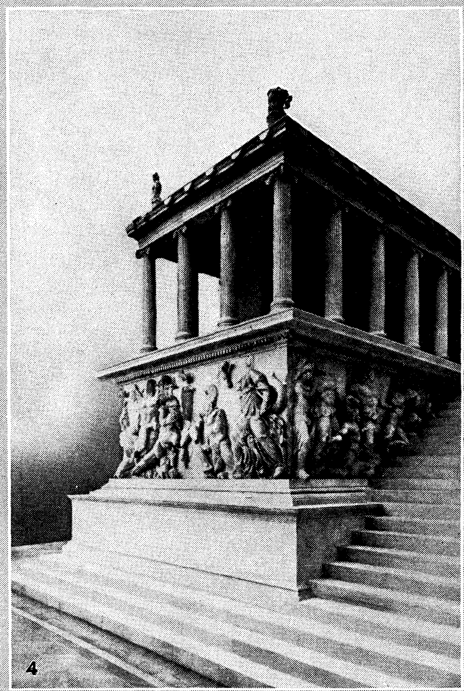
IONIC AND CORINTHIAN TEMPLES

1. The Erechtheum on the Acropolis at Athens (*c.* 421–405 B.C.); Mnesicles probably the original architect. View from the southwest, showing the irregular plan resulting from the limitations imposed on the architect by religion. There are three different Ionic orders (the east porch of six columns, one visible at extreme right; the north tetrastyle porch at extreme left, compare fig. 4; the sham portico of four engaged columns at the west) and at the south is the Caryatid porch. Rebuilt by the Greek authorities, 1903–1908. 2. Temple of Athena Niké (Niké Apteros) at Athens (*c.* 426 B.C.) as seen from the northeast; Callicrates, architect. An Ionic temple of miniature size, designed with special regard for its situation on a bastion of the Acropolis. 3. Temple of Apollo at Didyma near Miletus (332 B.C.–A.D. 41), Paeonius and Daphnis, architeots. Detail of colossal east façade, showing special stairway in the centre, adapted to human requirements, and varied column bases. 4. North porch of the Erechtheum (see fig. 1), the open proportions and elaborate decoration contrasting with the solidity and simplicity of the neighbouring Parthenon. 5. The Olympieum at Athens (174 B.C.–A.D. 131); Cossutius, architect. The only colossal Corinthian temple of the Greek period, with heavily proportioned columns; the frieze and cornice exist only in fragments. In the background appears the Acropolis





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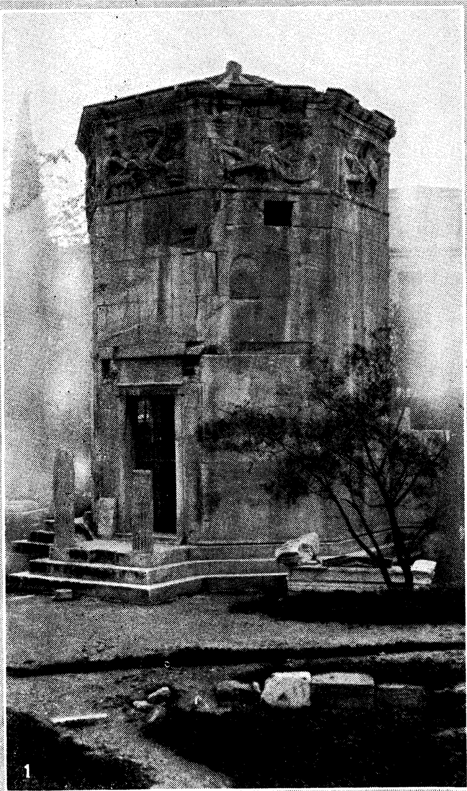
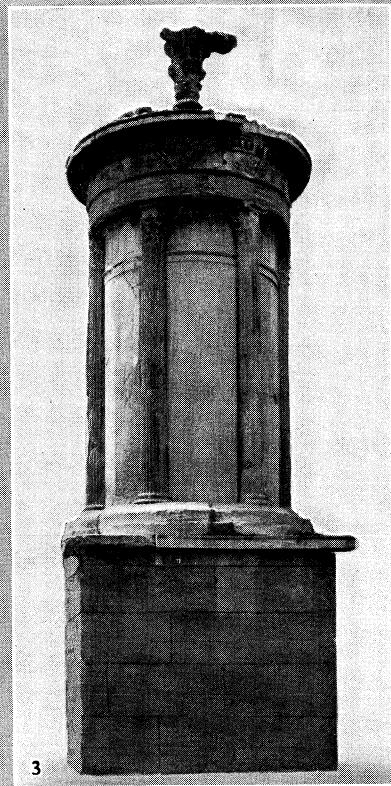
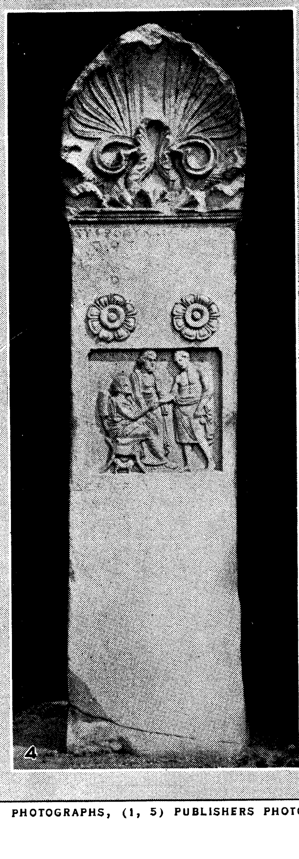
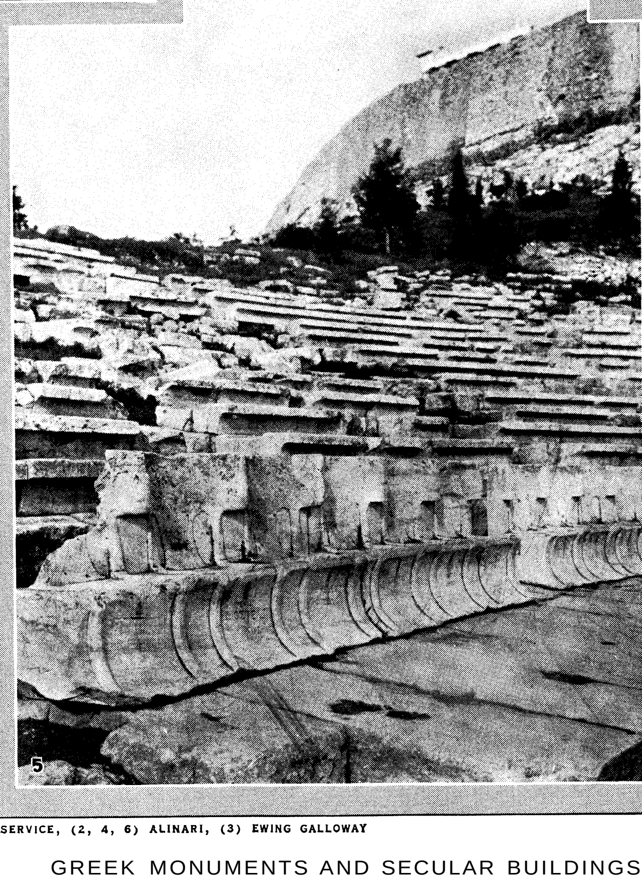
GREEK RELIGIOUS PRECINCTS

1. Athenian Treasury at Delphi (*c.* 515 B.C.), in the form of a small Doric temple, executed wholly in marble, originally with elaborate sculptured decoration (of which only casts of the metopes are in place). Rebuilt by the French authorities 1903–06, by fitting together the scattered fragments
2. The Propylaea of the Acropolis at Athens (437–432 B.C.); Mnesicles, architect. Inner or east front, showing the form of the Doric central porticoes, and the middle intercolumniation widened for processions. The parts above the columns were overthrown by an explosion about 1645, and rebuilt by the Greek authorities 1909–17. At the right appears the unfinished wall of the proposed northeast hall
3. The Propylaea at Athens (cf. fig. 2), showing outer or west front (injured by bombardment in 1687) and steeply sloping approach, with enframing wings at north and south (the latter not shown) terminating in pedestals which were to have enframed gateways to lower precincts. Upon the frustration of the latter portion of the scheme, the Temple of Athena Niké was built on the south (426 B.C.. see Plate II., fig. 2). and the great pedestal of Agrippa on the north (174 B.C.), at extreme left
4. The Great Altar of Zeus at Pergamum, built for Eumenes II. (197–159 B.C.). Detail of the reconstruotion in Berlin, showing podium decorated with colossal frieze, interrupted by stairs which ascend to a colonnaded court enclosing the altar. Only the foundations remain on the actual site









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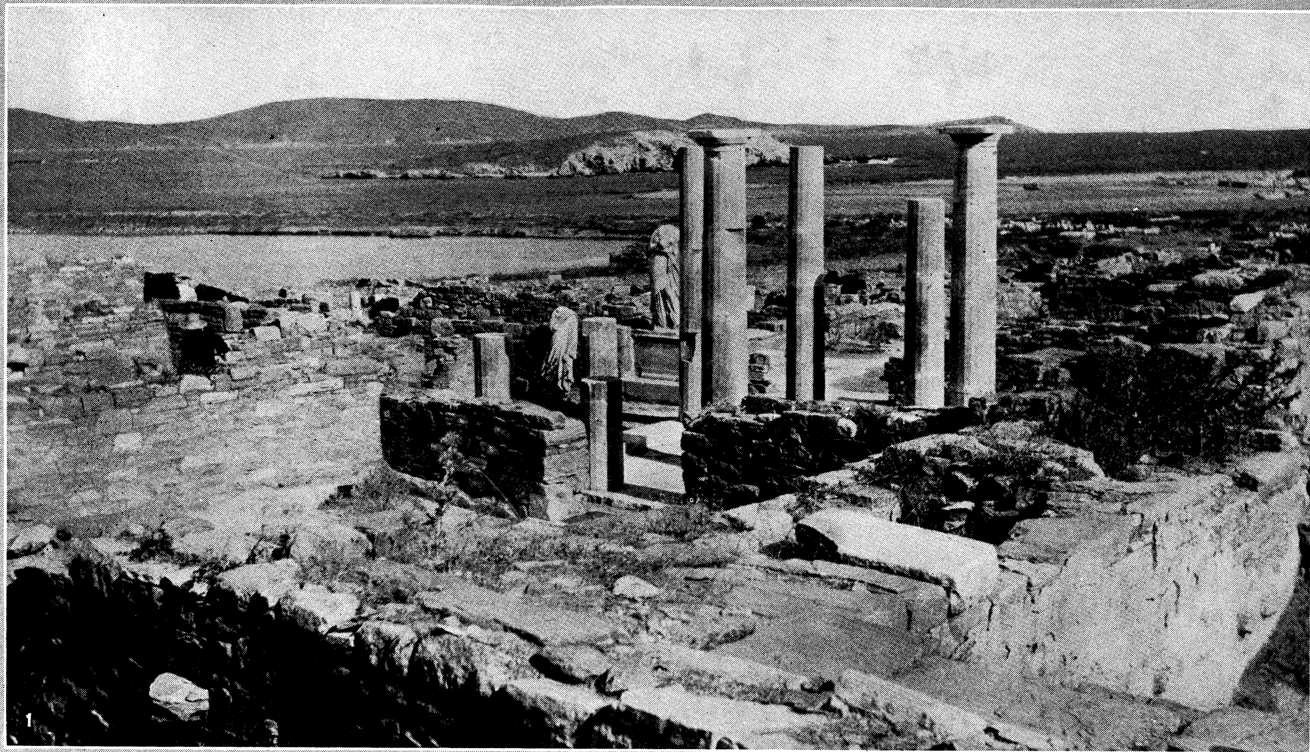
GREEK MONUMENTS AND SECULAR BUILDINGS

1. Tower of the Winds at Athens (*c.* **100** B.C.), designed by the astronomer Andronicus Cyrrhestes; view showing one of the two porches, each of which was composed of two Corinthian columns. Sundials on each of the eight sides, an allegorical frieze of the eight winds at the top, a conical roof surmounted by an octagonal capital and a bronze Triton as weather-vane, completed the design. 2. Grave stele of Hegeso (soon after 400 B.C.), tombstone of wide pedimental type from the Ceramicus cemetery at Athens; slightly projecting lateral antae enclosing scene of parting in relief. 3. Choragic Monument of Lysicrates at Athens (334 B.C.), showing the earliest external use of Corinthian columns, the six intervals filled with thin walls, and the conical roof and trefoil finial originally supporting a bronze tripod. 4. Grave stele of Bion (4th century B.C.), tombstone of narrow type from the Ceramicus cemetery at Athens, with palmette acroterion embellished with acanthus leaves, and two rosettes above the relief. 5. Theatre of Dionysus at Athens (c. 350-325 B.C.), on the south slope of the Acropolis, showing the marble thrones forming the lowest tier, and the ordinary limestone seats rising behind (cf. Plate V., fig. 2). 6. Grave stele of a maiden (4th century B.C.), tombstone of narrow type from the Ceramicus cemetery at Athens, with funeral vase (loutrophoros) in relief and mourning Siren as acroterion

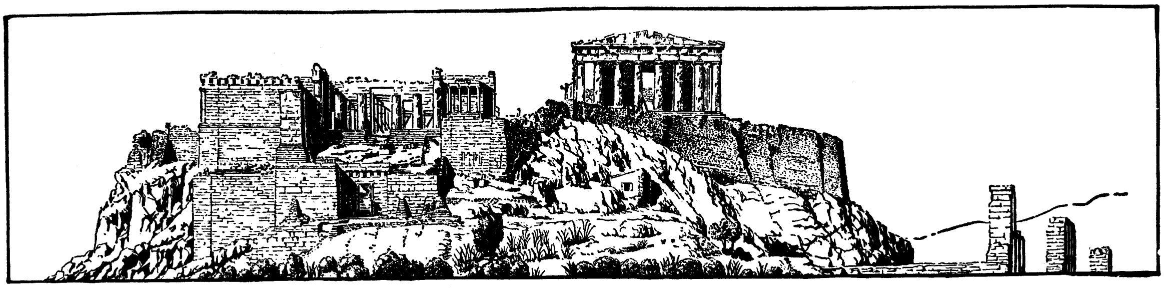


PHOTOGRAPHS, (1) PROF. C. H. YOUNG, (2) EWING GALLOWAY

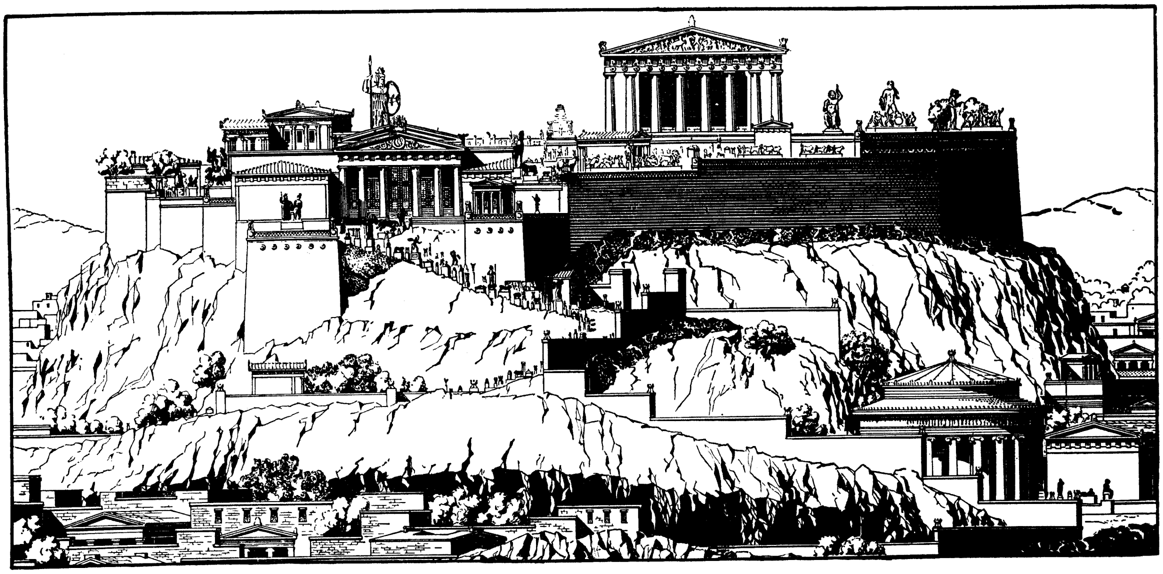
GREEK SECULAR BUILDINGS

1. "House of Cleopatra" at Delos (138 B.C.), a private house with **peristyle** court, the slender marble columns supporting a wooden **entablature,** and surrounding an **impluvium** with a mosaic floor and a cistern beneath
2. Theatre at Epidaurus (*c.* 325 B.C.); **Polycleitus** the Younger, architect.

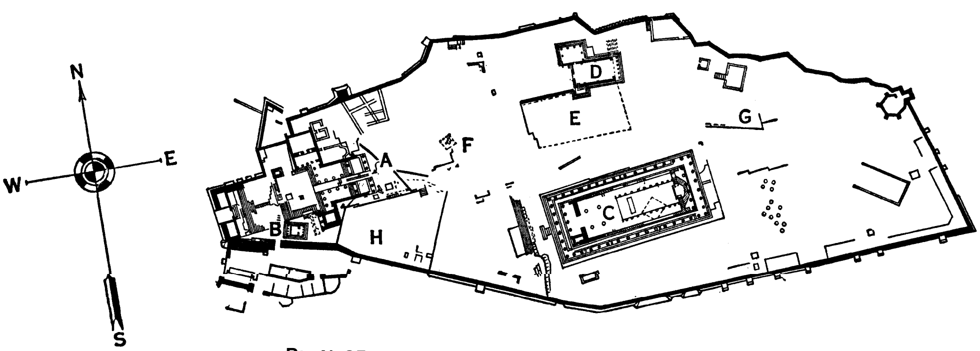
View showing the circular orchestra 66% **ft.** in diameter, with the foundation for the central altar, the surrounding auditorium occupying three-fifths **of** the circumference, the left entrance **(parodos)** gateway. The scene building, of which only the foundations remain, is of later **construction**



THE ACROPOLIS AT ATHENS: WEST FACE, PRESENT STATE



THE ACROPOLIS AT ATHENS, RESTORED

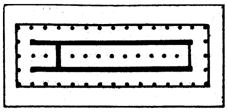


A : PROPYLAEA
B : TEMPLE OF NIKE APTEROS
C : PARTHENON
D : ERECHTHEUM
E : FOUNDATIONS OF THE TEMPLE OF ATHENA PRIOR TO THE PERSIAN WARS
F : BASE OF THE COLOSSAL STATUE OF ATHENA PROMACHOS
G : ALTAR OF ATHENA
H : PRECINCT OF THE BRAURONIAN ARTEMIS

PLAN OF THE ACROPOLIS AT ATHENS

AFTER D'ESPOUY, "MONUMENTS ANTIQUES"

The name given to the citadel in cities of Greece and Asia Minor was Acropolis. It was generally built upon a hill or rock, was fortified and commanded the city and surrounding territory. The Acropolis contained important buildings; in Athens the weights connected with the coinage were kept in the Acropolis (pronaos) might be added in front, a sanctuary (adytum) at the rear, repeating the Mycenaean megaron plan. Walls were of mud-brick resting on stone socles, their free ends (antae and door jambs) encased in wooden sheathing. Simultaneously the roof developed from the nomadic thatched beehive, through the long ogival mud-brick vault (thatched in a model from Perachora), to the sloping hipped roof with wooden rafters, supported by girders resting on the side walls, and so, eventually, to gables at one or both of the narrow ends.



FROM DINSMOOR THE ARCHITECTURE OF ANCIENT GREECE (BATSFORD)

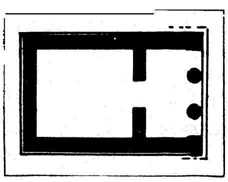
FIG 2 —TEMPLE AT THERMON

In wider temples these cross girders had to be reinforced by columns placed in single file along the main axis (Selinus. Prinias, Locri, Sparta, Neandria. Samos). Thus came into Greek architecture the characteristic post-and-lintel system. At first mere wooden posts, these internal supports were gradually molded on opposite sides of the Aegean sea, into two different types. proto-Doric and proto-Ionic. The former, with its circular molded capital and square abacus, was copied in wood from such surviving Aegean works as the Lion gate at Mycenae. The proto-Ionic type, originated as an elongated capital, early transformed into stone; slender unfluted shafts (sometimes with special bases) were capped by gariands of drooping leaves from which sprang vertical volutes (Lesbos, Neandria, Larisa).

In an open pronaos, a central column repeated the axial colonnade (Locri, Prinias); next, because central columns obscured the cult image, the axis was opened by using two internal colonnades and so two columns *in-antis* on the front. Thus the column first appeared on the exterior and introduced a new problem, the creation of an entablature. The transverse girder formed the architrave, a single solid beam in the Doric, compounded of superposed planks (fascias) in the Ionic; upon this rested the ends of ceiling beams, heavy and widely spaced (triglyphs) in the Doric, light and closely spaced (dentils) in the Ionic. Mutular eaves formed by overhanging rafters characterized the Doric cornice; the Ionic was merely hollowed to shed rain water. The light wooden Ionic entablature is best known through imitations in native rock-cut tombs of Asia Minor; the Doric forms are revealed through the survival of terra cottas which protected the bulky timbers, black or blue triglyphs, gaily painted terra-cotta metopes and facings with conventional patterns on the cornice. The hipped roof was still retained in the earlier temple of Hera on the Silaris (near Paestum). The ridge of the hipped roof was soon prolonged to the front. forming a gable (pediment). the rear end sometimes remaining hipped (Thermon, model at Sparta). The gutter (sima) which had hitherto crowned the cornice on all four sides was retained even under the pediment in the western colonies (Syracuse. Geloan treasury at Olympia); but the mutules, equally anachronistic symbols of rafters under a pediment, remained even on the facade. Semicircular terra-cotta tiles covered the joints between the concave pantiles, terminating at the eaves in semicircular antefixes.

The emergence of the column and the development of the orders inspired Dorian architects to further embellishments. The pronaos might be repeated in a rear porch jopisthodomus), or the whole temple surrounded by a peristyle. From the five lines of the flank walls and the axial and flank colonnades resulted pentastyle facades (Thermon), two internal colonnades required hexastyle facades (Heraeum at Olympia); the flanks were long in proportion, with 15 or 16 columns.

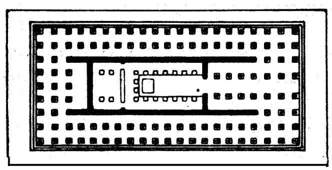
2. Archaic Period (600-500 B.C.).— The new-rich western colonies transformed the peripteral temple into limestone; the Ionian east soon followed with the greater splendour of marble. But the motherland of Greece remained conservative; during eight centuries the wooden columns of the Olympian Heraeum were gradually replaced in stone; as late as 513 B.C. marble was limited to one ostentatious temple façade (Delphi). Limestone, however, was coated with fine marble stucco; sandstone was often used in the west for carved members; terra-cotta cornice revetments were gradually eliminated and the terra-cotta gutters and even roof tiles replaced in more important temples by stone or marble.



FROM DINSMOOR, "THE ARCHITECTURE OF ANCIENT GREECE" (BATSFORD)

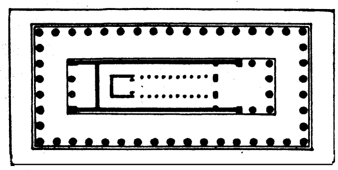
FIG. 3.— TEMPLE AT RHAMNUS

A few primitive types of plans survived, either apsidal (Delphi, Athens, Corinth, Olympia) or with axial colonnades (Olympia, Delos, Paestum, Metapontum). The simple diastyle *in-antis* plan long prevailed in Greece; the "hundred-foot" temple on the Athenian Acropolis was apparently tristyle *in antis* at both ends. But the most favoured temple plan was the hexastyle peripteral, sometimes (in Sicily) with the façade doubled for greater magnificence. The opisthodomus (rear porch) was customary in Greece, the closed adytum (secret chamber) in the west; the interior of the cella might have two rows of columns (in Greece) or none at all (in Sicily). The east outdid the west by doubling the colonnade on all sides, giving the octastyle dipteral plan (Ephesus, Samos, Magnesia), imitated also at Athens (Olympieum); at Corcyra and Selinus ("GT") the inner lines of columns were omitted, becoming pseudodipteral; at Acragas (Olympieum), while retaining the same vast total dimensions as at Selinus. the number of columns was reduced and the scale thereby so enlarged that the intervals were filled with walls, becoming pseudoperipteral. Employment of colossal dimensions, with stylobates measuring up to 180 by 365 ft., column diameters up to 13¼ ft. (Acragas), column spacings up to 28¾ ft. (Ephesus), afforded the tyrants of this period opportunities for lavish display. The entrance was usually toward the east (orientation), but in Asia Minor sometimes toward the west, as at Ephesus.



FROM DINSMOOR, "THE ARCHITECTURE OF ANCIENT GREECE" (BATSFORD)

FIG. 4.— TEMPLE AT EPHESUS (RESTORED)



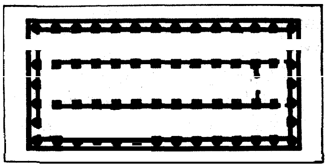
FROM DINSMOOR 'THE ARCHITECTURE OF ANCIENT GREECE' (BATSFORD)

FIG. 5.— TEMPLE "GT" AT SELINUS

The geographical cleavage between the styles continued. The western temples at Syracuse, Selinus, Acragas. Paestum. Pompeii, Tarentum. Metapontum and Corcyra, and those in Greece at Athens, Delphi, Eretria and Corinth, all were Doric. In the east, Naucratis, Ephesus, Samos. Naxos, Paros, Chios. Miletus and Magnesia furnish important landmarks of the archaic Ionic development. The Doric temple invaded the east. at Assos, suffering the intrusion of the Ionic frieze; reciprocally the Ionic temple penetrated the west, at Locri and Hipponium.

In the Doric order the sudden change of material, and timidity as to the strength of stone, caused violent changes. Not only were column shafts often constructed as monoliths, but proportions were at first extremely heavy, with intervals so close that the spreading capitals were nearly contiguous. With growing confidence, larger columns were eventually raised to 5 or even 5⅝ diameters, with intervals up to 1⅔ diameters. Spacings and diameters were often enlarged on the façades in Greece; uniform diameters but different spacings characterize most of the western peristyles. Triglyphs at first appeared only above columns, leaving horizontal oblong metopes between; interpolated triglyphs next reduced the metopes to vertical oblongs, which gradually approached squareness. the half mutules above the narrow metopes then becoming of full width. Relief sculpture succeeded painting in the metopes and pediments, changing in the latter to free statues; human and animal forms replaced the semicircular acroteria. and the antefixes changed from semicircles to prismatic forms, surmounted by palmettes.

The Ionic column, carrying a lighter entablature and longer habituated to stone, was more slender from the very beginning (about 8 diameters), with greater intervals (1½ to 2⅓ diameters); particularly noteworthy were the enormous intervals at the centres of the façades. Though the entablature was friezeless, broad bands of relief sculpture were inserted wherever possible, as on the sima at Ephesus. But in Greece a new type of Ionic entablature was created to vie with Doric proportions; the fascias of the architrave were suppressed, the dentils omitted and a high frieze inserted between architrave and cornice (Ionic treasuries at Delphi).

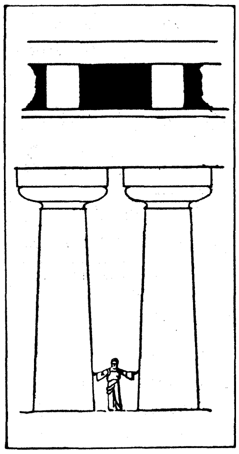


FROM DINSMOOR THE ARCHITECTURE OF ANCIENT GREECE (BATSFORD)

FIG. 6.—OLYMPIEUM AT ACRAGAS

Both orders were awkward at the corners of peristyles. In the Doric, the difficulty lay in reconciling triglyph and column spacings. while bringing a triglyph out to the corner of the entablature; in the west it was met by widening the angle triglyph and the adjacent metope, in Greece by contracting the end columnar interval; finally, metope expansion was combined with column contraction. In the Ionic, the bracket capital seemed incapable of turning the corner, until at Ephesus was devised an awkward L-shaped capital with an angle volute.

Other forms displaying the versatility of the archaic designers were the hybrid Doric-Ionic capitals of Amyclae, the bell capitals of Delphi and the use of human figures as supports, both male (atlantes of Acragas) and female (caryatids of Delphi). Other types of buildings yielded new opportunities — simple templelike treasuries (Olympia, Delphi), the square hypostyle hall (telesterion) at Eleusis, the archaic circular tholos at Delphi, the apsidal senate house at Olympia, altars as at Miletus and Delphi, the throne at Xmyclae and elaborate fountains built by the tyrants (Athens, Megara, Corinth, Samos). And in some of these minor works as in votive columns and grave monuments, migratory architects mingled the styles.

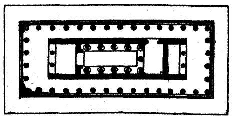


FROM DINSMOOR THE ARCHITECTURE OF ANCIENT GREECE (BATSFORD)

FIG 7 —EARLY ARCHAIC DORIC PROPORTIONS

3. Transitional Period (500–450 B.C.).—The grammar of forms and the types of buildings having been largely determined, the next step was that of refinement. The problem was all the more concentrated because the political subjection of the east to Persia now restricted architectural initiative to the Doric style of Greece and the west, which, furthermore. received fresh impetus from the victories over Persia and Carthage. And in particular at Athens the discovery of copious marble quarries contributed to the refinement of design.

Freedom was now abandoned in favour of strict canonization, resulting almost in monotony. Hexastyle peripteral Doric temples became universal: in Greece at Sunium, Athens (the unfinished older Parthenon), Aegina and Olympia; in the west at Syracuse, Himera, Gela. Caulonia, Acragas, Croton and Paestum. Work was continued on the never-finished colossi at Selinus and Acragas, with distinct changes of details. In the west, columns tended to be of uniform diameter and (except at Himera and Paestum) uniformly spaced on front and flank, apart from the contracted end intervals; and here appeared an innovation, double contraction at the corners. But in Greece some emphasis of the front, either with heavier columns or with wider spacing, was still prevalent; or the corner columns alone might be enlarged. The west adopted the opisthodomus of Greece, sometimes in addition to the adytum; but cella colonnades appeared in the west only at Paestum, apart from the huge octastyle at Selinus. Such internal colonnades were two (at Selinus three) stories in height, separated by architraves and carrying only ceiling and roof; the few known galleries (Aegina, Olympia) were later insertions; and stone staircases (Selinus, Himera, Paestum) ascended merely to storerooms above the ceilings.



FROM BORRMANN, GESCHICHTE DER BAUKUNST (ALFRED KRONER VERLAG)

FIG. 8.—TEMPLE AT BASSAE

In this period the Ionic temple first appeared in Greece (Sunium), with the peristyle strangely confined to one front and one flank, and with the typical mainland form of entablature nithout fascias or dentils. A larger but unfinished Ionic temple was begun at Delos.

Among other types of buildings, additional treasuries at Olympia, the reconstructed oblong telesterion at Eleusis and the similar Cnidian lesche (clubhouse) at Delphi, the old Propylon of the Athenian Acropolis. the colonnade of the Athenians at Delphi. the royal and painted stoas and the tholos at Athens, the Athenian theatre orchestra with wooden scene buildings and the imitation of the oriental gridiron city plan at Miletus, all paved the way for the masterpieces of the following period.

4. The Culmination at Athens (450–400 B.C.).—The middle period of the evolution centred at Athens, which signed peace with Persia in 449 B.C., and in the absence of military requirements nas free to use the wealth of the Athenian confederacy in rebuilding the temples ruined by the Persians. Under the personal initiative of Pericles, and in the hands of architects like Ictinus, Callicrates and Mnesicles, and the sculptors Phidias and Callimachus, Greek architecture reached its zenith.

The Doric style of Greece naturally retained the leading place, and was employed not only in hexastyle temples at Bassae, Rhamnus, Sunium and Athens (Hephaesteum and temple of Ares). but also in the octastyle Parthenon on the Acropolis; besides these erected by Athenian architects, we find hexastyles near Argos (Heraeum), at Acragas (temple of Concord), Segesta and Delos (the last prostyle). Most of those structures were comparatively small, owing their effect to perfection of design and execution, and, in the case of those in Attica, to the beauty of marble, and more slender proportions. Only Bassae retained the older system with heavier columns on the main façade and reduced spacing on both flanks; elsewhere uniformity prevailed. except at the corners. Cella colonnades were omitted except in the works of Ictinus, also in the Hephaesteum and at the Argive Heraeum; Ictinus obtained a new effect by returning the colonnade across the back, at Bassae separating adytum from cella (the lateral columns being engaged to the flank walls), in the Parthenon forming an ambulatory around the statue. The false gallery with two stories of Doric columns appeared for the last times in the Parthenon, Hephaesteum, and Argive Heraeum; a single Ionic order was preferred at Bassae (with three Corinthian capitals across the rear) and in the rear chamber of the Parthenon. The coalescence of the styles was marked by the inclusion of other Ionic elements, moldings and continuous friezes (Parthenon, Hephaesteum, Sunium). Sculptured reliefs in friezes and metopes. pediments filled with statues and crowned by great floral acroteria, these and the fine moldings and the marble ceilings enhanced by colour and gilding, broad masses of colour on triglyphs and in shadowed cornice soffits, further relieved the simplicity of Doric forms.

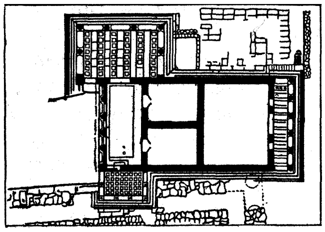
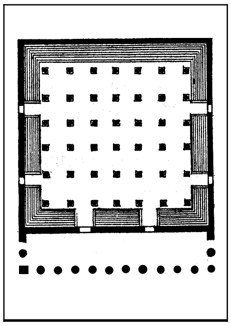


FIG 9 —ERECHTHEUM, DRAWN BY GORHAM P. STEVENS

The Ionic style was also employed independently in three nonperipteral temples at Athens (on the Ilissus river, the Nike temple and Erechtheum on the Acropolis); its foothold in Greece was now assured. The amphiprostyle tetrastyle plan was preferred, though in the Erechtheum (*q.v.*) the rising ground at the east so elevated the stylobate that in the final plan six columns were required in the width; and the tetrastyle portico originally planned for the west end was revolved to the north flank to respect the sacred olive tree, balanced by the miniature caryatid portico on the south, and replaced on the west by a sham portico of engaged columns, producing an irregular T-shaped plan. Rampant antefixes above the sima of the Erechtheum, and its elaborately carved moldings, exceptional in the 5th century, foreshadowed the elaboration of the following period.

Another symptom of change was the creation of a third style, the Corinthian, first appearing inside the temple at Bassae. Like the Ionic capitals in the same colonnade, the Corinthian capitals represent an attempt to invent a form symmetrical on all sides,



FROM BORRMANN, "GESCHICHTE DER BAUKUNST" (ALFRED KRONER VERLAG)

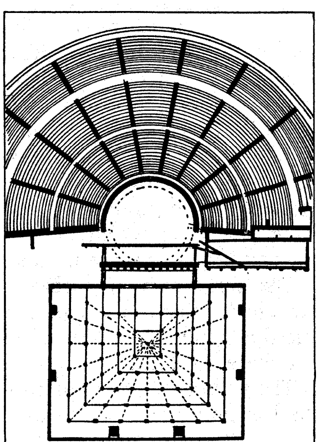
FIG. 10.—TELESTERION AT ELEUSIS

the bell capitals of Delphi being further elaborated with acanthus leaves, scrolls and palmettes.

Among buildings other than temples, the Propylaea (*q.v.*) at Athens take first rank in brilliance of conception. A cruciform plan 224 ft. in length (about equal to the Parthenon) would have formed a frontispiece across the west end of the Acropolis, with wings projecting westward to enframe the ascent; by war and priestly conservatism the design was curtailed until it resembled a lopsided T, only 154 ft. in length. The central building, with its Doric hexastyles and pediments dominating the low hipped roofed north and south arms and west wings (without columns except on the return faces of the wings), formed the entrance, the central intercolumniation widened 6 ft. to allow the passage of festal processions, and the five doorways graded in width like the intercolumniations, with heights varying in proportion. The west ceiling was supported by six Ionic columns in immediate juxtaposition with the Doric. Hardly less notable were the redesigned telesterion at Eleusis, a great square at first with seven rows each of seven columns within, then with four rows of five (these two projects never completed), and finally with six rows each of seven, and the odeum at Athens with internal columns arranged in nine rows of nine; both had clerestory lanterns above the roofs. Corresponding advances in city planning were the importation of the gridiron system to Greece (Peiraeeus) and the west (Thurii).

In these buildings, beauty of proportion was enhanced by "optical refinements," almost a speciality of the culmination. The curve of the platform, rising $\frac{3}{4}$ to 44 in. in a circular arc with a radius as great as $3\frac{1}{2}$ miles, gave vitality and corrected any sagging illusion in the colonnade. The entasis or swelling outline of the column shaft, preventing any sensation of concavity, attained its maximum ($\frac{1}{4}$ to $\frac{3}{4}$ in.) at half of the height, though in earlier and later periods it was much more pronounced. The inward inclination of the column axes (from $\frac{3}{8}$ to 34 in.) gave a pyramidal illusion of greater stability, the axes of the flank colonnades of the Parthenon meeting more than a mile above the pavement; walls, antae and other supposedly vertical surfaces might show similar inclinations. And the manner in which the various members were adjusted to each other, preserving these delicate relations and yet keeping the joints invisible, represents a triumph of calculation and stonecutting.

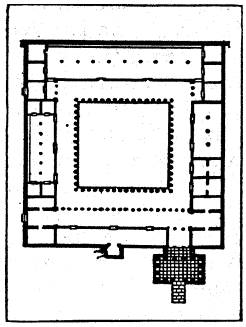
5. Fourth Century (400–300 **B.C.**).—The displacement of the political centre from Athens successively to Sparta, Thebes, Macedonia and Asia Minor was accompanied by unmistakable evidence of a decline from aesthetic perfection. The service of the gods began to be subordinated to that of men, and from the temple attention was diverted to a great variety of structures corresponding to the varied requirements of a more complex civilization. Even in religious architecture the striving for diversity and innovation is manifest in the increase of excessive ornament.



FROM BORRMANN, "GESCHICHTE DER BAUKUNST" (ALFRED KRONER VERLAG)

FIG. 11.—THEATRE AND THERSILION AT MEGALOPOLIS

In Greece the Doric style was still preferred for temples, but, incapable of further perfection, was now modified. Hexastyle plans (Delphi, Epidaurus, Tegea, Nemea, Stratos, Ptoon and Olympia) were often shortened by omitting the opisthodomus; temples at Delphi and Epidaurus were hexastyle prostyle. Columns were more slender ($5\frac{7}{8}$ to 64 diameters) and entablatures correspondingly lower (one-quarter of the column height), the reduction occurring in architrave and cornice while the frieze remained high to preserve the squareness of metopes. The enrichment of the sima by carved rinceaux and rampant antefixes was counterbalanced by the loss of such delicacies as the hyperbolic echinus profile. Following the example of Bassae, Corinthian internal columns were employed at Tegea, Stratos and Nemea, Ionic at Epidaurus; an inner row of Ionic columns lined a Doric facade at Delphi.



FROM BORRMANN, "GESCHICHTE DER BAUKUNST" (ALFRED KRONER

FIG. 12.—GYMNASIUM AT EPIDAURUS

More important was the Ionic Renaissance in Asia Minor. Not only hexastyle plans as at Priene, but colossal octastyles again became the fashion, at Ephesus repeating the archaic plan, at Sardis omitting the inner flank colonnades and becoming semi-pseudodipteral. Even the decastyle plan with 120 external columns appeared at Didyma near Miletus, with the cella unroofed (hypaethral). Column proportions continued to be slender, though because of the enormous dimensions the intervals were contracted; some facades (Sardis, Ephesus) show, however, enormous central spacings. Such abnormal embellishments as sculptured pedestals, bases, drums and capitals were confined to the larger temples. The entablature always lacks the frieze (except at Didyma where the work was protracted into Roman times). Only in Greece (tholos at Olympia) or in nonreligious and hence less conservative Asiatic structures, executed with collaborators from Greece (mausoleum at Halicarnassus), did the frieze penetrate the entablature, now always in combination with dentils.

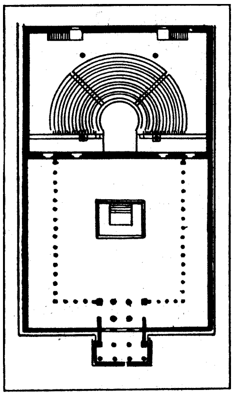
Important buildings other than temples were erected in both styles. In the Doric, treasuries at Delphi, choragic monuments at Athens, tholoi at Delphi and' Epidaurus, the huge dodecastyle facade of the telesterion at Eleusis and the analogous assembly hall (Thersilion) at Megalopolis, porticoes up to 550 ft. in length as at Corinth, the arsenal of 430 ft. at the Piraeus, the Lion tomb at Cnidus (another Doric intrusion in the east), all testify to the vitality of the style. The tholos was reproduced in the Ionic style at Olympia; monumental Ionic tombs in Asia Minor, the Nereid monument at Xanthus (a temple raised on a lofty pedestal) and the mausoleum at Halicarnassus (with a pyramid in turn elevated above a peristyle of 36 columns, attaining a height of 136 ft.), have remained unsurpassed in their field.

The Corinthian capital was developed as a secondary feature inside temples at Tegea, Nemea, Stratos and Didyma, inside tholoi at Delphi, Epidaurus and Olympia; but not until 334 B.C. was the style used independently and externally in a choragic monument at Athens, with an entablature devised by combining Attic frieze with Asiatic dentils.

A few noncolumnar designs require special mention. The Attic tomb stele with its ever-deepening frame of miniature antae and entablature, or with an elaborate floral acroterion, became extinct as the century ended. But the theatre, now provided with a stone auditorium encircling more than half of the orchestra (Athens, Epidaurus, Eretria), its one-storied scene building (also in stone) containing several great openings and flanked by projecting pavilions (parascenia) and sometimes faced by removable wooden proscenium porticoes, was yet in its infancy. The stadium, either round-ended or rectangular, repeated the theatre form. The market place (agora) became, if not strictly rectangular, at least more formal; and the newly founded or rebuilt cities of the period followed the gridiron plan (Priene and Cnidus).

6. Hellenistic Period (300–100 **B.C.**).—The even balance between east and west which had characterized the preceding century was overthrown by the transference of the political centres to the oriental kingdoms of Alexander's successors, resulting in the domination of the oriental elements in Greek architecture. The Doric style, now on the downward path, appeared chiefly in small temples, either ***in antis*** (Selinus, Acragas, Taormina) or prostyle (Pergamum, Lycosura, Samothrace, Gortyna, Oropos); belated peripteral hexastyles occurred at Troy, Pergamum, Cos, Delos and Lebadea — the last symbolic, the abandoned scheme of an eastern monarch. (174 B.C.). A proposal to erect a Doric temple of Dionysus was actually countermanded in favour of the Ionic style; architects frankly wrote that "sacred buildings ought not to be constructed of the Doric order" because of the difficulty of spacing triglyphs and columns. The few who adhered to the style sought new methods of appeal: engaged columns, lighter proportions with slender columns and thin entablatures requiring the interpolation of extra triglyphs; columns with Ionic fluting or even bases. Wall surfaces were modeled. with emphasized joints and belt courses. The cella might even have an internal apse (Lebadea, Samothrace), or projecting aisles at the sides (Lusoi).

The Ionic style, now the successor rather than rival of the Doric, is best exemplified in three beautiful pseudodipteral octastyles (Messa, Smintheum, Magnesia); less successful are smaller examples at Teos, Magnesia and Pergamum. Bases changed from the Asiatic to the Attic form, with plinths; capitals contracted in length; the rising echinus eliminated the downward droop of the cushion, and rinceaux filled the cushion and baluster. The entablature included the Attic frieze, and the dentils became small and meaningless, being used as decoration even in the raking cornice. These forms, and this moment of the Ionic supremacy, are reflected in the volume wherein Vitruvius interpreted Greek architecture to the Romans, using the Ionic as the typical order.



FROM BORRMANN "GESCHICHTE DER BAUKUNST (ALFRED KRONER VERLAG)

FIG 13 —BOULEUTERION AT MILETUS

Now, however, the Ionic supremacy began to be threatened by the Corinthian style, best exemplified at Diocaesarea and in the dipteral octastyle Olympieum at Athens (174 B.C.). Its merits were most obvious in peristyles, the capital being symmetrical on all sides and the entablature unhampered by triglyphs; but its popularity extended even to distyle porches (Messene).

Even more important than temples, however, were numerous other types of buildings. Monumental sacrificial altars rose at Syracuse (74 by 653 ft.). Pergamum (the "Seat of Satan," 112 by 120 ft.), Priene, and Magnesia. Doric porticoes surrounding the temple precincts (Ephesus, Priene. Magnesia); vast stoas built by Hellenistic kings for the cities of Asia (Pergamum, Assos, Priene) and Greece (Delos, Delphi, Athens, Megalopolis, Olympia), or, with slight modifications, used as market halls (Aegae, Alinda, Assos) and libraries (Pergamum); monumental propylaea (Samothrace, Delos, Lindos, Epidaurus, Olympia and Selinus), the tholos at Samothrace, the hypostyle hall at Delos and gymnasia (Epidaurus, Priene); all repeated earlier forms with slight variation. The long "Hall of the Bulls" at Delos surmounted at one end by a tower, the soaring lighthouse of 400 ft. at Alexandria and small senate houses with semicircular or rectangular auditoria imitated from the theatre (Miletus, Priene) were innovations. The theatre itself received a colonnaded stone proscenium before the scene building, of which the great openings were elevated to an upper story (Oropos, Epidaurus, Priene, Ephesus). Commemorative monuments were more lofty, high pedestals (Delphi, Athens) or pairs of columns supporting entablature (Delphi), forerunners of the Roman triumphal arch.. Private houses changed from the megaron type to the peristyle court (Priene, Delos), and in their likeness were designed great hotels with central courts (Epfdaurus, Olympia). The market place became a formally enclosed rectangle (Magnesia) rather than a picturesque group of colonnades and public buildings. The roads outside the city gates were lined with an ever-increasing variety of sepulchral monuments, including the mausoleum type (Acragas, Mylasa) and tumuli with vaulted chambers (Pergamum).

The conquest of the orient had brought Greece into contact with the arch and vault, now freely used in supporting great masses over openings, as in city gates, retaining walls, corridors, staircases and sepulchral chambers. Sloping or intersecting barrel vaults were not uncommon.

The post-and-lintel system was by no means supplanted, but the vaulting system of the orient was being perfected, ready for the Romans to assimilate with their Etruscan traditions. See ROMAN ARCHITECTURE.

7. Graeco-Roman Period (100 B.C.–A.D. 300).—Many of the buildings erected in Greek lands during the Roman domination were still characteristically Greek. Doric was used in propylaea at Athens and Eleusis, and in temples at Eleusis and Kourno. Greek Ionic appears in the circular temple on the Athenian Acropolis, in a propylon at Priene, and particularly in a series of octastyle pseudodipteral temples in Asia Minor (Aezani, Ancyra, Aphrodisias). A hybrid Corinthian style with mixed Doric-Ionic entablatures occurs at Eleusis and Paestum. A simple type of Corinthian capital was used in the clock tower ("Tower of the Winds") at Athens. But the developed Corinthian orders of temples at Sagalassus, Euromus, Cnidus and Pergamum are hardly to be differentiated from those of imperial Rome.

Even though the decorative orders might be those of Rome, some buildings were still distinctive in type. Side by side with true Roman theatres, with wide, low stages and semicircular orchestras (Aspendus), were erected theatres of a compromise type, with equally wide but lofty stages and three-quarter circular orchestras (Termessus); both types had lofty scene buildings incrusted with columns, sometimes connecting with colonnades at the top of the auditorium. The stadium likewise remained characteristically Greek, with further elaboration, such as semicircles at both ends and colonnades at the top.

However, the basilicas, baths, triumphal arches and other forms which flourished everywhere in Greece and Asia Minor at this epoch can with more propriety be considered as part of the purely Roman development.

See also ARCHITECTURE; BYZANTINE ARCHITECTURE; CAPITAL; GREEK ART; ORDER; and TEMPLE.

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GREEK ART. It is proposed in the present article to give a brief account of the history of Greek art and of the principles embodied in that history. The products of the various arts practised by a people constitute an objective and most important record of the spirit of that people. But all nations have not excelled in the same way: some have found their best expression in architecture, some in music, some in poetry. The Greeks most fully embodied their ideas in two ways. first in their splendid literature, both prose and verse, and secondly, in their plastic and pictorial art, in which matter they have remained to our days among the greatest instructors of mankind.

The three arts of architecture, sculpture and painting were brought by them into a focus; and by their aid the Greeks produced a visible splendour of public life such as has seldom been elsewhere attained.

The volume of the remains of Greek civilization is so vast, and the learning with which these have been discussed is so ample, that it is hopeless to attempt to find in a work like the present any complete account of either. Rather we shall be frankly eclectic, choosing for consideration such results of Greek art as are most noteworthy and most characteristic. In some cases it will be possible to give a reference to a more detailed treatment of particular monuments in these volumes under the heading of their authors or the places to ahich they belong. Architectural detail is relegated to GREEK ARCHITECTURE and allied articles. Coins and gems *(see* GEM: *Gems in Art)* are treated apart, as are vases (POTTERY AND PORCELAIN); in the article GREEK ARCHAEOLOGY will be found many references bearing on the rediscovery of Greek art and on the discovery of individual monuments and sites; *see* also the bibliography which closes this article.

THE GENERAL PRINCIPLES OF GREEK ART

The study of Greek art is one which is eminently progressive. It has over the study of Greek literature the immense advantage that its materials increase far more rapidly. And it may well be maintained that a sound and methodic study of Greek art is as indispensable as a foundation for an artistic and archaeological education as the study of Greek poets and orators is as a basis of literary education. The extreme simplicity and thorough rationality of Greek art make it an unrivalled field for the training and exercise of the faculties which go to the making of the art critic and art historian.

Before proceeding to sketch the history of its rise and decline, it is desirable briefly to set forth the principles which underlie it *(see* also P. Gardner's *Principles* of *Greek Art)*.

As the literature of Greece is composed in a particular language, the grammar and syntax of which have to be studied before the works in poetry and prose can be read, so Greek works of art are composed in what may be called an artistic language. To the accidence of a grammar may be compared the mere technique of sculpture and painting; to the syntax of a grammar correspond the principles of composition and grouping of individual figures into a relief or picture By means of the rules of this grammar the Greek artist threw into form the ideas which belonged to him as a personal or a racial possession.

No nation is in its works wholly free from the domination of climate and geographical position; least of all a people so keenly alive to the influence of the outer world as the Greeks. They lived in a land where the soil was dry and rocky, far less hospitable to vegetation than that of western Europe, while the land horizon was on all sides bounded by hard and jagged lines of mountain. The sky was extremely clear and bright, sunshine for a great part of the year almost perpetual, and storms, which are more than passing gales, rare. It was in accordance with these natural features that temples and other buildings should be simple in form and bounded by clear lines. Such forms as the cube, the oblong, the cylinder, the triangle, the pyramid abound in their constructions. Just as in Switzerland the gables of the chalets match the pine-clad slopes and lofty summits of the mountains, so in Greece, amid barer hills of less elevation. the Greek temple looks thoroughly in place. But its construction is related not only to the surface of the land, but also to the character of the race. Émile Boutmy, in his interesting *Philosophie de l'architecture en Grèce*, has shown how the temple is a triumph of the senses and the intellect, not primarily emotional, but showing in every part definite purpose and design. It also exhibits in a remarkable degree the love of balance, of symmetry, of a mathematical proportion of parts and correctness of curvature which belong to the Greek artist.

Here, however, our concern is not with the purposes or arrangements of a temple, but with its sculptural decoration, and we would note that elaborate decoration is reserved for those parts of the temple which have, or at least appear to have, no strain laid upon them. It is true that in the archaic age experiments were made in carving reliefs on the lower drums of columns (as at Ephesus) and on the line of the architrave (as at Assus). But such examples were not followed. Nearly always the spaces reserved for mythological reliefs or groups are the tops of walls, the spaces between the triglyphs. and particularly the pediments surmounting the two fronts, which might be left hollow without danger to the stability of the edifice. Detached figures in the round are in fact found only in the pediments, or standing upon the tops of the pediments. And metopes are sculptured in higher relief than friezes.

"When we examine in detail even the simplest architectural decoration, we discover a combination of care, sense of proportion, and reason. The flutings of an Ionic column are not in section mere arcs of a circle, but made up of a combination of curves which produce a beautiful optical effect; the lines of decoration, as may be best seen in the case of the Erechtheum, are cut with a marvellous delicacy. Instead of trying to invent new schemes, the mason contents himself with improving the regular patterns until they approach perfection, and he takes everything into consideration. Mouldings on the outside of a temple, in the full light of the sun, are differently planned from those in the diffused light of the interior. Mouldings executed in soft stone are less fine than those in marble. The mason thinks before he works and ahile he works, and thinks in entire correspondence with his surroundings." (*Principles of Greek Art,* p. 44.)

Greek architecture, however, is treated under GREEK ARCHITECTURE; we will therefore proceed to speak briefly on the principles exemplified in sculpture Existing works of Greek sculpture fall into tno classes The first comprises what may be called works of substantive art, statues or groups made for their own sake and to be judged by themselves. Such are cult-statues of deities from temple and shrine, honorary portraits of rulers or of athletes, dedicated groups and the like. The second comprises decorative sculptures. such as were made, usually in relief, for the decoration of temples and tombs and other buildings, and were intended to be subordinate to architectural effect

Speaking broadly, it may be said that the works of substantive sculpture in our museums are in the great majority of cases copies of doubtful exactness and verv various merit.

The Hermes of Praxiteles is almost the only marble statue which can be assigned positively to one of the great sculptors; we have to work back towards the productions of the peers of Praxiteles through works of poor execution, often so much restored in modern times as to be scarcely recognizable. Decorative works, on the other hand, are very commonly originals. and their date can often be accurately fixed, as they belong to known buildings. They are thus infinitely more trustworthy and more easy to deal with than the copies of statues of which the museums of Europe, and more especially those of Italy. are full. They are also more commonly unrestored But yet there are certain disadvantages attaching to them Decorative works, even when carried out under the supervision of a great sculptor, were but seldom executed by him. Usually they were the productions of his pupils or masons Thus they are not on the same level of art as substantive sculpture And they vary in merit to an extraordinary extent, according to the capacity of the man who happened to have them in hand, and who was probably but little controlled. Every one knous how noble are the pedimental sculptures of the Parthenon. But there is no reason why they should be so vastly superior to the frieze from Phigalia: nor why the heads from the temple at Tegea should be so fine, while those from the contemporary temple at Epidaurus should be comparatively insignificant From the records of payments made to the sculptors who worked on the Erechtheum at Athens it appears that they were ordinary masons, some of them not even citizens, and paid at the rate of 60 drachms (about 60 francs) for each figure, whether of man or horse, which they produced. Such piece-work would not, in our days, produce a very satisfactory result

1. Works of substantive sculpture may be divided into two classes, the statues of human beings and those of the gods. The line between the tuo is not. however. very easy to draw, or very definite For in representing men the Greek sculptor had an irresistible inclination to idealize, to represent what was generic and typical rather than what was individual, and the essential rather than the accidental And in representing deities he so fully anthropomorphized them that they became men and women, only raised above the level of everyday life and endowed with a superhuman stateliness. Moreover, there was a class of heroes represented largely in art who covered the transition from men to gods. For example, if one regards Heracles as a deity and Achilles as a

man of the heroic age and of heroic mould, the line between the two will be found to be very narrow.

Nevertheless one may for convenience speak first of human and afterwards of divine figures. It was the custom from the 6th century onwards to honour those who had done any great achievement by setting up their statues in conspicuous positions. The earliest example we have is the portraits of the twins Cleobis and Biton from Delphi mentioned by Herodotus.

Another of the earliest examples is that of the tyrannicides, Harmodius and Xristogiton, a group, a copy of which has come down to us. Again, people who had not won any distinction were in the habit of dedicating to the deities portraits of themselves or of a priest or priestess, thus bringing themselves, as it were, constantly under the notice of a divine patron. The rows of statues before the temples at Miletus, Athens and elsewhere came thus into being. But from the point of view of art, by far the most important class of portraits consisted of athletes who had won victories at some of the great games of Greece, at Olympia, Delphi or elsewhere. Early in the 6th century the custom arose of setting up portraits of athletic victors in the great sacred places. We have records of numberless such statues executed by all the greatest sculptors. When Pausanias visited Greece he found them everywhere far too numerous for complete mention.

It is the custom of studying and copying the forms of the finest of the young athletes, combined with the Greek habit of complete nudity during the sports, which lies at the basis of Greek excellence in sculpture. Every sculptor had unlimited opportunities for observing young vigorous bodies in every pose and in every variety of strain. The natural sense of beauty which was an endowment of the Greek race impelled him to copy and preserve what was excellent, and to omit what was ungainly or poor. Thus there existed, and in fact there was constantly accumulating, a vast series of types of male beauty, and the public taste was cultivated to an extreme delicacy. And of course this taste, though it took its start from athletic customs, and was mainly nurtured by them, spread to all branches of portraiture, so that elderly men, women, and at last even children, were represented in art with a mixture of ideality and fidelity to nature such as has seldom been reached by the sculpture of any other people.

The statues of the gods began with stiff and ungainly figures cut out of the trunk of a tree. In the Greece of late times there were still standing rude pillars, with the tops sometimes cut into a rough likeness to the human form And in early decoration of vases and vessels one may find Greek deities represented with wings, carrying in their hands lions or griffins, bearing on their heads lofty crowns. Rut as Greek art progressed it grew out of this crude symbolism. In the language of Brunn, the Greek artists borrowed from Oriental or Mycenaean sources the letters used in their works, but with these letters they spelled out the ideas of their oun nation. What the artists of Babylon and Egypt express in the character of the gods by added attribute or symbol, swiftness by wings, control of storms by the thunderbolt, traits of character by animal heads, the artists of Greece work more and more fully into the sculptural type; modifying the human subject by the constant addition of something which is above the ordinary level of humanity, until we reach the Zeus of Pheidias or the Demeter of Cnidus. When the decay of the high ethical art of Greece sets in, the gods become more and more warped to the merely human level They lose their dignity, but they never lose their charm.

2. The decorative sculpture of Greece consists not of single figures, but of groups; and in the arrangement of these groups the strict Greek laws of symmetry, of rhythm, and of balance, come in. We will take the three most usual forms, the pediment, the metope and the frieze, all of which belong properly to the temple, but are characteristic of all decoration, whether of tomb, trophy or other monument.

The form of the pediment is triangular'; the height of the triangle in proportion to its length being about 1:8. The conditions of space are here strict and dominant; lo comply with them requires some ingenuity. To a modern sculptor the problem thus presented is almost insoluble; but it was allowable in ancient art to represent figures in a single composition as of various sizes, in correspondence not to actual physical measurement but to importance. As the more important figures naturally occupy the midmost place in a pediment, their greater size comes in conveniently. And by placing some of the persons of the group in a standing, some in a seated, some in a reclining position, it can be so contrived that their heads are equidistant from the upper line of the pediment.

The statues in a Greek pediment, which are after quite an early period usually executed in the round, fall into three, five or seven groups, according to the size of the whole. As examples to illustrate this exposition we take the two pediments of the temple at Olympia, the most complete which have come down to us, which are represented in figs. 13 and 14.

The metopes were the long series of square spaces which ran along the outer walls of temples between the upright triglyphs and the cornice. Originally they may have been left open and served as windows; but the custom came in as early as the 7th century, first of filling them in with painted boards or slabs of stone, and next of adorning them with sculpture. The metopes of the Treasury of Sicyon at Delphi are as early as the first half of the 6th century. This recurrence of a long series of square fields for occupation well suited the genius and the habits of the sculptor. As subjects he took the successive exploits of some hero such as Heracles or Theseus, or the contemporary groups of a battle. His number of figures was limited to tno or three, and these figures had to be worked into a group or scheme, the main features of which were determined by artistic tradition, but which could be varied in a hundred ways so as to produce a pleasing and in some degree novel result.

With metopes, as regards shape, may be compared the reliefs of Greek tombs, which also usually occupy a space roughly square, and which also comprise but a few figures arranged in a scheme generally traditional. A figure standing, giving his hand to one seated, two men standing hand in hand, or a single figure in some vigorous pose, is sufficient to satisfy the simple and severe taste of the Greeks.

In regard to friezes, which are long reliefs containing figures ranged between parallel lines, there is more variety of custom. In temples the height of the relief from the background varies according to the light in which it was to stand, whether direct or diffused. Almost all Greek friezes, however, are of great simplicity in arrangement and perspective. Locality is at most hinted at by a few stones or trees, never actually portrayed There is seldom more than one line of figures, in combat or procession, their heads all equidistant from the top line of the frieze. They are often broken up into groups; and when this is the case, figure will often balance figure on either side of a central point almost as rigidly as in a pediment.

Some of the friezes executed by Greek artists for semi-Greek peoples, such as those adorning the tomb at Trysa in Lycia, have two planes, the figures in the background being at a higher level.

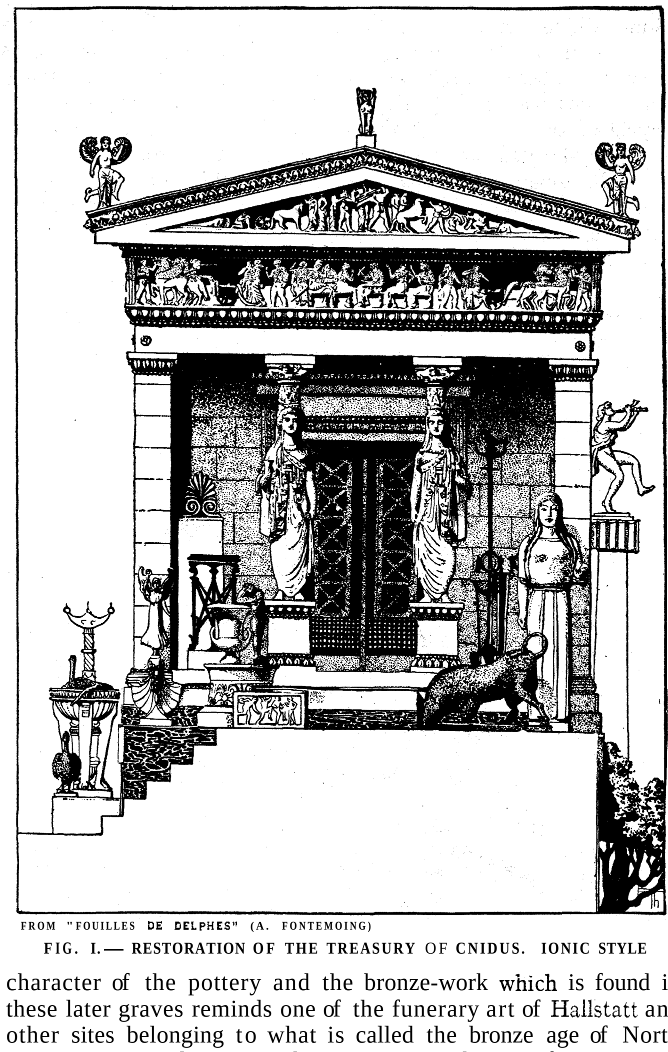
The rules of balance and symmetry in composition which are followed in Greek decorative art are still more clearly to be discerned in the paintings of vases, which must serve, in the absence of more dignified compositions, to enlighten us as to the methods of Greek painters. Great painters would not, of course, be bound by architectonic rule in the same degree as the mere workmen. But in any case the fact must never be lost sight of that Greek painting of the earlier ages was of extreme simplicity. It did not represent localities, save by some slight hint; it had next to no perspective; the colours used were but very few even down to the days of Apelles. Most of the great pictures of which we hear consisted of but one or two figures; and when several figures were introduced they were kept apart and separately treated, though, of course, not without relation to one another. Idealism and ethical purpose must have predominated in painting as in sculpture and in the drama and in the writing of history. The laws of balance and symmetry in Greek drawing are perhaps best shown in the decoration of vases (see POTTERY AND PORCELAIN).

HISTORIC SKETCH

To begin with, there was a rise of national art, after the destruction of the Minoan and Mycenaean civilizations by the irruption of tribes from the north (see ARCHAEOLOGY: Greek *and Roman* Orient [Including *Egypt-Indus*]), and then the Roman age of Greece, after which the Greek art works in the service of the conquerors (see ROMAN ART). The period (roughly 800–?50 B.C.) is divided into four sections: (1) to the Persian Wars, 480 B.C.; (2) the period of the early schools of art, 480–400 B.C.; (3) that of the later great schools, 400–300 B.C.; (4) that of Hellenistic art, 300–50 B.C. In dealing with these periods this article is confined to sculpture and painting, which in Greece are closely connected. The arts — pottery. gem-engraving and the like — are treated under their separate headings, and the reader is also referred to the biographical accounts of the chief artists (PHIDIAS, PRAXITELES, APELLES, etc.).

PERIOD I. 800–480 B.C.

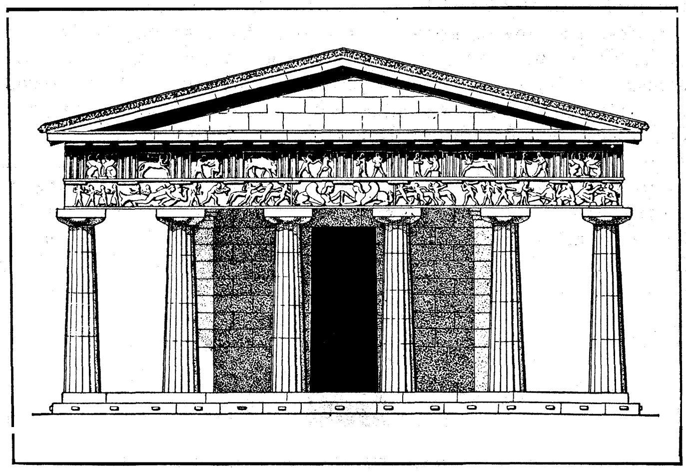
The Aegean or Mycenaean civilization was for the most part destroyed by what appears to have been a gradual invasion from the north; its racial character is much in dispute, though archaeological evidence abundantly proves that it was the conquest of a more by a less rich and civilized race. In the graves of the period (900–600 B.C.) is found none of the wealthy spoil which has made celebrated the tombs of Mycenae and Vaphio (*q.v.*). The



FROM "FOUILLES DE DELPHES" (A. FONTEMOING)

FIG. I. — RESTORATION OF THE TREASURY OF CNIDUS. IONIC STYLE

character of the pottery and the bronze-work which is found in these later graves reminds one of the funerary art of Hallstatt and other sites belonging to what is called the bronze age of North Europe. Its predominant characteristic is the use of geometrical forms, the lozenge, the triangle, the maeander, the circle with tangents, in place of the elaborate spirals and plant-forms which mark Mycenaean ware. For this reason the period from the 9th to the 7th century in Greece passes by the name of "the Geometric Age." It is commonly held that in the remains of the geometric age is traced the influence of the Dorians, who, coming in as a hardy but uncultivated race, probably of purer Aryan blood than the previous inhabitants of Greece, not only brought to an end the wealth and the luxury which marked the Mycenaean age, but also replaced an art which was in character essentially southern by one which belonged rather to the north and the west. The great difficulty inherent in this view, a difficulty which has yet to be



FROM PERROT AND CHIPIEZ, "HISTOIRE DE L ART" (CHAPMAN AND HALL, AND HACHETTE & CO.)

FIG. 2. — RESTORATION OF THE TEMPLE AT ASSUS, SHOWING THE FRIEZE OF ARCHAIC DECORATIVE SCULPTURES ALONG THE ENTABLATURE

met, lies in the fact that some of the most abundant and characteristic remains of the geometric age which we possess come, not from Peloponnesus, but from Athens and Boeotia, which were never conquered by the Dorians. For the early history of Greek work in gold and bronze refer to the articles METALWORK, DECORATIVE, and SILVERSMITHS' AND GOLDSMITHS' WORK.

Architecture **and** Sculpture. — The Greek temple in its character and form gives the clue to the whole character of Greek art. It is the abode of the deity, who is represented by his sacred image: and the flat surfaces of the temple offer a great field to the sculptor for the depicting of sacred legend. The process of discovery has emphasized the line which divides Ionian from Dorian architecture and art. The Ionians were a people more susceptible than were the Dorians to oriental influences. The dress, the art, the luxury of western Asia attracted them with irresistible force. We may suspect, as Brunn has suggested that Ionian artists worked in the great Assyrian and Persian palaces (and that the wall reliefs of those palaces were in part their handiwork). Some of the great temples of Ionia have been excavated in recent times notably those of Apollo at Miletus, of Hera at Samos, and of Artemis at Ephesus. Very little, however, of the architecture of the 6th century temples of those sites has been recovered,' though the French, who have been excavating at Delphi more or less continuously since 1892, have successfully restored the treasury of the people of Cnidus.(fig. 1), which is quite a gem of Ionic style, the entablature is supported in front not by pillars but by two maidens or Corae. and a frieze runs all round the building above. But though this building is of Ionic type, it is scarcely in the technical sense of Ionic style since the columns have not Ionic capitals, but are carved with curious reliefs. The Ionic capital proper is developed in Asia by degrees (see GREEK ARCHITECTURE; ORDER; CAPITAL; also Perrot and Chipiez, *Hist.* de *l'art,* vii, 4).

The Doric temple is not wholly of European origin, yet it was developed mainly in Hellas and the west. The most ancient example is the Heraeum at Olympia, next to which come the fragmentary temples of Corinth and of Selinus in Sicily. With the early Doric temple we are familiar from examples which have survived in fair preservation to our own days at Agrigentum in Sicily, Paestum in Italy, and other sites.

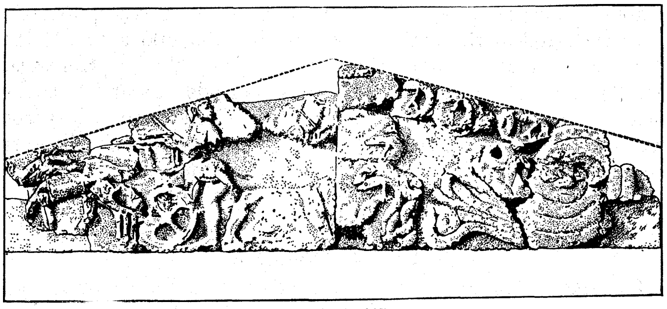
Of the decorative sculpture which adorned these early temples we have more extensive remains than we have of actual construction. It will be best to speak of them under their districts. On the coast of Asia Minor, the most extensive series of archaic decorative sculptures which has come down to us is that which adorned the temple of Assus (fig. 2). These were placed in a unique position on the temple, a long frieze running along the entablature, with representations of wild animals, of centaurs, of Heracles seizing Achelous, and of men feasting, scene succeeding scene without much order or method. The only figures from Miletus which can be considered as belonging to the original temple destroyed by Darius, are the dedicated seated statues, some of which, brought away by Sir Charles Newton in the middle of the 19th century, are now preserved at the British Museum. At Ephesus J. T. Wood was more successful (1869–74) and recovered considerable fragments of the temple of Artemis, to which, as Herodotus tells us, Croesus presented many columns. The lower part of one of these columns, bearing figures in relief of early Ionian style, has been put together at the British Museum; and remains of inscriptions recording the presentation by Croesus are still to be traced. Reliefs from a cornice of somewhat later date are also to be found at the British Museum. Among the Aegean islands, Delos has furnished us with the most important remains of early

FROM COLLIGNON, ('SCULPTURE GRECQUE"

FIG. 3.— STATUE OF NIKE OR VICTORY OF DELOS (RESTORED)

art. French excavators have there found a very early statue of a woman dedicated by one Nicandra to Artemis, a figure which may be instructively compared with another from Samos, dedicated to Hera by Cheramues. The Delian statue is in shape like a flat beam; the Samian, which is headless, is like a round tree. The arms of the Delian figure are rigid to the sides; the Samian lady has one arm clasped to her breast. A great improvement on these inexpressive figures is marked by another figure found at Delos, and connected, though perhaps incorrectly, with a bases recording the execution of a statue by Archermus and Micciades, two sculptors who stood, in the middle of the 6th century, at the head of a sculptural school at Chios. The representation (fig. 3) is of a running or flying figure, having six wings, like the seraphim in the vision of Isaiah, and clad in long drapery. It may be a statue of Nike or Victory, who is said to have been represented in winged form by Archermus. The figure, with its neatness and precision of work, its expressive face and strong outlines, certainly marks great progress in the art of sculpture. When the early sculpture of Athens is examined, reason is found to think that the Chian school had great influence in that city in the days of Peisistratus.

Athenian Sculpture. At Athens, in the age 650–480, may be traced two quite distinct periods of architecture and sculpture. In the earlier of the two periods, a rough limestone was used alike for the walls and the sculptural decoration of temples; in the later period it was superseded by marble, whether native or imported. Every visitor to the museum of the Athenian Acropolis stands astonished at the groups which decorated the pediments of Athenian temples before the age of Peisistratus — groups of large size, rudely cut in soft stone, of primitive workmanship, and painted with bright red, blue and green, in a fashion which makes no attempt to follow nature, but only to produce a vivid result. The two largest in scale of these groups seem to have belonged to the pediments of the early 6th century temple of Athena. On



FROM "ATHEN. MITTEIL. DEUTSCH. ARCH." INST. X. 237

FIG. 4.— ATHENIAN PEDIMENT REPRESENTING HERACLES SLAYING THE LERNAEAN HYDRA WHILE IOLAUS HOLDS THE REINS OF THE CHARIOT

other smaller pediments, perhaps belonging to shrines of Heracles and Dionysus, there are conflicts of Heracles with Triton or with other monstrous foes. It is notable how fond the Athenian artists of this early time are of exaggerated muscles and of monstrous forms, which combine the limbs of men and of animals; the measure and moderation which mark developed Greek art are as completely absent as are skill in execution or power of grouping. Fig. 4 shows a small pediment in which appears in relief the slaying of the Lernaean hydra by Heracles. The hero strikes at the many-headed water-snake, somewhat inappropriately, with his club. Iolaus, his usual companion, holds the reins of the chariot which awaits Heracles after his victory. On the extreme left a huge crab comes to the aid of the hydra.

There can be little doubt that Athens owed its great start in art to the influence of the court of Peisistratus, at which artists of

FROM "ATHEN. MITTEIL. DEUTSCH. ARCH "

FIG. 5.— ATHENA STRIKING AT A PROSTRATE FOE. FROM A MARBLE PEDIMENT ON THE TEMPLE OF ATHENA

all kinds were welcome. There was a gradual transformation in sculpture, in which the influence of the Chian and other progressive schools of sculpture was visible, not only in the substitution of island marble for native stone, but in increased grace and truth to nature, in the toning down of glaring colour, and the appearance of taste in composition. A transition between the older and the newer is furnished by the well-known statue of the calf-bearer, an Athenian preparing to sacrifice a calf to the deities, which is made of marble of Hymettus, and in robust clumsiness of forms is not far removed from the limestone pediments. The sacrificer has been commonly spoken of as Hermes or Theseus, but he seems rather to be an ordinary human votary.

In the time of Peisistratus or his sons a peristyle of columns was added to the old temple of Athena; and this necessitated the preparation of fresh pediments. These were of marble. In one of them was represented the battle between gods and giants; in the midst Athena herself striking at a prostrate foe (fig. S). In these figures no eye can fail to trace remarkable progress. On about the same level of art are the charming statues dedicated to Athena, which were set up in the latter half of the 6th century on the Acropolis, whose graceful though conventional forms and delicate colouring make them one of the great attractions of the Acropolis museum. We show a figure (fig. 6) which is the work of the sculptor Antenor, who was also author of a celebrated group representing the tyrant-slayers, Harmodius and Aristogiton. To the same age belong many other votive reliefs of the Acropolis, representing horsemen, scribes and other votaries of Athena.

FIG. 6.— FIGURE BY ANTENOR, UNRESTORED

Dorian Sculpture. From Athens we pass to the seats of Dorian art. And in doing so we find a complete change of character. In place of draped goddesses and female figures, there are nude male forms. In place of Ionian softness and elegance, hard, rigid outlines, strong muscular development, a greater love of and faithfulness to the actual human form—the influence of the palaestra rather than of religion. To the known series of archaic male figures modern exploration has added many examples. More especially may be mentioned figures from the temple of Apollo Ptoos in Boeotia, probably representing the god himself. Still more noteworthy are two colossal nude figures of Cleobis and Biton remarkable both for force and for rudeness, found at Delphi, the inscriptions of which prove them to be the work of an Argive sculptor. In the island of Crete was found the upper part of a draped figure, whether male or female is not certain, which should be an example of the early Daedalid school, whence the art of Peloponnesus was derived; it is hardly a characteristic product of that school; rather the likeness to the dedication of Nicandra is striking.

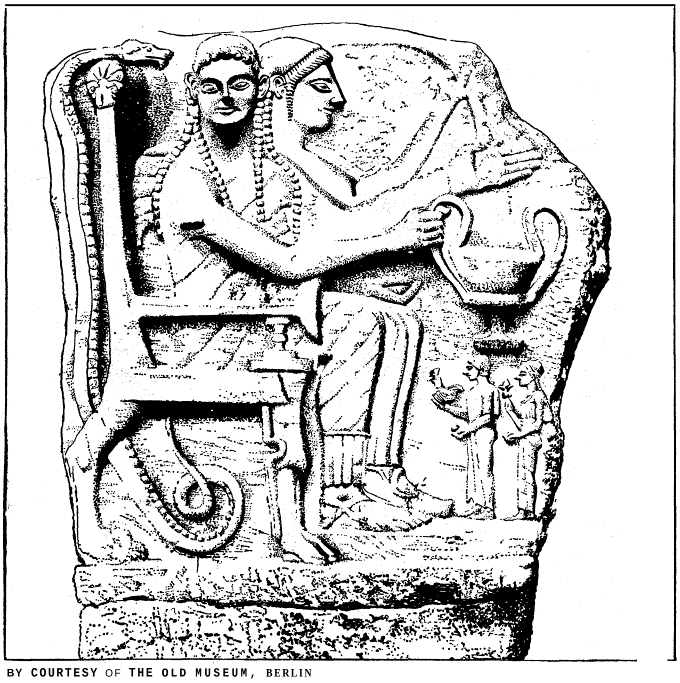
Another remarkable piece of Athenian sculpture, of the time of the Persian Wars, is the group of the tyrannicides Harmodius and Aristogiton, set up by the people of Athens, and made by the sculptors Critius and Nesiotes. These figures were hard and rigid in outline, but showing some progress in the treatment of the nude. Copies are preserved in the museum of Naples.

Olympia, Sparta, Selinus. Next in importance to Athens, as a find-spot for works of early Greek art, ranks Olympia. Olympia, however, did not suffer like Athens from sudden violence, and the explorations there have brought to light a continuous series of remains, beginning with bronze tripods of the geometric age and ending at the barbarian invasions of the 4th century A.D. Notable among the 6th century stone-sculpture of Olympia are the pediment of the treasury of the people of Megara, in which is represented a battle of gods and giants, and a huge rude head of Hera which seems to be part of the image worshipped in the Heraeum. Its flatness and want of style should be noted.

Among the temples of Greece proper the Heraeum of Olympia stands almost alone for antiquity and interest, its chief rival, besides the temples of Athens, being the other temple of Hera at Argos. It appears to have been originally constructed of wood, for which stone was by slow degrees, part by part, substituted. In the time of Pausanias one of the pillars was still of oak, and at the present day the varying diameter of the columns and other structural irregularities bear witness to the process of constant renewal which must have taken place. The early small bronzes of Olympia form an important series, figures of deities standing or striding, warriors in their armour, athletes with exaggerated muscles, and women draped in the Ionian fashion, which did not become unpopular in Greece until after the Persian Wars.

Excavations at Sparta have revealed interesting monuments belonging to the worship of ancestors, which seems in the conse ative Dorian states of Greece to have been more strongly developed than elsewhere On some of these stones, which doubtless belonged to the family cults of Sparta, are shown the ancestor seated holding a wine-cup, accompanied by his faithful horse or dog; on some we see the ancestor and ancestress seated side by side (fig 7), ready to receive the gifts of their descendants, who appear in the corner of the relief on a much smaller scale. The male figure holds a wine-cup, in allusion to the libations of wine made at the tomb. The female figure holds her veil and the pomegranate, the recognized food of the dead. A huge serpent stands erect behind the pair The style of these sculptures is as striking as the subject.—lean, rigid forms with severe outline, carved in a very low relief, the surface of which is not rounded but flat. The name of Selinus in Sicily, an early Megarian colony, has long been associated with some of the most curious of early sculptures, the metopes of ancient temples, representing the exploits of Heracles and of Perseus Even more archaic metopes have in recent years been brought to light, one representing a seated sphinx, one the journey of Europa over the sea on the back of the amorous bull, a pair of dolphins swimming beside her. In simplicity and rudeness of work these reliefs remind us of the limestone pediments of Athens (fig 4), but they are of another and a severer style; the Ionian laxity is wanting.

Delphi. The French excavations at Delphi add a new and important chapter to the history of 6th century art. Of the archaic temple of Apollo, built as Herodotus tells us by the Alcmaeonidae of Athens, the only sculptural remains which have come down to us are some fragments of the pedimental figures. Of the treasuries which contained the offerings of the pious at Delphi, the most archaic of which there are remains is that belonging to the people of Sicyon. To it appertains a set of exceedingly primitive metopes. One depicts Idas and the Dioscuri driving off cattle; another, the ship Argo; another. Europa on the bull, others merely animals. a ram or a hoar. The treasury of the people of Cnidus (or perhaps Siphnos) is in style some half a century later



BY COURTESY OF THE OLD MUSEUM, BERLIN

FIG. 7.— SPARTAN TOMBSTONE REPRESENTING ANCESTOR WORSHIP

FROM FURTWÄNGLER, "AEGINA" (A. BUCHHOLZ)

FIG. 8.— EAST AND WEST PEDIMENTS OF THE TEMPLE AT AEGINA AS RESTORED BY FURTWÄNGLER

(*see* fig. 1). To it belongs a long frieze representing a variety of curious subjects: a battle, perhaps between Greeks and Trojans, with gods and goddesses looking on; a gigantomachy in which the figures of Poseidon, Athena, Wera, Apollo, Artemis and Cybele

FIG. 9.— METOPE FROM SELINUS. EUROPA ON BULL. NOW AT PALERMO

can be made out, with their opponents, who are armed like Greek hoplites; Athena and Heracles in a chariot; the carrying off of the daughters of Leucippus by Castor and Pollux; Hephaestus with his fire. The treasury of the Athenians, erected at the time of the Persian Wars, was adorned with metopes of singularly clear-cut and beautiful style, but very fragmentary, representing the deeds of Heracles and Theseus.

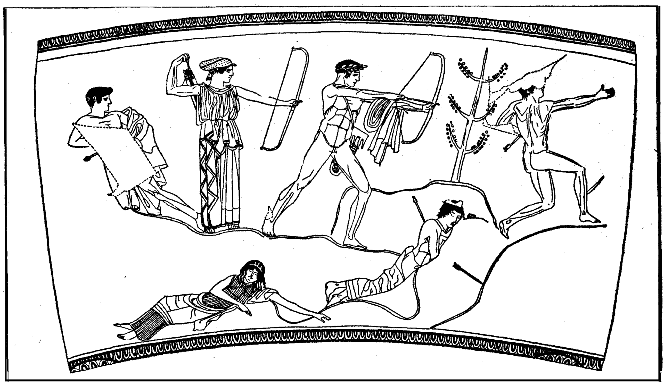
The most interesting and important of all Greek archaic sculptures are the pediments of the temple at Aegina (q *v*). These groups of nude athletes fighting over the corpses of their comrades are preserved at Munich, and are familiar to artists and students. But the very fruitful excavations of Prof Furtwangler put them in quite a new light. Furtwangler (*Aegina: Heiligtum* der *Aphaia*) entirely rearranged these pediments, in a way which removed the extreme simplicity and rigour of the composition, and introduced far greater variety of attitudes and motive. R e repeat here these new arrangements (fig. 8), the reasons for which must be sought in Furtwängler's great publication The individual figures are not much altered, as the restorations of Thorwaldsen, even when incorrect, have now a prescriptive right of which It is not easy to deprive them. Beside the pediments of Aegina must be set the remains of the pediments of the temple of Apollo at Eretria in Euboea, the chief group of which. Theseus carrying off an Amazon, is one of the most finely executed works of early Greek art.

PERIOD II. 480–400 B.C.

The most marvellous phenomenon in the whole history of art is the rapid progress made by Greece in painting and sculpture during the 5th century B C As in literature the jth century takes us from the rude peasant plays of Thespis to the drama of Sophocles and Euripides; a5 in philosophy it takes us from Pythagoras to Socrates; so in sculpture it covers the space from the primitive works made for the Peisistratidae to some of the most perfect productions of the chisel

In architecture the 5th century is ennobled by the Theseum, the Parthenon and the Erechtheum, the temples of Zeus at Olympia, ot Apollo at Phigalia, and many other central shrines, as well as by the Hall of the Mystae at Eleusis and the Propylaea of the Acropolis Some of the most important of the Greek temples of Italy and Sicily, such as those of Segesta and Selinus, date from the same age. It is, however, only or' their sculptural decorations, carried out by the greatest masters in Greece, that we need here treat in any detail.

Painting.— It is the rule in the history of art that innovations and technical progress are shown earlier in the case of painting than in that of sculpture, a fact easily explained by the greater ease and rapidity of the brush compared with the chisel. That this was the order of development in Greek art cannot be doubted. But our means for judging of the painting of the 5th century are very slight. The noble paintings of such masters as Eolygnotus, Micon and Panaenus, which once adorned the walls of the great porticos of Athens and Delphi, have disappeared. There remain only the designs drawn rather than painted on the beautiful vases of the age, which in some degree help us to realize, not the colour-

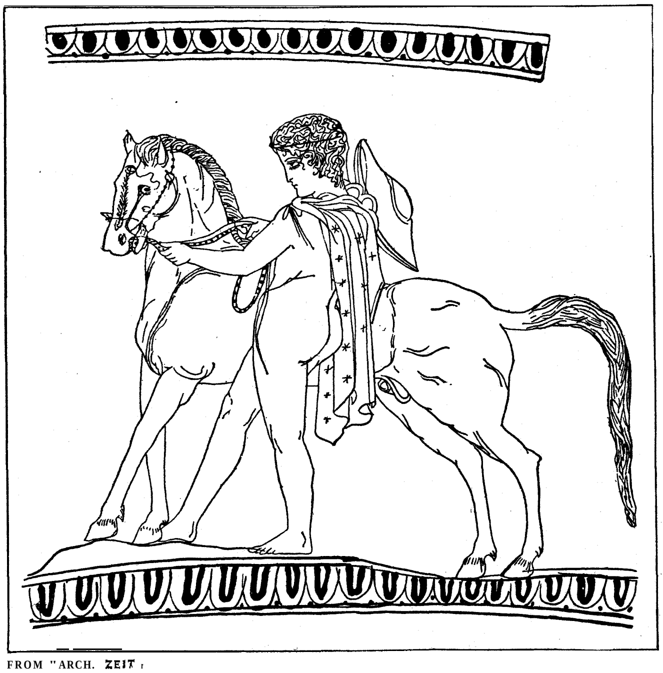


FROM "MONUMENTI DELL' INSTITUTO DI CORRESPONDENZA ARCHEOLOGICA" VOL. XI

FIG. 10.— VASEPAINTING FROM ORVIETO IN THE STYLE OF POLYGNOTUS. SHOWING THE SLAYING OF NIOBE'S CHILDREN. 5TH CENTURY B.C.

ing or the charm of contemporary paintings, but the principles of their composition and the accuracy of their drawing.

Polygnotus of Thasos was regarded by his compatriots as a great ethical painter. His colouring and composition were alike very simple, his figures quiet and statuesque, his drawing careful and precise. He won his fame largely by incorporating in his works the best current ideas as to mythology, religion and morals. In particular his painting of Hades with its rewards and punishments, which was on the walls of the building of the people of Cnidus at Delphi, might be considered as a great religious work, parallel to the paintings of the Campo Santo at Pisa or to the



FROM "ARCH. ZEIT.

FIG. 11.— VASE PAINTING. 5TH CENTURY B.C.

painted windows of such churches as that at Fairford. But he also introduced improvements in perspective and greater freedom in grouping.

It is fortunate for us that the Greek traveller Pausanias has left very careful and detailed descriptions of some of the most important of the frescoes of Polygnotus, notably of the Taking of Troy and the Visit to Hades, which were at Delphi. A comparison of these descriptions with vase paintings of the middle of the 5th century has enabled us to discern with great probability the principles of Polygnotan drawing and perspective. Prof. Robert has even ventured to restore the paintings on the evidence of vases. There is represented one of the scenes depicted on a vase found at Orvieto (fig. 10), which is certainly Polygnotan in character. It represents the slaying of the children of Niobe by Apollo and Artemis. Here may be observed a remarkable perspective. The different heights of the rocky background are represented by lines traversing the picture on which the figures stand;

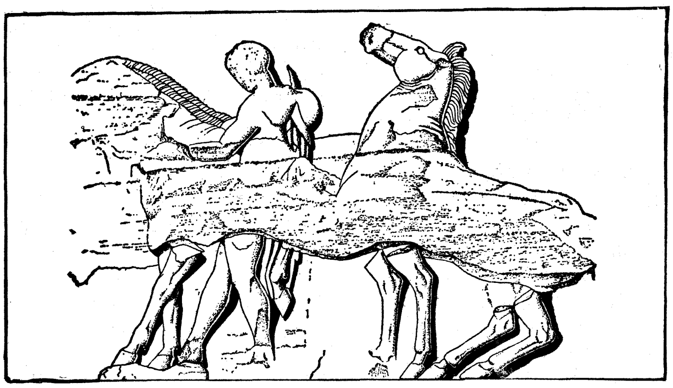
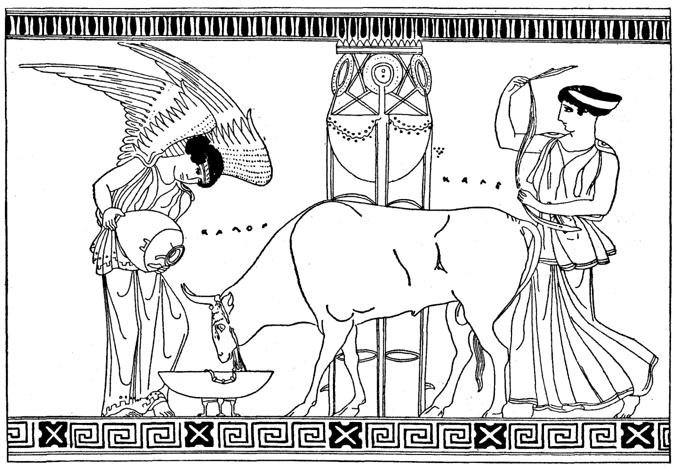


FIG. 12.—A GROUP FROM THE PANATHENAIC FRIEZE OF THE PARTHENON

but the more distant figures are no smaller than the nearer. The forests of Mount Sipylus are represented by a single conventional tree. The figures are beautifully drawn, and full of charm; but there is a want of energy in the action.

There can be little doubt that the school of Polygnotus exercised great influence on contemporary sculpture. Panaenus, brother of Pheidias, worked with Polygnotus, and many of the groupings found in the sculptures of the Parthenon remind us of those usual with the Thasian master. At this simple and early stage of art there was no essential difference between fresco-painting and coloured relief, light and shade and aerial perspective being unknown. Two vase-paintings are shown, one (fig. 11), a group of man and horse which closely resembles figures in the Panathenaic frieze of the Parthenon (fig. 12); the other (fig. 13), representing Victory pouring water for a sacrificial ox to drink, which reminds us of the balustrade of the shrine of Wingless Victory at Athens.

Most writers on Greek painting have supposed that after the middle of the 5th century the technique of painting rapidly im-



FROM GERHARD, "AUSERLESENE VASENBILDER"

FIG. 13.—VASE PAINTING OF NIKE AND BULL, 5TH CENTURY B.C.

proved. This may well have been the case; but there is little means of testing the question. Such improvements would soon raise such a barrier between fresco-painting and vase-painting—which by its very nature must be simple and architectonic—that vases can no longer be used with confidence as evidence for contemporary painting. The stories told us by Pliny of the lives of

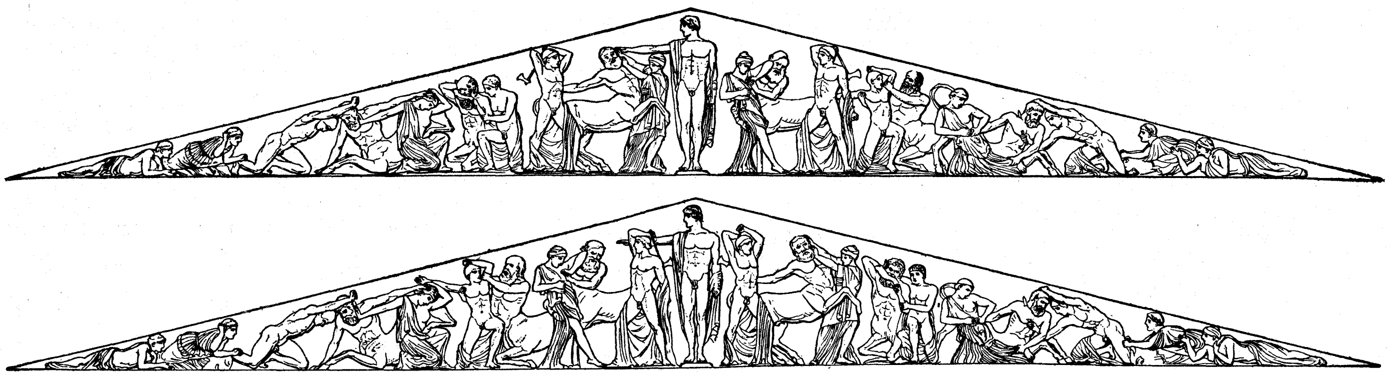


FIG. 14.—TWO CONJECTURAL RESTORATIONS OF THE WESTERN PEDIMENT OF THE GREAT TEMPLE OF ZEUS AT OLYMPIA

Greek painters are mostly of a trivial and untrustworthy character, and in them there are discernible only a few general facts. Of Agatharchus of Athens we learn that he painted, under compulsion, the interior of the house of Alcibiades, and we are told that he painted a scene for the tragedies of Aeschylus or Sophocles, thus leading some to suppose that he attempted illusive landscape. But this is contrary to the possibilities of the time, and it is fairly certain that what he really did was to paint the wooden front of the stage building in imitation of architecture; in fact he painted a permanent architectural background, and not one suited to any particular play Of other painters who flourished at the md of the century, such as Zeuxis and Aristides, it will be best to speak under the next period

It is now genrrally held, in consequence of evidence furnished by tombs that the 5th century saw the end of the making of vases on a great scale at Athens for export to Italy and Sicily. And, in fact, few things in the history of art are more remarkable than the rapidity with which vase-painting at Athens reached its highest point and passed it on the downward road. At the beginning of the century black-figured ware was scarcely out of fashion, and the masters of the severe red-figured style, Pamphaeus, Epictetus and their contemporaries, were in vogue. The schools of Euphronius Hiero and Duris belong to the age of the Persian wars. With the middle of the century the works of these makers are succeeded by unsigned vases of most beautiful design, some of them showing the influence of Polygnotus In the later years of the century, when the empire of Athena was approaching its fall, drawing becomes laxer and more careless, and in the treatment of drapery we frequently note the over-elaboration of folds, the want of simplicity, which begin to mark contemporary sculpture.

Olympia: Temple of **Zeus.**—Among the sculptural works of this period the first place may be given to the great temple of Zeus at Olympia. The statue by Pheidias, which once occupied the place of honour in that temple, and was regarded as the noblest monument of Greek religion, has of course disappeared, nor are we able with confidence to restore it. But the plan of the temple, its pavement, some of its architectural ornaments, remain The marbles which occupied the pediments and the metopes of the temple have been in large part recovered, having been probably thrown down by earthquakes and gradually buried in the alluvial soil. The utmost ingenuity and science of the German archaeologists have been employed in the recovery of the composition of these groups; and, although doubt remains as to the places of some figures, and their precise attitudes, we may fairly say that we know more about the sculpture of the Olympian temple of Zeus than about that of any other great Greek temple. The exact date of these sculptures is not certain, but with some confidence they may be placed between 470–460 B.C. (In speaking of them the opinion of Dr. Treu is followed, whose masterly work in vol. iii. of the great German publication on Olympia is a model of patience and of science.) In the eastern pediment (fig. I j), as Pausanias tells us, were represented the preparations for the chariot-race between Oenomaiis and Pelops, the result of which was to determine whether Pelops should find death or a bride and a kingdom. In the midst, invisible to the contending heroes, stood Zeus the supreme arbiter. On one side of him stood Oenomaiis with his wife Sterope, on the other Pelops and Hippodameia, the daughter of Oenomaus, whose position at once indicates that she is on the side of the newcomer, whatever her parents may feel. Next on either side are the four-horse chariots of the two competitors, that of Oenomaus in the charge of his perfidious groom Myrtilus, who contrived that it should break down in the running, that of Pelops tended by his grooms. At either end, where the pediment narrows to a point, reclines a river god, at one end Alpheus, the chief stream of Olympia, at the other his tributary Cladeus. Only one figure remains, not noticed in the careful description of Paussnias, the figure of a handmaid kneeling, perhaps one of the attendants of Sterope. The illustration gives two conjectural restorations of the pediment, that of Treu and that of Kekulé, which differ principally in the arrangement of the corners of the composition; that of the central figures and of the chariots can scarcely be called in question. The moment chosen is one, not of action, but of expectancy, perhaps of preparation for sacrifice. The arrangement is undeniably stiff and formal, and in the figures we note none of the trained perfection of style which belongs to the sculptures of the Parihenon, an almost contemporary temple. Faults abound, alike in the rendering of drapery and in the representation of the human forms, and the sculptor has evidently trusted to the painter who was afterwards to colour his work, to remedy some of his clumsiness, or to make clear the ambiguous.

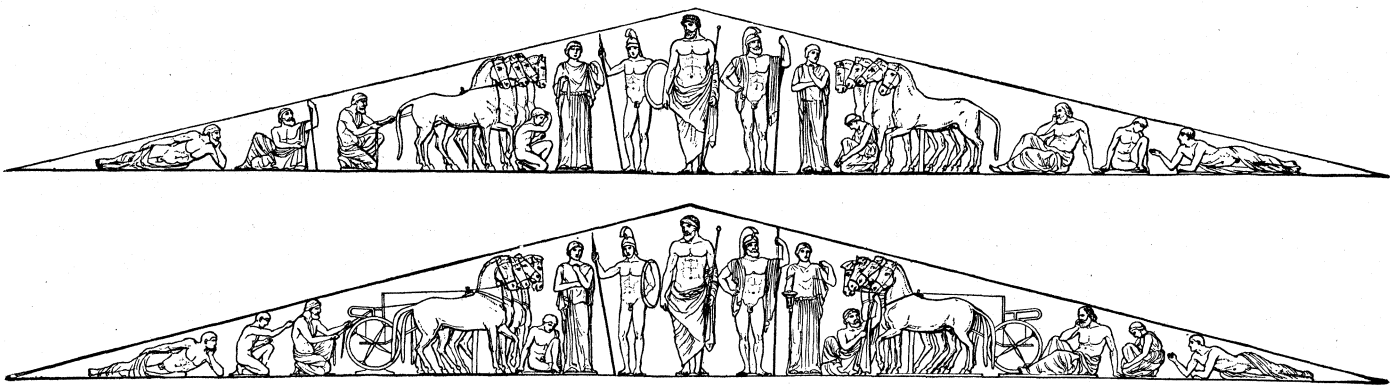
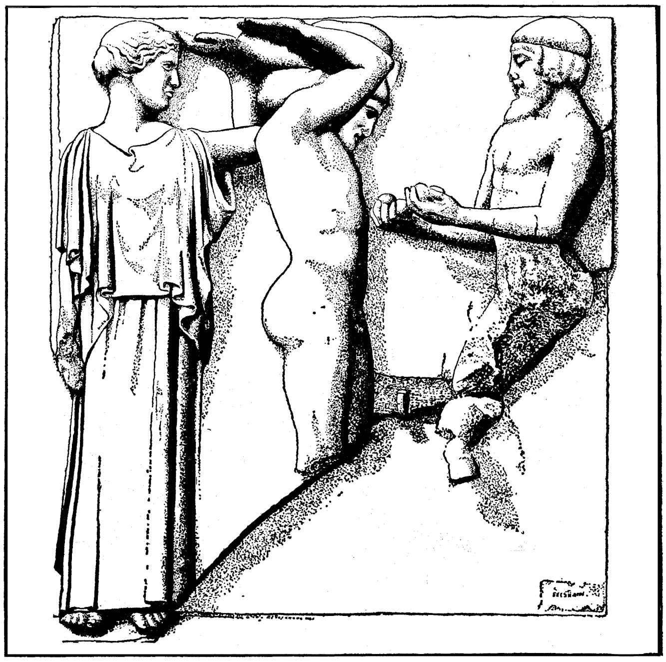


FIG. 15.—TWO CONJECTURAL RESTORATIONS OF THE EASTERN PEDIMENT OF THE GREAT *TEWPLE* OF ZEUS AT OLYMPIA

Nevertheless there is in the whole a dignity, a sobriety and a simplicity, which indicates that this pediment was certainly regarded in antiquity as a noble work. fit to adorn even the palace of Zeus. In the western pediment (fig. 14), the subject is the riot of the centaurs when they attended the wedding of Peirithous in Thessaly, and, attempting to carry off the bride and her comrades,



FROM "OLYMPIA," VOL. III., E. TREU, EDITOR

FIG. 16.— METOPE FROM THE TEMPLE OF ZEUS AT OLYMPIA REPRESENTING ONE OF THE 12 LABOURS OF HERACLES (UNRESTORED)

were slain by Peirithous and Theseus. In the midst of the pediment, invisible like Zeus in the eastern pediment, stands Apollo, while on either side of him Theseus and Peirithous attack the centaurs with weapons hastily snatched. The illustration gives two possible arrangements. The monsters are in various attitudes of attempted violence, of combat and defeat; with each grapples one of the Lapith heroes in the endeavour to rob them of their prey. In the corners of the pediment recline female figures, perhaps attendant slaves, though the farthest pair may best be identified as local Thessalian nymphs, looking on with the calmness of divine superiority, yet not wholly unconcerned in what is going forward. Though the composition of the two pediments differs notably, the one bearing the impress of a paradelike repose, the other of an overstrained activity, the style and execution are the same in both, and the shortcomings must be attributed to the inferior skill of a local school of sculptors compared with those of Athens or of Aegina. It even appears likely that the designs also belong to a local school. Pausanias, it is true, said that the pediments were the work of Alcamenes, the pupil of Pheidias, and of Paeonius. a sculptor of Thrace, respectively; but it is almost certain that he was misled by the local guides, who would naturally be anxious to connect the sculptures of their great temple with well-known names.

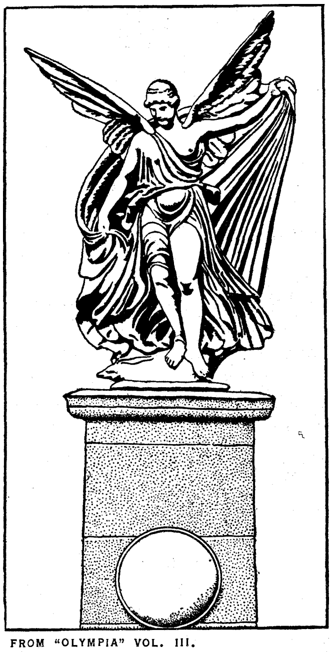
The metopes of the temple are in the same style of art as the pediments, but the defects of awkwardness and want of mastery are less conspicuous, because the narrow limits of the metope exclude any elaborate grouping. The subjects are provided by the 12 labours of Heracles; the figures introduced in each metope are but two or at most three; and the action is simplified.

The example shown (fig. 16), represents Heracles holding up the sky on a cushion, with the friendly aid of a Hesperid nymph, while Atlas, whom he has relieved of his usual burden, approaches bringing the apples which it was the task of Heracles to procure.

Another of the fruits of the excavations of Olympia is the Floating Victory by Paeonius, unfortunately faceless (fig. 17), which was set up in all probability in memory of the victory of the Athenians and their Messenian allies at Sphacteria in 425 B.C. The inscription states that it was dedicated by the Messenians and people of Naupactus from the spoils of their enemies, but the name of the enemy is not mentioned in the inscription. The statue of Paeonius, which comes floating down through the air with drapery borne backward, is of a bold and innovating type, and its influence may be traced in many works of the next age.

Delphic **Charioteer.**—Among the discoveries at Delphi none is so striking and valuable as the life-size statue in bronze of a charioteer holding in his hand the reins. Théophile Homolle maintained this to be part of a chariot group set up by Polyzalus, brother of Gelo and Hiero of Syracuse, in honour of a victory won in the chariot race at the Pythian games at Delphi (fig. 18). The charioteer is evidently a high-born youth, and is clad in the long chiton which was necessary to protect a driver of a chariot from the rush of air. The date would be about 480–470 B.C. Bronze groups representing victorious chariots with their drivers were among the noblest and most costly dedications of antiquity; the present figure is the only satisfactory representative of them. In style the figure is very notable, tall and slight beyond all contemporary examples. The contrast between the conventional decorousness of face and drapery and the lifelike accuracy of hands and feet is very striking, and indicates the clashing of various tendencies in art at the time when the great style was formed in Greece.

Myron. — The three great masters of the 5th century, Myron, Pheidias and Polyclitus are all in some degree known from their works. These are copies of two works by Myron, the Marsyas with Athena and the Discobolus. The Marsyas (a copy in the Lateran museum) represents the satyr so named in the grasp of conflicting emotions, eager to pick up the flutes which Athena has thrown down, but at the same time dreading her displeasure if he does so. More recently the Athena also was identified. The Discobolus was usually judged from the examples in the Vatican and the British Museum, in which the anatomy was modernized and the head wrongly attached. However, photographs of the superior replica in the Lancelotti gallery at Rome show a pose which is much nearer to the original.



FROM "OLYMPIA" VOL. III.

FIG. 17.— FLOATING VICTORY BY PAEONIUS. C. 425 B.C. (RESTORED)

A restoration was made at Munich by combining the Lancelotti head with the Vatican body.

Pheidias.—Of the works of Pheidias there is unfortunately no certain copy, excepting the small replicas at Athens of his Athena Parthenos. The larger of these was found in 1880: it is very clumsy, and the wretched device by which a pillar is introduced to support the Victory in the hand of Athena can scarcely be supposed to have belonged to the great original. Tempting theories were published by Adolf Furtwangler (*Masterpieces of Greek Sculpture)* and other archaeologists, which identify copies of the Athena Lemnia of Pheidias, his Pantarces, his Aphrodite Urania and other statues; but doubt hangs over all these attributions.

A more pertinent and more promising question is how far one may take the decorative sculpture of the Parthenon, since Lord Elgin's time the pride of the British Museum, as the actual work of Pheidias or as done from his designs. Again there is no conclusive evidence; but it appears from the testimony of inscriptions that the pediments at all events were not executed until after Pheidias's death.

Of course, the pediments and frieze of the Parthenon (*q.v.*)

whose work soever they may be, stand at the head of all Greek decorative sculpture. Whether we regard the grace of the composition, the exquisite finish of the statues in the round, or the delightful atmosphere of poetry and religion which surrounds these sculptures, they rank among the masterpieces of the world. The Greeks esteemed them far below the statue which the temple was made to shelter; but to us, who have lost the great figure in ivory and gold, the carvings of the casket which once contained it are a perpetual source of instruction and delight. The whole is reproduced by photography in A. S. Murray's Sculptures *of* the *Parthenon.*

An abundant literature has sprung up in regard to these sculptures, but it will suffice here to mention the discussions in Furtwangler's Masterpieces, and the very ingenious attempts of Sauer to determine by a careful examination of the bases and backgrounds of the pediments as they now stand how the figures must have been arranged in them. The two ends of the eastern pediment are the' only fairly well-preserved parts of the pediments.

FIG. 18.— BRONZE CHARIOTEER FROM DELPHI. 480–470 B.C.

Among the pupils of Pheidias who may naturally be supposed to have worked on the sculptures of the Parthenon, the most notable were Alcamenes and Agoracritus.

Some fragments remain of the great statue of Nemesis at Rhamnus by Agoracritus, and an interesting light has been thrown on Alcamenes by the discovery at Pergamum of a professed copy of his Hermes set up at the entrance to the Acropolis at Athens. This, however, is conventional and archaistic in style, and we can scarcely regard it as typical of the master. Another noted contemporary who was celebrated mainly for his portraits was Cresilas, a Cretan. Several copies of his portrait of Pericles exist, and testify to the lofty and idealizing style of portraiture in this great age.

There have been found also admirable sculpture belonging to the other important temples of the Acropolis, the Erechtheum and the temple of Nike. The temple of Nike is the earlier, being possibly a memorial of the Spartan defeat at Sphacteria. The Erechtheum belongs to the end of our period, and embodies the delicacy and finish of the conservative school of sculpture at Athens just as the Parthenon illustrates the ideas of the more progressive school.

The reconstruction of the Erechtheum has been a task which has long occupied the attention of archaeologists (see the paper by Stevens in the American Journal of Archaeology, 1906). Maidens, called both Corae and Caryatides, support the entablature of the south porch of the building. This use of the female figure in place of a pillar is based on old Ionian precedent (*see* fig. 1), and is not altogether happy; but the idea is carried out with remarkable skill, the perfect repose and solid strength of the maiden being emphasized.

Polyclitus.—Beside Pheidias of Athens must be placed the greatest of early Argive sculptors, Polyclitus. His two typical athletes, the Doryphorus or spear-bearer, and the Diadumenus, have long been identified, and though the copies are not first-rate, they rec er the principles of the master's art. Among the bases discovered at Olympia, whence the statues had been removed, are three or four which bear the name of Polyclitus, and the definite evidence furnished by these bases as to the position of the feet of the statues which they once bore has enabled archaeologists, especially Furtwangler, to identify copies of those statues among known works. Copies of Polyclitan works have also been discovered, and at Delos was found a copy of the Diadumenus, which is of much finer work than the statue in the British Museum from Vaison. The Boston Museum of fine arts has a very beautiful statue of a young Hermes, who but for the wings on the temples might easily pass as a boy athlete of Polyclitan style. In fact, as regards the manner of Polyclitus besides Roman copies of the Doryphorus and Diadumenus, there is quite a gallery of athletes, boys and men, who all claim relationship, nearer or more remote, to the school of the great Argive master, and in the Ashmolean museum is a very beautiful bronze head of the Polyclitan school. It might have been hoped that the excavations, made under the leadership of Prof. Waldstein (Walston) at the Argive Heraeum, would have brought enlightenment to us as to the style of Polyclitus. Just as the sculptures of the Parthenon are the best monument of Pheidias, so it might seem likely that the sculptural decoration of the great temple which contained the Hera of Polyclitus would show us at large how his school worked in marble, but unfortunately the fragments of sculpture from the Heraeum are few. The most remarkable is a female head, which may perhaps come from a pediment (fig. 19). But archaeologists are not in agreement whether it is Polyclitan in style or whether it rather resembles in style Attic works. Other heads and some highly-finished

FIG. 19.— MARBLE FEMALE HEAD EXCAVATED AT THE ARGIVE HERAEUM

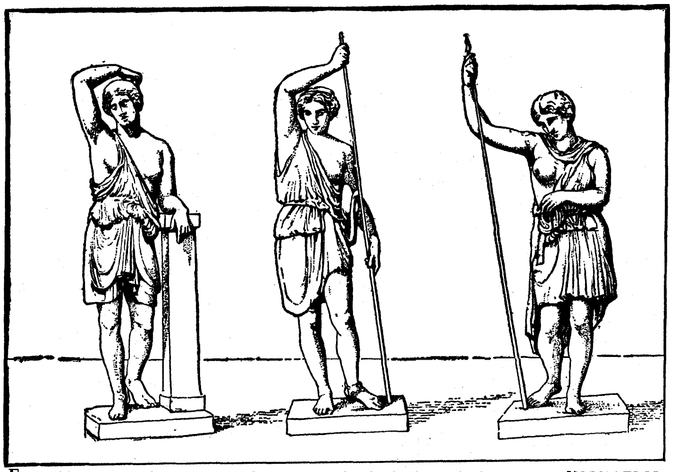
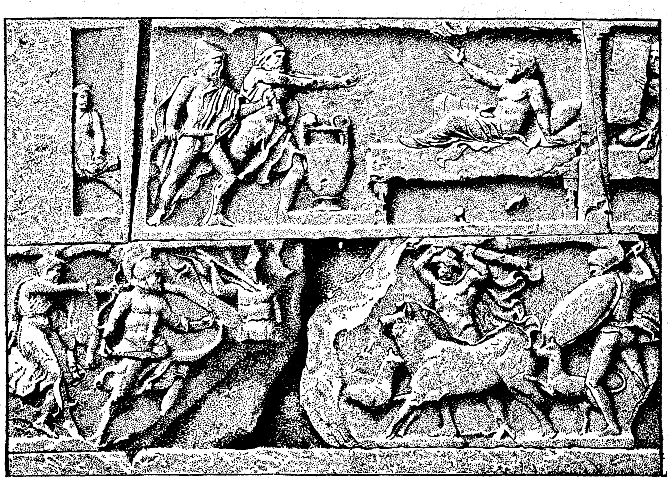


FIG. 20.— TYPES OF 5TH CENTURY AMAZONS RESTORED BY MICHAELIS

fragments of bodies come apparently from the metopes of the same temple. (See also ARGOS.)

Another work of Polyclitus was his Amazon, made it is said in competition with his great contemporaries, Pheidias, Cresilas and Phradmon, all of whose Amazons were preserved in the great temple of Artemis at Ephesus. In the museums are many statues of Amazons representing 5th century originals. These have usually been largely restored, and it is no easy matter to discover their original type. Prof. Michaelis has recovered successfully three types (fig. 20). The attribution of these is a matter of controversy. The first has been given to Polyclitus; the second seems to represent the Wounded Amazon of Cresilas; the third has by some archaeologists been assigned to Pheidias. It does not represent a wounded Amazon, bur one alert, about to leap upon her horse with the help of a spear as a leaping pole



PROM "HEROON OF GYEUL BASHI TRYSA"

FIG. 21.---FRAGMENT OF A FRIEZE OF THE VIENNA TOMB. ABOVE: ULYSSES SHOOTING SUITORS: BELOW: BOAR HUNTING

Lycia.—It is impossible to devote little more than a passing mention to the sculpture of other temples and shrines of the later 5th century, which nevertheless deserve careful study. The frieze from the temple of Apollo at Phigalia, representing Centaur and Amazon battles, is familiar to visitors of the British Museum. where, however, its proximiry to the remains of the Parthenon lays stress upon the faults of grouping and execution which this frieze presents It seems to be the work of local Arcadian artists. More pleasing is the sculpture of the Ionic tomb called the Nereid monument, brought by Sir Charles Fellows from Lycia Here we have not only a series of bands of relief which ran round the tomb, but also detached female figures. whence the name which it bears is derived, though these women with their fluttering drapery may be not nymphs of the sea, but personifications of sea-breezes.

Lycian sculpture is well represented by the friezes, now in the Vienna Museum, which adorned a heroon near Gyeul Bashi and date from not much later than the middle of the 5th century. In the midst of the enclosure was a tomb. and the walls of the enclosure itself were adorned within and without with a great series of reliefs, mostly of mythologic purport Many subjects which but rarely occur in early Greek art, the siege of Troy, the adventure of the Seven against Thebes, the carrying off of the daughters of Leucippus, Ulysses shooting down the Suitors, are here represented in detail. Prof Benndorf, who has published these sculptures in an admirable volume. is disposed to see in them the influence of the Thasian painter Polygnotus. Anyone can see their kinship to painting, and their subjects recur in some of the great frescoes painted by Polygnotus, Micon and others for the Athenians. Like other Lycian sculptures, they contain non-Hellenic elements; in fact Lycia forms a link of the chain which extends from the wall-reliefs of Assyria to works like the columns of Trajan and of Antoninus. but is not embodied in the more purely idealistic works of the highest Greek art. A small part of the frieze of the Vienna tomb is shown in fig, 21; in this fragment are two scenes, one directly above the other; in the upper Ulysses, accompanied by his son Telemachus, is in the act of shooting the suitors, who are reclining at table in the midst of a feast; a cup-bearer, possibly Melanthius, is escaping by a door behind Ulysses; and in the lower is the central group of a frieze representing the hunting of the Calydonian boar, the boar being shown—as is usual in the best period of Greek art—as an ordinary animal and no monster.

Portraits.— Archaeoloeists formerly paid little attention to an interesting branch of Greek art, that of sculptured portraits, but the known portraits of the 5th century now include Pericles, Herodotus, Thucydides, Anacreon, Sophocles Euripides, Socrates and others. As might be expected in a time when style in sculpture was so strongly pronounced, these portraits. as we may see from later copies, are notably ideal. They represent the great men whom they portray not in the spirit of realism Details are neglected. expression is not elaborated; the sculptor tries to represent what is permanent in his subject rather than what is temporary. Hence these portraits do not seem to belong to a particular time of life; they only represent a man in the perfection of physical force and mental energy. And the race or type is clearly shown through individual traits. In some cases it is still disputed whether statues of this age represent deities or mortals, so notable are the repose and dignity which even human figures acquire under the hands of 5th century masters. The Pericles after Cresilas in the British Museum and the athlete-portraits of Polyclitus, are good examples.

PERIOD III. 400–300 B.C.

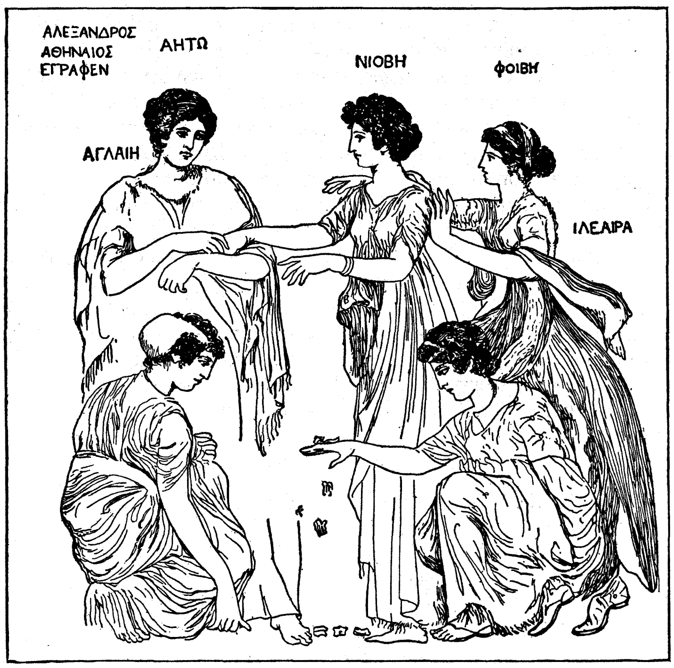
The high ideal level attained by Greek art at the end of the 5th century is maintained in the 4th There cannot be any question of decay in it save at Athens. where undoubtedly the loss of religion and the decrease of national prosperity acted prejudicially. But in Peloponnesus the time was one of expansion, several new and important cities. such as Messene, Megalopolis and Mantinea, arose under the protection of Epaminondas. And in Asia the Greek cities were still prosperous and artistic, as were the cities of Italy and Sicily which kept their independence On the whole there is during this age some diminution of the freshness and simplicity of art; it works less in the service of the gods and more in that of private patrons; it becomes less ethical and more sentimental and emotional On the other hand, there can be no doubt that technique both in painting and sculpture advanced with rapid strides; artists had a greater mastery of their materials, and ventured on a wider range of subject

In the 4th century no new temples of importance rose at Athens; the Acropolis had taken its final form; but at Messene, Tegea, Epidaurus and elsewhere. very admirable buildings arose. The remains of the temple at Tegea are of wonderful beauty and finish; as are those of the theatre and the so-called *Tholus* of Epidaurus. In Asia Minor vast temples of the Ionic order arose, especially at Miletus and Ephesus. The colossal pillars of Miletus astonish the visitors to the Louvre; while the sculptured columns of Ephesus in the British museum show a high level of artistic skill. The Mausoleum erected about 350 B.C at Halicarnassus in memory of Mausolus, king of Caria, and adorned nith sculpture by the most noted artists of the day, was reckoned one of the wonders of the world It has been in part restored in the British museum, where also are models of various conjectural restorations. A small part of the sculptural decoration representing a battle between Greeks and Amazons is shown, wherein the energy of the action and the careful balance of figure against figure are remarkable. We possess also the fine portraits of Mausolus himself and his aife Xrtemisia, nhich stood in or on the building, as well as part of a gigantic chariot with four horses which surmounted it.

Another architectural work of the 4th century, in its way a gem, is the structure set up at Athens by Lysicrates, in memory of a choragic victory. This still survives, though the reliefs with which it is adorned have suffered severely from the weather.

The 4th century is the brilliant period of ancient painting. It opens with the painters of the Asiatic school, Zeuxis and Parrhasius and Protogenes, with their contemporaries Nicias and Apollodorus of Athens, Timanthes of Sicyon or Cythnus, and Euphranor of Corinth. It witnesses the rise of a great school at

Sicyon, under Eupompus and Pamphilus, which was noted for its scientific character and the fineness of its drawing, and which culminated in Apelles, the painter of Alexander the Great. and probably the greatest master of the art in antiquity. To each of these painters a separate article is given, fixing their place in the history of the art. Of their paintings, unfortunately, only a very inadequate notion can be formed. Vase-paintings, which in the 5th century give us some notion at least of contemporary drawing, are less careful in the 4th century. Now and then are found on them figures admirably designed, or successfully foreshortened; but these are rare occurrences. The art of the vase decorator has ceased to follow the methods and improvements of contemporary fresco painters, and is pursued as a mere branch of commerce.



BY COURTESY OF THE NATIONAL MUSEUM, NAPLES

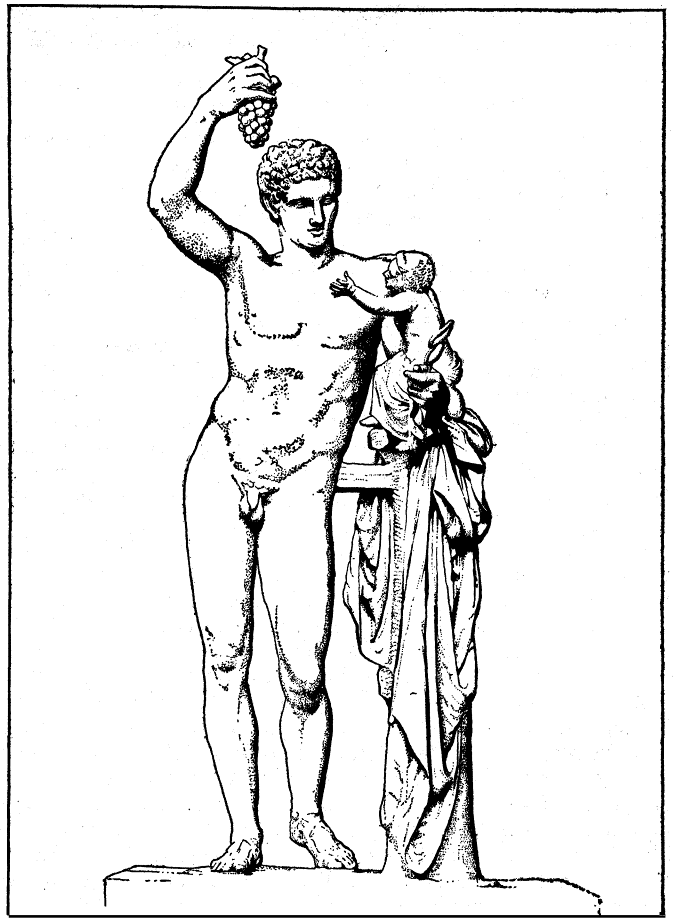
FIG. 22.— DRAWING OF WOMEN PLAYING AT KNUCKLEBONES. 400 B.C.

But few actual paintings of the age survive, and even these fragmentary remains have with time lost the freshness of their colouring; nor are they in any case the work of a noteworthy hand. The illustration (fig. 22) represents the remains of a drawing on marble. showing a group of women playing knucklebones. It was found at Herculaneum. Though signed by one Alexander of Athens. who was probably a worker of the Roman age, Prof Robert correctly maintained that Alexander only copied a design of the age of Zeuxis and Parrhasius. In fact the drawing and grouping is so closely like that of reliefs of about 400 B.C. that the drawing is of great historic value, though there is no colouring. Several other drawings of the same class were found at Herculaneum, and on the walls of the Transtiberine Villa at Rome.

Praxiteles.—Until about 1880 the knowledge of the great Greek sculptors of the 4th century was derived mostly from the statements of ancient writers and from Roman copies, or what were supposed to be copies, of their works. but there is now at least one undoubted original work of Praxiteles as well as sculptures executed under the immediate direction of, if not from the hand of, other great sculptors of that age—Scopas, Timotheus and others. Among all the discoveries made at Olympia in 1877 none became so familiar to the artistic world as that of the Hermes of Praxiteles, a first-rate Greek original by one of the greatest of sculptors. Before its discovery almost all the statues in the museums were either late copies of Greek works of art or else the mere decorative sculpture of temples and tombs, but the Hermes can be submitted to the strictest examination, and it can be seen in every line and touch that it is the work of a great artist This is more than can be said of any of the literary remains of antiquity—poem, play or oration. Hermes is represented by the sculptor in the act of carrying the young child Dionysus to the nymphs who were charged with his rearing. On the journey he pauses and amuses himself by holding out to the child-god a bunch of grapes, and watching his eagerness to grasp them. To the modern eye the child is not a success; only the latest art of Greece is at home in dealing with children. But the Hermes, strong without excessive muscular development, and graceful without leanness, is a model of physical formation, and his face expresses the perfection of health, natural endowment and sweet nature. The statue can scarcely be called a work of religious art in the modern or Christian sense of the word but from the Greek point of view it is religious, as embodying the result of the harmonious development of all human faculties and life in accordance with nature.

The Hermes not only added to the knowledge of Praxiteles, but also confirmed the received views in regard to him. Already many works in galleries of sculpture had been identified as copies of statues of his school.

Noteworthy among these were: the group at Munich representing Peace nursing the infant Wealth, from an original by Cephisodotus, father of Praxiteles; copies of the Cnidian Aphrodite of Praxiteles, especially one in the Vatican, and a torso in the British Museum; copies of the Apollo slaying a lizard (Sauroctonus), of a Satyr (in the Capitol museum), and others. These works, which are noted for their softness and charm, make understandable the saying of ancient critics that Praxiteles and Scopas were noted for the pathos of their works, as Pheidias and Polyclitus for the ethical quality of those they produced. But the pathos of Praxiteles is of a soft and dreamy character; there is no action, or next to none; and the emotions which he rouses are sentimental rather than passionate. Scopas was of another mood The discovery of the Hermes naturally set archaeologists searching in the museums of Europe for other works, which may from their likeness to it in various respects be



FROM "OLYMPIA"

FIG. 23.— THEHERMES OF PRAXITELES FROM OLYMPIA (RESTORED)

set down as Praxitelean in character. In the case of many of the great sculptors of Greece—Strongylion, Silanion, Calamis and others—it is of little use to search for copies of their works, since there is little trustworthy evidence on which to base our enquiries; but in the case of Praxiteles one really stands on a safe level.

Naturally it is impossible in these pages to give any sketch of the results, some almost certain, some very doubtful, of the researches of archaeologists in quest of Praxitelean works. But we may mention a few works which have been claimed by good judges as coming from the master himself Professor Brunn claimed as work of Praxiteles a torso of a satyr in the Louvre, in scheme identical with the well-known satyr of the Capitol. Professor Furtwangler puts in the same category a delicately beautiful head of Aphrodite at Petworth. And his translator, Mrs. Strong, regards the Aberdeen head of a young man in the British Museum as the actual work of Praxiteles Certainly this last head does not suffer when placed beside the Olympian head of Hermes.

At Mantinea (*q v.)* there was found a basis whereon stood a group of Latona and her two children, Apollo and Artemis, made supposedly by Praxiteles. This base bears reliefs representing the musical contest of Apollo and Marsyas, with the Muses as spectators, reliefs very pleasing in style, and quite in the manner of Attic artists of the 4th century. But of course they cannot be ascribed to the hand of the master himself; great sculptors did not themselves execute the reliefs which adorned temples and other monuments, but reserved them for their pupils. Yet the graceful figures of the Muses of Mantinea suggest how much was due to Praxiteles in determining the tone and character of Athenian art in relief in the 4th century. Exactly the same style which marks them belongs also to a mass of sepulchral monuments at Athens, and such works as the Sidonian sarcophagus of the Mourning Women, to be presently mentioned

Scopas.—Excavation on the site of the temple of Athena Alea at Tegea (*q.v.*) in 1883 and later resulted in the recovery of works of the school of Scopas. Pausanias tells that Scopas was the architect of the temple, and so important in the case of a Greek temple is the sculptural decoration, that it can scarcely be doubted that the sculpture also of the temple at Tegea was under the supervision of Scopas, especially as he was more noted as a sculptor than as an architect. In the pediments of the temple were represented two scenes from mythology, the hunting of the Calydonian boar and the combat between Achilles and Telephus. To one or other of these scenes belong several heads of local marble discovered on the spot, which are very striking because of their extraordinary life and animation. Unfortunately they are so much injured that they can scarcely be made intelligible except by the help of restoration; one, the head of a warrior from Tegea, Scopas, 4th century B.C , as restored by a German sculptor, has a strong bony frame and depth from front to back no less noteworthy than the parted lips and deeply set and strongly shaded eye. The latter features impart to the head a vividness of expression such as has been found in no previous work of Greek art, but which sets the key to the developments of art which take place in the Hellenistic age. A draped torso of Atalanta from the same pediment has been fitted to one of these heads. Hitherto Scopas was known, setting aside literary records, only as one of the sculptors who had worked at the Mausoleum. Ancient critics and travellers, however, bear ample testimony to his fame, and the wide range of his activity, which extended to northern Greece, Peloponnese and Asia Minor His Maenads and his Tritons and other beings of the sea were much copied in antiquity. But perhaps he reached his highest level in statues such as that of Apollo as leader of the Muses, clad in long drapery; a head of Apollo found in the Mausoleum, now in the British Museum, is almost certainly a work of Scopas.

Timotheus, Bryaxis, **Leochares.**—In the interesting precinct of Aesculapius at Epidaurus have been found specimens of the style of an Athenian contemporary of Scopas, who worked with him on the Mausoleum An inscription which records the sums spent on the temple of the Physician-god, tells that the models for the sculptures of the pediments, and one set of acroteria or roof adornments, were the work of Timotheus. Of the pedimental figures and the acroteria considerable fragments have been recovered, and it may be assumed with confidence that at all events the models for these were by Timotheus. It is strange that the unsatisfactory arrangement whereby a noted sculptor makes models and some local workman the figures enlarged from those models, should have been tolerated by so artistic a people as the Greeks. The subjects of the pediments appear to have been the common ones of battles between Greek and Amazon and between Lapith and Centaur. There are fragments of some of the Amazon figures, one of which striking downwards at the enemy, is here shown (fig. 27). Their attitudes are vigorous and alert; but the work shows little delicacy of detail. Figures of Nereids riding on horses, which were found on the same site, may very probably be roof ornaments (acroteria) of the temple. There are also several figures of Victory, which probably were acroteria on some smaller temple, perhaps that of Artemis. A base found at Athens, sculptured with figures of horsemen in relief, bears the name of Bryaxis, and was probably made by a pupil of his. Probable conjecture assigns to Eeochares the originals copied in the Ganymede of the Vatican, borne aloft by an eagle, and the noble statue of Alexander the Great at Munich (see LEOCHARES).

Thus it may fairly be said that students are now acquainted with the work of all the great sculptors who worked on the Mausoleum—Scopas, Bryaxis, Leochares and Timotheus; and are in a far more advantageous position than were the archaeologists of 1880 for determining the artistic problems connected with that noblest of ancient tombs.

The School of Argos and Sicyon.—This was contemporary with the Athenian school of Praxiteles; and of it Lysippus was the most distinguished member. Lysippus continued the academic traditions of Polyclitus, but he was far bolder in his choice of subjects and more innovating in style. Gods, heroes and mortals alike found in him a sculptor who knew how to combine fine ideality with a vigorous actuality. He was at the height of his fame during Alexander's life, and the grandiose ambition of the great Macedonian found him ample employment, especially in the frequent representation of himself and his marshals.

There have been discovered none of the actual works of Lysippus; but the best evidence for his style will be found in the statue of Agias, an athlete, found at Delphi, and shown by an inscription to be a marble copy of a bronze original by Lysippus.

The Apoxyomenus of the Vatican (man scraping himself with a strigil) has hitherto been regarded as a copy from Lysippus; but of this there is no evidence, and the style of that statue belongs rather to the 3rd century than the 4th. The Agias, on the other hand, is in style contemporary with the works of 4th century sculptors.

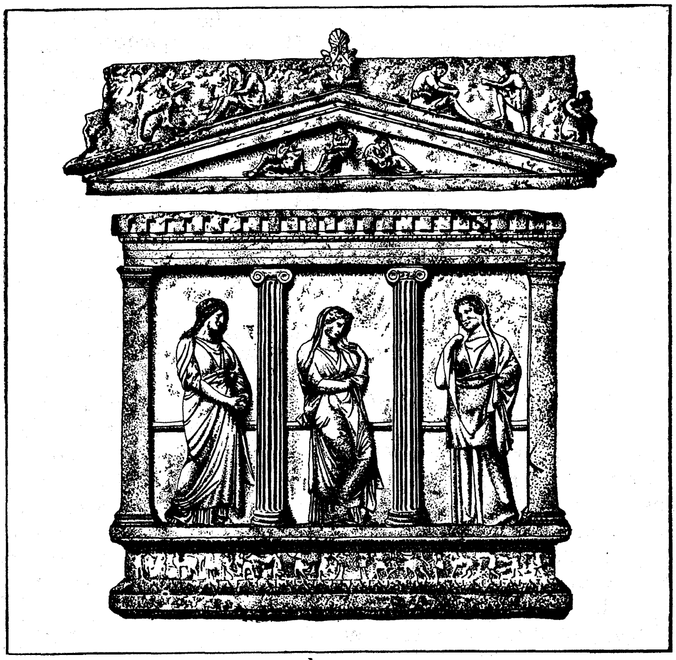
Of the elaborate groups of combatants with which Lysippus enriched such centres as Olympia and Delphi, or of the huge bronze statues which he erected in temples and shrines, no adequate notion can be formed. The recent excavations at Cyrene have produced a figure of Alexander of which the head is of remarkable style, and probably Lysippic in type; a pupil of Lysippus, Eutychides, made a very original and charming statue of the city of Antioch, seated above the river Orontes. The type was widely copied in later sculpture.

Many noted extant statues may be attributed with probability to the latter part of the 4th or the earlier part of the 3rd century. The celebrated group at Florence representing Niobe and her children falling before the arrons of Apollo and Artemis is certainlv a work of the pathetic school, and may be by a pupil of Praxiteles. Niobe, in an agony of grief. which is in the marble tempered and idealized, tries to protect her youngest daughter from destruction. Whether the group can have originally been fitted into the gable of a temple is a matter of dispute.

Two great works preserved in the Louvre are so noted that it is but necessary to mention them, the Aphrodite of Melos, in which archaeologists are now disposed to see the influence of Scopas, and the Victory of Samothrace, an original set up by Demetrius Poliorcetes after a naval victory won at Salamis in Cyprus in 306 B.C. over the fleet of Ptolemy, king of Egypt.

Nor can two works so celebrated as the Apollo of the Belvedere in the Vatican and the Artemis of Versailles be passed over without notice. The Apollo is now by most archaeologists regarded as probably a copy of a work of Leochares, to whose Ganymede it bears a superficial resemblance. The Artemis is regarded as possibly due to some artist of the same age. But it is by no means clear that either of these figures can be removed from among the statues of the Hellenistic age. The old theory of Preller, which saw in them copies from a trophy set up to commemorate the repulse of the Gauls at Delphi in 278 B.C., retained its plausibility.

Sarcophagi of **Sidon.**—This may be the most appropriate place for mentioning the remarkable find made at Sidon in 1886 of a number of sarcophagi, which once doubtless contained the remains of kings of Sidon. They were placed in the museum of Constantinople, and were admirably published by Hamdy Bey and T. Reinach (*Une Nécropole royale à Sidon*, 1892–96). The sarcophagi in date cover a considerable period. The earlier are made on Egyptian models, the covers shaped roughly in the form of a human body or mummy. The later, however, are Greek in form, and are clearly the work of skilled Greek sculptors, who seem to have been employed by the grandees of Phoenicia in the adornment of their last resting places. Four of these sarcophagi in particular claim attention, and in fact present examples of Greek art of the 5th and 4th centuries in several of its aspects. To the 5th century belong the tomb of the Satrap, the reliefs of which bring to light the activities and glories of some unknown king, and the Lycian sarcophagus, so-called from its form, which resembles that of tombs found in Lycia, and which is also adorned with reliefs which have reference to the past deeds of the hero buried in the tomb, though these deeds are represented, not in



FROM HAMDY AND REINACH, "NÉCROPOLE À SIDON"

FIG. 24.— TOMB OF MOURNING WOMEN AT SIDON. 4TH CENTURY B.C.

the oriental manner directly, but in the Greek manner, clad in mythological forms. To the 4th century belong two other sarcophagi. One of these is called the Tomb of Mourning Women. On all sides of it alike are ranged a series of beautiful female figures, separated by Ionic pillars, each in a somewhat different attitude, though all attitudes denote grief (fig. 24). The pediments at the ends of the cover are also closely connected with the mourning for the loss of a friend and protector, which is the theme of the whole decoration of the sarcophagus. Depicted in them are the telling of the news of the death, with the results in the mournful attitude of the two seated figures. The mourning women must be taken, not as the representation of any persons in particular, but generally as the expression of the feeling of a city. Such figures are familiar to us in the art of the second Attic school; there are parallels to the sarcophagus among the 4th century sepulchral reliefs of Athens. The attribution of the workmanship of this beautiful sarcophagus to some sculptor trained in the school of Praxiteles cannot be mistaken. And it is a conjecture full of probability that it once contained the body of Strato, king of Sidon, who ruled about 380 B.C., and who was *proxenos* or public friend of the Athenians.

More celebrated is the astonishing tomb called that of Alexander, though there can be no doubt that, although it commemorates the victories and exploits of Alexander, it was made to hold not his remains but those of some ruler of Sidon who was high in his favour. Among all the monuments of antiquity which have come down to us, none is more admirable than this, and none more characteristic of the Greek genius. The illustration shows, in two lines, the composition which adorned one of the sides of this sarcophagus. It represents a victory of Alexander, probably that of the Granicus (fig. 25). On the left can be seen the Macedonian king charging the Persian horse, on the right his general Parmenio, and in the midst a younger officer, perhaps Cleitus. Mingled with the chiefs are foot soldiers, Greek and Macedonian, with whom the Persians are mingled in unequal fray. What most strikes the modern eye is the remarkable freshness and force of the action and the attitudes. Those, however, who have seen the originals have been specially impressed with the colouring, whereof, of course, our reproduction gives no hint, but which is applied to the whole surface of the relief with equal skill and delicacy. There are other features in the relief on which a Greek eye would have dwelt with special pleasure—the exceedingly careful symmetry of the whole, the balancing of figure against figure, the skill with which the result of the battle is hinted rather than depicted. The composition is one in which the most careful planning and the most precise calculation are mingled with freedom of hand and expressiveness in detail. The faces in particular show more expression than would be expected in art of the previous century. Authorities were unable to assign an author or even a school to the sculptor of this sarcophagus, which comes to us as a new and striking phenomenon in the history of ancient art. The reliefs which adorn the other sides of the sarcophagus are almost equally interesting. On one side is Alexander again, in the company of a Persian noble, hunting a lion. The short sides also show scenes of fighting and hunting. In fact it can scarcely be doubted that if there was but a clue to the interpretation of the reliefs they would be found to embody historic events of the end of the 4th century. There are only a few other works of art, such as the Bayeux tapestry and the Column of Trajan, which bring contemporary history so vividly before our eyes. The battles with the Persians represented in some of the sculpture of the Parthenon and the temple of Nike at Athens are treated conventionally and with no attempt at realism; but here the ideal and the actual are blended into a work of consummate art. which is at the same time, to those who can read the language of Greek art, a historic record. The portraits of Alexander the Great which appear on this sarcophagus are almost contemporary, and the most authentic likenesses of him. The great Macedonian exercised so strong an influence on contemporary art that a multitude of heads of the age, both of gods and men, and even the portraits of his successors, show traces of his type.

There are yet to be mentioned what are among the most charming and the most characteristic products of the Greek chisel, the beautiful tombs, adorned with seated or standing portraits or with reliefs, which were erected in great numbers on all the main roads of Greece. A great number of these from the Dipylon cemetery were preserved in the Central museum at Athens; they impress visitors by the gentle sentiment and the charm of grouping which they display.

PERIOD IV. 300-50 B.C.

There can be no question but that the period which followed the death of Alexander, commonly called the age of Hellenism,

FROM HAMDY AND REINACH. "NÉCROPOLE À SIDON"

FIG. 25.—PAINTED RELIEF ADORNING ONE SIDE OF A SARCOPHAGUS CALLED THE TOMB OF ALEXANDER. PROBABLY REPRESENTING THE VICTORY AT GRANICUS. SIDON. 4TH CENTURY B.C.

was one of great activity and expansion in architecture. The number of cities founded by himself and his immediate successors in Asia and Egypt was enormous. The remains of these cities have in a few cases (Ephesus, Pergamum, Assus, Priene, Alexandria) been partially excavated. But the adaptation of Greek architecture to the needs of the semi-Greek peoples included in the dominions of the kings of Egypt, Syria and Pergamum is too vast a subject to be entered upon here.

Painting during this age ceased to be religious. It was no longer for temples and public stoae that artists worked, but for private persons; especially they made frescoes for the decoration of the walls of houses, and panel pictures for galleries set up by rich patrons. The names of very few painters of the Hellenistic age have come down to us. There can be no doubt that the character of the art declined, and there were no longer produced great uorks to be the pride of cities, or to form an embodiment for all future time of the qualities of a deity or the circumstances of scenes mythical or historic. But at the same time the mural paintings of Pompeii and other works of the Roman age, which are usually more or less nearly derived from Hellenistic models, prove that in technical matters painting continued to progress. Colouring became more varied, groups more elaborate, perspective was worked out with greater accuracy, and imagination shook itself free from many of the conventions of early art. Pompeian painting, however, must be treated of under Roman, not under Greek art. There is shown a single example, to depict the elaboration of painting at Alexandria and elsewhere, the wonderful Pompeian mosaic (fig. 28), which represents the victory of Alexander at Issus This work being in stone has preserved its colouring; and it stands at a far higher level of art than ordinary Pompeian paintings. This, on the contrary, is certainly copied from the work of a great master. It is instructive to compare it with the sarcophagus illustrated in fig. 25, which it excels in perspective and in the freedom of individual figures, though the composition is much less careful and precise. Alexander charges from the left (his portrait being the least successful part of the picture), and bears down a young Persian; Darius in his chariot flees towards the right; in the foreground a young knight is trying to manage a restive horse. It will be observed how very simple is the indication of locality: a few stones and a broken tree stand for rocks and woods.

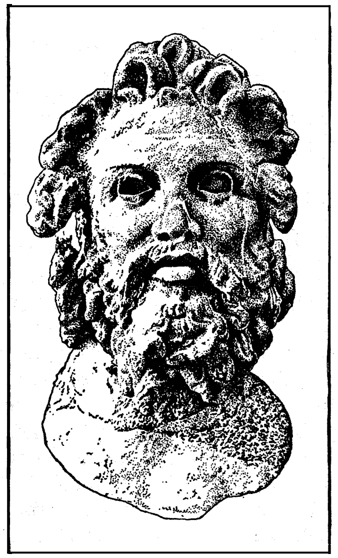


FIG. 26.—THE HEAD OF THE TITAN ANYTUS. ONE OF THE COLOSSAL HEADS FOUND AT LYCOSURA

Among the original sculptural creations of the early Hellenistic age, a prominent place is claimed by the statue of Fortune, typifying the city of Antioch, a work of Eutychides, a pupil of Lysippus.

Of this we possess a small copy, which is sufficient to show how worthy of admiration was the original. We have a beautiful embodiment of the personality of the city, seated on a rock, holding ears of corn. while the river Orontes, embodied in a young male figure, springs forth at her feet.

Almost the only remaining work of the early 3rd century which shows imagination is the above-mentioned statue typifying the city of Antioch by Eutychides, a pupil of Lysippus. Sculptors often worked on a colossal scale, producing such monsters as the colossal Apollo at Rhodes, the work of Chares of Lindus, which was more than 100ft. in height; but they did not show freshness or invention, and for the most part contented themselves with varying the types produced in the great schools of the 4th century. The wealthy kings of Syria, Egypt and Asia Minor formed art galleries, and were lavish in their payments; but it has often been proved in the history of art that originality cannot be produced by mere expenditure.

A great artist, whose date has been disputed, but who is now assigned to the Hellenistic age, Damophon of Messene, is known from his actual works. He set up in the shrine of the *Mistress* (Despoena) at Lycosura in Arcadia a great group of figures consisting of Despoena, Demeter, Artemis and the Titan Anytus. Three colossal heads found on the spot probably belong to the three last-mentioned deities. The illustration is of the head of Anytus, with wild disordered hair and turbulent expression (fig. 26). Dr. Dorpfeld argued, on architectural grounds, that shrine and images alike must be given to a later time than the 4th century; and this judgment is now confirmed by inscriptional and other evidence.

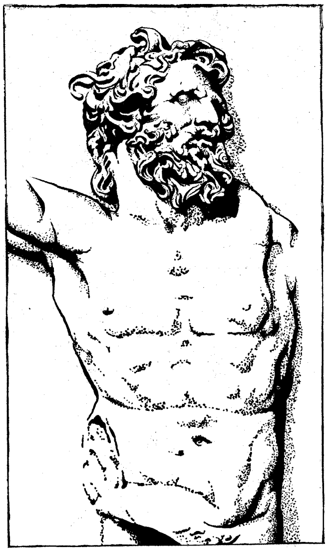


FIG. 27.—GIANT FROM THE GREAT ALTAR OF PERGAMUM; SHAGGY HAIR, FIERCE EXPRESSION, AND HUGE MUSCLES PROBABLY DERIVED FROM THE GALATIANS

In one important direction sculpture certainly made progress. Hitherto Greek sculptors had contented themselves with studying the human body whether in rest or motion, from outside. The dissection of the human body, with a consequent increase in knowledge of anatomy, became usual at Alexandria in the medical school which flourished under the Ptolemies. This improved anatomical knowledge soon reacted upon the art of sculpture. Works such as the Fighter of Agasias in the Louvre, and in a less degree the Apoxyomenus, display a remarkable internal knowledge of the human frame, such as could only come from the habit of dissection. Whether this was really productive of improvement in sculpture may be doubted. But it is impossible to withhold one's admiration from works which show an astonishing knowledge of the body of man down to its bony framework, and a power and mastery of execution which have never since been surpassed.

With accuracy in the portrayal of men's bodies goes of necessity a more naturalistic tendency in portraiture. The art of portraiture was at a high ideal level in the Pheidian age; and even in the age of Alexander the Great, notable men were rendered rather according to the idea than the fact. To a base and mechanical naturalism Greek art never at any time descended. But from 300 B.C. onwards there is a marvellous series of portraits which may be termed rather characteristic than ideal, which are very minute in their execution, and delight in laying emphasis on the havoc wrought by time and life on the faces of noteworthy men. Such are the portraits of Demosthenes, of Antisthenes, of Zeno and others, which exist in our galleries. And it was no long step from these actual portraits to the invention of characteristic types to represent the great men of a past generation, such as Homer and Lycurgus, or to form generic images to represent weather-beaten fishermen or toothless old women.

Altar **of Pergamum.**—The knowledge of the art of the later Hellenistic age is greatly indebted to the German Archaeological institute, the systematic labours of which since 1875 have resulted in recovering the remains of Pergamum, the fortress-city which was the capital of the dynasty of the Philetaeri. Among the ancient buildings of Pergamum none was more ambitious in scale and striking in execution than the great altar used for sacrifices to Zeus, a monument supposed to be referred to in the phrase of the Apocalypse "where Satan's throne is." This altar, like many great sacrificial altars of later Greece, was a vast erection to which one mounted by many steps, and its outside was adorned with a frieze which represented on a gigantic scale, in the style of the 2nd century B.C., the battle between the gods and the giants. This enormous frieze (*see* PERGAMUM) is now one of the treasures of Berlin, and it cannot fail to impress visitors by the size of the figures, the energy of the action, and the strong vein of sentiment which pervades the whole, giving it a certain air of modernity, though the subject is strange to the Christian world. In early Greek art the giants where they oppose the gods are represented as men armed in full panoply, "in shining armour, holding long spears in their hands," to use the phrase in which Hesiod describes them. But in the Pergamene frieze the giants are strange compounds, having the heads and bodies of wild and fierce barbarians, sometimes also human legs, but sometimes in the place of legs two long serpents, the heads of which take with the giants themselves a share in the battle. Sometimes also they are winged. The gods appear in the forms which had been gradually made for them in the course of Greek history, but they are usually accompanied by the animals sacred to them in *cultus,* between which and the serpent-feet of the giants a weird combat goes on. We can conjecture the source whence the Pergamene artist derived the shaggy hair, the fierce expressions, the huge muscles of his giants (fig. 27); probably these features came originally from the Galatians, who at the time had settled in Asia Minor, and were spreading the terror of their name and the report of their savage devastations through all Asia Minor. The victory over the giants clearly stands for the victory of Greek civilization over Gallic barbarism; and this meaning is made more emphatic because the gods are obviously inferior in physical force to their opponents, indeed, a large proportion of the divine combatants are goddesses. Yet everywhere the giants are overthrown, writhing in pain on the ground, or transfixed by the weapons of their opponents; everywhere the gods are victorious, yet in the victory retain much of their divine calm.

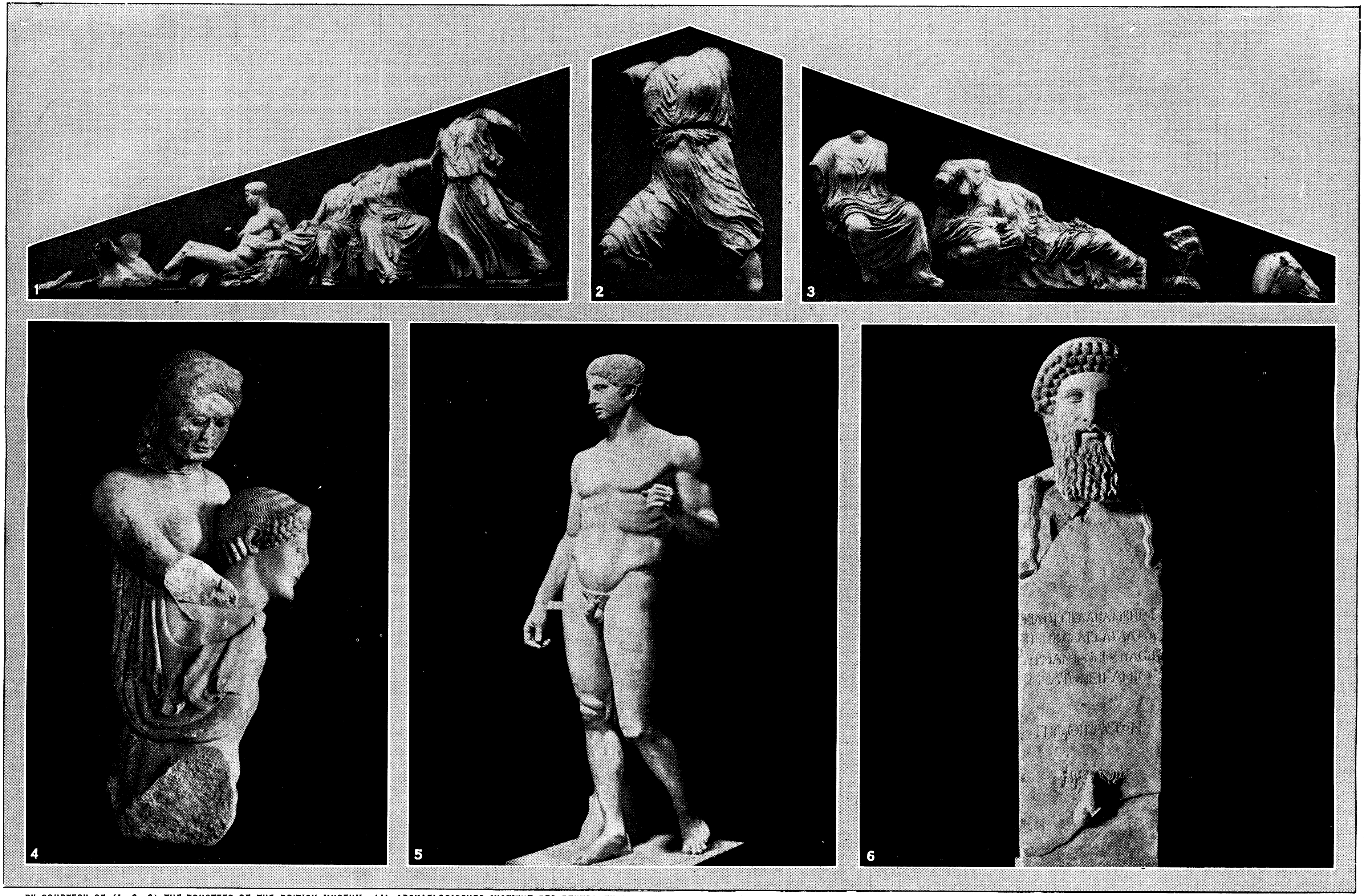
The piecing together of the frieze at Berlin has been a labour of many years; it is now complete, and there is a special museum devoted to it. Some of the groups have become familiar to students from photographs, especially the group which represents Zeus slaying his enemies with thunderbolts, and the group wherein Athena seizes by the hair an overthrown opponent, who is winged, while Victory runs to crown her, and beneath is seen Gaia, the earth-goddess who is the mother of the giants, rising out of the ground, and mourning over her vanquished and tortured children.

Another and smaller frieze which also decorated the altar-place gives us scenes from the history of Telephus, who opposed the landing of the army of Agamemnon in Asia Minor and was overthrown by Achilles; it is quite fragmentary, but was pieced together by Dr. Schneider in the *Jahrbuch* of the German Archaeological institute for 1900.

Since the Renaissance Rome has produced a continual crop of works of Greek art of all periods, partly originals brought from Greece by conquering generals, partly copies, such as the group at Rome formerly known as Paetus and Arria, and the overthrown giants and barbarians which came from the elaborate trophy set up by Attalus at Athens, of which copies exist in many museums.

A noted work of kindred school is the group of Laocoön and his sons, signed by Rhodian sculptors of the 1st century B.C., which has been perhaps more discussed than any work of the Greek chisel, and served as a peg for the aesthetic theories of Lessing and Goethe. In our days the histrionic and strained character of the group is regarded as greatly diminishing its interest, in spite of the astounding skill and knowledge of the human body shown by the artists. To the same school belong the late representations of Marsyas being flayed by the victorious Apollo, a somewhat repulsive subject, chosen by the artists of this age as a means for displaying their accurate knowledge of anatomy.

On what a scale some of the artists of Asia Minor would work

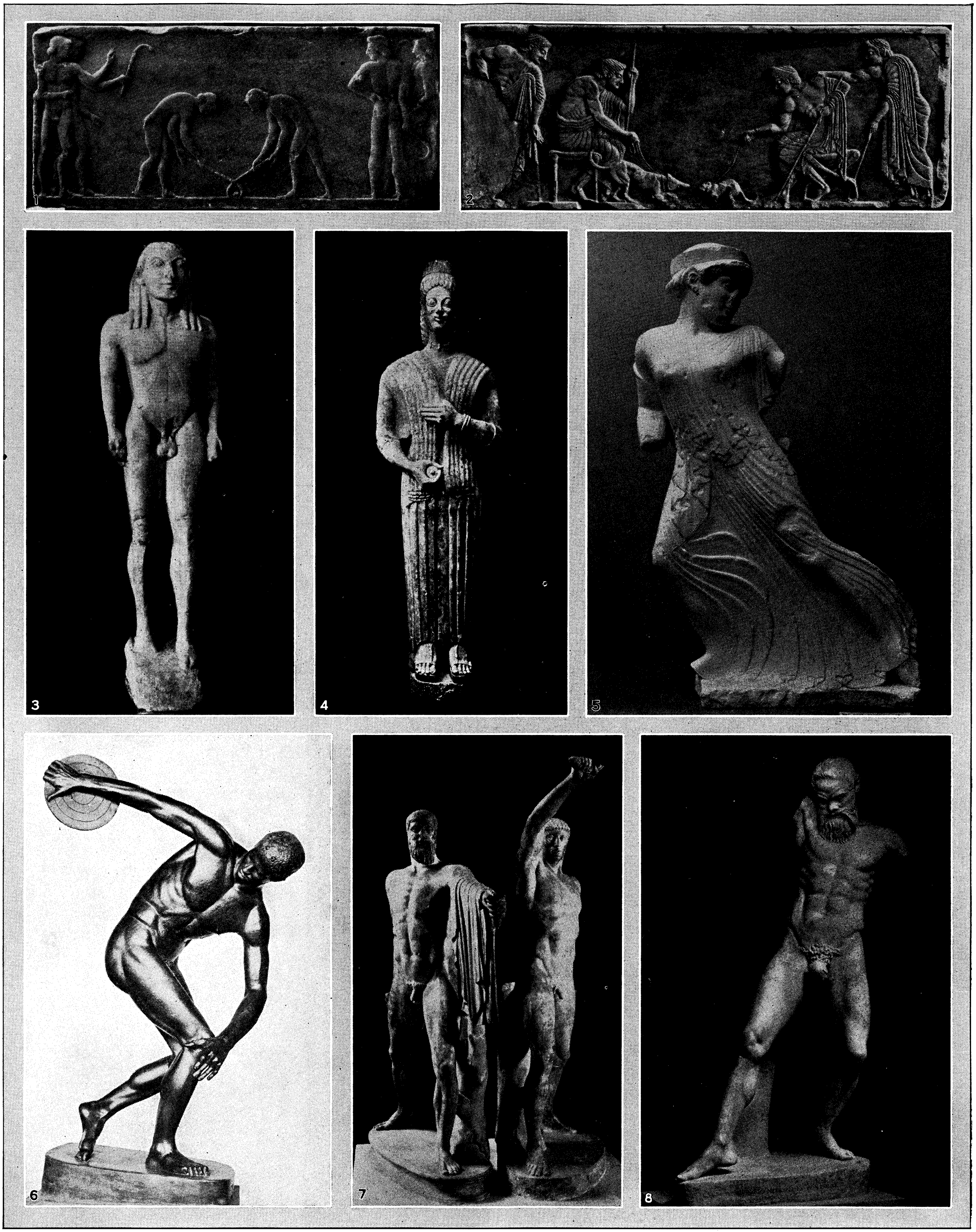


BY COURTESY OF (1, 2, 3) THE TRUSTEES OF THE BRITISH MUSEUM, (4) ARCHAELOGISCHES INSTITUT DES DEUTSCHEN REICHES, ATHENS; PHOTOGRAPHS, (5) ALINARI, (6) SEBAH AND JOAILLER

ARCHAIC AND FIFTH CENTURY SCULPTURE

1. East pediment of the Parthenon, left end, the birth of Athena; 5th century B.C.
2. Figure of Victory from one of the pediments of the Parthenon (probably not from the East pediment, parts of which are shown in figs. 1 and 3)
3. East pediment of the Parthenon, right end, three female figures called the Three Fates
4. Theseus and Amazon (Eretria), Archaic period
5. Roman copy of the Doryphorus or spear-bearer of Polyclitus. type of the 5th century B.C. National Museum, Naples
6. Roman copy of the Hermes of Alcamenes (head), type of the 5th century B.C. Museum, Constantinople

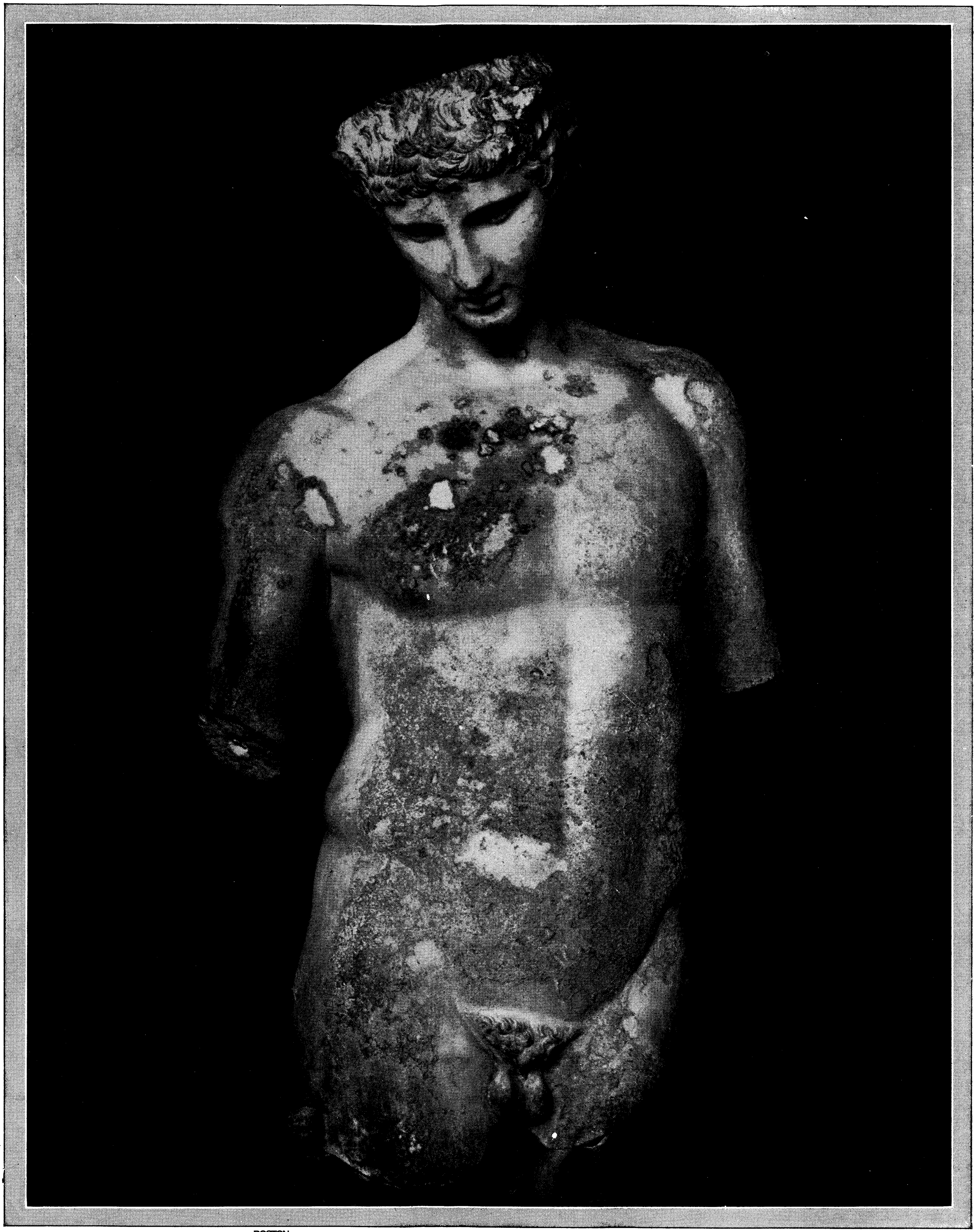
GREEK ART



BY COURTESY OF (1, 2) CLARENCE KENNEDY, (5) THE METROPOLITAN MUSEUM OF ART, NEW YORK, (6) F. BRUCKMANN; FROM (4) "DIE ANTIKE II," (WALTER DE GRUYTER AND COMPANY), (7) RICHTER, "SCULPTURE AND SCULPTORS OF THE GREEKS" (YALE UNIVERSITY PRESS); PHOTOGRAPHS, (3) ALINARI, (8) ANDERSON

GREEK SCULPTURE OF THE VI. AND V. CENTURIES B.C.

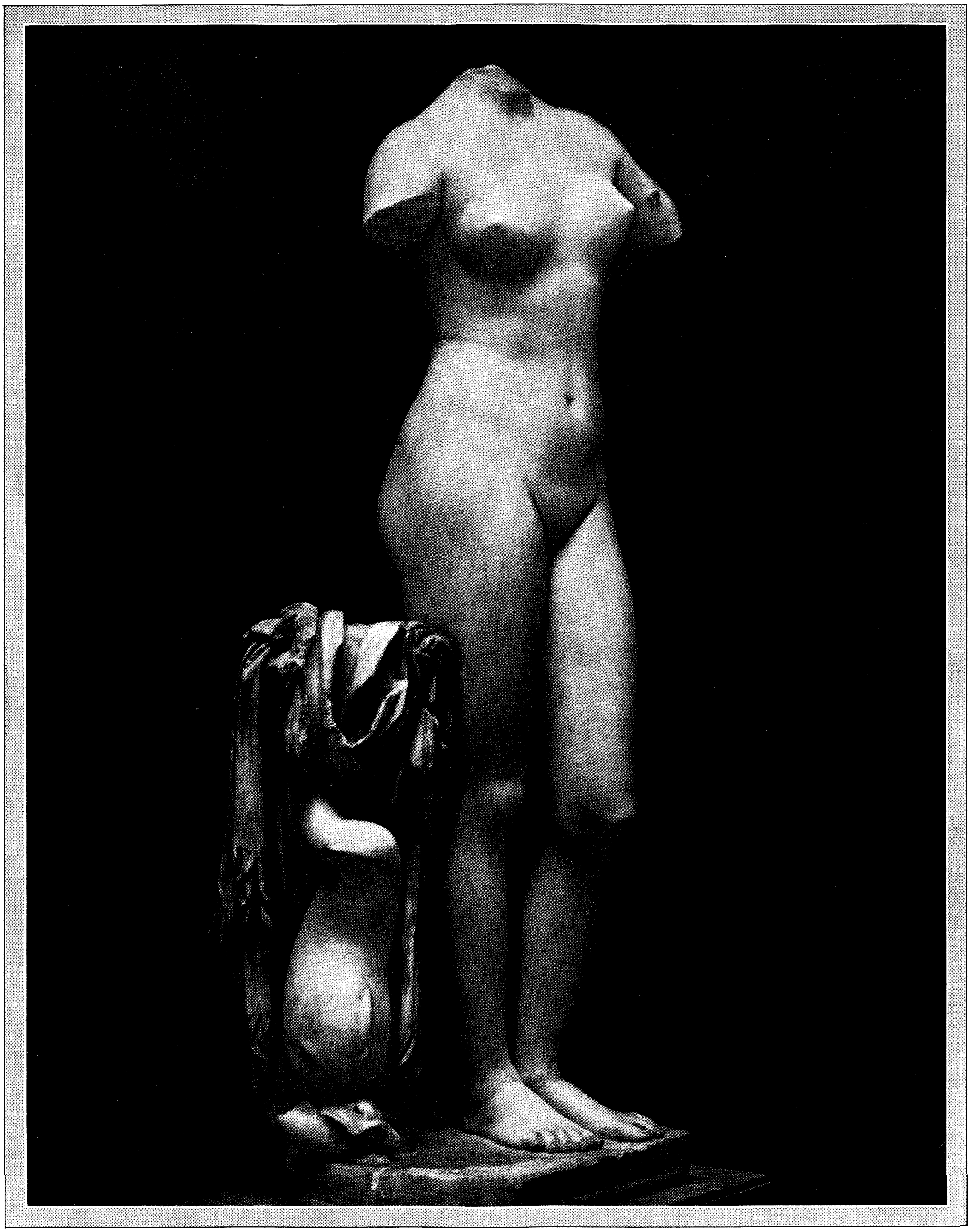
1 and 2. Reliefs from statue bases found in the ruins of the wall of Themistocles, Athens, in 1922. 3. Cleobis, at Delphi, by an Argive sculptor, 6th century; earliest example of Greek portrait sculpture. 4. Standing maiden Museum, Berlin. 5. Statuette of girl running, early 5th century: a cast. original in Museum of Eleusis. 6. Discobolus, by Myron. 5th century: restored by Prof. A. Furtwangler. 7. Harmodius and Aristogiton, probably Roman copies of Greek works of 477-76 B.C. National Museum, Naples. 8. Marsyas. by Myron, 5th century; copy. Lateran Museum, Rome



BY COURTESY OF THE MUSEUM OF FINE ARTS, BOSTON

YOUNG HERMES

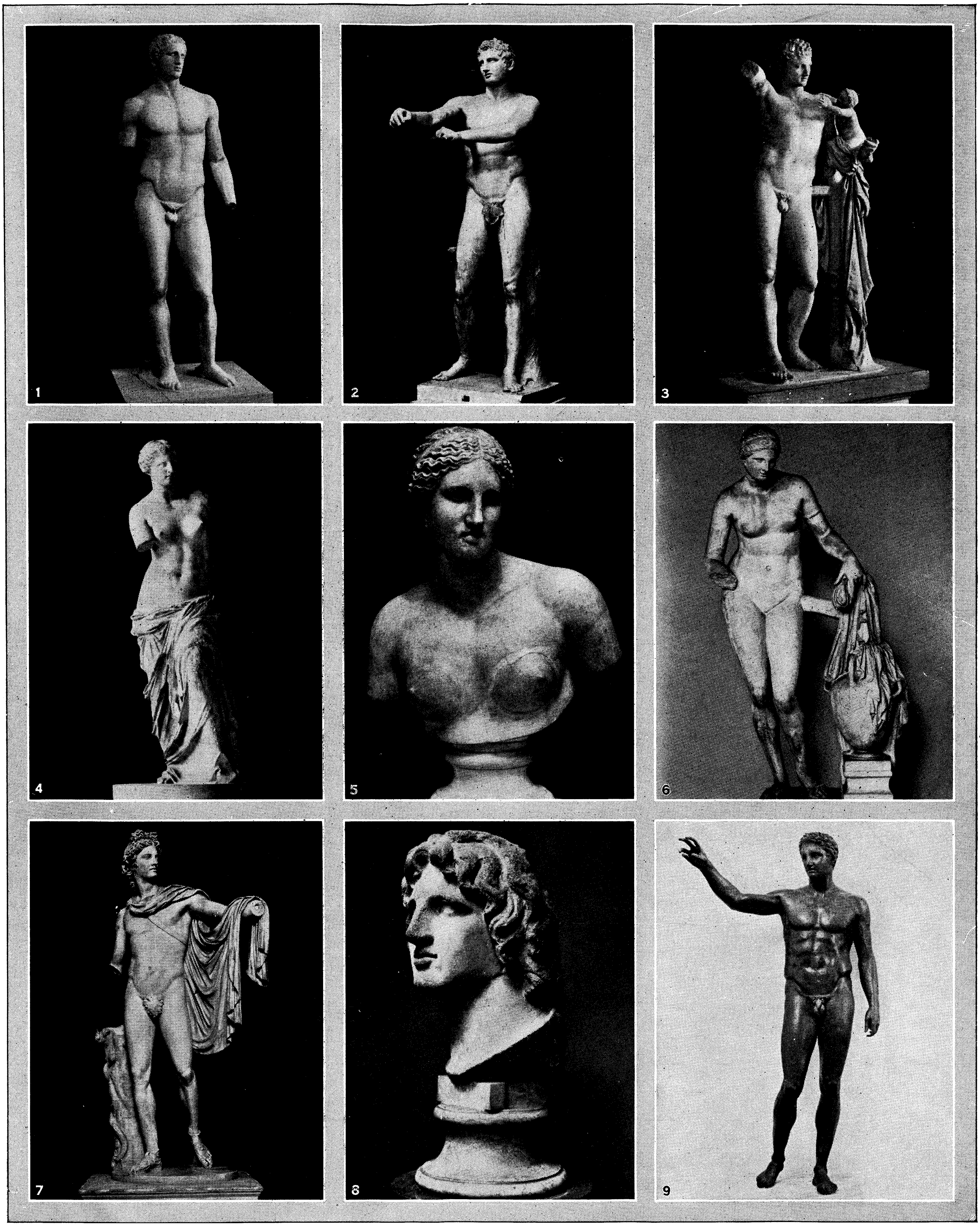
In the Polyclitan style. It may represent Hermes Psychopompos, the Conductor of Souls, and was found near Capua. Roman copy, Graeco-Roman period, 100 B.C.–A.D. 200



PHOTOGRAPH, ALINARI

APHRODITE OF CYRENE

This Venus, found in the Thermae at Cyrene in December 1913, represented the goddess just risen from the sea and wringing out her hair. The support at the side represents a dolphin. The statue may be early Hellenistic, of the Alexandrine school, or possibly a Roman copy. Terme Museum, Rome



GREEK SCULPTURE, IV. TO II. CENTURY B.C.

1. Agias, athlete, Delphi, 4th c. 2. Copy of Apoxyomenos, Lysippus, late 4th c. Vatican. 3. Hermes with the infant Dionysus, Praxiteles, 4th c. Olympia. Original found in 1877. 4. Aphrodite of Melos (Venus de Milo), 2nd c. Louvre. 5. Bust of Aphrodite of Praxiteles, 4th c. copy. British Museum. 6. Aphrodite of Cnidus, 4th c. copy, from a cast. Original in the Vatican. 7. Apollo of the Belvedere, 4th (?) c. Vatican. 8. Head of young Alexander from Cyrene, about 4th c. British Museum. 9. Bronze. athlete, found in the sea near Cythera, style of 4th c. Athens

GREEK ART

BY COURTESY OF (8) THE METROPOLITAN MUSEUM OF ART, NEW YORK; PHOTOGRAPHS, (1, 5, 6, 9) ALINARI, (2, 7) GIRAUDON, (3) F. BRUCKMANN, (4) ANDERSON

GREEK SCULPTURE

1. Niobe and her youngest daughter, 4th–3rd c. B.C.; copies. Uffizi Gallery, Florence. 2. Winged Victory of Samothrace; original, 4th c. B.C. Louvre. 3. Niobid, probably an original of the 5th c. B.C. Terme Museum, Rome. 4. Seated boxer, bronze, late Hellenistic. Terme Museum, Rome. 5. Laocoon group, first c. B.C. Vatican. 6. Flaying of Marsyas, Rhodian school. Villa Albani, Rome. 7. Fighter, of Agasias. Louvre. 8. "Marathon boy." Found in the bay of Marathon; 4th c. B.C. 9. Symbolic figure of the city of Antioch, seated above the river Orontes; 3rd c. B.C. Vatican

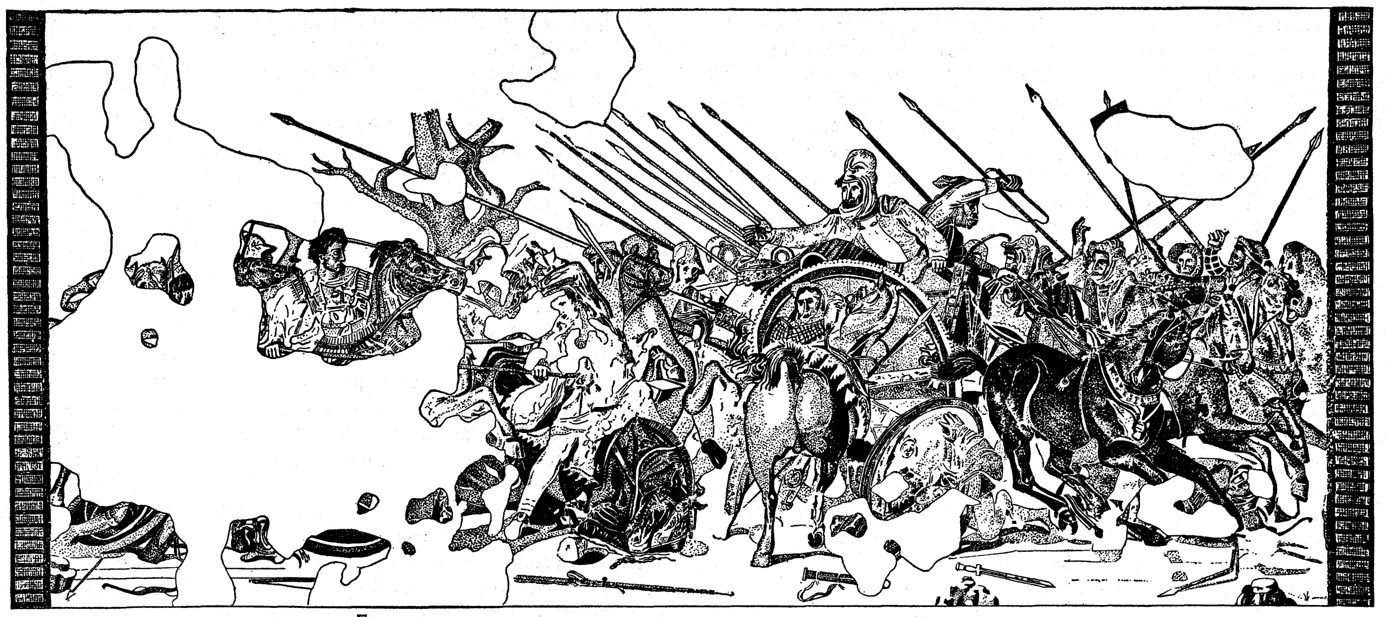


FIG. 28.—BATTLE OF ISSUS AFTER THE MOSAIC IN THE NAPLES MUSEUM

is shown us by the enormous group, by Apollonius and Tauriscus of Tralles, which is called the Farnese Bull, and which represents how Dirce was tied to a wild bull by her stepsons Zethus and Amphion.

Rome. — The extensive excavations and alterations which have taken place at Rome in recent years have been very fruitful; the results may be found partly in the palace of the Conservatori on the Capitol, partly in the Museo delle Terme. Among statues found in our own days none excel in interest some bronzes of large size dating from the Hellenistic age. In the figure of a seated boxer, in scale somewhat exceeding life, attitude and gesture are expressive. Evidently the boxer has fought already, and is awaiting a further conflict. His face is cut and swollen; on his hands are the terrible caestus, here made of leather, and not loaded with iron, like the caestus described by Virgil. The figure is of astounding force; but though the face is brutal and the expression savage, in the sweep of the limbs there is nobility. even ideal beauty. To the last the Greek artist could not set aside his admiration for physical perfection. Another bronze figure of more than life-size is that of a king of the Hellenistic age standing leaning on a spear. He is absolutely nude, like the athletes of Polyclitus. Another large bronze presents us with a Hellenistic type of Dionysus.

Beside the bronzes found in Rome we may set those retrieved from the sea on the coast of Cythera, the contents of a ship lost on the way from Greece to Rome. The date of these statues has been disputed, but, even if executed in the Roman age, they go back to originals of the 5th and 4th centuries The most noteworthy among them is a beautiful athlete, standing mith hand upraised, which reflects the style of the Attic school of the 4th century.

After 146 B.C. when Corinth was destroyed and Greece became one of the Roman provinces, Greek art, though by no means extinct, worked mainly in the employ of the Roman conquerors *(see* ROMAN ART).

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GREEK FIRE, the name applied to inflammable and destructive compositions used in warfare during the middle ages and particularly by the Byzantine Greeks at the sieges of Constantinople. The employment of liquid fire is represented on Assyrian bas-reliefs. At the siege of Plataea (429 B.C.) the Spartans attempted to burn the town by piling up against the walls wood saturated with pitch and sulphur and setting it on fire (Thuc. ii. 77), and at the siege of Delium (424 B.C.) a cauldron containing pitch, sulphur and burning charcoal, was placed against the walls and urged into flame by the aid of a bellows, the blast from which was conveyed through a hollow tree-trunk (Thuc. iv. 100). Aeneas Tacticus in the following century mentions a mixture of sulphur, pitch, charcoal, incense and tow, which was packed in wooden vessels and thrown lighted upon the decks of the enemy's ships. Later, as in receipts given by Vegetius (*c.* A.D. 350), naphtha or petroleum is added, and some nine centuries afterwards the same substances are found forming part of mixtures described in the later receipts (which probably date from the beginning of the 13th century) of the collection known as the *Liber ignium* of Marcus Graecus. In subsequent receipts saltpetre and turpentine make their appearance, and the modern "carcass composition," containing sulphur, tallow, rosin, turpentine, saltpetre and crude antimony, is a representative of the same class of mixtures, which became known to the Crusaders as Greek fire but were more usually called wildtire. Greek fire, properly so-called, was, however, of a somewhat different character. It is said that in the reign of Constantine Pogonatus (648–685) an architect named Callinicus, who had fled from Heliopolis in Syria to Constantinople, prepared a wet fire which was thrown out from siphons (*τὸ διὰ τῶν σιφώνων ἐκφερόμενον πῦρ ὑγρόν*), and that by its aid the ships of the Saracens were set on fire at Cyzicus and their defeat assured. The art of compounding this mixture, which is also referred to as *πῦρ θαλάσσιον*, or sea fire, was jealously guarded at Constantinople, and the possession of the secret on several occasions proved of great advantage to the city. The nature of the compound is somewhat obscure. It has been supposed that the novelty introduced by Callinicus was saltpetre, but this view involves the difficulty that that substance was apparently not known till the 13th century, even if it were capable of accounting for the properties attributed to the wet fire. Lieut.-Col. H. W. L. Hime, after a close examination of the available evidence, concludes that what distinguished Greek fire from the other incendiaries of the period was the presence of quicklime, which was well known to give rise to a large development of heat when brought into contact with water. The mixture, then, was composed of such materials as sulphur and naphtha with quicklime, and took fire spontaneously when wetted—whence the name of wet fire or sea fire; and portions of it were "projected and at the same time ignited by applying the hose of a water engine to the breech" of the siphon, which was a wooden tube, cased with bronze. A revival of the idea, if transformed in character by modern chemistry. was seen in the flame throwers (*q.v.*) of World War I and World War II.

See H. W. L. Hime, Gunpowder and Ammunition, their Origin and Progress (London, 1904).

GREEK INDEPENDENCE, WAR OF, the name given to the great rising of the Greek subjects of the sultan against the Ottoman domination, which began in 1821 and ended in 1833 with the establishment of the independent kingdom of Greece. The circumstances that led to the insurrection and the general diplomatic situation by which its fortunes were from time to time atiected are described elsewhere (see GREECE: Modern History; TURKEY: History). If we exclude the abortive invasion of the Danubian principalities by Prince Alexander Ypsilanti (March 1821), which collapsed ignominiously as soon as it was disavowed by the tsar. the theatre of the war was confined to continental Greece, the Morea and the adjacent narrow seas. Its history may, broadly speaking, be divided into three periods: the first (1821–24), during which the Greeks, aided by numerous volunteers from Europe, were successfully pitted against the sultan's forces alone; the second, from 1824, when the disciplined troops of Mehemet Ali, pasha of Egypt, turned the tide against the insurgents; the third, from the intervention of the European powers in the autumn of 1827 to the end.

When, on April 2, 1821, Archbishop Germanos, head of the *Hetaeria* in the Morea, raised the standard of the cross at Ralavryta as the signal for a general rising of the Christian population, the circumstances were highly favourable. In the Morea itself, in spite of plentiful warning, the Turks were wholly unprepared; while the bulk of the Ottoman army, under Kurshid Pasha, was engaged in the long task of reducing Ali, pasha of Iannina (see ALI [called the Lion of Janina]) Another factor, and that the determining one, soon came to the aid of the Greeks. In warfare carried on in such a country as Greece, sea-girt and with a coast deeply indented, inland without roads and intersected aith rugged mountains, victory—as Wellington was quick to observe—must rest with the side that has command of the sea. This was assured to the insurgents at the outset by the revolt of the maritime communities of the Greek archipelago. The Greeks of the islands had been accustomed from time immemorial to seafaring; their ships were well armed. to guard against the Barbary pirates and rovers of their own kin; lastly, they had furnished the bulk of the sailors to the Ottoman navy which, now that this recruiting ground was closed, had to be manned hastily with impressed crews of dock-labourers and peasants. The Turkish fleet, "adrift in the Archipelago"—as the British seamen put it—though greatly superior in tonnage and weight of metal, could never be a match for the Greek brigs, manned as these were by trained. if not disciplined. crews.

Outbreak **of the** Insurrection.—The war was begun by the Greeks without definite plan and without any generally recognized leadership The force with which Germanos marched from Kalavryta against Patras was composed of peasants armed with scythes, clubs and slings, among whom the "primates" exercised a somewhat honorary authority. The town itself was destroyed, but the citadel remained in the hands of the Turks till 1828. Meanwhile, in the south, leaders of another stamp had appeared: Petros, bey of the Maina (*q.v*) chief of the Mavromichales, who at the head of his clan attacked Ralamata and put the Mussulman inhabitants to the sword; and Kolokotrones, a notable brigand once in the service of the Ionian government, who—fortified by a vision of the Virgin—captured Karytaena and slaughtered its infidel population. Encouraged by these successes the revolt spread rapidly; within three weeks there was not a Mussulman left in the open country. The flames of revolt now spread across the Isthmus of Corinth: early in April the Christians of Dervenokhoria rose, and the whole of Boeotia and Attica quickly followed suit; at the beginning of May the Mussulman inhabitants of Athens were blockaded in the Acropolis. In the Morea, meanwhile, a few Mussulman fortresses still held out. One by one they fell, and everywhere were repeated the same scenes of butchery. The horrors culminated in the capture of Tripolitsa, the capital of the vilayet. In September this was taken by storm; Kolokotrones rode in triumph to the citadel over streets carpeted with the dead; and the crowning triumph of the Cross was celebrated by a cold-blooded massacre of 2,000 prisoners of all ages and both sexes. This completed the success of the insurrection in the Morea, where only Patras, Nauplia, and one or two lesser fortresses remained to the Turks.

Meanwhile, north of the Isthmus, the fortunes of war had been less one-sided. In the west Khurshid's lieutenant. Omar Vrioni (a Mussulman Greek of the race of the Palaeologi), had inflicted a series of defeats on the insurgents, and relieved the Acropolis; but the rout of Mohammed Pasha, who was coming to his aid in the defile of Mount Oeta, forced him to retreat and the campaign of 1821 ended with the retirement of the Turks into Thessaly. The month of April had witnessed the revolt of the principal Greek islands, Spetsae, Psara, Hydra and Samos. Their fleets were divided into squadrons, of which one, under Tombazes, was deputed to watch for the entrance of the Ottomans into the archipelago, while the other under Andreas Miaoulis (*q.v.*) sailed to blockade Patras and watch the coasts of Epirus. At sea, as on land the Greeks opened the campaign with hideous atrocities.

General Character of **the** War.—These inauspicious beginnings, indeed, set the whole tone of the war, which was frankly one of mutual extermination. On both sides the combatants were barbarians, without discipline or competent organization. At sea the Greeks rapidly developed into mere pirates, and even Miaoulis, for all his high character and courage, was often unable to prevent his captains from sailing home at critical moments, when pay or booty failed. On land the presence of a few educated Phanariots, such as Demetrios Ypsilanti or Alexander Mavrocordato, was powerless to inspire the rude hordes with any sense of order or of humanity in warfare; while every lull in the fighting was the signal for internecine conflicts due to the rivalry of the leaders. Their cause, indeed, was helped more by the impolitic reprisals of the Turks than by the heroism of the insurgents. All Europe stood aghast at the news of the execution of the Patriarch Gregorios of Constantinople (April 22, 1821) and the wholesale massacres that followed. The cause of Greece was now that of Christendom, of the Catholic and Protestant west, as of the Orthodox east. European Liberalism, too, gagged and fettered under Metternich's "system," recognized in the Greeks the champions of its own cause; while even conservative statesmen, schooled in the memories of ancient Hellas, saw in the struggle a fight of civilization against barbarism. This latter belief, which was flattering to their vanity, the Greek leaders were astute enough to foster; the propaganda of Adamantios Coraës had done its work: and wily brigands, like Odysseus of Ithaka, assuming the style and trappings of antiquity, posed as the champions of classic culture against the barbarian. All Europe hailed with joy the exploit of Constantine Kanaris, who on the night of June 18–19, succeeding in steering a fireship among the Turkish squadron off Scio, burned its flagship with 3.000 on board.

Expedition of Dramali, **1822.**—Meanwhile Sultan Mahmud, now wide awake to the danger, had been preparing for a systematic effort to suppress the rising. The threatened breach with Russia had been avoided by Metternich's influence on the tsar Alexander; the death of Ali of Iannina had set free the army of Khurshid Pasha, who was charged with the task of reducing the hforea. In the spring of 1822 two Turkish armies advanced southwards: one, under Omar Vrioni, along the coast of western Hellas, the other, under Ali, pasha of Drama (Dramali): through Boeotia and Attica. Omar was held in check by the mud ramparts of Missolonghi; but Dramali crossed the Isthmus and with the over-confidence of a conquering barbarian advanced to the relief of the hard-pressed garrison of Nauplia. He crossed the perilous defile of Dervenaki unopposed; and at the news of his approach most of the members of the Greek Government assembled at Argos fled in panic. Demetrios Ypsilanti, however, with a few hundred men joined the Mainote Karayanni in the castle of Larissa, which crowns the acropolis of ancient Argos. This held Dramali in check, and gave Kolokotrones time to collect an army. The Turks, in the absence of the fleet which was to have brought them supplies, were forced to retreat (Aug. 6); the Greeks, inspired with new courage, awaited them in the pass of Dervenaki. where the undisciplined Ottoman host. thrown into confusion by an avalanche of boulders hurled upon them, was annihilated. In western Greece Omar Vrioni opposed and was forced to abandon the siege of Missolonghi and retire northwards.

Civil War Among the Greeks.—The victorious outcome of the year's fighting had a disastrous effect upon the Greeks. Their victories had been due mainly to the guerilla leaders; Mavrocordato, whose character and antecedents had marked him out as the natural head of the new Greek state, in spite of his successful defense of Rlissolonghi, had been discredited by failures elsewhere, and the Greeks thus learned to despise their civilized advisers and to underrate the importance of discipline. The temporary removal of the common peril let loose all the sectional and personal jealousies and the year 1823 witnessed the first civil war between the Greek parties. These internecine feuds might easily have proved fatal to the cause of Greece. All semblance of discipline and cohesion had vanished from the Creek fleet. Had Khosrev, the new Ottoman admiral, been a man of enterprise, he might have regained the command of the sea and, with it, that of the whole situation. But the fate of his predecessor had filled him with a lively terror of Kanaris and his fireships; he contented himself with a cruise around the coasts of Greece, throwing supplies and troops into Coron, Modon and Petras. On land the Turks gained some initial successes, but in the end the harassing tactics of the guerilla bands forced them back northwards. At the end of the year the Greeks were once more free to renew their internecine feuds. Just when these feuds were at their height, in Jan., 1824, the most famous of the Philhellenes uho sacrificed themselves for the cause of Greece. Lord Byron, arrived at Missolonghi. The year was destined to be a fateful one for the Greek cause. The large loans raised in Europe, while providing the Greeks with the sinews of war, provided them also with fresh material for strife. To the struggle for power was added a struggle for a share of this booty, and a second civil war broke out, Kolokotrones leading the attark on the forces of the Government. Early in 1825 the Government was victorious and Kolokotrones was in prison.

Intervention of **Mehemet Ali.—A** new and more terrible danger now threatened Greece. Sultan Mahmud, despairing of suppressing the insurrection by his own power, had reluctantly summoned to his aid Mehemet Ali, pasha of Egypt, whose well equipped fleet and disciplined army were now thrown into the scale against the Greeks. Crete, subdued a year previously, now became the base of operations against the Greeks. On June 19, the Egyptian fleet, under Ibrahim Pasha, sailed from Alexandria. Khosrev, too, emboldened by this new sense of support, ventured to sea, and although his attack on Samos was frustrated by Miaoulis's fireships, he succeeded in joining Ibrahim off Budrun; two indecisive engagements followed with the united Greek fleet on Aug. 5 and 10. The object of Ibrahim was to reach Suda Bay with his transports, which the Greeks should at all costs have prevented. A first attempt was defeated by Miaoulis on November 16, but the Greek admiral was unable to keep his fleet together, thus leaving the sea unguarded. Ibrahim again set sail, and reached Suda without striking a blow. Here he completed his preparations and, on February 24, 1825, landed at Modon in the Morea with a force of 4.000 regular infantry and 500 cavalry. The rest followed, without the Greeks making any effort to intercept them. The conditions of the war were now completely changed. The Greeks. who had been squandering the money provided by the loans, affected to despise the Egyptian invaders, but they were soon undeceived. Ibrahim had laid siege to **Navarino,** and after some delay a Greek force of some 7,000 very mixed men was sent to its relief. On April 19 they were met by Ibrahim at Krommydi with 2,000 regular infantry, 400 cavalry and four guns. The Greek entrenchments were stormed at the point of the bayonet by Ibrahim's fellahin at the first onset and the defenders broke and fled. The news of this disaster, and of the fall of Pylos and Navarino that followed, struck terror into the Greek Government; and in answer to popular clamour Kolokotrones was taken from prison and placed at the head of the army. But his guerrilla tactics were powerless against Ibrahim, who marched northward, seized Tripolitsa and made this the base from which his columns marched to devastate the country far and wide.

Reshid "Kutahia" Besieges **Missolonghi.**—Meanwhile from the north the Ottomans were making another supreme effort. The command of the army that was to operate in west Hellas had been given to Reshid "Kutahia," pasha of Iannina, an able general and a man of determined character. On April 6, after bribing the Albanian clansmen to neutrality, he passed the defile of Makrynoros, which the Greeks had left undefended, and May 7 opened the second siege of Missolonghi. For twelve months the population held out, repulsing the attacks of the enemy, refusing every offer of honourable capitulation. This resistance was rendered possible by the Greek command of the sea, Miaoulis from time to time entering the lagoons with supplies; it came to an end when this command was lost. In Sept. 1825 Ibrahim, at the order of the sultan, had joined Reshid before the town; piecemeal the outlying forts and defences now fell, until the garrison staked all on a final sortie. This took place on the night of April 22, 1826; but a mistaken order threw the ranks of the Greeks into disorder. The Turks entered the town pell-mell with the retreating crowd.

Karaiskakis.—The fall of Missolonghi, followed as this was by the submission of many of the more notable chiefs, left Reshid free to turn his attention to east Hellas, where Gouras had been ruling as a practically independent chief and in the spirit of a brigand. The peasants of the open country welcomed the Turks as deliverers and Reshid's conciliatory policy facilitated his march to Athens, which fell at the first assault on Aug. 25, siege being at once laid to the Acropolis, where Gouras and his troops had taken refuge. Round this the war now centered; for all recognized that its fall would involve that of the cause of Greece. In these straits the Greek Government entrusted the supreme command of the troops to Karaiskakis, an old retainer of Ali of Iannina, a master of the art of guerilla war, and, above all, a man of dauntless courage and devoted patriotism. A first attempt to relieve the Acropolis, with the assistance of some disciplined troops under the French Col. Fabvier, was defeated at Chaidari by the Turks. The garrison of the Acropolis was hard pressed and the death of Gouras (October 13) would have ended all, had not his heroic wife taken over the command and inspired the defenders with new courage. For months the siege dragged on, while Karaiskakis fought with varying success in the mountains, a final victory at Distomo (February 1827) over Omar Vrioni securing the restoration to the Greek cause of all continental Greece, except he towns which were actually held by the Turks.

Cochrane and Church.—It was at this juncture that the Greek Government, reinforced by a fresh loan from Europe. handed over the chief command at sea to Lord Cochrane (earl of Dundonald [*q.v.*]) and that of the land forces to General Church, both Miaoulis and Karaiskakis consenting to serve under them. Cochrane and Church at once concentrated their energies on the task of relieving the Acropolis. Already, on February 5, Gen. Gordon had landed and entrenched himself on the hill of Munychia, near the ancient Piraeus. When Church and Cochrane arrived, a general assault on the Ottoman camp was decided on. This was preceded, on April 25, by an attack, headed by Cochrane, on the Turkish troops established near the monastery of St. Spiridion, the result of which was to establish communication between the Greeks at Munychia and Phalerum. The monastery held out for two days longer, when the Albanian garrison surrendered on terms, but were massacred by the Greeks as they were marching away under escort. For this miserable crime Church has, by some historians, been held responsible by default; it is clear, however, from his own account that no blame rests upon him (see his MS. Narrative, vol. i. chap. ii. p. 34). The assault on the Turkish main camp was fixed for May 4; but, unfortunately, a chance skirmish brought on an engagement the day before, in the course of which Karaiskakis was killed, an irreparable loss in view of his prestige with the wild armatoli. The assault on the following day was a disastrous failure. The Greeks, advancing prematurely over broken ground and in no sort of order, were fallen upon in flank by Reshid's horsemen and fled in panic. Church held Munychia till the 27th, when he sent instructions for the garrison of the Acropolis to surrender. On June 5 the remnant of the defenders marched out with the honours of war, and continental Greece was once more in the power of the Turks. Had Reshid at once advanced over the Isthmus, the Morea also must have been subdued; but he was jealous of Ibrahim and preferred to return to Iannina to consolidate his conquests.

Renewed Anarchy.—The fate of Greece was now in the hands of the Powers, who after years of diplomatic wrangling had at last realized that intervention was necessary if Greece was to be saved for European civilization. The worst enemy of the Greeks was their own incurable spirit of faction, and a third civil war had only been prevented by the arrival of Cochrane and Church. Under their influence a new National Assembly met at Troezene in March 1827 and elected as president Count Kapodistrias (*q.v.*), formerly Russian minister for foreign affairs; at the same time a new constitution was promulgated which. when the very life of the insurrection seemed on the point of flickering out, set forth the full ideal of Pan-Hellenic dreams. Anarchy followed; war of Rumeliotes against Moreotes, of chief against chief; rival factions bombarded each other from the two forts at Nauplia over the stricken town, and in derision of the impotent government. Finally, after months of inaction, Ibrahim began once more his systematic devastation of the country. To put a stop to this the Powers decided to intervene by means of a joint demonstration of their fleets, in order to enforce an armistice and compel Ibrahim to evacuate the Morea (Treaty of London, July 6, 1827). The refusal of Ibrahim to obey, without special instruction from the sultan, led to the entrance of the allied British, French and Russian fleet into the harbour of Navarino and the battle of October 20, 1827 (see NAVARINO, BATTLE OF). This, and the two campaigns of the Russo-Turkish War of 1828–29, decided the issue.

BIBLIOGRAPHY.—There is no trustwoithy history of the war, based on all the material now available, and all the existing works must be read with caution, especially those by eye-witnesses, who were too often prejudiced or the dupes of the Greek factions. The best-known works are: G. Finlay, *Hist. of the Greek Revolution* (2 vols., London. 1861); T. Gordon, *Hist. of the Greek Revolution* (London, 1833); C. W. P. Mendelssohn-Bartholdy, *Geschichte Griechenlands,* etc. (*Staatengeschichte der neuesten Zeit*) (2 vols., Leipzig, 1870–74); F. C. H. L. Pouqueville, *Histoire de la régénération de la Grèce,* etc. (4 vols., Paris, 1824),—the author was French resident at the court of Ali of Iannina and aiterwards consul at Patras; Count A. Prokesch-Osten, *Geschichte des Abfalls der Griecken vom türkischen Reich,* etc. (6 vols., Vienna, 1867), the last four volumes consisting of *pièces justificatives* of much value. *See* also W. Alison Phillips, *The War of Greek Independence* (London and New York, 1897), a sketch compiled mainly from the above-mentioned works. Of great value also are the 29 volumes of Correspondence and Papers of Sir Richard Church, now in the British Museum (Add. mss. 36,543–36,571). For further references *see* the bibliography appended to W. Alison Phillips's chapter on "Greece and the Balkan Peninsula" in the *Cambridge Modern Hislory,* x. 803. (W. A. P.)

GREEK LANGUAGE. This term is commonly applied to the tongues of both ancient and modern Greece. These, however, differ so much that it is necessary to deal with them in separate sections.

Of both the alphabet is as follows:

Name	Sign	Conventional equivalent	Kame	Sign	Conventional equivalent
Alpha	Α α	A	Nu	Ν ν	N
Beta.	Β β	B	Xi	Ξ ξ	X
Gamma	Γ γ	G	Omicron	Ο ο	short O
Delta	Δ δ	D	Pi	Π π	P
Epsilon	Ε ϵ	Short E	Rho	Ρ ρ	R
Zēta	Ζ ζ	Z (DZ)	Sigma	Σ(C) σς	S
Ēta	Η η	long E	Tau	Τ τ	T
Theta	Θ θ	TH	Upsilon	Υ υ	U
Iōta	Ι ι	I	Phi	Φ ϕ	PH
Kappa	Κ κ	K	Chi	Χ χ	CH
Lambda	Λ λ	L	Psi	Ψ ψ	PS
Mu	Μ μ	M	Omega	Ω ω	long O

ANCIENT

Greek, one of the Indo-European languages, was spoken in one or other of its forms (dialects) in the Balkan peninsula, on the west coast of Asia Minor, in south Italy and Sicily, and in the islands of the Ionian and Aegean seas. By the fourth century B.C. the political supremacy of Athens and the greatness of Attic literature had caused the Attic dialect to become the basis of a lingua *franca* for all Greeks, which in the long run superseded the other dialects. The conquests of Alexander the Great caused Greek (in the form of this *lingua franca* or *κοίνη* to become the speech of the whole Near East (Asia Minor, Syria, Mesopotamia, Egypt). Under the Romans these regions continued to use Greek, and at the present day Russians and Serbians use a modified form of the Greek alphabet.

Authenticity of Our Texts.—Documents written in Greek have reached us, some in the originals, others in copies. The originals are: (a) inscriptions, decrees, treaties, temple inventories, dedications, etc., engraved on stone and found in Greece and all over the Near East; the earliest may date from the eighth century B.C. and they become numerous in the fifth and later centuries; (b) documents (letters, contracts, petitions, accounts, etc.) written on papyrus between the late fourth century B.C. and the eighth century A.D., and preserved by the dry sands of Egypt, from which the excavations, mainly of the end of the 19th and beginning of the 20th century, have brought them to light in large numbers (see PAPYROLOGY). Papyri have not been recovered from other parts of the Greek-speaking norld (except at Herculaneum, where they were buried by the eruption of Vesuvius in AD. 79), but legal documents written on vellum in the second and first centuries B C. have been found at Sâlihîyeh (the ancient Dura-Europos, in Mesopotamia), and at Avroman (Parthia).

The copies, on which we rely for our knowledge of almost all Greek literary works, are written at first on papyrus, and later on vellum or paper. For long the oldest known Greek mss. were those containing the Greek Bible, written on vellum and dating from the 4th and 5th centuries A.D., and the texts of other Greek works rested on vellum (later paper) mss. which were (in general) not older than the 9th and 10th centuries A.D. These remain the broadest basis of our knowledge, but recent excavations have brought to light papyrus mss., some mere scraps, others very substantial rolls or books, of Homer and other classical texts, a few of them written in the 3rd, and and 1st centuries B.C., and many of them in the earliest centuries of the Christian era. In a number of cases we have recovered papyrus copies of works which had perished, no copies having reached us in mediaeval mss. (see GREEK LITERATURE).

Important accessions to our knowledge of the language, its pronunciation, spelling and vocabulary, have resulted from the recovery of so many well-authenticated texts. So long as the mediaeval copies were the only source of our knowledge it was impossible to have much confidence in the spelling which they offered, and certain variations which they exhibited, *e.g.* the variation between ει and ι (τειμή-τιμή; ἀποτεῖσαι-ἀποτῖσαι, etc.) presented a little understood problem. Moreover, the grammatical treatises of Herodian (2nd century A.D.), Choeroboscus (6th century A D.) and others, show that these problems presented themselves already in the early centuries of the Christian era; these grammarians drew up lists of words recommending particular spellings in doubtful cases. It remained doubtful, hon ever, how far the grammarians could be regarded as knowing the truth or as providing a trustworthy criterion for the correction of the mss.

The inscriptions and papyri often provide evidence which settles once and for all a disputed question of spelling. They often carry us back to a time when speech-sounds which later became identical were still distinct from one another. For instance, the inscriptions and papyri of any date earlier than about 150 B.C. are almost wholly free from the hesitation between ει and ι. They have ει without exception in certain words (*e.g.* ἀποτεῖσαι "to pay") and ι without exception in certain others (e g., τιμή). Before 150 B.C. (approximately) the two spellings represented distinct sounds; after 150 B C. the sounds were identical; and the spellings ει and ι were interchangeable. Again the Greek of the 3rd century B.C. possessed the long diphthongs αι ηι ωι (the spelling ᾳ ῃ ῳ is not older than the 12th century A.D.). From the end of the 2nd century B C they are written α η ω nithout the iota. The uniformity nith nhich this happens, and the appearance of the iota in the wrong place (spellings like ἄνωι for ἄνω are frequent) shows that the iota, which must have been pronounced in the 3rd century B C., had ceased to be pronounced in the 1st century B.C., and was sometimes added in writing by persons who thought (rightly or mrongly) that they knew the older spelling. At least one erroneous restoration of iota has been perpetuated. Where our mediaeval mss. (even the most accurate of them) and late inscriptions give us ῥαιθυμεῖν, the papyri of the 3rd century B C. have ῥαθῦμεῖν (without iota), which must be the original and only correct spelling. Unlike ῥᾴδιος, the word can never have been pronounced with an iota. Many of the inscriptions and still more of the papyri are written by persons of little education, whose spelling tends to be phonetic; their very errors throw light on the pronunciation. One instance must suffice: the word ἑαυτοῦ in inscriptions and papyri of the 1st century B C. is often written ἑατοῦ, whereas αὐτοῦ is not written ἀτοῦ. The reason is that ἑαυτοῦ was pronounced at first ἑᾱυτοῦ (being derived by contraction from ἕο αὐτοῦ like the Ionic ἑωυτοῦ which has a different type of contraction) later ἑᾶτοῦ. By the study of such spelling-variations the chief changes in the pronunciation of Greek can be dated with considerable accuracy. Many of the changes which mark the passage from ancient to modern Greek took place in the three or four centuries preceding and the three or four centuries following the Christian era. The language of the period (2nd century A.D.) in which Herodian spoke and wrote was already so different from Attic that his spelling-rules must be assumed to be based not on observation of contemporary pronunciation (it was in fact the divergence between this and the traditional spelling which made spelling-rules a necessity) but on antiquarian research, and in this field the modern investigator has the advantage over him.

Nature of the Tradition of the Accents.—Greek texts, whether on stone, papyrus, vellum or paper, are usually written without spaces between the words. and the continuous use of breathings and accents is found only in mediaeval mss. from the 9th century onwards. Inscriptions (with rare exceptions) and non-literary papyri are entirely without breathings and accents. The same is often true of literary papyri, but these are sometimes more or less sporadically marked with breathings and accents, especially if epic, dramatic or lyric texts. The accentuated literary papyri are in the main not older than the opening centuries of our era. On the other hand, the features of pronunciation of which breathings and accents are the written signs are more ancient than the use of the signs. From numerous references in Greek authors, and especially from Apollonius Dyscolus and his son Herodian, who wrote in the 2nd century A D., we learn many details of the accentuation of Greek, which was a variation of pitch; the syllable marked with the acute accent was high-pitched, the others, those which in the printed books are marked with the grave accent or with no mark at all, nere spoken on the low pitch, while circumflexed syllables, were spoken on a descending pitch, the first part of the syllable being higher than the second. Such is the most probable inference from the statements of grammarians and certain other evidence (*e.g.* the marks found in accented papyri, and the scanty remains of Greek music), though several points are still disputed.

The general accuracy, and at the same time the great antiquity, of the traditional accentuation of Greek in modern printed editions may be proved by means of a comparison between it and the accentuation of Vedic Sanskrit; the tno exhibit a number of striking coincidences which point to an unbroken oral tradition in both cases from the hypothetical parent "Indo-European." In 1876 Karl Verner demonstrated that certain consonant changes in Germanic could be explained if the position of the accent thus observed in Greek and Sanskrit were admitted to have existed at one time in Germanic also. The antiquity of the distinction between the acute and the circumflex has been demonstrated by a comparison with the accentuation of modern Lithuanian, in mhich a corresponding distinction has been observed.

The breathings and accentual marks found in our text of a classical author, such as Plato, cannot have been copied, even at many removes, from his autograph: Plato cannot have written more than the bare series of letters forming the words. It is, however, clear that he pronounced an h or a high pitch even when he did not put it down in writing, and that those who, in transmitting his text to us, inserted the breathings and accentual marks (in the main Byzantine scholars of the 9th century) were guided by contemporary living speech (the position of the accent is in general still the same in Modern Greek), and by antiquarian knowledge to a very large measure of success.

Varieties of Early Greek.—The language of the inscriptions from the 7th to the 4th century B.C. presents varieties of two kinds, varieties of alphabet and spelling, and varieties of dialect.

(1) Varieties of alphabet and spelling. The Greek alphabet is an adaptation of the Semitic alphabet, and differs according

to locality and date. One of these differences throws much light on the language, viz., the varying mode of representing ε sounds and o sounds.

The contraction of ε+ε (ĕ+ĕ) must obviously have resulted, to begin with, in a long ē, and similarly the contraction of o+o must have given ō. Hence EL in the 4th century Attic (and later Greek) form ἐπεστάτει (from ἐπεστάτε-ε) must have been pronounced from the beginning not as a diphthong, but as a long ē, and similarly the ου of μισθοῦμεν (from μισθόομεν) must have been from the first pronounced 6, not as a diphthong ου. In the oldest inscriptions these sounds are in fact written E and O (επεστατε, μισθομεν). When EL and ου are thus demonstrably monophthongs, they are called "spurious diphthongs."

In the local Attic and many other alphabets there was no vowel-symbol η (H), and no ω (Ω). In such alphabets E had to represent three sounds, viz., ε (as in φέρω), ē (as in ἐπεστατε) and the other kind of ē which was written η when that letter was introduced (ανεθεκε, later ανεθηκε). Similarly o had to represent o (in φερομεν), ō (in μισθομεν) and the other ō which was later written ω (δορον later δῶρον).

But EL and ου are not always spurious diphthongs. In εἶμι ("I shall go") the EL is, in origin at least, a diphthong (Lith. *einù*, "I go," Lat. eo from ei-o through *e[y]-o*, *i-tur* from ei-tur; Gr. ἴμεν shows the i-element bereft of the e). In εἰλήλουθα the υ is the same as in ἤλυθον, so that ov is here in origin a genuine diphthong. In early inscriptions. EL and ου are in certain words fixed and not capable of alternating with E and o. Thus εἶπε, δοκεῖ (from δοκέ-ει), πρεσβεία, πειθομένοις, ἔπει (Dat. of ἔπος), ἐπεί ("when"), εἰ, ἀτέλεια, οὐκ, οὐδένος, are constant spellings, of course without accents even in an inscription (Dittenberger, Sylloge[3] 64), which has only E and o in place of the later "spurious diphthongs" (ἒναι, τρῆς, τô δέμο, 78 Διὸς, τô Ὀλυμπίο, οἰκôντες, etc.). Thus the early inscriptions sometimes yield information attainable in no other way, *e.g.* they tell us that οὐκ, οὗτος, εἶπε and φέρεις φέρει have genuine diphthongs.

The spurious diphthongs sometimes owe their origin to what is known as "compensatory lengthening." Just as the long ᾱ in πᾶς arises from a lengthening of the ᾰ in *πάνς (from *παντ-ς *cf.* Genitive παντ-ός) to compensate for the loss of the v, so the nominative *τιθέντ-ς became *τιθένς and then τιθēς, which is written τιθες on the older inscriptions, τιθείς in later Attic, and τιθής in some other dialects.

At the end of the 5th century B.C. the local Ionic alphabet, which possessed the vowel signs η and ω in addition to ε and o, began to supersede the other Greek alphabets. It was officially adopted at Athens in place of the Attic alphabet in 403 B.C., and by the end of the 4th century it was in general use throughout Greece.

The ē and ō mhich resulted from contraction and compensatory lengthening were not everywhere written in the same way in the 4th century B.C. In some dialects we find not τελεῖτε, τιθείς, διδούς, but τελῆτε, τιθής, διδώς. Within the Doric area both spellings are found (*e.g.* in some places ἦμεν, in others εἶμεν, from *es-men*, infinitive of the verb "to be"). The difference is perhaps one not of pronunciation, but only of spelling.

The distinction between genuine and spurious diphthongs shows itself even after general adoption of the Ionic alphabet in the case of contractions with a preceding vowel; *e.g.* ὁράεις ὁράει, which have the genuine EL, become ὁρᾶις ὁρᾶι (ὁρᾳς ὁρᾳ in mediaeval rnss.), but ὁράειν, which has the spurious EL, becomes ὁρᾶν. Similarly in οὐκέθ' ὁμῶς τιμῆς ἔσεαι (Il. 9, 605), τιμῆς is the contracted form of τιμήεις, which has the spurious EL (τιμη-[ϝ]εις from -ϝεντ-ς *cf.* gen. -εντ-ος, Sanskrit *-vant-*). In 11. 3, 13, where the mss. have κονίσαλος ὤρνυτ' ἀελλῆς, Buttmann's conjecture, that the last word is a contraction of ἀελλήεις "eddying," involves only a change of accent (to ἀελλῆς): it would be a mistake to write, as he proposed, ἀελλῆς.

The study of the ancient Greek language is based on written documents and the textual critic seeks to restore and interpret the actual letters of the autograph, in cases where this autograph has not reached us.

The mediaeval mss. offer texts written in the Ionic alphabet, and in a spelling which, at its most accurate, is that of the 3rd century B C., but more often shows signs of the passing of the centuries between that date and the 9th and 10th centuries A.D. The spelling of the 3rd century B.C. is clearly not appropriate to authors who wrote in the 5th century B.C. (especially the beginning of it), or earlier; in the case of Homer the composition of the poems was earlier than the knowledge of writing in Greece.

Many of the great Athenians (Sophocles, Euripides, Aristophanes, Thucydides) arote in the second half of the 5th century. They may well have used the Ionic alphabet, which inscriptions prove to have been used at Athens some decades before 403 B.C. Aeschylus, who wrote in the first half of the 5th century, is more likely to have used the Attic alphabet, employed in fragments of the earlier lyrics which are painted on Attic vases of the 6th and 5th centuries. The old spellings may well have survived longest in the case of the oldest books (Homer, Hesiod, Theognis, Alcman, etc.).

The study of the Homeric poems from this point of view has led to tangible results. In the older alphabets of Greece, ε and o, as already mentioned, can stand for ē and ō ("spurious" EL and ου), and a single consonant is written where the later practice is to write it double (ἀλογλωσος = ἀλλογλώσσους). Both features are to be seen in τειχιοσης (= Τειχιούσσης) in a Milesian inscription of the 6th century B.C. In the line καιροσέων δ'ὀθονέων ἀπολείβεται ὑγρὸν ἔλαιον (Od. 7. 107) καιροσέων is the archaic spelling of καιρουσσέων, a word which was so rare that the rhapsodes of the 6th century did not understand what they found in their written texts of Homer. In this way the spelling escaped modernization. The word ἀνηρείψαντο which is given by our mss. of Il. 20, 234 is a mistake for ἀνηρέψαντο as we now know from the forms ἀ[να]ρέψατο in a Paean of Pindar and ἀναρεψαμένη in mss. of Hesiod (Theog. 990). In Il. 7, 434 ἔγρετο means "gathered, assembled," and is the archaic spelling of the aor. of ἀγείρω (later written ἤγρετο). It was mistaken for the aor. of ἐγείρω (ἔγρετο "arose") and to this mistake it owes its preservation. In Il. 5, 293: αἰχμὴ 6' ἐξελύθη ("came out") παρὰ νείατον ἀνθερεῶνα the poet clearly meant ἐξέλυθε, the unaugmented form corresponding to the augmented ἐξήλυθε; because it resembled the aorist passive of ἐκλύω and because the metre demanded a long vowel in the last place, it became ἐξελύθη.

The two instances just given (ἔγρετο, ἐξελύθη) show us a Homer written in an alphabet which possessed no H, but used E instead.

Certain other indications point to a time when the poems existed only in oral transmission and had not yet been written down. Bentley showed that many irregularities in the metre vanished when once it was admitted that at the time of the composition of the poems the language possessed the sound w (written ϝ in dialect-inscriptions, but nowhere written in our mss. of Homer).

The traces of this sound consist of lengthenings of a preceding vowel (*e.g.*, κᾱλός is really καλϝός—this form occurs in a Boeotian inscription of the 7th century B.C.), and of cases of hiatus (*e.g.*, ὄπα ἀρνῶν Il. 4, 43j—the dialect inscriptions have ϝαρήν, ϝαρνός).

Bentley's observations were true, but more recently it has been recognized that some lines in the poems may have been composed nhen the w-sound was already lost from the language. It is probable that the composing of the poems extended over a long period, within which the w ceased to be pronounced.

In Il. 24, 154 ὃς ἄξει is defective both metrically and in point of sense; the parallel ὅς a' ἄξει (line 183) shows that the poet meant in 154 8s ϝh' ἄξει, where ϝhε is the older form of the Attic ἑ (Doric ϝε and Pamphylian ϝhε are found in inscriptions). Such cases (there are several of them) bring out clearly the reality of the sound w in Homer. In a number of other respects the spelling which we find in our mss. of Homer can be shown to be unoriginal. The first person plur. subj. of ἔστην is written στείομεν (Il. 1j, 297), instead of στήομεν as the analysis requires (the root is στᾱ, *cf.* Lat. *stāre*, which gives Ionic στη-, and the sign of the subjunctive in unthematic verbs is a short -ο- or -ε-). The later Ionic form στέωμεν (which arose by a regular change of -ηο- to -εω- cf. βασιλῆος: βασιλέως) occurs in Il. 11. 348. The reciters found στεομεν in their written texts of Il. 15. 297, and lengthened the ε to ē (which they wrote EI, as we have seen), because, as the living form nas στέωμεν, it did not occur to them that στεομεν was the old way of writing στήομεν. The group -ηο- thus came to be written -ειο- in many other words as well.

The word εἰνάτερες was believed by Herodian to be the plural of εἰνάτηρ. Inscriptions have proved however that the nominative sing. was ἐνάτηρ, and εἰνάτερες is the poet's arbitrary way of modifying the word ἐνάτερες in order to fit it into a hexameter. Here again, the lengthening of ε is expressed by the spurious diphthong, the introduction of nhich into the text can hardly be much older than the 4th century B.C. Other examples of EI and ov resulting from metrical lengthening are εἰν ἀγορῇ, Πειρίθοος, δουλιχόδειρος (for δολυχόδερϝος) οὐλόμενος, Οὐλύμποιο, and many others. The numerous forms of which ὁρόωντες, ὁράασθαι are specimens, in which the older ᾰο, ᾰε seem to have become ow and αᾱ, have no parallel in dialect inscriptions. The poets (whether in writing or in oral composition) must have used the forms ὁράοντες, ὁράεσθαι. In the course of the transmission the later contracted forms ὁρῶντες, ὁρᾶσθαι tended to be substituted, but the metre compelled the reciters to "pull out" the contracted forms into ὁρόωντες and ὁράασθαι, by prefixing in each case to the long vowel (which resulted from the contraction) its short form (ο, a). Forms, such as ναιετάει, which did not survive (there was no ναιετᾷ in later Greek), were not exposed to this modernizing tendency, and were left untouched.

Distinct from differences of alphabet and spelling are differences between the spoken forms of the language in different places, *i.e.*, differences of dialect. Our knowledge of the dialects is derived mainly from inscriptions of the 6th, 5th, 4th and 3rd centuries B.c.; from the time of the Athenian supremacy the Attic dialect begins to supersede the others, so that many documents show a mixture of non-Attic and Attic elements. In later centuries there were revivals of the use of dialects in inscriptions, but their artificial character is proved by the presence in them of forms which earlier inscriptions show to have been long obsolete, *e.g.* ῥαψάϝυδος (=ῥαψῳδός) in a late Boeotian inscription, whereas earlier Boeotian inscriptions indicate that ϝ between vowels had long been lost. The literary documents written in dialect are often of larger compass than the inscriptions, and therefore in some ways more instructive, especially for the vocabulary; but the variations in the manuscript tradition (*e.g.*, of Hippocrates and Herodotus) constitute a difficulty which only the inscriptions can help us to overcome. The inscriptions have in fact enabled us to pick our way with greater certainty among the variants, and to detect (for instance) the fact that the consistent absence of the so-called v ἐφελκυστικόν from our mss. of Herodotus is not a feature of the Ionic dialect, but is the result of unintelligent editing by some unknown ancient critic; the Ionic inscriptions have this v in even greater profusion than the Attic (Ion. ἐποίειν where Att. has ἐποίει).

The main dialect divisions are: (1) Ionic, of which Attic is a sub-dialect; (2) Aeolic; (3) Arcadian and Cyprian; (4) Doric. In the 6th and jth centuries B.C. the local distribution was as follows: Ionic was spoken in the central part of the coast of Asia Minor, in many of the Aegean islands, in Euboea and the Chalcidian peninsula, and (in its Attic form) in Attica. Aeolic is the collective name of the dialects spoken in the northern part of the Asiatic coast (Aeolis) including Lesbos, and (with a Doric admixture) in Thessaly and Boeotia. Arcadian and Cyprian are named from the places in which they were spoken; the recognition of their close resemblance in spite of the great distance between them was one of the surprises which resulted from the discovery of Arcadian and Cyprian inscriptions and of the deciphering of the Cyprian syllabary in the '70s and '80s of the 19th century. Lastly Doric in many varieties was spoken in the Peloponnese (except Arcadia) in north-west Greece (Locris, Phocis, Epirus) in the more southerly Aegean islands, especially Thera, Crete, Cos, Rhodes, and on the neighbouring part of the Asiatic coast.

Colonists took with them the dialect of the mother-city; we find Ionic spoken in several Milesian settlements on the Black sea coast, and Doric in Syracuse and other Doric foundations in Sicily and south Italy.

Such, in outline, is the geographical distribution of the Greek dialects at the period when they become known to us. For an earlier period we have to rely mainly on the evidence of Greek historians (especially Herodotus and Thucydides). From them we learn that there was in early times a migration from Epirus into the Aeolic land of Thessaly, which drove before it another migration from Thessaly into Boeotia. At the time of the Trojan War, according to Thucydides, the later Boeotians were not yet in Boeotia. From Herodotus, Strabo and Pausanias, we learn of the former presence of Ionians in Cynuria, and on the shores of the Saronic gulf. The resemblance between the land-enclosed Arcadian dialect and the distant Cyprian is less surprising when we find that Arcadian mas at one time spoken as far south as the promontory of Taenarum. This is proved by the name of the festival to Poseidon which was celebrated there, viz., Π*oh*οιδαια. The dialect of Taenarum in historical times was Laconian (Doric), in which σ between vowels had become *h*. Accordingly Π*oh*οιδαια is the Laconized form of Ποσοιδαια, and an Arcadian inscription proves that Ποσοιδαν was the Arcadian name of the god. It may be inferred that Arcadian was once spoken throughout the Peloponnese and perhaps over a still wider area, before it was overwhelmed and shut in by the Dorian migration.

Greek and the Other Indo-European Languages.—The dialects show considerable differences from one another in respect of sounds, inflexions, syntax and vocabulary, and the comparison of the dialects with one another often throws light on the past, enabling us to reconstruct an earlier condition of the Greek language. In this reconstruction use is made at the same time of a comparison with the other Indo-European languages. In what follows an attempt will be made to indicate briefly some of the more important sound-changes to which Greek owes its differences from the other languages.

Of the consonants which the parent speech had, Greek has lost inter-vocalic y and s; Sanskrit *tráyas* "three" and Greek (Cretan) τρέες are both descended from Indo-Eur. *trĕyĕs;* Sanskrit tras-ati "trembles" and Greek τρέ-ω come from tres-. At the beginning of a word both y and *s* became h: ὅς (rel. pron.) corresponds to Sanskrit yas (Indo-Eur. yos), and the article 6 to Sanskrit sa (Indo-Eur. so). Sometimes *y* became ζ (Sanskrit *yugdm*, Gr. ζυγόν). The earliest records of many dialects show a complete loss of the sound *w* (*e.g.*, ὄϊς [οἶς] from Indo-Eur. *owis*, cf. Lat. *ovis*) but other dialects retain this sound (which is written ϝ [digamma]), *e.g.*, ὄϝινς (accus. plur.) is found in an Argive inscription of the 5th century B.C.

The loss of these three sounds often left two vowels standing next one another in a word; this was at first tolerated, but later led to contraction into a single vowel. These contractions occurred in the main after the composition of the Homeric poems, and the method of contraction differs in different dialects. Hence forms like ναιετάει in Homer, and the contrast between (*e.g.*) Att. τιμῶ, τιμᾷ and Dor. τιμῶ, τιμῇ or between Att. φιλῶ and Ion. φιλέω.

In combination with liquids and nasals y, *s* and w often caused a lengthening of the preceding vowel before disappearing; ἔτεινα (pronounce ἔτēνα) arose from ἔ-τεν-s-α, τείνω (pron. τēνω) from τεν-yω, Ion. ξεῖνος (pron. ξēνος) from ξένϝος (πρόξενϝος occurs in an inscription). Here too, the dialects diverge; the details are too complex to be enumerated here.

A y following a guttural, dental or labial stop combined with it into a single sound: φυλακ-yω became φυλάσσω, μεθ-yος (*cf.* Lat. *medius*, Sanskrit *madhyas*) became μέσσος and then μέσος, μεγ-yων became μέζων (Ion.), χαλεπ-yω became χαλέπτω.

A nasal before σ (which generally arose, as in yiaos, from a dental +*y*, sometimes from a dental +*s*) disappeared in most dialects (*e.g.*, Att. πᾶσα from πάνσα, τιθεῖσα from τιθένσα) leaving behind it a lengthened vowel. Some dialects, however, *retained the -νσ- combination (Arc. πάνσα).*

When the numerous long vowels which arose from contraction and from compensatory lengthening are left out of account, the remainder of the Greek vowels are found to be, in the main, survivals from the parent speech: e.g., μάτηρ (Dor. etc.), Lat. miter; δῶρον, Lat. dō-num; (ϝ)ίς, Lat. vis; μῦς, Lat. mūs; πλῆ-το, Lat. plē-nus; ἄγω, Lat. ago; ὄ(ϝ)ις, Lat. ovis; φέρω, Lat. *fero; sometimes when most of the languages agree in ᾰ (πατήρ, pater, etc.) Sanskrit has ĭ (pitar-); in such cases the parent-form is believed to have had an indistinct vowel like the first o in potato.*

Indo-Eur. t, p, d, b have survived unchanged in Greek (some instances will be found among the words already quoted). Sanskrit has the sounds dh, bh; these go back to Indo-Eur. dh, bh, which have yielded Greek θ, φ (pronounced like t, p, in the Irish pronunciation of English), e.g., Sanskrit bhar-, Lat. fero, Greek φέρω, Sanskrit dadhāmi, Lith. dd-ti (infin. "to *lay"), Greek τίθημι.*

The Indo-Eur. gutturals are of two kinds, technically called palatals and labio-velars.

The palatals appear in Greek as κ, γ, χ, in Latin as c, g. h, and as gutturals in Celtic and Germanic: e.g., κύων, Lat. canis; ἄγω, Lat. ego; χιών, Lat. hiems. In the Eastern group of Indo-Eur. languages (Indo-Iranian, Armenian, Slavonic and Baltic) they appear as sibilants, e.g., Sanskrit śvā (stem Sun)"dog," ajati "he drives," himàs "frost, snow," Lith. Sun-"dog," žiemà and Slav. zima "winter."

The labio-velars were sounds of the **qu** *'or k^w type, They survive more or less clearly in Latin quis, ni-n-guit. In some languages they drop the u or w element, and become k, g* and *gh (so in Sanskrit). Sometimes they appear as p, b; e.g., Oscan* **pis** *corresponding to Latin quis, Old Irish ben "woman" corresponding to English queen. In the Greek dialects they tend to appear before a and o* vowels *as labials (π, β, φ) e.g., ποινή, Avestan kadna* "punishment," *Lith. kaina "price" (all from Indo-Eur. kwoind);* **-βόρος**, Lat.*-vorus, Sankr. -garó̄s* "swallowing"; **φόνος**, *Sanskrit ghands (from Indo-Eur. gwhonos). Before e and i vowels they tend to appear as dentals, e.g., τίνω, τεῖσαι (from kwĭ-, k^wei-, forms of* the *same root as in ποινή), τις,* Lat. *quis, θείνω, Sanskrit hanti "he kills," Hittite kuenzi "he kills" (Indo-Eur. g^when-ti, from the same root as φόνος, ἔπεφνε, πέφαται).* In Aeolic *the labials appear even before e*-vowels, *e.g., πήλοι* "far," Att. τῆλε; Boeot. *πέτταρες*, Att. *τέτταρες*, Dor. *τέτορες* (*cf.* Lat. *quatuor*). Occasionally *a* labio-velar develops into a Greek guttural, *often* owing *to the* neighbourhood of *u*, e.g., **βου-κόλος** with the same *ending* as *αἰ(γ)-πόλος, cf.* Lat. *colo, in-quiz-inus;* **κύκλος**, Lith. *kāklas "neck,"* Eng. *wheel; γυνή*, Boeot. *βανά*, Eng. *queen.* The *pronoun τις appears in* Thessalian as *κις*; for *πότερος, πῶς Herodotus has κότερος, κῶς.*

The Greek *πατράσι* (dat. pl. of *πατήρ*) corresponds very closely *(even in respect* of *the accent)* to *the Sanskrit Locative pitṛṣu. In this, as in many Sanskrit words, r functions as a vowel. This* "sonant" *r as it is called, is descended from the same sound in the parent-speech. In the other langages the result is r preceded or* followed by a short vowel: *Greek ρᾰ or ᾰρ, Lat. or, Lith. ir, Ger. ur, etc. The variation in the quality of the vowel is a sign that* it has been separately developed in each language. The same *phenomenon is observed in the case of l, m and n. So-nant m, for* example, is observed in the word for 100, Indo-Eur. *kṃtom, Lat. centum, Lith. šimtas, Ger. hund; Greek ἑ-κατόν and Sanskrit śatám indicate that* sonant *m became a in these languages. The same ᾰ from ṃ or ṇ (to use the technical notation of these sounds) is found in πόδ-α from ποδ-m* (which *has the same ending as the o-stem ἔργο-ν* [from *-o-m*], *Lat. illu-m), and in γεγράφαται (from γεγράφηται) which has the same ending as λέλυ-νται.*

The Aeolic *dialect has po and not pa in place* of *the* sonant, *e.g. στρότος and not στρατός from stṛtos.*

Bibliography.—*Texts. A* list *of editions of Greek authors,* inscriptions and papyri will be found in Pt. I (Oxford, *1925*) of the 9th ed. *of* Liddell *and Scott's Greek-English Lexicon (see below).* For *Facsimiles see* Palaeography. *Grammars.* The fullest reference work (it **is** not *always* **up** *to date)* is *R. Kuhner's* ***Ausführliche Grammatik** der griechischen Sprache, 3rd ed. by F.* Blass *and B. Gerth,* 1890–1904. *For details of the spelling of Greek inscriptions and papyri the best works are K. Meisterhans, Grammatik der attischen Inschriften (3rd ed. by E. Schwyzer,* 1900); *W. Cronert, Memoria Graeca Herculanensis, Leipzig* (1903) *(compares the Herculaneum papyri with the other papyri, inscriptions and* mss.); *E. Mayser, Grammatik der griechischen Papyri aus der Ptolemäerzeit (esp. vol. I [Leipzig,* 1906]; vol. *2* [1926] *contains the syntax); H. St. J. Thackeray, Grammar of the Old Testament in Greek, I, Cambridge,* 1909; *J. H.* Moulton, *Grammar of New Testament Greek,* vol. *I* (3rd *ed.), Edinburgh,* 1908; *vol. 2, pts.* i. *and* ii. *revised by W. F. Howard,* 1919, *1920; F.* Blass, *Grammatik des Neutestamentlichen Griechisch,* 5th *ed. by A. Debrunner, Gottingen, 1921. The language of* Homer *is treated in D. B. Monro, Homeric Grammar,* 2nd ed. *Oxford, 1891; J.* Wackernagel, *Sprachliche Untersuchungen zu Homer, Gottinpen,* 1916; *K. Meister, Die Homerische Kunstsprache, Leipzig, 1921. The dialects are treated by C. D. Buck, Introduction to the Greek Dialects (grammar, texts, vocabulary, rev. ed.* 1928) *and by F. Bechtel, Die Griechischen Dialekte,* 1921–24 *(grammar only). A convenient collection of* dialect-*inscriptions is E. Schwyzer, Dialectorum graecarum exempla epigraphic~potiora, Leipzig,* 1923 *(with index). The relation of Greek to the other Indo-Eur. languages is studied in K. Brugmann, Griechische Grammatik, 4th ed. revised by A. Thumb, Munich,* 1913, *and in Brugmann and* Delbrück's *large Grundriss der vergleichenden Grammatik der Indogermanischen Sprachen,* 2nd *ed.. Strassburg* 1897–1916; *more briefly in A. Meillet, Introduction à l'étude comparative des langues indo-européennes,* 1908 *(and later eds.). Lexicons. The Thesaurus Linguae Graecae of H. Stephanus (Henri Etienne), first* published *in* 1572, *was greatly enlarged by K. B. Hase and the brothers W. and L. Dindorf (Paris,* 1831–65) *and remains valuable, but does not cover the inscriptions and papyri. The vocabulary of the non-literary papyri is covered by F. Preisigke, Worterbuch der griechischen Papyrusurkunden, which* was *rapidly published at Berlin in* 1924 *and the following years. The papyri and inscriptions are included in the new* (9th) *ed. of* Liddell *and Scott's Greek-English Lexicon, revised and enlarged by H. Stuart Jones* with *the assistance of R.* McKenzie *and with the co-operation* of *many scholars, which is in course of publication. The New Testament vocabulary is treated in J. H.* Moulton *and G. Milligan's Vocabulary of the Greek Testament illustrated from the papyri and other non-literary sources (Pt. VI. carrying the work down to ῥώννυμι appeared in 1926). The best etymological dictionary is E. Boisacq, Dictionnaire e'tymologique de la langue grecque, Heidelberg-Paris,* 1916. *For the numerous special lexicons, see H. Schone, Repertorium griechischer Wörterverzeichnisse* und *Speziallexika,* Leipzig, 1907. *(R.*McK.)

MODERN

Apart from numerous differences in *dialect, there are* two *broad* types of language used in modern Greece, viz., the "pure," or *καθαρεύουσα* and the "popular," or *δημοτική*, *to use the most dig*nified of the terms employed *to* distinguish *them. The former* is a conscious and artificial *return to Ancient Greek,* and is taught in schools, and used for official *purposes* and generally *by news*papers; the latter is the natural language of *the* people, *and em*bodies a good many foreign words which have crept into the language in the course of later Greek history. The "popular" is primarily a spoken language, that of the Greek *songs* and bal*lads, and as such has not a fixed orthography, but it possesses the force* of a living language, and is largely employed by modern writers of poetry and fiction. Tendencies towards compromise may be observed between the "purist" and "popular" schools.

Phonetics.—One broad distinction between Ancient Greek and *the modern language is that the ancient accent was a "pitch"* or "musical" accent, the modern is a "stress" accent, so that if a line of ancient Greek poetry, say of Homer, is read aloud with the modern stress value *assigned to the accented syllables, the rhythm is destroyed, and the modern Greek can only regain its* effect by arbitrarily shifting the stress accent in such a way that *the values of the ancient quantities are approximately reproduced.*

This change in the effect, though not in the position, of the accent in Modern Greek has resulted in a levelling out of vowel values, although the ancient vowel forms are retained in writing, a is pronounced, continental fashion, as ah (father); ϵ as eh (led); η, ι, υ have all the same value -ee (see); o and ω oh (cope). Of the diphthongs, αι is pronounced as ϵ; ει, οι, υι as η, etc.; *ου as oo (brood); αυ as ahv, except before the hard consonants* (κ, π, τ, χ, φ, θ, σ), when it is pronounced *ahf. Similarly ευ* is pronounced as *ev* and *ef* respectively. *ηυ* as *eev* and *eef*. The consonants *approximate to the sounds* of *the corresponding* English *consonants, with these exceptions: β* is pronounced *as v; γ as hard* gh, except before e, η, ι, υ, αι, ευ, οι, υι, when it has the value of y; when doubled or before κ, it has the value of ng; δ is sounded as th (the), φ as f; χ as ch in Scotch loch, but before the vowels and diphthongs mentioned under γ it is soft, as in German ich; ψ has the value of ps. To express the equivalents of English b, d and hard g, Modern Greek uses μπ, ντ and γκ respectively. In the middle of words, π after μ has a b sound, e.g., ἔμπορος=émboros; τ after ν a d sound, e.g., ἐντροπή=endropée. The final ν of the article and the initial π or τ of the following word also undergo a change of sound. Thus τὸν πατέρα tom batéra, τὴν τέχνην teem dechneen. The above are the main rules for pronunciation, though some refinements of minor importance for the English student are omitted. The accented syllable is strongly stressed, so much so that the beginner seems only to catch the accented syllable. The distinction between acute, grave and circumflex is immaterial for speaking, but is generally retained in writing after the manner of Ancient Greek. There is no aspirate in pronunciation, though the signs for rough and smooth breathing are retained in writing.

Grammar.— The "popular" language diverges from Ancient Greek far more than the "purist," both as regards forms and the shifting of accent. Full information can be obtained from some of the works mentioned in the Bibliography.

Declension.— Modern Greek has lost the dual. Except in the very "purist" style and in a few stereotyped phrases, it has also lost the dative case; in place of this, εἰς or πρός with the accusative, the accusative alone, or the genitive is substituted. For the genitive, ἀπό with the accusative is often used, or the simple accusative. As regards substantives in general, though the "purist" language practically follows the classical, the following features of the "popular" should be noted: words of the first declension ending in -α, -η, -ας or -ης, have plural in -ες. In the second declension there is a tendency to favour neuters, e.g., τὸ χερί for ἡ χείρ. In the third, Popular Greek adopts accusative singular of feminine nouns as nominative, e.g. μητέρα, τρίχα, etc., and the accusative plural of masculine nouns, e.g., πατέρας, γέροντας, etc. Often masculine forms in this declension are shifted to the second, e.g., γέρων to γέρος, γόνυ to γόνατον, etc. Note also that the plural of nouns of the third declension are often augmented by a syllable, e.g. παπᾶς, priest, plural παπάδες; παπουτζῆς, shoemaker; plural, παπουτζῆδες.

Adjectives.— "Popular" usage retains -η in the feminine after ρ and in words compounded with α-negative, e.g., ἄσπρη, ἄμορφη, and prefers uncontracted adjectives, e.g., χρυσός for χρυσοῦς. In forming comparatives πλέον is much used with the positive form. To express "than" after comparatives the following are used: genitive case, ἤ or παρά with nominative, or ἀπό with accusative. To express superlatives, the definite article is used with the comparative form, e.g., ὁ καλύτερος.

Pronouns.—In case of ἐγώ and σύ note accusative singular ἐμένα, ἐσένα and genitive plural μᾶς, σᾶς; in αὐτός genitive singular τοῦ, τῆς and genitive plural τῶ(ν), τούς. The curious indeclinable expression τοῦ λόγου μου, σου, του, της for *myself*, etc. is worth remarking; in possessive pronouns ἰδικός, e.g. ὁ ἰδικός μου υἱός my own son; in relative pronouns, ὁ ὁποῖος and ὁποῦ (indeclinable)=who; in indefinite pronouns, κάτι, something; τίποτε anything, nothing; κανείς anyone, no one; καθείς, any, every, and expressions like κάθε ἄνθρωπος, *everyman*; κάποιος, *a certain*; κάμποσος, several. Of interrogatives, note τί invariable, e.g., τί ὥρα εἶνε; what's the *time*? τί λογῆς; *of what* sort?

Numerals.— The general usage follows the classical, but "popular" Greek has many divergent forms, such as ἕξη (6), τριάντα (30), σαράντα (40), πενῆντα (50), ἑξῆντα (60), etc. The following miscellaneous expressions may be noted: ἑκατομμύριον (*million*), δωδεκάς (dozen), δύο φοραίς (twice), τρία τέταρτα (3/4), δύο ἀπὸ τὰ πέντε (2/5), δύο στὸ πέντε (2/5), ἕξε τοῖς ἑκατόν (6%), μισὴ ὥρα (*half-hour*), εἰς τὰς πέντε (5 o'clock), τρεῖς καὶ τέταρτο (3.15), ἕξε παρὰ εἴκοσι (5.40), εἴκοσι Φεβρουαρίου εἰς τὰ χίλια ἐννακόσια εἰκοσιοκτώ (20th Feb., 1928).

Conjugation.— The Modern Greek verb has no dual, optative or infinitive. The optative is expressed by εἴθε νά e.g., εἴθε νὰ ἦτο would that it had been, the infinitive by νά followed by the subjunctive, e.g., θέλω νὰ γράφω, I want to write. There is a tendency to substitute the -ω ending for μι, e.g., δεικνύω, and to abandon contracted verbs, e.g., χρυσόνω takes the place of χρυσόω. The auxiliary verbs ἔχω and θέλω have largely taken the place of the old tense forms; θέλω is generally used in its abbreviated form θά thus θὰ εἶμαι, I shall be; ἔχω λάβει, I have *received*; θὰ εἶχον λάβει, I should have received. In these examples λάβει is an invariable form, corresponding (according to some) to an infinitive without ν, according to others, to the 3rd singular aorist subjunctive and as such sometimes written λάβῃ. The corresponding passive form is ληφθῆ—ἔχω ληφθῆ, I *have* been received. For the imperative, ἄς with the subjunctive is largely used, e.g., ἄς γράφῃ, let *him* write. It should be observed that for the forms described as subjunctive, the corresponding indicative forms, γράφει, etc., are freely used. The invariable present participle form ending in -οντας should be noted, e.g., ὄντας, *being*, γράφοντας, *writing*. As to the principles of the Modern Greek verb with regard to time, the most important distinction is between the continuous (present) and the momentary (aorist), e.g., θὰ γράφω I shall be *writing*, and θὰ γράψω, I shall write. In conditionals, classical refinements have been largely obliterated: ἐάν or ἄν is commonly used with the indicative, e.g., ἐὰν εἶχε γράψει, ἤθελον μάθει, If he had written, I *should* have learned; thus θέλω has ousted ancient ἄν in the apodosis.

Vocabulary.— The "purists" go to Ancient Greek for their vocabulary, and are anxious to oust all foreign words. To meet modern conditions, they introduce many neologisms, coined on analogy with the ancient language; e.g., ἀσύρματος τηλεγραφία, wireless telegraphy; ῥαδιοτηλεγράφημα, wireless *telegram*; δακτυλογραφία, typewriting; συνάλλαγμα, bill *of* exchange; ὑπάλληλος, employee; καρβουνότουβλα, *briquettes*; ταχυδρομεῖον, *post-office*; ἁμαξοστοιχία, railway *train*; ἀτμόπλοιον, steamer; ὑποβρύχιον, submarine; θωρηκτόν, *warship*; εὔελπις, cadet; συνταγματάρχης, colonel; ἀεροπλάνον, aeroplane; πολυβόλον, *machine-gun*; περίστροφον, *revolver*, etc.

The foreign words still surviving in "popular" language mirror the vicissitudes of post-classical Greece; they are naturally far more common in the literature of mediaeval Greece than they are to-day. The principal languages from which such words are drawn are Latin, Italian and Romance languages (reminiscent of the settlements of the crusading Latins in Greece), Slav, Walachian, Albanian, and above all Turkish (in which may be included some earlier Arabic survivals). Examples:

Latin.—ἀκκουμβῶ, *lean*; ἄρματα, *arms*; βάρκα, boat; βέργα, rod; βοῦλλα, seal; κάμπος, *field*; κουρσεύω, be pirate; παλάτιον, *palace*; πλουμίζω, adorn; σπίτι, house; στράτα, street; ταβέρνα, tavern.

Italian and **Romance.**—ἁρμάδα, *fleet*; βελοῦδο, velvet; γάτα, cat; κάλτσα, stocking; καπέλλο, hat; καπετάνιος, captain; κουμπάρος, best-man; λεβάντες, E. *Wind*; λίστα, list; μοῦτσος, *cabin-boy*; ντάμα, lady; πέννα, pen; πονέντες, W. *Wind*; πόρτον, *harbour*; ῥιμάρω, rhyme; σαλόνι, *saloon*; τιμόνι, tiller; φορτοῦνα, storm. It is sometimes difficult to distinguish between borrowings from Latin and Italian and Romance languages.

Slav.—βάλτος, marsh; γοῦνα, *fur*; κουνέλι, rabbit; ῥοῦχα, clothes.

Walachian.—βλάχος, rustic; κατσίβελος, *gypsy*.

Albanian.—κοπέλα, girl; λουλούδι, *flower*.

Turkish and Arabic.—ἀμπᾶς, *serge*; γάιδαρος, ass; δραγουμάνος, *interpreter*; ζαγάρι, hunting-dog; (Ar.); καδῆς, judge; καζάνι, cauldron; καΐκι, *boat*; καλαφατίζω, caulk (Ar.); κέφι, good *humour*; κιόσκι, kiosk; λουφές, pay; μαιμοῦ, monkey; μουσαφίρης, *guest*; μπαρούτι, gunpowder; ντουλάπι, *cupboard*; ὀντᾶς, *room*; παζάρι, *bazaar*; παπούτσι, shoe; παράδες, *money*; ῥακί, spirits; ῥαχάτι, ease; σαράγι, palace; σαράφης, *money-changer* (Ar.); σεφέρι, war; τζάμι, glass; τζαμί, *mosque*; τεμπέλης, lazy; τουμπεκί, tobacco; φλιτζάνι, *cup*; χαμπάρι, *news*; χάνι, inn; χαράτσι, tribute; χαρτζιλίκι, *pocket-money*; χατίρι, *favour*.

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GREEK LAW. The basis for the development of Greek law was laid by the rise in Greece of city-states (*poleis*). Primitively all Greeks were tribal; or, to use their own term, ethnic. But between 1200 and 800 B.C. among those of them who had entered the area of the Aegean civilization tribes were replaced by city-states. Of Greek tribal law little need be said. Its source was twofold. For the most part it issued from kindred-groups—families and brotherhoods (*phratries*)—by which also in this event it was enforced. But it likewise sprang from the tribal government—kings, elders and assemblies; and tribal, and even intertribal, pressure operated to produce or maintain a general sameness in the rules and regulations of the lesser groups. Tribal law, and the law of the early city-states as well, consisted of customary rules preserved by popular memory. So long as they were thus intangible they could be changed only unconsciously by the slow processes of social growth. Thus, they seemed unchangeable. Nor did the gods withhold their hands after they had laid down the fundamental ordinances. From Zeus there came to every king, so Homer tells us, the dooms *(themistes)* according to which he settled disputes (*Il.* ix. 99).

Tribal justice had as its mainspring self-help. Its course may be illustrated in cases of homicide. Fear of vengeance at the hands of the kindred of the slain man drove his slayer, whether guilty or innocent, to seek exile, sanctuary or the protection of his blood-brothers. But to avoid the feuds, to which acts of violence and reprisals gave rise, recourse was had to commutation, and if this proved inefficacious, to arbitration. The oldest Greek trial of which we have record was one arising out of a dispute between a slayer and avenger as to the receipt or non-receipt of blood-money. The hearing was held publicly, in the place of assembly, and was attended by partisans of both contestants, who were restrained by public officers (heralds). The "daysman" (ἵστωρ) was supported by the elders. They sat on "polished stones in the sacred circle," and in their midst lay two pieces of gold to be awarded either to the disputant who made good his contention or to the elder who declared most righteously the rule of law (δίκη) governing the case (*Il.* xviii. 497–508).

The scope of self-help was wider than the scope of kinsmen-help. The adulterer, no less than the homicide, could be dealt with directly by the party aggrieved; but since unmitigated self-help was socially suicidal, even if he were caught *in flagrante delicto* he might be ransomed if a bondsman went surety for him (Od. viii. 344–599). Where death or violence were not its normal accompaniments the practice of affirming rights solely by self-help lasted longer. Until a late date a creditor might seize the person of his debtor for nonfulfillment of contract. Long after the rights of talio and "distress" had been subordinated to state law they continued to he legitimate remedies of international law.

The *Iliad* and *Odyssey* of Homer are the sole contemporary source for early Greek law. They reflect its condition in the period of transition from the tribe to the city-state. Between Homer and the 7th century revolutionary changes in constitutional law occurred. They affected comparatively little the rules applicable within the family sphere; but the autonomy of the kinsmen-groups in pursuing private vengeance was radically affected by the coming to prevalence of an attitude toward homicide that lifted murder out of the category of ordinary acts of violence; the slayer was thought to pollute the entire community. So the state could no longer remain neutral.

The defects of unwritten laws were not so much their vagueness as their failure to cover new situations. They might coerce facts and outlaw novelties, like those of the ancient Spartans and the modern Albanians. But where new situations developed in spite of them, a frontier region of uncertainty arose in which the magistrates were unguided and unrestrained. Such was the characteristic aspect of justice in the "iron age" in which Hesiod wrote (700 B.C.). An obvious remedy was to separate the determining of law from the passing on facts and to leave one function only to magistrates. The function Rome left them was the one Athens took from them. In *c.* 683 B.C. it created a body of six "determiners of customs" *(thesmothetai:* cf. the Persian *databara*), to whom, it may be assumed, the chief magistrates (archon, *q.v.* polemarch, king) were bound to refer for an authoritative definition of the "law" that bore on disputes brought before them.

In the 7th century the Greek city-states began putting their laws into writing. The method used was to entrust the task of determining all the laws and issuing them in the form of a code to a single individual described as a "law-determiner" (*nomothetes).* The early codes have all perished except for a few isolated passages; so that our direct knowledge of them is slight. But we may say that laws were, on the one hand, instructions issued for the guidance of boards and officials in the performance of their public duties, and, on the other hand, rules of general application containing prohibitions with their attendant penalties, and specifications as to what should be done in certain contemplated acts or situations. Since the rules were linked up for enforcement with definite organs of government, the entire code was arranged under the heads of the competent public authorities.

Greek law-codes were accordingly a blend of public law, including the forms to be observed by priests in public worship, and private law. A pre-condition for their publication was the spread of literacy. Since they were demanded because of the inadequacy of traditions, they naturally appeared first in the colonies and in progressive states. The earliest *nomothetes* is said to have been Zaleucus of Locri in Magna Graecia. Charondas of Catana was perhaps a younger contemporary. Other famous law-givers were Dracon of Athens (*c.* 621 B.C.), Pittacus of Mitylene and Philolaus of Corinth. The historical reality of Lycurgus of Sparta, Theseus of Attica, and even Minos of Cnossus has been sustained by some recent writers, and the divinity of Zaleucus, Charondas, and even Draco has been affirmed by others; unwisely in both instances.

Since each city-state had its own law it is apparent that strictly there was no such thing as Greek law, but only hundreds of local codes. And indeed in the sense in which England developed a common law and France "received" another, there was no possibility for a common law to arise in Greece, unless it be in the area of the short-lived Athenian empire (477–405 B.C.). The common law which Greece possessed was simply the law that was common to all its numerous codes. This need not have been inconsiderable. The law given by Zaleucus to Locri was adopted by Sybaris; that given by Charondas to Catana was shared by the other Chalcidian cities in Sicily and Italy, and what is even more remarkable, it was not only drawn on by Thurii, but also used in Mazaca in Cappadocia. None the less cases of migratory codes were exceptional. The unity of Greek law, such as it was, depended rather upon the possession by all Greeks of a common stock of legal principles. This was partly an inheritance from a distant past. The rules governing marriage, right of succession (*anchisteia*), the disposition of heiresses, adoption-family life in general—were everywhere similar because they were derived from ancient Hellenic ideas. But it was also the outcome of reciprocal borrowing. Commerce in Greece was at all times international in part and largely in the hands of metics. The ideas of commercial right and wrong were established in the international ports and on the high seas by a kind of mental and moral barter. They were brought to greater precision by the negotiation of commercial treaties (σύμβολα); and finally they became so consolidated that Demosthenes jxxxv. 45) could affirm that the laws governing commercial cases "were everywhere identical."

Between the 7th and 4th centuries codes tended to converge. The movement of law had to conform to the general movement in Greece, which was towards greater and greater uniformity. But there was an inevitable relation between laws and the character of states; and since for a long time noble or class-states, which had existed generally at the time laws were first codified, persisted in certain parts of Greece, the convergence was at first on two types of law rather than on one—an aristocratic type and a democratic type. The former is well illustrated in the laws of Gortyn in Crete.

As these have reached us, they consist of earlier and later portions, the latter a supplement made at c. 450 B.C. In this collection, especially in its earlier portions, the rules of a class-state predominated. A magistrate, unassisted by jurors, judged cases, and there was a special judge for the privileged class. The right to make a will was not recognized Women inherited as well as men. The penalties for offences varied with personal status. For private seizure of an alleged wrong-doer in advance of trial a fine of 10 staters was imposed if he was a freeman, one of j if he was a slave. Rape of a free man or woman was penalized by roo staters, rape of an apetairos by 10, and of a serf by 5; but if the violator was a slave the penalty was doubled. The number of witnesses required to prove an allegation varied similarly; five, for example, to convict a free man. three to convict an apetairos, one to convict a serf. In the event of conflict the law defined which witnesses "were nearer," that is, should prevail.

The other type of code emphasized by contrast what the Greeks called *isonomia.* This meant. in terms of public law, the admission of all free-born native adult males to equal share in the assemblies in which sovereign action was taken, and, in terms of private law, the cancelling of all class distinctions. Athens is the classic example of this type; and the influence, power and policy of Athens helped greatly to spread throughout Greece the principles of law for which it itself stood. Historically there was a connection between political and legal equality, and in Athens both were realized finally on a basis of self-government in 507 B.c., after the expulsion of the Peisistratids. But they were not inseparable. In Boeotia, for example, a way was found to reserve participation on equal terms in the sovereign assemblies to citizens of the middle and upper classes without giving them any rights under private law which all free-born native adults did not also have. Those owning a certain amount of property simply became "councillors"; and councillors alone were organized for the transaction of public business. For a brief time after the fall of the Four Hundred in 411 B.C. Athens itself adopted this form of *isonomia.* There the experiment failed politically and was not repeated.

Growth **of** Law in Athens.—In the centre of Greek law, as we know it, stands the law of Athens. It was first codified by Dracon. The thought then, uppermost in the minds of the Athenians was to fix once for all existing customs. Stability, presumed for the law while it was unwritten, was naturally presumed for the written law also. But, owing, as it seemed, to the rapacity of the rich and the extravagant hopes of the poor, the situation became so acute within a generation that Solon, archon for the year 594 B.C., on being given the full power of the state to reconcile the warring factions, took the extreme step of issuing a new code of laws. The only part of Dracon's code which he retained unchanged was the law of homicide. The constitutional provisions, including those regulating judicial procedure, were profoundly altered, notably by a rule, pregnant with history, authorizing appeal from judicial decisions of magistrates to a popular assembly organized as a court (heliaia). All free-born adult males native in Attica were given the public-law rights of isonomia—membership on equal terms in Assembly and heliaia. For classes based on birth Solon substituted classes based on property. These new classes were recognized in the distribution of public offices and services. Were they also recognized in the assessment of legal penalties? There is no conclusive evidence on the point. The spirit of the Solonian constitution was hostile to their maintenance. It struck at the roots of privilege by including wrongs done to citizens individually in the category of wrongs done to the state. In all cases (excepting homicide), which involved more than business settlements, Solon established the right of any citizen whatsoever to appear as public prosecutor.

Solon regarded law-making as an abnormal function of government and he bound the Athenians by oath not to resort to it again for 100 years. This attitude toward it persisted under the Peisistratids, who preserved Solon's laws while administering them to serve their own ends. Cleisthenes, too, was an extra-constitutional law-maker. But at some point, not precisely determinable, between the time of Cleisthenes and the downfall of the Four Hundred in 411 B.C., the method of legislating through suspension of the constitution in favour of an autocratic nomothetes was abandoned for the more democratic method of vesting the law-giving power in a board of nomothetai; and it was according to the more modern method that the *régime* of the Five Thousand was inaugurated in August 411 B.C. and the democratic laws re-enacted on the overthrow of the Thirty and the Ten in 403 B.C. On the latter occasion it proved necessary both to make a general revision of the laws and to issue a new code. The legislative work was entrusted to a corps of 1,000 representatives taken from the demes, half by lot and half by popular vote (the *nomothetai*). This body issued the laws, old and new, in the form of drafts (συγγραφαί) and put them in the hands of a commission of "publishers" (*anagrapheis*) for editing. This body had them cut on stone slabs in the King's Porch, where also the old code had been inscribed.

Thus far legislation was an occasional and not a regular function of government. But this view of it was now abandoned. Athens had henceforth a process by which the laws might be changed annually. It was initiated at the first meeting each year of the Assembly. Votes were then taken on the laws, section by section, to determine whether or not they seemed adequate; first on the laws concerning the Councils; secondly, on those classified as general (κοινοί); thirdly, on those relating to the nine archons, and finally on those relating to the other magistrates. For the defence of laws judged inadequate five attorneys were elected; and during the succeeding three weeks anyone who chose might bring forward substitutes for laws under indictment and have them posted on the state bulletin boards. Then, at its third meeting the Assembly ordered nomothetai to be chosen. The nomothetai—on one occasion 1,001 in number (Dem. xxiv. 27)—were selected from the jurors (dicasts) empanelled for the year. In this particular they resembled a court. Their proceedings, too, were in the form of a trial with pleas by the proponents of changes and counter-pleas by the attorneys for the defendant laws. But since their presiding officers consisted of the identical type of presidency used in the Assembly, they also resembled the sovereign political body. Their decisions, too, were reached as in an Assembly and not in a court—by open vote. Unlike a decree a law could be enacted only after due notice had been given and the public interests had been defended by counsel. It emanated from a body carefully selected to ensure the representation of every section of the population, not, like a decree, from the group of citizens who chanced to be present at a particular meeting of the Assembly. The nomothetai were dicasts; but they rendered a political not a judicial verdict. Hence unlike the action of a court, it was subject to suspension. like the action of the Assembly, if indicted for illegality, and became definitely binding only when reaffirmed by a regular tribunal.

The code was a thing of many complex interrelations. An alteration at one point might produce unsuspected trouble at others. The officials who had most to do with law-enforcement were the *thesmothetai.* It was therefore made incumbent upon them to examine the code carefully in the course of their administration, and, if they found in it obsolete articles not so designated, or articles which contradicted or duplicated one another, to put on the bulletin boards the editorial revisions they deemed necessary. For the validation of these clerical corrections an ordinary meeting of the Assembly was competent, but it was held constructively to have been a session of *nomothetai.* A much less innocuous participation of the Assembly in legislation is demonstrated by documents for the period following c. 360 B.C. Impeded in action it wished to take by lack of legal authority, the Assembly passed votes requiring the chairmen and president who should preside at the first session of *nomothetai* to present for consideration the additions to the laws it desired. This may have led to an over-weakening of constitutional law (Dem. xx. 89 sqq.); but so long as this was fused with private law there was no alternative. The magistrates' courts, being incompetent to render judicial decisions except in trifles, were incapable of developing a *ius honorarium.* Neither could law in Athens be court-made, since every verdict of the dicasts was independent of every other verdict.

Until the age of Pericles, the Athenians entrusted the function of acting as "guardian of the laws" to the Areopagus. Then they did away with it as being derogatory to popular sovereignty. Yet the laws had to be safeguarded, not perhaps against the demos itself—for like the king the dentos could do no wrong—but against individuals in Council and Assembly who should mislead it. The remedy applied was to hold all makers of motions at meetings of these bodies liable to public actions for illegality (γραφαὶ παρανόμων), thus placing the protection of the laws in the large category of public interests for the vindication of which each and every citizen in good standing might assume the rôle of state prosecutor. The test of illegality was that the motion should seek to accomplish something prohibited by the laws. There was, however, nothing illegal in persuading the Assembly to use decrees (*psephismata*) to fill gaps in the laws; and in the 5th century, when legislation was still a quasi-revolutionary activity, this course was frequently followed. It was by means of decrees primarily that law was built up for the empire. The constitution of the council itself was extended by decree. New magistracies were created in this way. Decrees were therefore often indistinguishable from laws in subject matter, and since the courts were required to take account of them both, they might have precisely the same force as laws. Yet there was a fundamental difference between the two. A decree could be abrogated by a new decree without ceremony, whereas a law stood until annulled by further legislation. The revisions of 411–10 and 403 B.C. must have conferred the superior status of laws on many rules which theretofore had rested on decrees alone; and thenceforth the Athenians lessened the need for decrees to trespass on the province of laws by providing for annual legislation. Naturally they made the proposers of new laws liable to the same form of public action as the proposers of new decrees. And indeed they went even farther than this; they made them liable to public prosecution if the laws originated by them were found within a year to be inexpedient. After the twelve months had expired, laws, like decrees, alone were indictable, not their authors.

Official transcripts of the laws were ordered to be made on stone tablets in 410–04 B.C.; and to this measure we owe the preservation, though in a very fragmentary condition, of Dracon's law on involuntary homicide (I.G. I. 115), Cleisthenes' law on the Council of the Five Hundred (I G. I. 114), and a law of uncertain date governing grants of maintenance in the *prutaneion* (I.G. I. 77). On the occasion of the revision made in 403 B.C. a new text was issued in the Ionic alphabet then officially adopted. The new laws passed during the following 80 years were attached to the code in the form of the minutes of the sessions of *nomo*thetai in which they originated, and like the laws of Rome they were regularly cited by the names of their proposers. A small number of these novellae has come into our possession textually, three in inscriptions (I.G. II. 140, 333, 244). Most of the laws that have reached us, whether in whole or in part or in paraphrase, were entered by ancient grammarians at points where they seemed to be called for in the speeches of the Attic orators. These and others, culled from lexicographers and scholiasts and elsewhere, are collected in Telfy's Corpus *Juris Attici* (Pest and Leipzig, 1868). The descriptive portion of Aristotle's *Constitution* of Athens (§§42–70), composed between 329 and 322 B.C. was based directly on the code of that epoch. Though it is confined to an exposition of public law and has reached us without its final portions, it is by far the most extensive abstract of the Athenian laws that we possess.

So far as we can judge from the specimens preserved, the laws of Athens were drafted in simple language. Some ancient phrases survived in their older portions. In style they resembled the laws of the Twelve Tables rather than the matured legislation of republican Rome. No attempt was made in them completely, to define parties or objects concerned by the use of synonymous terms and to adhere rigorously thereafter to the definitions once made—a defect that opened the way to subterfuge in litigation (Lysias, x. 1;), but was less troublesome in the equitable processes of the dicastic courts than it would have been in courts guided by strict law. The laws dealt with concrete situations that had arisen in actual experience. Hence they were adequate through being numerous and detailed rather than through embodying principles that were capable of wide application. The distinctions between the hundred and more actions open to suitors were drawn with acuteness, if not with over-subtlety. The rules of procedure were "at times casual and incomplete (set practice being taken for granted), at times minutely specific." Penalties for "criminal" offences were remarkable for their severity—a reflex doubtless of the passion and intensity of their political life; they included death (with circumstances of atrocious cruelty in the case of common malefactors) ; fines that were often confiscatory; total or partial disfranchisement; and detention, but not imprisonment. The code was thought not to measure up to the standards of contemporary jurisprudence; but when it was refashioned by Demetrius of Phalerum to give effect to the Peripatetic theory of society (317 B.C.), the Athenians would have none of it. On the expulsion of the unpopular *nomothetes*—his office was an anachronism, no less than many of his laws—they revived the "laws of Solon," revised them to suit the altered circumstances and republished them (307–304 B.C.).

The task of abstracting the law of Athens (or of Greece) from the instructions of magistrates, and setting it out under appropriate headings for comparison with Roman and other systems of law, has been undertaken by modern scholars, notably lawyers. But from the nature of the materials, which also precludes any attempt to summarize the laws under their original headings. we must content ourselves here with citing the works by Beauchet, Partsch, Mitteis, Vinogradoff and Weiss mentioned in the bibliography.

Judicial System **of** Athens in **the 4th** Century.—Except for (1) a special group of public actions, itself divisible into subgroups, suits fell into two general categories: (2) dikai, or private suits, and (3) *graphai,* or public suits.

1. The special actions may be thought of as a residuum of the means in use before Solon for dealing with crimes against the state. The small fines (ἐπιβολαί) imposable by administrative officials upon citizens who disputed their authority represented another such residuum. Their common characteristic is that the council and assembly or the magistrates were competent to punish, if they chose, without observing the regular forms of judicial procedure. The most striking example of executive justice is apagoge (with its variants endeixis and *hyphegesis*), the arrest and detention of malefactors (κακοῦργοι, *e.g.,* thieves) caught in the act or of persons (exiles, state debtors and the like) caught exercising rights of which they had been legally deprived. If the prisoners admitted their guilt the "eleven" were authorized to inflict summarily the penalties prescribed, ordinarily death; otherwise, they, or exceptionally the thesmothetai, had to conduct the case as a public action.

By far the most important of these special forms was impeachment (εἰσαγγελία). Typically it may be described as the process designed to cover acts that may be loosely defined as treason. The offences were at first left indeterminate, but eventually a law *was elaborated including among them, specifically, treason and conspiracy to commit treason; betrayal of a city, ship, army or fleet; unauthorized traffic with an enemy, residence in his country or service in his army; the acceptance by a public man of bribes as a consideration for misleading the demos. From actions of this type many causes célèbres arose, notably the trial of the eight generals who commanded in the battle of Arginusae. The denunciation might be presented to either the council or the assembly and accepted or rejected by them. If accepted, the defendant was arrested and if the matter was grave he was kept in prison pending trial,. The council drew up the definite proposal for action, in the one instance on its own initiative, in the other at the request of the assembly. If the penalty deemed sufficient was a fine of 500 drachmae or less, the council was fully competent to impose it. Otherwise it transmitted its proposal, through the agency of the thesmothetai, to the Assembly, which had thereupon to decide either to try the case itself, which it did by the process used in enacting a decree, or, as was more usual, to hand it over to a dicastery. The penalty was ordinarily death with confiscation of property. The dead bodies of traitors were cast beyond the boundaries of Attica. "Presentment" (προβολή) was somewhat similar to impeachment. Actions regarding contraband (φάσις) and wrongful possession of public property (ἀπογραφή) were also special in that those who prosecuted them paid court fees, as in civil suits, but received half or three-fourths of the penalty. This was the prime source of sycophancy (the trade of informing).*

2. **Dikai**—The *characteristic feature of dikai was that the right to bring them rested upon the possession by the plaintiff of a private interest. But they fall into two altogether different classes: (a) actions for homicide, and (b) civil suits.*

(a.) Because of its antiquity the law of homicide contained a relic of the primitive practice of self-help. It placed the obligation of seeking redress for homicide upon the kinsmen of the slain man — upon his father, brothers and sons as prosecutors, and upon his cousins, sons of cousins, male relatives by marriage and blood-brothers (phratores) as co-prosecutors. A man belonging to the inner group alone had the right to bring action; or, more probably, his was the prior right, since in cases where it was permissible to arrange a settlement (αἴδεσις), even the blood-brothers were competent to act if none of the nearer relatives existed. Dracon had recognized the essential difference that exists between wilful murder and other kinds of homicide; but it was a distinction that did not permit any discrimination in the religious ritual of the occasion; the king-archon presided and voted at all trials, the courts sat in holy places in the open air, and pending trial the accused was excluded from the agora and all shrines and religious ceremonies, but not imprisoned. When the offence charged was wilful murder, or wounding or poisoning or arson with intent to kill, and the victim was an Athenian, the Areopagus as a whole formed the court, it sat on Ares' Hill, and the penalty, when life was taken, was death; otherwise exile. Other kinds of homicide were regarded as of lesser seriousness, and a board of judges called Ephetai—originally a commission, perhaps, of 51 Areopagites, later a panel of dicasts — constituted the tribunal. The place in which the trial was held varied with the nature of the defence. To the Palladium belonged cases of involuntary homicide and instigation thereto, the penalty being temporary exile; also suits for killing non-citizens—slaves, metics, and foreigners. To the Delphinium belonged cases of justifiable killing, and to the Phreatto, accusations against citizens already in exile. The defendant pleaded from a boat anchored off the shore so as not to pollute the country by setting foot on it. In the Prytaneum the king-archon had the phulobasileis, instead of the Areopagus or the Ephetai, associated with him as judges, and to it belonged trials which were purely ceremonial in character — where the "doer" was unknown or an animal or, as in the obsolete English law of "deodands," something inanimate. The objects found guilty were cast beyond the frontiers.

(b.) Civil suits could be brought only by the parties interested or their legal representatives. Their entry was governed by the general principle of Athenian law that magistrates should accept cases arising in the sphere of their own administration; but the principle was inapplicable to magistrates whose duties were mainly or wholly judicial. Of these the thesmothetai were comparatively unimportant in civil suits. The other t o — the Introducers and the Forty — received civil suits only. The competence of the Introducers was limited to suits which by reason of their special urgency had to be brought to trial within a month of the filing of the cornplaint (δικαὶ ἔμμηνοι); but not all such suits came to them. Those that they received were actions arising from non-restitution of dowry, from loans that were in the nature of an accommodation — where the rate of interest was low (12% or less) or the security poor — from transactions with business associates, partners, or bankers, and from trierarchies. Also actions for assault. For each pair of phulae there was one Introducer.

Of the Forty, four acted for each phule. If the object of litigation was worth 10 drachmae or less they settled it with full authority. Otherwise they referred it to a public arbitrator (διαιτητής), whose business was first of all to reconcile the parties. Failing in this he heard the case. If his decision was accepted by both parties it was final. But if the loser chose to appeal from it, the arbitrator sealed up in caskets all the papers submitted at the hearing, those of each litigant separately, and referred the case back to the section of the Forty uhence it came. This had then to take it to a public court, where the usual course was followed.

It was characteristic of civil-suits that the winner had himself to obtain the rights awarded; but if he encountered resistance he could bring a suit of ejectment. The feature of this class of actions that calls for special notice was the provision for compulsory arbitration. It applied to all civil suits that came before the Forty either directly, or indirectly from other magistrates. Excepting the monthly suits, which would not brook delay, most disputes about property, sales, leases, contracts, debts, etc., implicating either citizens (office-holders and non-office-holders alike) or metics and other privileged aliens had to be submitred to arbitration. The task of arbitrating was reserved exclusively to the last class of citizens on the roll of those liable for military service; in other words, the Athenians in their 60th year. The appointment of the arbitrator for each case was made by lot and the arbitrator on whom the lot fell could not decline to serve, unless he were holding office or absent from the country, without incurring the penalty of disfranchisement, to which he was also liable, on complaint to the whole body of arbitrators, if he abused his position. The state had more confidence in the average capacity of its sexagenarians than it had in their public spirit and integrity. But what of the litigants? That they would respect the findings of an obviously incompetent arbitrator, however unbiassed he might be, was not to be expected. The essence of the system was "that in a large number of disputes the constitution did not compel two quiet citizens to face the ordeal of a trial in court, but provided a cheap and simple and reasonable means of getting justice" (Wyse).

3. **Graphai.**—The *judicial vindication of a public interest was the object of these suits. They could be entered by any citizen in good standing. He might be himself the aggrieved party, but in that event, even if the award was pecuniary, it fell to the state, which in all cases exacted the penalty. As in private suits, so in public, the magistrates were confined to a passive rôle: before taking action they had to wait till private individuals filed complaints with them. The principle that executive competence determined judicial competence also prevailed.*

Accordingly the generals and the other army officers were alone competent to receive suits for infractions of military duty. To the archon and the polemarch came suits (private or public as the case demanded) concerning matters of family — the rights of widows, orphans, minors and heiresses, the management and division of family prooerty, the appointment of guardians or patrons, etc.—to the a-chon, if they involved citizens; to the polemarch, if they involved metics and other privileged aliens. The king-archon received suits concerning religious marters — impiety, hereditary priesthoods, the share of genê and priests in sacrificial offerings and the like. Since over 100 species of suits are known, divided about equally between dikai and graphai, it is impossible here to give a complete classification of suits and magistrates. But the rôle of the *thesmothetai* calls for special comment. The six men constituting this board had duties to perform in connection both with making and administering the law which make it almost unintelligible that they should have been elected by lot (after 487 B.C.) and changed every year. They acted as intermediaries of the Council and the Assembly in cases which went to the courts from either of these bodies; and they were alone competent to receive indictments of decrees and laws and their authors, as well as of officials who presided at sessions of the deliberative and legislative assemblies They also received actions against the generals. Besides offences against the state many offences against society were within their competence—theft, adultery, bribery and corruption of officials, councillors, and dicasts; usurpation of rights of citizenship, sycophancy, falsification or suppression of records, etc. Their civil suits were incidental.

The correct entry of suits required no small acquaintance with law on the part of average citizens, but so did the entire judicial system. The magistrates who accepted .entries, with unimportant exceptions, were always new to their office and possessed neither more nor less legal training than litigants. All litigants had to be their own attorneys. The state depended wholly upon private initiative to set the judicial processes in motion. What was everybody's business proved to be the business of a low rather than a high type of citizen; so that the community was harassed by blackmailing and sycophants. Suits were as thick in Athens as leaves in Vallombrosa. Instead of employing fisticuffs or duelling or lawyers the Athenians went to law It has been said that they were a nation of lawyers; but it has been also said that they were a nation without lawyers. And both statements are true.

The duty of assessing the evidence dnd rendering the verdict devolved upon tribunals on which sat jurors (Areopagites, *ephetai*, dicasts) ranging in number from 201 to 2,500 and exceptionally to 6,000. The Areopagus was a fixed body of about 220 members made up of ex-archons; and cases of wilful murder came to it automatically. Seeing that the archons were elected by lot with regard to local distribution, the Areopagites were simply typical Athenians; but they entered the tribunal fresh from an exceptional experience with the whole judicial system, and as the years passed they acquired a close knowledge of the law and physiognomy of murder. Hence their judgments enjoyed in marked degree general respect.

The king-archon was the only magistrate for whom the tribunal was fixed in advance The rest had to apply to the *thesmothetai*, who assigned panels of dicasts to them by lot, 201 or 401 for ordinary civil cases, 501 or 1,001 for ordinary public cases The *thesmothetai* determined on which one of the days fixed by them for sessions each magistrate should have his case tried and in which court-house the trial should be held. The selection of the panel of dicasts for each court-house was made on the day of the trial by a most intricate process of lot (Aristotle, *Constitution of Athens, $63 sqq.)*. Its objects were fivefold; to ensure (1) that each individual in each of the ten sections into which the *heliaia* was divided should have a like chance to serve; (2) that every panel, containing, as it must, a like number of dicasts from each *phule,* should reproduce in miniature the whole people for which constructively it was to act; (3) that no one whatsoever should know in advance of the entrance of the dicasts into the court-house who was to judge any particular case; (4) that no one should impersonate the dicasts selected; (5) that dicasts who failed to turn up in the court-house should not receive their daily stipend of 3 obols. There was no mistaking the intention of the Athenians: they desired every panel to speak with the voice of all Athens, uninfluenced by bribery, intimidation, or collusion. And they got their wish.

The sorting of the evidence was made at a preliminary hearing *(anakrisis)*. There the elements of the proof and disproof were assembled—the statements under oath of the parties, the depositions of witnesses, laws, decrees, contracts, and the like. The testimony of slaves was admissible only when elicited by torture; that of women and minors was admissible only in murder cases, and that of the parties to the suit was not admissible at all. Hearsay evidence was excluded. The cross-examination of witnesses was not permitted. Till 403 B.C. the pleadings were oral, but written pleadings, found necessary in cases appealed under the system of public arbitration, were adopted generally early in the 4th century. There were permissible ways of barring suits by contesting their admissibility. A civil suit might be dropped at any time. The prosecutor, however, must proceed with a public suit once it was instituted or pay a fine of 1,000 drachmae and forfeit the right to bring further actions, and he incurred the same penalty if he failed to secure one-fifth of the dicasts' votes. Court fees were collected in civil suits. Public suits more than paid for themselves by fines and confiscations. There were careful rules to govern default.

The presidency of the tribunal belonged either to the *thesmothetai* or ordinarily, to the magistrate who was connected with the suit in its earlier stages. The president had to see that the trial followed the course laid down by law, and, since his legal training was no greater than that of the litigants and dicasts, he had no claim or right to intervene further. Precedents having no legal standing, no one was needed to assess their bearing. The dicasts were in fact under oath to disregard them and to make decisions solely on the evidence and arguments presented, giving effect to laws and decrees where these sufficed, otherwise to their own sense of right. The proceedings in court consisted essentially of arguments addressed to the dicasts by the plaintiff and the defendant personally and by friends (not paid professional advocates) who appeared to support either party with their reputation and court experience. At the proper places the statements and depositions contained in the *dossier* of the preliminary hearing were read by the clerk of the court and acknowledged under oath by the litigants and the witnesses. The law authorized actions to compel the appearance of witnesses and the production by third parties of relevant documents, which, too, were read from the *dossier* by the clerk. A time, greater in public than in private suits, was set for the entire argument. Half of it was given to each party, and the water-clock *(klepsudra),* by which it was apportioned, was stopped during the reading. An inarticulate litigant would normally leave the burden of the argument to his supporters, and the practice was general for the main speeches to be prepared by professional speech-writers *(logographoi),* whose art consisted in no small degree in concealing their handiwork. If we except the disreputable tribe of sycophants, from whom speakers took special pains to distinguish themselves, this was the only professional class produced by the administration of law in Athens. They were accomplished pleaders, versed in the intricacies and pitfalls of the law, adepts in appealing to the prejudices of the dicasts; and since some of them were active in instituting public suits, they might come very near to being lawyers.

Once the arguments were concluded the dicasts voted, without discussion, either to acquit or to condemn. The utmost care was taken to preserve secrecy and honesty in the balloting. If the vote was against the defendant, but the bare decision did not suffice to dispose of the case, an argument upon the penalty ensued, at the end of which the dicasts balloted to decide whose estimate, the winner's or the loser's, should be accepted. The court was powerless to substitute an estimate of its own. but a compromise could be reached if the litigants chose to meet each other half way in their estimates. An appeal from the verdict was possible only in cases of non-culpable default; or on the ground of perjury, and then only if notice to contest the verdict on this score were given before the dicasts voted.

We do not possess the *dossier* of a single trial. The opposing arguments have seldom reached us. The speeches of the Attic orators were published as masterpieces of eloquence. They do not form a case-book of Athenian law. What they reveal is the sort of argument to which the dicasts were thought to be responsive. In public cases appeals were made to their ignorance, prejudices and cupidity, which, if successful, must have made their verdicts travesties of justice; and we know that in times of great political excitement they succeeded all too frequently But the courts were a political as well as a judicial body They were there to give the *coup de grâce* to discredited politicians; they were the heirs of ostracism. In private cases the speeches were often such as might be addressed to modern juries; and we have little reason to impugn the verdicts. The vicious tendencies of the judicial system are obvious; the contamination of justice by politics; the weakening of responsibility through its diffusion among so many jurors; the rendering of unlike decisions in like cases. But the correctives were also present; the unexampled familiarity of common man with law and legal practice; and their unique experience in taking collective action in large bodies. History contains no other instance of justice so thoroughly organized to accord with the principles of radical democracy. The Athenians were so situated that they did not feel the need either of delegating their government to picked representatives or of entrusting their justice to experts specialized in lam. The Romans enshrined their justice in their great system and profession of the law, and. thus safeguarded in their private rights, left their government to autocrats.

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GREEK LITERATURE has a continuous history extending from the 1st millennium B C. to the present day. From the beginning its writers were Greeks living not only in Greece proper but also in Asia Minor, the Aegean islands and Magna Graecia (Sicily and southern Italy); later, after the conquests of Alexander the Great. as Greek became the common language of the eastern Mediterranean lands and then of the Byzantine empire, Greek literature was produced over a much wider area and also by those whose mother tongue was not Greek. Even before the Turkish conquest (1453) the area had begun to shrink again, and now it is chiefly confined to the territory of the kingdom of Greece.

The main divisions of this article are as follows:

I. ANCIENT (TO THE 4TH CENTURY A.D.)

Of the literature of ancient Greece only a relatively small proportion survives. Yet it remains important, not only because much of it is of supreme quality but also because until the mid-19th century the greater part of the literature of the western world was produced by men who were familiar with the Greek tradition, either directly or through the medium of Latin. who were conscious that the forms they used were mostly of Greek invention and who took for granted in their readers some familiarity with classical literature.

A. CLASSICAL POETRY

Tno things are likely to appear strange to anyone unfamiliar with Greek literature. First, Greek poetry was intended to be sung or recited publicly, not to be read in private; the audience might be a large part of the population of a city. as for a play or a small private party, but poetry before the Hellenistic period (beginning c. 300 B.C.) was part of social activity. Secondly. the subject of Greek poetry was myth, that is to say the great mass of traditional material which was one of the peculiar riches of the Greek spirit; this was part legend, sometimes based on the dim memory of historical events like the fall of Troy or Thebes. part folk tale, part primitive religious speculation (*see* GREEK RELIGION). The myths of the Greeks, unlike those of most peoples, nere not closely associated for the most part with religious ritual. Accordingly, although they told of gods and of half-divine, heroic men. and often suggest the forms under which the gods were visualized. they had no particular authority and could be varied and developed as the poet wished. Indeed in the early stages Greek thought advanced largely by the half-conscious refashioning of the myths to give expression to new conceptions. The poet enjoyed the immense advantage of using material familiar to his audience, who would be sensitive to every new emphasis or fresh interpretation of the ideal of heroic life which the myth contained.

1. The Epic Tradition.— At the beginning of Greek literature stand the two great epics, the *Iliad* and the *Odyssey (see* HOMER). in their existing form not earlier than the 8th century but with roots reaching far into the Mycenaean age *(see* AEGEAN CIVILIZATION). perhaps to 1500 B C. The *Iliad* is the tragic story of the wrath of Achilles, the splendid hero, son of a goddess and richly endowed with all the qualities that make men admirable who destroys himself by his own love of honour. Being slighted by Agamemnon, the Greek leader, he refuses to take any further part in the nar against Troy; when the Greeks are hard pressed and Agamemnon offers amends. he persists in his refusal; the plight of the Greeks worsens and Achilles is so far moved by pity that he sends his friend Patroclus in his own armour to their aid; Patroclus saves the Greeks but is killed himself; Achilles in a frenzy of grief returns to the war and kills Hector. the slayer of Patroclus. and outrages his dead body. Finally he brings himself to restore the body to Priam, Hector's father, and the poem ends in reconciliation. Achilles' end is outside the poem, but right from the beginning the brilliant hero is shadowed by the knowledge of earlv death With his readiness to sacrifice all to honour. Achilles embodies the Greek heroic ideal, and the contrast between his superb qualities and his short and troubled life reflects the sense of tragedy which was alnays a part of the sad wisdom of the Greeks, though in Homer. more than in later literature, the vitality is such that it is easy to forget the strain of melancholy. Whereas the *Iliad*, though earlier than the invention of drama, is tragedy as the Greeks themselves allowed, the *Odyssey* is tragicomedy. It is an enriched version of the old folk tale of the wanderer's return and of his triumph over those who were usurping his rights and persecuting his wife at home. Odysseus too represents a Greek ideal. Though by no means inadequate in battle, he works mainly by craft and guile; only so can he defeat the superior strength of the Cyclops and the superior numbers of the suitors who have taken possession of his palace. During his ten-year journey home from Troy he loses first his fleet, then his own ship and crew, and back in Ithaca he moves disguised as a beggar in his own palace. Through all these hazards it is by mental superiority that he survives and prevails.

Both poems are based on plots which grip the reader, and the story is told in language which 'is simple and direct, yet full of natural eloquence and nobility. In the course of previous generations the epic storytellers had fashioned a linguistic instrument of extraordinary beauty and flexibility, even though, since it resembled no language ever spoken by Greeks, it was highly artificial. The *Iliad* and the *Odyssey,* though the oldest European poetry, are by no means primitive. They mark the fulfillment rather than the beginning of the literary form to which they belong. Whether or not the poems in their present form were composed with the aid of writing, they are in essence and in origin oral poetry. Nameless poets over a period of centuries had recited, or rather performed. the traditional stories, developing and modifying them in the process. Comparison with oral poetry as it has survived elsenhere suggests that the poet did not learn by heart a traditional work but was free to re-create his poems within a given framework with fresh detail. The conventional epic style was sufficiently rich in phrase and formula for it to be possible for a professional bard to perform the difficult feat of improvisation in a strict metre for comparatively long periods. If this is how the Homeric poems developed, it need cause no surprise thal the world they reflect is full of so-called inconsistencies; weapons belong to both the Bronze and Iron Ages; objects like those found in Mycenaean excavations jostle others from the Geometric period five centuries later; the fabulous wealth of Egyptian Thebes in the 15th century B.C. is referred to along with the activities of Phoenician traders in the 9th. But certain mysteries remain. What was the date of the great poet or poets nho gave structure and shape to the two epics which survive? What was the social function of poems which take several days to recite? By what process and at what stage did these poems come to be recorded in writing? These are among the Homeric questions of today.

In the ancient world the *Iliad* and *Odyssey* stood in a class apart among epic poems. Of these there were a large number known later as the epic cycle, sometimes referred to as the work of Homer, sometimes associated with various shadowy figures of whom the latest in time was Eugammon of Cyrene (*c.* 600). They covered the whole story of the wars of Thebes and Troy as well as other famous myths. A number of shorter poems in epic style, the Homeric Hymns, include three addressed to Demeter, Apollo and Xphrodite which are of considerable beauty.

Didactic poetry was not regarded by the Greeks as a form distinct from epic, since it used the same metre and the same composite dialect. Yet Hesiod belongs to an altogether different world from Homer. He liver! in Boeotia about 800 B.C. In his *Works and Days,* under pretense of advising his idle brother Perses, he describes the ways of peasant life and incidentally gives an unforgettable description of the dreary Boeotian plain afflicted by heat, cold and the oppression of a "gift-devouring" aristocracy. He believed passionately what is rarely hinted at in Homer, that Zeus cares about right and wrong and that Justice is his daughter. His other surviving poem, the *Theogony,* tells of the generations of the gods and attempts in mythical terms to supply a cosmogony and to reduce to a coherent system the mass of legends about the gods and their parentage. Near eastern influence is clearly to be seen, especially in some of the cruder speculation about the origin of the universe. Similar attempts at systemization were made by the Hesiodic school of poets, writers of "catalogues" which were often attributed to Hesiod himself. They tried to reduce to order the stories of gods and heroes and of the many aristocratic families who claimed descent from them.

By the end of the 6th century the epic tradition was a spent force until its revival in the Hellenistic period, and the few composers of epic narrative left little but their names. One of the last of them was Panyassis, the uncle of Herodotus, who wrote an epic on Heracles.

2. Lyric Poetry.—Hesiod, unlike Homer, tells us something of himself. and the same is true of the lyric poets. who were responsible for most of the poetry written in Greece between the decline of epic and the rise of drama. Except for Pindar and Bacchylides at the end of the period, only fragments of the works of these poets survive, but like Homer they show no signs of immaturity. There had always been lyric poetry in Greece, and in Homer there are occasional references to vintage songs, funeral dirges and the like. All the great events of life as well as many occupations had their proper songs, and here too the way was open to advance from the anonymous to the individual poet.

The word "lyric" is inadequate for describing the various categories of poetry which the Greeks distinguished. On the one hand, lyrics in the narrow sense, poems sung by individuals or chorus to lyre or sometimes to the flute, were called melic; elegiacs. in which the epic hexameter alternated with a shorter line, the pentameter, were traditionally associated with lamentation and a flute accompaniment, but they were used for many kinds of poem, often with a more personal tone than was appropriate to the hexameter, and were spoken as well as sung. Iambics were the verse form of the lampoon and usually of an abusive or satyrical character. Like the trochaic verse, which was used in much the same way. iambics were not normally sung. While the melic poets confined themselves for the most part to the numerous varieties of their own medium, iambics, elegiacs and trochaics were often written by the same poet, so that the main division comes between melic and nonmelic writers. (*See* PROSODY, CLASSICAL.)

If Archilochus, from the Aegean island of Paros, was really writing as early as 700 B C., he was the first of the post-epic poets, but there is some reason for dating him 50 years later. The not very numerous fragments suggest a trenchant personality to which he gave uninhibited expression. They reflect the turbulent life of an embittered adventurer and soldier of fortune, son of an aristocratic father and a slave mother. Scorn both of men and convention is the emotion which seems uppermost, and the story that he hounded to his death Lycambes, who had withdrawn his daughter from a promised marriage, is. true or not, a fair tribute to Archilochus' powers of invective. Though much of his poetry was unedifying, he was regarded throughout antiquity as a major poet.

Somewhat younger than Archilochus, Simonides or Semonides of Amorgos is represented by a long and rather laboured fragment in which women are compared to animals, and nearly a century later the iambics of Hipponax of Ephesus showed something of the savagery of Archilochus without his genius, but his vivid pictures of low life were much imitated by writers of the Hellenistic age.

Like the iambic writers, the elegiac poets came mostly from the islands and the Ionian regions of Asia Minor. Callinus of Ephesus, a little after 700, called on his countrymen to defend their city against the barbarians, but a more characteristic use of the elegiac was made by Mimnermus of the neighbouring city of Colophon, who sang in tuneful but low-spirited verse of the sweetness of love and the horrors of old age; since he exchanged verses on the latter theme with the Athenian Solon (b. *c.* 638 B.C.), he must have lived well into the 6th century. On the mainland of Greece Tyrtaeus roused the spirit of the Spartans in their desperate struggle with the Messenian rebels in the years after 650. His martial poems were among the few that Spartans were encouraged to be familiar with; today they are perhaps valued more for their historical than for their literary interest. The same is to some extent true of the poems in elegaic. iambic and trochaic metres by Solon. He was no professional poet, but at a time when books did not exist a poem was the best medium for propaganda, and he used verse to rouse the Athenians for the reconquest of Salamis *c.* 600 B C., to express his views about the source of their political troubles and, after he had carried out his great reforms, to explain and to defend them, as well as to assert his faith that in the long run the gods see that justice prevails. Xenophanes (b. *c.* 560). rather in the same may, used his poems, both elegiac and hexameter, to propagate his revolutionary religious and ethical ideas. The collection of elegiacs which has come down under the name of Theognis seems to be composed of poems of various dates suitable for use at drinking parties. Many of them are from the hand of Theognis himself (c. 580–530?). Some give uninhibited expression to his hatred of the lower-class rulers who had ousted the aristocracy of Megara; others are love poems, sometimes passionately reproachful, to the boy Cyrnus; others again are gnomic, neat statements of the commonplaces of Greek wisdom and morality (see GNOME AND GNOMIC POETRY).

About the beginning of the 6th century a new kind of poetry made its appearance in the island of Lesbos off the coast of Asia Minor. It was composed in the local Aeolic dialect by members of the turbulent and faction-ridden aristocracy. Alcaeus (b. *c.* 620) and Sappho, a few years younger, both spent part of their lives in exile. Alcaeus, absorbed in political feuds and in civil war, expresses with striking directness searing hate and blind exultation. With the same directness and infinite grace, Sappho, who seems to have enjoyed a freedom unknown to the women of mainland Greece, tells of her loves and, hardly less frequently, of her hates. Of the milieu in which she moved and of her relations with the girls who are named in her poems much has been guessed but nothing can be regarded as known. The remains of their successor in personal lyric, the Ionian Anacreon of Teos, a generation later, suggests a more convivial amorousness. His reputation has suffered from the ascription to him of a number of feeble poems of late date, the *Anacreontea* (see ANACREONTICS).

The Greeks did not themselves distinguish choral lyric as a separate category. but it was associated with the Dorian parts of the Greek mainland and the settlements in Sicily and south Italy as opposed to the poetry for solo performance of the Ionian coast and the Aegean islands, and for this reason it was composed in a dialect with a Doric flavour even when, as often, the poets were themselves of Ionian birth.

Choral lyric, quite apart from the music, of which little is known except that both lyre and flute had their appropriate uses. was highly complicated in structure. It aid not use traditional lines or stanzas, but the metre was formed afresh for each poem and never used again in exactly the same form, though the metrical units from which the stanzas, or strophes, were built up were drawn from a common stock. The strophes, either single or in systems of three, were repeated through the poem, and in many cases their form was related to the accompanying dance. This elaborate art form with its need for a trained choir and skilled musicians was connected mainly with the cult of the gods or, as in the case of Pindar, the celebration of the victors in the great Hellenic games.

The earliest poet of choral lyrics of whose work anything survives was Alcman, whose choirs performed in Sparta in the late 7th century before the Spartans put aside the graces of life. His original home may have been Lydian Sardis. In the next century Stesichorus worked in Sicily, an area to which Homeric poems may not yet have penetrated, and his lyric versions of the great myths mark an important stage in the development of these stories. Simonides of Ceos in Ionia, whose long life extended far into the 5th century, mas among the most versatile of Greek poets. He traveled far and wide in Greece, celebrating in Thessaly. in Athens and in Sicily the princely houses whose patronage he enjoyed. He was famed for his pathos, which is admirably revealed in his lines describing Danae set adrift with her child on the open sea. But today he is best known by his elegiac epitaphs, especially those on the Greeks who fell in the struggle against Persia, the epitome of the grace, restraint and sincerity to be found in the greatest Greek art.

But the supreme poet of choral lyric mas Pindar from Thebes in Boeotia, a part of the Greek world otherwise undistinguished in the annals of poetry except for Hesiod and for Pindar's contemporary, if contemporary she mas, the lyric poetess Corinna. Pindar (*c.* 520–440), though he composed many varieties of choral lyric, is known mainly by his epinician odes, poems in honour of the victors at the great games held at Olympia, Delphi, the isthmus of Corinth and Nemea. They were usually performed as part of the festivities which greeted the triumphant athlete on his return to his city. Among Pindar's patrons were many of the most aristocratic houses of Greece, but they were patrons whom Pindar, intensely conscious of his own divine gift of inspiration, treated as equals. In honouring athletes in the hour of glory, when they were exalted almost to the level of the heroes of old from whom they claimed descent, Pindar felt he was making no unworthy use of his gift. Even in Pindar's day the athletic ideal was growing obsolete and it is hard to recapture in imagination, hut the glowing magnificence of his tributes and the splendid passages of lyric narrative embedded in them still represent one of the extremes of poetic grandeur.

The last of the lyric poets was Bacchylides (b. *c.* 510), a nephew of Simonides. whose work, though often exquisite, is empty. The myth was losing its significance and becoming merely ornamental, and Bacchylides' treatment of it is a foretaste of the antiquarian prettiness of Hellenistic poetry.

3. Tragedy.— Before the 5th century Athens was celebrated rather for the visual arts than for poetry. But under the patronage of the tyrants, poets gathered at Athens and poetry had its part in the festivals with which the tyrants tried to popularize their rule. The decisive moment was when, in or about 534 B.C., tragedy became an official part of the spring festival of the Dionysia. Tragedy is generally believed to have developed from the dithyramb, the choral cult song of Dionysus (see DRAMA: Greek *Drama:* Origins). Arion of Lesbos. who worked at Corinth *c.* 600, was the first to write serious poetry in this medium. Lasus of Hermione, the teacher of Pindar. produced dithyrambs at Athens; and Thespis; 6th century B.C., possibly combining with them something of the Attic ritual of Dionysus of Eleutherae, invented tragedy by introducing an actor who conversed with the leader of the chorus and gave its songs a quasi-dramatic point of reference; but nothing approaching true drama was possible until Aeschylus (525?–456), the creator of the tragedy, introduced a second actor. However, his drama is still centred in the chorus, to whom, rather than to each other, his actors direct themselves.

It was customary at the tragic contests at the Dionysia for each of the three competing poets to produce three tragedies and a satyr play. the last being of a burlesque character with a chorus of satyrs who were part men. part horse or goat. Aeschylus, unlike later poets. usually made of his three tragedies a dramatic whole, treating a single story which might extend over a considerable period of time. His main concern was not dramatic structure and the portrayal of character but rather the presentation of human action in relation to the overriding purpose of the gods, though at times the accumulation of tension through long passages of lyric leads to scenes of tremendous emotional force. And the un-Greek opulence of his language and his richness of metaphor make him to most modern readers the most obviously exciting of Greek poets after Homer.

The successor of Aeschylus was Sophocles (495?–406), who abandoned for the most part the practice of writing in trilogies, reduced the importance of the chorus and introduced a third actor. The myth as the expression of an aristocratic and heroic ideal remained for him a satisfying theme and his heroes are still the heroes of Homer somewhat modified by contact with the standards of 5th-century Athens. But whereas Aeschyius tried to make more intelligible the workings of the divine purpose in its effects on man's life, Sophocles was readier to accept the gods as given and to reveal the values of life as it can be lived within the traditional framework of moral standards. He believed that in the fullness of time the wicked are punished, but not that all human suffering is punishment for wickedness. His earliest surviving plays, the *Ajax* and the *Antigone,* are the closest to Aeschylus both in stiffness of movement and in the awareness that the divine will is being fulfilled. Thereafter the actors become more detached from the background. and Sophocles' supreme skill in control of dramatic movement and his mastery of speech are devoted to the presentation of the decisive, usually tragic, hours in the lives of men and women at once "heroic" and human, such as Oedipus.

Euripides (c. 485–407), the last of the three great tragic poets, was only about ten years younger than Sophocles. but he belonged to a different world. When he came to manhood the Sophistic movement was in full swing (see SOPHISTS). Traditional beliefs were scrutinized in the light of what claimed, not always unjustifiably. to be reason, and this was a test to which much of Greek religion was highly vulnerable. The whole structure of society and its values was called in question. It is rarely possible to tell precisely what a dramatist thinks. but this movement of largely destructive criticism n-as clearly not uncongenial to Euripides. as it was to Sophocles. But as a dramatic poet Euripides found himself in an unfortunate position. He was bound to draw his material from myths, which for him had to a great extent lost their meaning. He strained and twisted them to make room for contemporary problems which were his real interest, and the divine presuppositions of the myth are accepted or rejected from moment to moment as the plot requires. In consequence, many of his plays suffer from a certain internal disharmony. On the other hand, his sensibilities and his moments of psychological insight bring him far closer than most Greek writers to modern taste. There are studies, wonderfully sympathetic, of wholly unsympathetic actions in the *Medea* and *Hippolytus,* a vivid presentation of the beauty and horror of religious ecstasy in the *Bacchae,* in the *Electra* a *reductio ad absurdum* of the values of a myth that justifies matricide, in the *Helen* and *Iphigeneia in Tauris* melodrama with a faint flavour of romance.

4. Comedy.—Like tragedy, comedy arose from a ritual in honour of Dionysus, a riotous ritual full of abuse and obscenity which was inspired not only by high spirits but by hopes of averting the attentions of evil demons and of encouraging fertility *(see* DRAMA: *Greek Drama: Origins).* The parabasis, the part of the play in which the chorus broke off the action and commented in their own persons on characters and events of the day, was probably a direct descendant of such revels. The dramatic element may have been derived from the secular Dorian comedy without chorus which is said to have arisen at Megara and was developed at Syracuse by Epicharmus *(c.* 530–*c.* 440). Hardly anything survives of his farces or of the mimes. short scenes of everyday life, of which Sophron of Syracuse was the most celebrated writer. At Athens comedy did not become an official part of the celebrations of Dionysus till 50 years later than tragedy, and the early years of its growth are correspondingly more obscure. The earliest comic poef of n-hom it is possible to form an impression was Cratinus. About 50 years later Aristophanes and Eupolis, who together with Cratinus make up the great trio of comic poets, refined somewhat the wild robustness of the older poet. But even so, for boldness of fantasy, for merciless invective, for unabashed indecency and, in the earlier plays, for freedom of political criticism, there is nothing like the Old Comedy of Aristophanes. whose work alone has survived. Cleon the politician, Socrates the philosopher, Euripides the poet are alike the victims of his masterly unfairness. the first in *The Knights,* the second in *The Clouds,* the third in the *Thesmophoriazusae* and *The Frogs,* while in *The Birds* the Athenian democracy itself is held up to a kindlier ridicule. As the war situation grew grimmer, direct political criticism became more dangerous and may have been the subject of legal restrictions. Aristophanes survived the fall of Athens in 404. but the Old Comedy had no place in the revived democracy. Except for short episodes the two plays of his of 4th-century date which have come down lack the sparkle and the poetic brilliance of his best work.

The gradual change from Old to Middle Comedy took place in the early years of the 4th century; the *Ecclesiazusae* and *Plutus* of Xristophanes belong to the transition. Of Middle Comedy no fully developed specimen has survived. It seems to have been distinguished by the disappearance of the chorus and of outspoken political criticism and by the growth of social satire and of parody; Xntiphanes and Alexis were the two most distinguished writers. Some plays appear to have had intricate plots treated in a comparatively realistic spirit. and it was these which led on to the New Comedy of Diphilus. Philemon. and. most important. Menander. one of the most admired poets in the ancient world. The transition took place around *320.* One complete play, the *Dyscolus*, and appreciable fragments of four others, out of Menander's 105 plays are extant on papyrus. New Comedy, as ancient critics were aware. was derived in part from Euripidean tragedy; its characteristic plot was a translation into terms of city life of the story of the maiden wronged by a god who bears her child in secret, exposes it and recognizes it years after by means of the trinkets she had put in its cradle. The god becomes a young man about town, the child a courtesan with whom a young man about town of the next generation is involved and whom he joyfully marries when she is revealed as the daughter of free parents. However great the delicacy of the language and the subtlety of the portrayal of the recurring types, it is hard to believe that such essentially barren themes of amiable virtue and petty vice could ever again arouse an enthusiasm such as possessed the ancient world for several centuries after Menander's death.

B. Early and Attic Prose

By the end of the 7th century the first written codes of law were appearing and knowledge of reading and writing was becoming more widespread. This encouraged the development of a prose literature. When writing replaced verse as an aid to memory, it was natural that the poetry of the Hesiodic school, dealing with the origin of the world and with the ordering of the generations of gods and heroes, should continue in prose form and supply the beginnings both for philosophy and history. There is no positive evidence that fables associated with the name of Aesop and traditional stories like those that appear in Herodotus' history were written down in the course of the 6th century. No prose writer is known earlier than Pherecydes *(c.* 550 B.C.) of Syros, who wrote about the beginnings of the world, but the earliest extant author among many otherwise unknown names is Hecataeus of Miletus, who played the part of elder statesman at the time of the Ionian revolt (499–494) ; he wrote both about the mythical past and about the geography of the Mediterranean and surrounding lands.

Prose came late to Athens. The oldest extant piece of Attic prose is an antidemocratic essay on the constitution of Athens (preserved as a result of a false attribution to Xenophon), the sole example of a considerable pamphlet literature. It was probably written c. *430* B.C., just after the outbreak of the Peloponnesian War, and it is an example of effective rather than elegant expression. But since Athens had risen after the Persian Wars to be the capital of a great confederacy, distinguished foreigners had been frequent visitors or residents, among them Anaxagoras from Clazomenae near Ephesus, author of one of the earliest philosophic essays in prose, and sophists like Protagoras who contributed both to originating the study of language and to developing the theory of its use as a means of persuasion through rhetoric. All these. as well as the medical writers of the Hippocratean corpus, used the traditional language of prose, Ionic.

1. History.—By far the most important of the writers of history was Herodotus, who was born at Halicarnassus and, after travels which took him as far as the First cataract on the Nile. Babylonia and southern Russia, spent some time in Athens in the years after 450 before settling in the Athenian colony of Thurii in south Italy. The theme of his history, written in large part for Athenian readers, is the clash between Europe and Asia culminating in the Persian War, but it is likely that he began by writing an account of the countries on the fringe of the Greek world in the manner of Hecataeus of Miletus, and that the idea of writing history, a thing which so far existed only in the form of local, largely mythical, chronicles, occurred to him as his work progressed. The account of the war itself. which occupies roughly the second half of the work. must have been composed by means of laborious inquiry from those whose memories were long enough to recall events which happened when Herodotus was a child or earlier. The whole history, though in places badly put together, is magnificent in its compass and unified by the consciousness of an overriding power which keeps the balance of the universe even and humbles the ambition of those who aspire too high. Though his notion of historical causation is rather naïve—the impulse which leads men to action is usually simple and purely personal, most often the desire to avenge a wrong—he has served mankind better as the faithful recorder of what he sa and what he was told than he could ever have done had he subordinated his narrative to more sophisticated notions. The style is equable. conversational, yet capable of quiet solemnity, rarely self-conscious or artificial, and the earlier books

in particular abound in enchanting digressions.

Of prose writers who were Herodotus' contemporaries the most important was Hellanicus of Lesbos, who wrote, among a large number of historical works and works on mythology, the first *Atthis,* a chronicle of the local legends and traditions of Attica.

Thucydides (c. 460–c. 400) was perhaps the first person to apply a first-class mind to a prolonged examination of the nature of political power and the factors by which policies of states are determined. At the outbreak of the Peloponnesian War (431–404) he recognized its momentousness and decided to record its history. As a member of the board of generals he acquired inside knowledge of the way policy Is shaped. After his failure to save Amphipolis in 424 he spent 20 years in exile, which he used as an opportunity for getting at the truth from both sides. The result is a history of the war narrowly military and political, but of the most penetrating quality. It was Thucydides' belief not that history repeats itself but that the forces which go to make history are unchanging: the judgment and insight of statesmen and their necessary limitations, the psychological pressures of success and failure exerted both on peoples and individuals and the incalculable element of chance. His own interpretation of the workings of these forces are given mainly in the numerous speeches, often in balancing pairs, in which he reveals the essentials of the situation as it presented itself to the leading participants at decisive moments in the war. Scholars have found some difficulty in believing that these speeches reproduce as much of the substance of what was actually said as Thucydides appears to claim. And though the war is described throughout with an appearance of utter detachment, the author reveals much about his own ideals in his admiration for the sagacity of Themistocles and the authority of Pericles, who represents the spirit of that Athens which the war destroyed, and in his detestation of Cleon's demagogic opportunism.

The Greek of Thucydides, especially in the speeches, is of great difficulty. As he wrote he was forging the instrument to express the most complicated thought yet conveyed in writing. Though harsh and austere in the opinion of Greek critics, he was not uninfluenced by contemporary fashion, but he owes less to the euphuism of Gorgias (see below) than is often supposed. In using the new methods of grouping ideas in a balanced and antithetical pattern he sometimes failed to fit his subject matter to the pattern which he imposed upon it; this, together with an occasional overconcentration of thought, is the main source of the obscurity which has troubled ancient as well as modern readers.

Just as Thucydides had linked his work by means of a digression in his first book to the point at which Herodotus had stopped, so Xenophon (c. 430–c. 354) began his *Hellenica* where Thucydides' unfinished history breaks off in 411, as did Theopompus and Cratippus after him. He carried it down to the end of the war and later wrote a continuation down to 362. His work is superficial by comparison with that of Thucydides, but he writes with authority of military affairs and accordingly appears at his best in the *Anabasis,* an account of his participation in the enterprise of the Greek mercenary army with which the Persian prince Cyrus tried to expel his brother from the throne, and of the adventurous march of the Greeks after the murder of their leaders by the Persians, from near Babylon to the Black sea coast. Xenophon also wrote three books, *Memorabilia, Symposium* and Apologia, in praise of Socrates, whom he seems to have admired rather than to have understood. His other major work, the *Cyropaedia,* was a piece of acknowledged fiction, perhaps the first of its kind, an imaginary account of the education of the great Cyrus, the founder of the Persian empire. He wrote also a number of short essays of which those on hunting and horsemanship are the best. His personality is engaging, but his moralizing is rather prosy, and the survival of a possibly disproportionate bulk of his work is due to the high esteem in which his style was held in antiquity.

No other historical writing of the 4th century has survived except for a substantial papyrus fragment containing a record of events of the years 396–395. The two leading historians who are known to have covered this period are Ephorus (c. 405–330) of Cyme in Asia Minor who n-rote the first universal history of Greece beginning in the heroic age with the coming of the Dorians c. 1000 B.C. and continuing to his own time, a highly influential work much used as a source by later writers; and Theopompus of Chios. Both were closer in spirit to Xenophon than to Thucydides, lavish with moral judgments and rhetorical embellishment. They mark the beginning of the decline of history toward the position of a mere province of rhetoric, the composition of a narrative which will at once edify and divert a reader, so that it was possible, four centuries later, for Dionysius of Halicarnassus to censure Thucydides for choosing a historical subject so little to the credit of his countrymen as the Peloponnesian War.

More scientific work was done by the successors of Hellanicus in the field of regional histories, especially of Attica. Androtion and Cleidemus in the 4th century and Philochorus continuing into the 3rd century did valuable work in an unpretentious way, basing their conclusions to a considerable extent on the study of the Athenian archives. In the west Philistus (c. 430–*c.* 360) of Syracuse, himself a man of action, wrote a history of Sicily which was highly esteemed. The same cannot be said of Ctesias who at the other end of the Greek world served as physician at the Persian court of Artaxerxes II (404–358) and wrote histories of Persia and India which were a byword for mendacity.

2. Rhetoric and Oratory. — In few societies has the power of fluent and persuasive speech been more highly valued than it was in Greece, and even in Homer there are speeches which are pieces of finished rhetoric. But it was the rise of democratic forms of government that provided the great incentive to study and instruction in the arts of persuasion, which were equally necessary for political debate in the assembly and for attack and defense in the law courts. Litigants mere not represented by advocates and the only professional help available to the private individual was that of the speech writer who could use his skill and knowledge to provide a speech to be learned and delivered before the jury (see RHETORIC).

The formal study of rhetoric seems to have originated in the democracy of Syracuse *c.* 460 B.C. with Corax and with his pupils Tisias and Gorgias (d. 376 B.C.); they also gave instruction in Athens. Corax is reputed to have been the first to write a *techne* or handbook on the art of rhetoric dealing with such topics as arguments from probability and the parts into which speeches should be divided; soon a number of such works were in circulation. Most of the Sophists had pretensions as teachers of the art of speaking, especially Protagoras with his doctrine that on each subject there is a stronger and a weaker (not a better and a worse) argument and that by art the weaker can be made to prevail, and Prodicus (c. 465–after 399 B.C.) of Ceos with his studies in the use of words.

Antiphon (c. 480–411), the first professional speech writer, was an opponent of democracy and influential behind the scenes politically. Three speeches of his have been preserved, all dealing with homicide cases, and three "tetralogies," sets of two pairs of speeches containing the arguments to be used on both sides in imaginary cases of homicide. Their authenticity has been doubled, but they are undoubtedly early, and they are of great interest because of the primitive ideas concerning bloodguilt and the duty of vengeance which they contain. The style of Antiphon is bare and closely knit and the structure sometimes rather crudely antithetical; he was little influenced by the technical advances of the late 5th century. Gorgias from Sicily! who paid a memorable visit to Athens in 427, introduced an elaborate balance and symmetry emphasized by rhyme and assonance by which the Athenians were for a short time much attracted: and Thrasymachus of Chalcedon, best known for his appearance in Plato's *Republic,* made a more solid contribution to the evolution of a periodic and rhythmical style.

Andocides (*c.* 440–*c.* 390) was involved in the scandal of the profanation of the Eleusinian mysteries in 415 (see ALCIBIADES) and spent much of his life in exile. His three speeches contain vivid narrative: but as an orator he was admittedly amateurish. Of the earlier generation of orators the most important was Lysias (*c.* 455–c. 380), who lived at Athens for many years as a resident alien and supported himself by writing speeches when he lost his wealth and all but his life in the troubled times which followed the fall of the city. Of all the Attic orators he is the one most likely to be read with pleasure today. His simple, lucid style has obvious charm, though those who preferred him to Plato carried their devotion to Attic purity rather far. His speeches, some of them written for litigants of humble station, show dexterous adaptation to the character of the speaker, though the most interesting of all is his own attack on Eratosthenes, one of the "Thirty Tyrants" imposed on Athens by the Spartans in 404 B.C., which contains a brilliant account of their reign of terror.

The 12 extant speeches of Isaeus, who was active in the first half of the 4th century B.C., all deal with testamentary cases, and are of interest mainly for the light they throw on Athenian law. But Isocrates, who was influential in Athens for half a century before his death at the age of 98 in 338, exerted an influence out of proportion to his talents. He perfected a periodic prose style which through the medium of Latin was widely accepted as a pattern, and he helped to give to rhetoric its predominance in the educational system of the ancient world. Because of the weakness of his voice and the diffidence of his temperament he did not himself speak in public, but after a short career as a writer of forensic speeches he set up a school of rhetoric and political science at Athens which was attended by many of the most distinguished figures of the period. His own writings were in the form of speeches, but were never intended to be delivered. He shows some insight into the political troubles of the Greek world with its endless bickerings between cities incapable of co-operation, and he dreamed of unity expressing itself in common action against Persia under the leadership of Athens or, when that became impossible, of blacedon. But he thought and wrote in generalities and drew his examples from bogus history; he may have done something to prepare Greek opinion for what was to come, but his appeal was to the emotions. Never has a political pamphleteer been so utterly devoid of incisiveness, and this defect in his mind was reflected in his style. He avoided the exuberant excess of his master Gorgias while retaining much of his balance and symmetry. He was the first master of the long periodic sentence in which the clauses are so grouped and subordinated to the sense of the whole that the reader is never in danger of losing the thread of the argument. This was a great achievement, but Isocrates had insufficient mental vigour and technical finesse to avoid monotony.

The greatest of the orators was by general consent Demosthenes (384/3–322), supreme in vehemence and power though lacking in some of the more delicate shades of rhetorical skill. In his case a number of deliberative speeches have survived, the actual words —or something very like them—spoken before the assembly, in addition to forensic speeches of which many are of a political character. He made efforts to rouse the Athenians to an awareness of the growing menace of Macedon, and in the series of three great speeches culminating in *On the Crown* his bitter feud with the opposing orator Aeschines lives again, the more vividly because the speeches which he answers are the only three of Aeschines that survive.

After Demosthenes, oratory faded together with the political setting to which it owed its pre-eminence. Of Hyperides (*c.* 390–322), an able all-round speaker, a good deal has been recovered on papyrus; of the statesman and financier Lycurgus (*c.* 396–325) a single speech survives, and of the undistinguished Dinarchus (c. 361–c. 290), probably three.

3. Philosophy.—Philosophic prose, the greatest literary achievement of the 4th century, derives from Socrates (who himself wrote nothing) and his characteristic method of teaching by question and answer, which leads naturally to the dialogue. Socratic dialogues were first composed by Alexamenus of Teos and the dialogue form was used also by Antisthenes, both disciples of Socrates. But by far the greatest of these writers was Plato (428/7–348/7), uho came of a distinguished Athenian family. Shortly after Socrates' death in 399 he wrote some dialogues, mostly short, which probably owed a good deal to the prose mimes of Sophron of Syracuse; to this group of works belongs the *Apology*, an idealized version of Socrates' defense at his trial, and probably two profounder dialogues, *Protagoras* and *Gorgias* In the decade after 385 he wrote the series of brilliant works, *Phaedo*, *Phaedrus*, *Symposium*, culminating in the *Republic*. His Socrates is the most carefully drawn character in Greek literature. The personal touches, the mannerisms and turns of phrase which the dramatic poets had excluded from their art are here used with wonderful effect. Subsequent dialogues became more austerely philosophical; Socrates tends increasingly to be a mere spokesman for Plato's thought, and in the last of his works, the *Laws*, he is replaced by a colourless "stranger."

Plato's style is a thing of matchless beauty, though ancient critics, who were apt to entangle themselves in the rules they had invented, found it too poetical. All human experience is within its range; it fits itself to every nuance of a developing argument, rises to the heights of earnest eloquence in discourse on man's destiny, and reflects with equal faithfulness the wit and gaiety of a drinking party and the grandeur of Socrates in the condemned cell.

Plato's pupil Aristotle (384–322) was admired in antiquity for his style, but those of his works which have survived are all of the "esoteric" sort, intended for use in connection with his philosophical and scientific school, the Lyceum. They are without literary grace and approximate at times to lecture notes, the only exception being the *Constitution of Athens*. His works on literary subjects, the *Rhetoric* and, above all, the *Poetics*, had an immense effect on literary theory in the centuries after the Renaissance, which was not less potent because they were generally misunderstood. But in the ancient world Aristotelian doctrine was known mainly through the works of his successor Theophrastus (371/0–288/7), which are lost except for two books on plants and the famous collection of 30 *Characters*, sketches of human types much imitated by English writers of the 17th century.

With Theophrastus Attic prose dies out until the artificial revival in the 2nd century A.D. In the meantime a vast amount of prose was written, much of it of a very technical nature. but with few literary pretensions. Rhetoric, become a mere literary exercise in a world in which rhetoric was divorced from political influence, developed an ornate and flowery manner associated with the Asian school of Hegesias of Magnesia (fl. *c.* 300 B.C.).

C. Hellenistic and Greco-Roman Periods

Alexander the Great's conquest of Asia between 334 and 323 transformed Greek life. Macedonians and Greeks composed the new governing class over the whole of the eastern Mediterranean and much of the continent beyond, and Greek became the language of administration, a new composite dialect based to some extent on Attic and spoken with little variation over wide areas, the so-called koine or common language. At the same time the cities of Greece and Asia Minor, even when they preserved their independence, lost most of their significance. The city ceased to be the universal frame within which the life of the people was conducted. More than ever before the individual was becoming aware of his isolation and seeking consolation and satisfaction outside corporate society. Henceforward the impulse to artistic creation and its reward came from the individual patron and not from a city, and the poet's audience, except at Athens. where comedy was still a living form during the first third of the 3rd century, consisted of a body of highly cultivated readers scattered over the Greek world. The things which appealed to this audience were finished workmanship and aealth of learned allusion. Their self-consciousness led them to appreciate psychological subtlety, above all in the treatment of love, and since many lived in the great cities whose growth was a feature of the period they began to develop the townsman's sensibility to values which are taken for granted when all human life is within reach of the country. Nature began to take a new place in poetry.

An event of great importance for the development of the new tendencies was the founding of the Museum, the shrine of the Muses, at Alexandria, the most famous of Alexander's new cities. Ptolemy I, Alexander's general. to whom fell the kingdom of Egypt when the empire was divided up in the civil wars which followed Alexander's death, was inspired by Demetrius Phalereus. both a man of action and a member of the Peripatetic school of philosophers founded by Aristotle, to establish this institution with its enormous library and facilities for pursuing the life of scholarship. The chief librarian was a sort of regius professor and sometimes a poet, as well as tutor of the heir apparent. The task of accumulating and preserving knowledge was for the first time properly endowed; the Sophists had begun it, Aristotle. who attached more importance than did most philosophers to knowledge for its own sake, had continued it, his Peripatetic followers developed this rather than the philosophic side of their master's activity, and finally the scholars of Alexandria pursued with zeal numerous branches of research. To them are owed not only the texts of ancient authors but a great deal of the learning required for their elucidation. More often than not the scholars were the poets of the Hellenistic age, and their scholarship influenced their poetry more perhaps than their poetry their scholarship.

The Hellenistic period lasted from the establishment of the kingdoms into which Alexander's empire was resolved to the end of the 1st century B.C., when Roman supremacy had been extended over the near east and a new Greco-Roman culture began to develop. For the next three centuries, until Constantinople became the capital of the later Roman or Byzantine empire, Greek writers were conscious of belonging to a world of which Rome was the centre, even though by a convention rarely disregarded they ignored the existence of Latin literature.

1. Poetry. — The creative period of Hellenism was practically contained within the span of the 3rd century. To this period belong the outstanding poets, Theocritus, Callimachus and Apollonius of Rhodes, to whom ancient critics would have added Xratus. Theocritus (c. 310–250), born at Syracuse, was associated with Phiietas of Cos, earliest of Hellenistic poets, and enjoyed the patronage of Ptolemy II at Alexandria. He was essentially a writer of mimes, short dramatic scenes of everyday life. and he is best known as the inventor of bucolic mime or pastoral poetry, in which he presented with varying degrees of realism scenes from the lives of shepherds and goatherds in Sicily and southern Italy; whether he adopted the device of later pastoral poetry and presented in the guise of rustics persons from higher walks of life is uncertain. He also dramatized mith brilliant realism scenes from middle-class life, and in his second idyll Simaetha. who tries by incantations to recover the love of the man who has deserted her, touches the fringe of tragedy. He used also another Hellenistic form, the epyllion, which is the modern name for the short scene of heroic narrative poetry in which heroic stature is often reduced by playful realism and delicate psychology. It may seem strange that one who touches so rarely on serious things should rank so high among poets, but in his hands the hexameter attained a lyric purity and sweetness unrivaled elsewhere, and in it he expressed the awakening delight in the charms of nature. His followers in bucolic were Moschus and Bion; not all the few poems ascribed to them are genuine and some are as late as the 1st century B.C.

Callimachus (fl. *c.* 260 B.C.) was a scholar as well as a poet. and his great catalogue of the Alexandrian library was of enduring importance. His most famous work, of which substantial fragments survive, was the *Aitia,* an elegiac poem describing the origins of various rites and customs; it was heavy with learning but diversified by passages of entertaining narrative. His six hymns show immense poetic expertise; solemnity, playful charm, downright humour, antiquarian sentiment — everything is there except religious feeling. which the obsolete gods of Olympus could no longer be expected to awaken unless used symbolically, as by the Stoic Cleanthes in his *Hymn* to *Zeus.*

Callimachus also wrote epigrams, and fragments survive of *Iambi,* a revival in milder terms of Hipponax. The form was used by a number of writers of the 3rd century, many of them under the influence of Cynic philosophy, to denounce the vanities of the world; their work, sometimes in mixed prose and verse. had connections with both satire and the popular sermon. Bion the Borysthenite. Menippus of Gadara. Cercidas and Phoenix of Colophon, the last two represented by appreciable fragments, were the chief writers in this field in the 3rd century B.C.

Callimachus seems to have advanced a poetic theory strongly hostile to the full-scale epic and favouring the high intensity possible only in shorter works. His epyllion *Hecale,* telling the story of Theseus and the boar of Marathon, was something of a manifesto in opposition to Apollonius of Rhodes (b. c. 295 B.C.), scholar, tutor to Ptolemy III and author of the only extant classical Creek epic apart from the *Iliad* and the *Odyssey.* Apollonius' epic on the voyage of the Argonauts is so full of local legend, connected with the places touched at by the voyagers, that the coherence of the poem is lost, but Medea's wild passion for Jason is marked by a new sort of romantic awareness of which there are only hints in Euripides and which is fully realized in the Dido episode of Virgil's *Aeneid.* Though Callimachus is usually counted the immediate victor in the controversy with Apollonius, who nonetheless achieved the office of head librarian, epics continued to be written in large numbers; Rhianus (275–195) wrote an epic on the war between Sparta and Messenia.

The desire to combine learning mith poetry led to the revival of didactic verse; a form which had lost its *raison d'être* when prose came into general use. The *Phainomena* of Aratus (c. 315–c. 240), a work which enjoyed a strange celebrity and was several times translated into Latin, is a versification of a treatise on the stars by Eudoxus of Cnidus (c. 400–c.347); its appeal. not obvious to the modern reader. must have lain in the skill with which an intractable theme was handled in verse. Chance has preserved the poems of Nicander (probably 2nd century B.c.) on the unlikely subjects of cures for bites and antidotes to poisons. An even more repulsive example of versified erudition is the *Alexandra* attributed to Lycophron (fl. c. 285 B.c.), a riddling prophecy of 1,500 iambics spoken by Cassandra.

The mimes of Herodas (3rd century B.c.), short realistic sketches of low life in iambic verse, have affinities both with the nonpastoral mimes of Theocritus and with the satire of the 6th-century Hipponax. They perhaps give a hint as to the character of the literature of popular entertainment, now lost except for a few scraps such as the moving complaint of a deserted maiden. the *Fragmentum Grenfellianum (c.* 2nd century B.C.). Much of the theatrical entertainment of the early empire consisted of mimes, though the pantomime in which the dancer expressed himself entirely by gesture was even more popular.

After the middle of the 3rd century poetic activity largely died away, though the great period of scholarship at Alexandria and at Pergamum was still to come. A few names of poets are known only because of their influence on Latin writers: Euphorion (b. c. 275 B.C.) of Chalcis and Parthenius (fl. 1st century B.c.), the teacher of Virgil. Thereafter Greek poetry practically ceases apart from a sporadic revival in the 4th century A.D. There is one exception; epigrams, usually in elegiac couplets, a form which goes back at least to Archilochus, continued to be written far into the Byzantine period. They have survived mainly in the two great compilations, the Planudean and Palatine Anthologies *(see* ANTHOLOGY'). based on several earlier collections of which the first of importance was the *Garland* of the Syrian poet Meleager of Gadara. made c. 100 B.C. This diminutive form was well suited to the exquisiteness of Hellenistic technique, and many of these little poems are of special interest because they seem to provide an outlet for the purely personal emotion so rarely expressed by Greek poets. Apart from poets otherwise known the chief epigrammatists were Asclepiades (fl. 270 B.C.j. Leonidas (3rd century B.c.) of Tarentum and Philodemus (d. 40 B.c.).

2. Prose. — Of the great mass of Hellenistic and later prose, historical, scholarly and scientific, almost all has perished, unconsciously condemned to destruction by the readers and schoolmasters of the later Roman and Byzantine empires. What they selected for reading was copied from papyrus onto parchment and had some chance of survival till the age of printing: the rest was left to crumble away and only relatively few scraps on papyrus have been rescued from the rubbish heaps of Egypt. In a world addicted to rhetoric and indifferent to science, the businesslike but rarely elegant prose of the koine aroused no interest.

History.—Among historians Polybius (c. 200–*c.* 118), the most outstanding. has survived in a fragmentary condition. Himself a leader of the Achaean league! then for many years a hostage in Italy where he won the friendship of Roman Hellenists, he was in a good position to appreciate the great historical phenomenon of the time, the rise of Rome. He wrote mainly of events of which he had direct experience, often with great insight; his work. in 40 books of which 5 are extant, covered the period from 264 to 146. The surviving books of the universal history of Diodorus Siculus (1st century B.C) are important to historians for the information derived from better writers which they contain. Considerable excerpts remain of the immense work of Nicolaus of Damascus (1st century B.c.), who was secretary to Herod and tutor to the children of Antony and Cleopatra, but they contain as much fable as history. The most considerable of lost historians was Timaeus (c. 350–c. 250), whose history of the Greeks in the west down to 264 provided Polybius with his starting point. Later historians were Dionysius of Halicarnassus (fl. c. 20 B.C.), the literary critic, about half of whose Roman Antiquities are extant, Appian of Alexandria, who lived at Rome at the time of Hadrian and wrote on Rome and its conquests, and Arrian (c. 96–c. 180 A.D.) from Bithynia, who is the most valuable source for the life of Alexander the Great.

Criticism.—The modest treatise On Style by an unknown Demetrius, sometimes identified with Demetrius Phalereus, is a piece of work in the Peripatetic tradition, perhaps as late as the 1st century A.D. It is generally believed that the treatise On the Sublime was written c. A.D. 40 by an otherwise unknown author (usually known as Longinus). Alone among ancient critics he does justice to creative literature as "the echo of a great soul," and he is exceptional for a Greek in that he mentions both Cicero and the Book of Genesis. On a lower plane Dionysius of Halicarnassus discussed with great subtlety the stylistic techniques of various writers. The so-called Bibliotheca of Apollodorus, long attributed to Apollodorus of Athens (c. 180 B.c.) but probably belonging to the Greco-Roman period, is a handy compendium of mythology, and in a sense a work of learning. The rest of the vast literary learning of the age is lost except for the little that mas preserved by later commentators and a few papyrus fragments like Satyrus' chapters on Euripides.

Science and Topography.—Scientific work such as the astronomy and geography of Eratosthenes (c. 276–c. 192) of Alexandria, also a poet of some distinction, is known mainly from later summaries, but considerable quantities of the mathematicians, especially of Euclid (fl. 300 B.C.) and of Archimedes (c. 287–212), have been preserved.

The great medical writer Galen (c. 130–c. 200) was physician to both Marcus Aurelius and Commodus; an enormous voluine of his work has survived. The medical writings of his contemporary Sextus Empiricus are lost, but his philosophical writings are an important source for the history of Greek philosophy. The survey of the Mediterranean by Strabo in the time of Augustus preserves much valuable information and so, in a more limited field. does the description of Greece by Pausanias, which is rich in local legend and useful to the archaeologist for its account of the monuments and works of art to be seen in the later part of the 2nd century A.D. The Greek achievement in astronomy and geography was summed up in the work of Ptolemy of Alexandria in the 2nd century A.D.

Judaeo-Christian Writings.—Prose of a different kind has come down from the eastern end of the Mediterranean. Greek became the language of the large settlement of Jews at Alexandria; Hebrew and Aramaic were forgotten by many, and the Septuagint, the Greek version of the Old Testament for Greek-speaking Jews, was completed by about the end of the 2nd century. Most of the Apocrypha is extant in Greek, and much of it was originally composed in that language. A surprising work, fragments of which are preserved in Eusebius of Caesarea, is the Exagoge of Ezekiel, a play in more or less Euripidean iambics on the exodus of the Jews from Egypt. In Alexandria the change from Macedonian to Roman rule made little difference. Philo in the early years of the Roman empire commented on the Jewish scriptures in the light of Greek thought. Josephus (c. 37–c. 98) fought on both sides in Roman-Jewish wars and wrote important works on Jewish history. The New Testament was written in popular Greek (koine), though in some parts the influence of Aramaic is to be suspected. Clement of Rome and Ignatius of Antioch were the most famous of the Apostolic Fathers. Justin Martyr (c. 100–c. 165) was the first in the line of Christian apologists which culminated in Clement of Alexandria (c. 150–c. 215) and Origen (c. 185–C. 254).

Plutarch.—The Parallel Lives of famous Greeks and Romans by Plutarch (c. 45–c. 120) of Chaeronea in Boeotia was for centuries one of the formative books for educated Europeans. Great figures from an idealized past are presented for the edification of the lesser men of his own day, and the anecdotes with which the Lives abound are of various degrees of credibility. They belong to biography rather than to history, though they are an important source for historians. A number of shorter works on a wide variety of subjects have come down under the title of Moralia. Plutarch's rambling curiosity and uncritical piety show the intellectual tide of Greece as being well on the ebb.

Second Sophistic Movement.—There was much concern over a question which had been argued ever since the days when Athens had ceased to be a free city: to what extent was Attic prose a norm which writers and especially orators were bound to follow? Those who preferred the more full-blooded Asiatic style could claim that they were escaping from an unprofitable bondage to the past, but hardly anything is left to show its quality. Many prose writers, notably Dionysius, had given their language an Attic flavour, but it was not until near the end of the 1st century A.D. that, with the movement which is flattered by the name of the Second Sophistic. the task of reviving a dead dialect was pursued with full vigour. These writers were orators in the sense that they gave displays of their virtuosity in a society which was still greedy for the spoken word and they published their speeches to be read in a wider circle; some of them also wrote essays and dialogues. Dio Chrysostom (c. 40–after 114) of Prusa in Bithynia exemplified in exile under Domitian the virtues of Stoic and Cynic philosophy, and was too intent on his message to be a mere stylist. His experiences as a wanderer in remote provinces gave his speeches an extraneous interest! but they have also many of the qualities of the sermon. A more thoroughgoing Atticist was Aelius Aristides (c. 117–189), a writer of undeniable brilliance, interesting mainly for his account of his prolonged search for an escape from ill-health. But the only writer of real consequence from this period was Lucian (c. 125–after 180) of Samosata in Syria. His works are mainly slight and satirical, but his gift of humour, even though it is repetitive, cannot be denied. His talent was for revealing the ridiculous side of things, and in an increasingly credulous world of astrologers, charlatans and miracle mongers he found much to ridicule. but an undue proportion of his effort was devoted to making easy fun of the moribund deities of Olympus. Yet he is the last Greek to show confidence in the validity of human reason as a test of the possible and the credible. The defect of this quality can be illustrated from the fascinating Life of *Apollonius* of Tyana, philosopher and mystic, by Philostratus (*c.* 170–c. 245 A.D.), who also wrote the Lives of the *Sophists.* A more valuable though less accomplished work is the Lives and Opinions of Famous Philosophers by an otherwise unknown Diogenes Laertius probably of the 3rd century A.D. Other examples of learned miscellanies, often frivolous and always undiscriminating, are the compilations of Aelian and of Athenaeus, both of the same period as Philostratus.

Philosophy.—Philosophical activity in the early empire was almost confined to moralizings based on Stoicism. Epictetus (b. *c.* A.D. 50) has had a wide appeal to the seriods-minded of all periods, and he influenced especially the philosophic emperor Marcus Aurelius (121–180), whose *Meditations* have taken their place beside works of Christian devotion. Many of Plutarch's *Moralia* are Platonic with vaguely mystical tendencies, but Plotinus (205–270) is the last major thinker in the classical world. He gave a new direction to Platonic and Pythagorean mysticism expressed in a style usually obscure but rising at times to real grandeur (see NEOPLATONISM).

The Novel.—The latest creation of the Greek genius was the novel. or erotic romance. It now seems likely that the first developments were as early as the 1st century B.C., and the origins reach back to such plays of love triumphant as the lost Andromeda of Euripides and the New Comedy, to Xenophon's daydreams about the education of Cyrus and to the largely fictitious narratives which were one extreme of what passed for history from the 3rd century B.C. onward. Of these last the best-known examples are the Alexander Romances. a mildly distorted and embroidered version of the exploits of Alexander the Great which supplied some of the favourite reading of the middle ages. Erotic elegy and epigram may have contributed something and so may the lost "Milesian Tales" of Aristides of Miletus (c. 100 B.C.), though these last appear to have depended on a pornographic interest which is almost completely absent from the Greek romances. Of the Sinus romance (dealing with the love of Ninus, founder of Nineveh), which was probably of the 1st century B.C., only fragments survive. but full-length works survive by Chariton (2nd century A.D.). Heliodorus (3rd century A.D.). Xenophon (2nd or 3rd century A.D.) of Ephesus and Achilles Tatius (2nd century A.D.); all deal with true lovers separated by innumerable obstacles of human wickedness and natural catastrophe and finally united. *Daphnis and Chloe* by Longus (probably 3rd century A.D.) stands apart from the others because of its pastoral rather than quasi-historical setting. The works of Dictys Cretensis and Dares Phrygius belong to the same period. They claim to give a pre-Homeric account of the Trojan War. The Greek originals are almost wholly lost. but the Latin version was for the middle ages the main source for the story of Troy. (D. W. Ls.)

II. BYZANTINE (4TH CENTURY A.D.–1453)

1. Characteristics. — By Byzantine literature is meant the literature written in Greek during the so-called Byzantine period (*c.* 300–1453). After Byzantine art it is the most genuine and direct expression of Byzantine civilization — that is to say, of that self-contained medieval Christian culture of which the Byzantine empire was the vehicle. If it is to be rightly judged it is of no use either to apply to it the standards of value of modern literary criticism. or to bring to it a mind attuned by the classics to an overrating of Greek antiquity. Instead, an attempt must be made to understand the particular religious, political and social worlds from which it derives.

Byzantine literature was a constituent part of a civilization whose character was determined by the centralized structure of politics in the Byzantine empire, particularly by court life in Constantinople (Byzantium). Byzantine culture was the direct and organic continuation of Greco-Roman culture in Christian dress. In the 3rd century A.D. the spiritual foundations of literature and art were a mixture of religious and philosophical tendencies—a union of Neoplatonic emanation doctrine, Gnosis. heliolatry, emperor cult and magic. To this Christianity, strengthened and organized by three centuries of persecution, brought a new note which in the course of a further three centuries succeeded in becoming the dominant in all literary activity in the empire. This came about after Constantine the Great christianized Augustus' idea of a Roman world empire and made the Christian church the guardian of the Greco-Roman cultural tradition. It came about in the tough fight against the ancient powers of civilization—against paganism, Seoplatonism, Gnosticism and against the Christian heresies; and in the course of that fight there flowed from these into the new Christian orthodoxy an abundance of ideas and beliefs. In the process Constantinople, the "New Rome" on the Bosporus, raised by Constantine to be the new capital, drew all the significant powers of the empire to itself. allowing the old cities of learning and literature — Rome. Alexandria, Antioch, Athens — gradually to decay. Byzantine literature thus acquired a metropolitan. court and exclusively aristocratic character. This development explains many of its peculiarities, for instance the number and the solemnity of the laudatory speeches to the emperor and his family and the preponderance of poems on the emperor's glorious deeds. which become intelligible in view of the unique position which the Byzantine emperor held as Christ's substitute on earth: the praise won from his subjects is therefore paid primarily to Christ himself.

In the light of the same development Byzantine conservatism in the use of outward literary forms, particularly language, becomes understandable. This language had to preserve the forms of the speech of the New Testament and the Fathers and, on the other hand, those of the Attic models from the great literary past. For it was the pride of the Byzantines that God had given mankind his revelation (beyond which no advance in human knowledge seemed possible) in the Greek tongue; and that the classical poetry and learned writings of the pagan forefathers, who had cultivated the most varied sorts of literature, was also clothed in this language; and that in addition the "Attic" language was up to that time the speech of the cultured in all the schools of the known world. Thus they would not permit this language to display in literature the leveling and simplifying influences which it suffered in daily use in the mouths of the people. This Byzantine pride in being the chosen people of the New Covenant and the heir of an unsurpassable spiritual culture is also the basic explanation of the principle of excluding all fertilization and invigoration by the ideas and literature of other nations. While the language of daily life developed according to its own intrinsic laws into modern Greek (a process practically complete by the middle of the 15th century), in the literary field Byzantium clung to speech forms artificially frozen at the Hellenistic Greek stage, falling into what was at times misunderstood Atticism. Mimesis (imitation of the ancients) became the principle behind all literary forms and scarcely allowed the genuine note of feeling and passion, springing straight from the heart, to appear in poetry or preaching. The undue value placed on form soon began to smother the sense for originality of content and invention; virtuosity in the mastery of verse technique or of the rules of rhetoric became an end in itself, so that metrical forms were even used, for example, in astronomical or legal treatises. On the other hand the consciousness of being in sole possession of the treasures of knowledge inherited from the ancients led to an overrating of erudition — hence the pedantic, obtrusively didactic form of many Byzantine writers or the gloss mania of philologists like John Tzetzes (d. 1185), who thought it necessary to annotate the copious literary conceits of his own letters.

In addition there is the all-pervading Byzantine rationalism, which forms a curious polarity to the religious tendency toward mysticism and which at times assumes that the secrets of nature and of the divine are to be stormed by a naïve prosiness. Further, there is the deeply rooted individualism, still to be seen in the Greek people, which caused a peculiar tension with regard to the confining bonds of ecclesiastical and political orthodoxy. These contrasts explain the discords which are to be felt in much Byzantine literature: the direct juxtaposition of devout Christian faith and an occasional flippant atheism; the lack of humour and the pleasure in malicious ridicule which appears from time to time; the tendency toward a bigoted asceticism shot through by fear of eternal retribution. All this explains why love lyrics form a very small part of early Byzantine literature and inner experience takes refuge in religious lyrics, though these are sometimes magnificent of their type.

The failings of Byzantine literature stem, therefore, largely from the religious and political tendencies of the time, though the psychological make-up of the Byzantine world also plays a part. The failings are balanced by certain merits. Thus, belief in the divine vocation of the Christian "Roman empire of the Greek nation!' meant that Byzantine historical writing preserved the best traditions of the Roman *historia* right through the centuries until the end of the empire with only short interruptions, and accompanied Byzantine history to the end with a long series of highly finished accounts of events; it was the 12th century before western Europe had anything comparable to set beside this achievement. In these works Byzantine rationalism provides to a large extent not only a good descriptive survey of the fate of the empire but in addition information about the many neighbouring European and non-European peoples against whom the empire had perpetually to assert itself; in many cases Byzantine historical writing provides the only available information about the period. Then, the traditionalism of the Byzantines, their ambition to match the ancient models, saved for posterity the best of ancient Greek literature, which served them as a pattern; even so, much was allowed to perish on the principle enunciated by the emperor Constantine VII Porphyrogenitus (d. 959) in the preface to his great series of excerpts: that it is better for mankind to possess a careful selection of a whole literature than an endless abundance of inferior work. As a result of the Byzantine tendency toward pedantry. many early scholia (explanatory notes) were preserved and added to by such Byzantine scholars as Eustathius of Thessalonica (d. 1194) or Maximus Planudes (early 14th century); without these scholia, begun by the Alexandrine scholars of the 4th century B.C., many passages in ancient literature would remain obscure. The comparative purity in which the ancient texts have come down to us is also largely due to the pedantry of Byzantine scholars. An especially important result of the speculative propensity of the Byzantines was the shaping of early Christian theology by the philosophically trained Fathers of the Church, particularly by the 4th-century Basil of Caesarea, Gregory of Nazianzus, Gregory of Nyssa; Christianity, at a critical stage in its history, was thus equipped to win its way against the philosophically supported religions and ideologies (Gnosticism, Neoplatonism) and to become the religion also of the educated and the upper classes. Further, one result of Byzantine melancholia was the mysticism embodied in its purest form in the Pseudo-Dionysius the Areopagite. This was important not only for theologians in the Christian east, such as Symeon the New Theologian (d. 1022) and Nicholas Cabasilas (14th century); after the 9th century it became influential in the west also and may be viewed as the root of one of the basic ideals of piety in European spiritual history. The rich garland of ecclesiastical Byzantine poetry, at once deeply felt and varied in form, sprang from the same piety, which penetrated all sections of life.

The Byzantine achievement in the sphere of popular poetry perhaps appeals most to modern taste. It is composed in the language of the people, that is to say in the language evolved from the idiom of daily life, and in the also popular pentadecasyllabic (15-foot) metre. The higher officials and clerics, the class which dominated literary criticism, did not therefore regard this folk poetry as "literature" at all and it consequently survived only in relatively late manuscripts (15th–17th century; *i.e.*, partly from the post-Byzantine period). Besides the extensive, imaginative epic of Digenes Akritas, whose origins go back to the 10th century, this poetry, filled with the spirit of the common people, includes a quantity of fairy tale and historical material clothed in epic form: the animal fables particularly show an overflowing power of invention and great epic talent.

In spite of the unquestioned superiority of Byzantine literature over western literature of the same period, which was written in Latin, and in spite of the admiration which the west entertained for Byzantine culture, the effect of the one on the other was comparatively small. On the one hand, the Byzantines, as has been mentioned, excluded on principle western literary forms and, up to the 12th century, western material and subjects; in the west, on the other hand, the Germanic conquests made a break in cultural tradition which meant that the knowledge of Greek was soon lost. Jerome and Rufinus translated a relatively small amount into Latin in the 4th and 5th centuries, but even Augustine could scarcely read the Greek authors in the original. The important influence of the 5th–6th century Pseudo-Dionysius the Areopagite was only transmitted to the west after his work had been translated into Latin in the 9th century by Abbot Hildwin of St. Denis and by Duns Scotus Erigena. A Latin translation of the Pege gnoseos ("Fountain of Knowledge") by John of Damascus also exercised a certain influence on Thomas Aquinas (d. 1274); on the other hand. it was not until c. 1400 that parts of Aquinas' writings were knonn in the Byzantine world and then they had no noticeable effect. Give and take in the realm of popular literature is more frequent and more noticeable, being an accompaniment of the contact of the lower classes through the crusades. especially in the 12th century; saga and story, much of which had come to Byzantium from the middle east, was at that time freely exchanged In general. however, literary contact between the Byzantine empire and its western neighbours suffered from the mistrust which was increased by religious schism and the political rivalries aroused by the crusades.

Even in Egypt and Asia Minor, both of which were centres of theological literature in the 4th and 5th centuries, the influence of Greek literature could not withstand the revival of the vernaculars (Coptic, Syriac), and after the provinces were conquered by the Arabs (641) it was completely lost.

On the other hand, Byzantine literature exercised a relatively strong influence on the peoples of eastern Europe, especially on the Slavs. There, to Bulgaria, to Serbia and, after Prince Vladimir's conversion to Christianity (c. 988), to Russia, Byzantine missionaries brought not only the Bible and liturgical texts but also the sermons of their best preachers and the "chronicles" (history books; see below) which were saturated with the spirit of Byzantine theocracy; and through their tenure of the most important missionary bishoprics they saw to it that the education and political and ecclesiastical life of the newly won converts remained Byzantine. It was by these means that Byzantine literature acquired its most important and, for world history, its most significant success.

2. Theology. — The great period of Greek theological literature, in the 4th and early 5th centuries, was largely the product of two factors: the establishment of Christianity as a permitted and then as the official religion of the state, and the stimulus afforded by heretical teachers such as Arius, Apollinaris, Nestorius and Eutyches (see also ARIANISM; MONOPHYSITES). The main theologians of the 4th–5th centuries were Athanasius (c. 295–373), the chief opponent of Arius and creator of the pattern for Byzantine hagiography in his life of St. Anthony of Egypt; Eusebius (c. 260–c. 340), who wrote the first ecclesiastical history as well as apologetic and antiheretical works and biblical commentaries; the three Cappadocian Fathers, Basil of Caesarea (St. Basil the Great; *c.* 330–379), who organized eastern monasticism, his brother Gregory of Nyssa (c. 330–c. 395), the earliest Greek ascetical author, and their friend Gregory of Nazianzus (c. 329–c. 389), known as Gregory the Theologian, who was also a poet; John Chrysostom (c. 347–407), bishop of Constantinople, the great preacher; Cyril (376–444) of Alexandria, untiring opponent of Nestorius, who represented the Alexandrian school; Theodoret (c. 386–*c.* 457) of Cyrrhus, who represented the school of Antioch.

After the middle of the 5th century theological literature was largely concerned with combating heresy. Leontius of Byzantium (d. *c.* 545), the first to introduce Aristotelian definitions into theology, wrote against Monophysites as did Anastasius of Sinai (d. c. 700) and Maximus the Confessor, the 7th-century mystic. Iconoclasm was opposed by John of Damascus whose Pege gnoseos was the first comprehensive exposition of Christian dogma, and who was one of the chief composers of the kanons (see Religious Poetry, below). The works of Theodore Studites (759–826), who also attacked iconoclasm, include kanons and homilies which give much information about monastic life. The great bibliographer Photius (d. 895), patriarch of Constantinople, was the first to crystallize the differences between the Latin and the Eastern churches into rigid formulas. The emperor Leo VI the Wise (c. 866–911) wrote liturgical poems and homilies for a number of festivals. In the early 12th century Euthymius Zigabenus compiled his *Panoplia dogmatica,* an armoury of theology against all heresies.

At this time (11th to 12th century) there arose a tendency to introduce a kind of dialectic into theology in place of the accumulated citations from the Fathers, which had hitherto been the cherished and the only recognized method of supporting a dogmatic thesis. But, instead of developing into something like western scholasticism, this tendency, represented by Michael Psellus, John Italus (both 11th century) and Eustratius of Nicaea (d. c. 1120), soon fell under the reproach of heresy and disappeared. Anti-Latin writings increased in number; their authors include the emperor Theodore II Lascaris (1222–58). Gregory Palamas and Nilus Cabasilas (both 14th century). In the last century of the empire theological writing was almost wholly concerned with the Latin question and nith hesychasm, the doctrine of the uncreated light on Mt. Tabor, of which Gregory Palamas was the defender.

3. Hagiography. — The literature consisting of the acts of the martyrs and the lives of the saints forms an independent group which is comparatively unaffected by theological issues. Its main interest centres in the personalities of the martyrs and saints themselves. Apart from Athanasius' life of St. Anthony, Palladius' Lausiac history (5th century), Cyril of Scythopolis' lives of St. Saba and six other Palestinian abbots (6th century) and the life of John the Merciful, bishop of Alexandria, by Leontius of Neapolis in Cyprus (7th century), the authors are mostly anonymous. Most of the acts of the martyrs date from the great persecutions before the Byzantine period; together with the later lives of the saints, they were revised in the 10th century by Simeon Metaphrastes on the rhetorical and linguistic principles of his own day. His new collection, in several volumes, largely superseded the older original texts (see also HAGIOLOGY; BOLLANDISTS). From the popular lives of the saints, which for the reading public of the Byzantine empire formed the chief substitute for modern belles-lettres, it is easy to trace the transition to the religious novel, of which the best-known example is the story of Barlaam and Josaphat.

4. Religious Poetry. — The oldest surviving religious poetry was composed in the ancient Greek metres and was for use in private devotions, not public services; belonging to this group are the so-called "maiden's song" in the *Symposium* of Methodius of Philippi (not "of Olympus" as he is mistakenly called; *c.* 311) and the religious poems of Gregory of Nazianzus (written between 381 and 389; the few poems extant under his name which are not in ancient metres are not by him). The heretic Apollinaris of Laodicea (4th century) turned the Psalms into hexameters, perhaps with the intention of evading the emperor Julian's interdict on Christian education. Synesius, bishop of Cyrene (early 5th century). who was also the valiant defender of his city against its barbarian attackers, showed himself in the Christian hymns which he composed in classical metres to be saturated with the Neoplatonic spirit; the poems are a Christian counterpart to the pagan hymns of his contemporary Proclus.

More important than this private religious poetry are the Byzantine liturgical hymns. From comparatively modest beginnings the need for congregational hymns developed under the influence of the propagandist success which the Gnostics and above all the heretic Arius (d. *c.* 335) had with their religious poetry set to folk music. The model for the poetical development may well have been the Syrian church hymns. The earliest evidence which has been preserved, short poems (tropes) clinging closely to the language of the Scriptures, dates from the end of the 5th century. The verses are arranged in lines all with the same number of syllables, the accent (which here regulates the rhythm) coinciding with the emphasis. The principle behind ancient Greek prosody of regulating the rhythm by long and short syllables ceased to function; from about the 2nd century A.D. all syllables became the same length in Greek, so that accent took over the function of regulating rhythm. On this principle there grew up from the 5th–6th century the kontakion of several strophes, each having the same refrain, preceded by a strophe of irregular rhythmical form (the kukulion). The most prolific and successful writer of kontakia was the Syrian Romanos (6th century); besides the 85 kontakia which have survived under his name he probably wrote the famous Aknthistos hymn to the Virgin Mary. The dramatic construction of some of the kontakia shows that this literary form was a substitute to the Byzantines for the religious and secular drama which they did not possess.

In the 7th century church poetry entered upon a new stage, characterized by an increase in artistic finish and a falling-off in poetical vigour, with the composition of the kanon, a poem built up out of eight or nine lyrics, all differently constructed. Andrew of Crete (c. 650–720) is regarded as the inventor of this new class of song. The most celebrated writers of kanons are John of Damascus and Cosmas of Jerusalem (both first half of the 8th century). Later. the composition of kanons was more particularly cultivated in the monastery of Studiu in Constantinople by its abbot, Theodore Studites, and others.

5. History. — Byzantine historical accounts fall into two groups: historical works, describing a period of history in which the authors had lived and moved or one which only immediately preceded their own times, and chronicles, briefly recapitulating the history of the world. This second class has no exact counterpart in ancient literature.

Byzantine histories of contemporary events do not differ substantially in nature from ancient historical works, except in their Christian colouring. Yet even this is often very faint and blurred because of the close adherence to ancient methods. Apart from this, neither a new style nor a new critical method nor any radically new views appreciably altered the main character of Byzantine historiography.

The outstripping of the Latin west by the Greek east, which after the close of the 4th century was a self-evident fact, is reflected in historiography also. After Constantine the Great (d. 337), the history of the empire, although its Latin character was maintained until the 6th century, was mostly written by Greeks; *e.g.*, Eunapius (d. *c.* 347), Olympiodorus (5th century), Priscus, Malchus (c. 490) and Zosimus, the last pagan historian (c. 500), all of whom, with the exception of Zosimus, are preserved only in fragments.

To this period also belong the 5th-century continuations of Eusebius' ecclesiastical history made by Gelasius of Caesarea (d. *c.* 394), by Philip of Side (fl. early 5th century) and by Philostorgius (d. *c.* 439), who shows Arian sympathies. These survive only in fragments and extracts. A complete church history for the years 305–439 was written by the lawyer Socrates (fl. early 5th century); the work of Sozomen (d. 443) provides a source partly independent of Socrates. Historiography received a great impulse in the 6th century. Procopius and Agathias described the stirring and eventful times of Justinian I; and Theophanes of Byzantium. Menander Protector, John of Epiphaneia, of whose works only fragments survive, and Theophylact Simocattes described the second half of the 6th century. The last independent ecclesiastical historian, Evagrius Scholasticus, who wrote the history of the church from 431 to 593, lived in the latter part of the 6th century. After his time there was little historical writing, beyond the compilation of a few chronicles, until a fresh impetus was provided by the revival of classical studies in the 10th century.

Several historical works are associated with the name of the emperor Constantine VII Porphyrogenitus (10th century). To his learned circle belonged also Joseph Genesius, who at the emperor's instance compiled the history of the period from 813 to 886. The priest John Cameniata wrote an eyewitness account of the taking of Thessalonica by the Cretan corsairs in 904, which is interesting from the point of view of historical and ethnographical science. Leo Diaconus left a graphic account of the period 959–975 which covered the wars of the Byzantines with the Arabs in Crete and with the Bulgarians. A continuation of this was undertaken by the philosopher Michael Psellus in work covering the period from 976 to 1077, a valuable supplement to which (describing the period from 1034 to 1079) was supplied by the jurist Michael Attaliates. The history of the empire during the first four crusades was written by Nicephorus Bryennius, his wife Anna Comnena and John Cinnamus; an exhaustive work by Nicetas Choniates (d. *c.* 1215) is authoritative for the history of the fourth crusade. The unhappy conditions and decay of the empire under the Palaeologi (13th–15th centuries) are described in a similar lofty style, though with a still closer following of classical models. The events which took place between the taking of Constantinople by the Latins and the restoration of Byzantine rule (1203–61) are recounted by George Acropolites, who emphasized his own share in them. The history of the succeeding period was written by George Pachymeres (d. c. 1310), Nicephorus Gregoras and the emperor John VI Cantacuzenus. Lastly, the death struggle between the Byzantine empire and the rising power of the Ottoman Turks was narrated by three historians, all differing in culture and in style, Laonicus Chalcocondyles, Ducas and George Sphrantzes. With them may be classed a fourth (though he lived outside the Byzantine period), Critobulus, a highborn Greek of Imbros, who wrote, in the style of the age of Pericles, the history of the times of the sultan Mohammed II (1451–67).

The essential importance of the Byzantine chronicles consists in the fact that they in part replace older lost aorks, and thus fill up many gaps (*e.g.*, for the period from about 600 to 800, of which few records remain). They lay no claim to literary merit, but are often interesting from the linguistic point of view. The authors of the chronicles were mostly monks, which explains the strong clerical and popular tendency of these works. And it is due to these two qualities that the chronicles obtained a circulation abroad, both in the west and also among the peoples christianized from Byzantium, *e.g.*, the Slavs, and in all of them sowed the seeds of an indigenous historical literature. Thus the chronicles, despite their jejune style and uncritical treatment of material, were of far greater importance for the general culture of the middle ages than the erudite contemporary histories designed only for the highly educated circles in Byzantium. The oldest extant Byzantine chronicle of universal history is that of John Malalas (6th century), which is also the purest type of this class of literature. In the 7th century the Paschal Chronicle (Chronicon *Paschale*) was completed. About the end of the 8th or the beginning of the 9th century George the Syncellus compiled a concise chronicle, which began with the creation and was continued down to the year A.D. 284. At the request of the author the continuation of this work was undertaken by Theophanes Confessor, who brought down the account from 284 to his own times (813).

Besides Theophanes there is for the years 602–769 the short history of the patriarch Nicephorus (d. c. 529) which was largely drawn from the same sources. Theophanes' chronicle was also extended to cover the period 813–886 by the so-called *Theophanes Continuatus* commissioned by Constantine VII Porphyrogenitus; this consists of five biographies of the emperors reigning during the period, Constantine VII Porphyrogenitus, who commissioned the work, himself contributing the life of his grandfather Basil. A further continuation for the period 886–961 was made by Theodorus Daphnopates. George the Monk compiled an influential chronicle of the world's history (from Adam until the year 842, the end of the Iconoclast movement), far more theological and monastic in character than the work of Theophanes. Among later chroniclers John Scylitzes stands out conspicuously. His work (covering the period from 811 to 1057), as regards the range of its subject matter, is something between a universal and a contemporary history. In the 11th century Georgius Cedrenus embodied the whole of Scylitzes' work, almost unaltered, in his universal chronicle. In the 12th century the general increase in literary production was also reflected in the number of chronicles produced. From this period dates, for instance, the most distinguished and learned work of this class, the great universal chronicle of John Zonaras. Lastly, in the 12th century, Constantine Manasses wrote a universal chronicle in "political" verse (see below).

6. Geography. — Two works dealing with geography and topography deserve mention, the 6th-century Topographia Christiana of Cosmas Indicopleustes, which contains important information as to Byzantine trade, and the 10th-century history and description of Constantinople entitled *Patria.* Besides these there were handbooks of navigation, guides for pilgrims and catalogues of provinces. cities, metropolitan sees and bishoprics.

7. Philosophy. — Ancient Greek philosophy under the empire sent forth two new shoots — Neopythagoreanism and Neoplatonism. It was the latter with which moribund paganism essayed to stem the advancing tide of Christianity. The last great exponent of this philosophy was Proclus (410–485) in Athens. The dissolution, by order of Justinian I, of the school of philosophy at Athens in 529 was a fatal blow to this nebulous system, which had long outlived the conditions that made it a living force. Nevertheless, it had contributed many ideas to the world of early Christian thought, and contributed essentially to its philosophical framework. In the succeeding period philosophical activity was of two main kinds: on the one hand, the old philosophy. *e.g.*, that of Aristotle, was employed to systematize Christian doctrine; on the other, the old works were furnished with copious commentaries and paraphrases. Leontius of Byzantium introduced Aristotelian definitions into Christology; but the real founder of medieval ecclesiastical philosophy was John of Damascus. As a result, however, of his having early attained to canonical authority, the independent progress of ecclesiastical philosophy was arrested; and to this it is due that in this respect the later Byzantine period is far poorer than the corresponding era in the west. In the 11th century there was a revival of philosophical studies, mainly because of Michael Psellus, who again laid more emphasis on Platonic ideas, as against Aristotelian, and John Italus, who attempted in vain to introduce into Byzantium a philosophy free from the tutelage of theology. The attempt of Gemistus Pletho, about the middle of the 15th century, to introduce, in conjunction with plans for a political restoration, the old pagan religion and the old Platonism also came to nothing.

Ethics mas represented in Byzantium by the numerous "mirrors for princes"; in these the prince was exhorted to all the virtues, the prototype being that by the deacon Agapetus (6th century).

8. Rhetoric. — Ancient rhetoric was cultivated in the Eyzantine period with greater ardour than scientific philosophy, being regarded as an indispensable aid to education. Among the almost tedious rhetorical productions of the time are to be found a few interesting pieces, such as the short dialogue entitled *Philopatris*, in the style of Lucian, which gives a remarkable picture of the times of Nicephorus Phocas (10th century). Lucian's Nekyomantia was also the prototype for the satirical *Mazaris' Journey* to Hades (composed c. 1414–15). An important branch of rhetoric for the Byzantines was the public speech, usually a state speech addressed to the emperor on feast days, particularly at Epiphany. In this field considerable fame was won by the pagan Libanius (d. 393), head of a school of rhetoric at Antioch, who numbered among his pupils John Chrysostom and Basil (afterward bishop of Caesarea) and whose thought profoundly influenced the emperor Julian. Of his writings there survive imperial eulogies, funeral speeches and more than 1,500 declamations and letters. Rhetorically elaborate letters were also considered by the Byzantines as a considerable artistic achievement; collections of them were made so as to preserve them for posterity. There are collected letters also of Photius, Psellus, Eustathius and Michael Choniates, archbishop of Athens, and many other important figures of Byzantine literature. The great number of treatises written on rhetoric also shows the high regard of the Byzantines for this literary form.

9. Scholarship.—Byzantium was dominated to an extravagant extent by the rules of what in modern times is termed classical scholarship. The numerous works which belong to this category, such as grammars, dictionaries, encyclopaedias, commentaries on ancient authors, extracts from ancient literature and metrical and musical treatises, are of little general interest, although of great value for special branches of literary study, *e.g.*, for tracing the influences through which surviving ancient works have passed, as well as for their interpretation and emendation; for information about ancient authors now lost; for the history of education; and for the underlying principles of intellectual life in Byzantium. The most important monument of Byzantine scholarship is perhaps the Bibliotheca or Myriobiblon of the patriarch Photius, which consists of 280 essays summarizing all he had read. Much literature now lost is thus preserved in epitome. Rather more than a century later appeared the Suda Lexicon (sometimes erroneously attributed to "Suidas"), an encyclopaedia including valuable biographical information on classical and Byzantine authors. Eustathius (d. c. 1194), archbishop of Thessalonica, was a commentator on classical texts; various scholia on the Iliad and the Odyssey and fragments of other lost writings survive in his works.

10. Military Science. — The Byzantines had shown an interest in military science since the time of Arrian (d. c. 180), who wrote an account of the campaigns of Alexander the Great. The *Strategikon*, a book attributed to the emperor Maurice (582–602), shows the changes made in Byzantine tactics in order to meet the attacks of contemporary invaders, the Avars, Persians and Turks. This treatise was several times brought up to date under the names, among others, of the emperors Leo VI and Constantine VII. The emperor Nicephorus Phocas (d. 969) is credited with an original manual on guerrilla warfare.

11. Law. — The emperors Leo VI the Wise and Constantine VII Porphyrogenitus issued the Basilica, the Greek translation of the emperor Justinian I's Institutes and Digest, which had been published in Latin; they were newly arranged and enlarged by the addition of the imperial constitutions of Justinian's Codex and its *Novels,* which had been in Greek from the first. The Peira is one of the collections of high court judgments which the chief justice Eustathius (11th century) caused to be compiled. The canon law was an important contribution of the Byzantines to jurisprudence.

12. Secular Poetry. — The metre of secular poetry is, for the most part, either the Byzantine regular 12-syllable verse which took the place of the ancient trimeter or the 15-syllable ("political") verse; more rarely the heroic and Anacreontic measures.

Epic popular poetry, in the ancient sense, begins only with the vernacular Greek literature (see below); but among the literary works of the period there are several which can be compared with the epics of the Alexandrian age. Nonnus (fl. *c.* 400) wrote. while still a pagan, an epic on the triumphal progress of the god Dionysus to India. and, as a Christian, a lengthy versification of St. John's Gospel. Paulus Silentiarius (6th century) wrote in perfectly correct Nonnian hexameters a description (*Ekphrasis*) of Hagia Sophia. built by Justinian I; the Church of the Apostles, also a splendid erection of Justinian I, had to wait until 940 to find a less gifted poet in Constantine of Rhodes. The historic epic was also carefully preserved by the Byzantines. In the 7th century George the Pisidian described in several iambic poems the wars of the emperor Heraclius. Later the deacon Theodosius (10th century) immortalized in extravagant language the capture of Crete by the emperor Nicephorus Phocas.

In the 12th-century revival of culture under the Commeni several long poems were composed in imitation of the ancient Greek romances. Two of these are written in the duodecasyllable metre: the story of Rodanthe and Dosicles by Theodore Prodromus, and an imitation of it, the story of Drosilla and Charicles by Nicetas Eugenianus; one in political verse, the love story of Aristander and Callithea by Constantine Manasses, which has only been preserved in fragments; and one in prose, the story of Hysmine and Hysminias by Eustathius Macrembolites. These Byzantine romances are of interest chiefly by way of contrast to the romances in the vernacular produced in the 13th and 14th centuries.

The detached and ascetic point of view which dominated the whole Byzantine period was fatal to the development of secular lyrical poetry. A few poems by John Geometres and Christopher (11th century) of Mytilene and others, in which personal experiences are recorded with some show of feeling, may be placed in this category. The dominant form for all subjective poetry was the epigram, which was employed in all its variations from playful trifles to long elegiac and narrative poems. George the Pisidian treated the most diverse themes epigrammatically. In the 9th century Theodore Studites immortalized monastic life in a series of epigrams. The same century produced the only Byzantine poetess, Casia, who wrote several epigrammatic productions and church hymns. Epigrammatic poetry reached its highest development in the 10th and 11th centuries, in the productions of John Geometres, Christopher of Mytilene and John Mauropus. Less happy are Theodore Prodromus (12th century) and Manuel Philes (14th century). From the beginning of the 10th century also dates the most valuable collection of ancient and of Byzantine epigrammatic poems, the Anthologia Palatina (see ANTHOLOGY).

The didactic poem was a much loved form among the Byzantines; this predilection was in line with their tendency, noted above, to instruct their fellow men rather intrusively and to display the fullness of their own knowledge. John Tzetzes wrote metrical commentaries on Homer, Hesiod, Pindar, Aeschylus, Euripides and Aristophanes. Constantine Manasses also composed a verse chronicle of the world of this kind.

Dramatic poetry, in the strict sense of the term, was as completely lacking among the Byzantine Greeks as was the condition necessary for its existence, namely, public performance. Apart from some moralizing allegorical dialogues (by Theodore Prodromus. Manuel Philes and others), the only work of the Byzantine period which resembles a drama, at least in external form is the *Christos paschon.* This cento on the passion, erroneously included among the works of Gregory of Nazianzus but written probably in the 12th century, is largely composed of lines taken from ancient playwrights, *e.g.,* Aeschylus, Euripides and Lycophron; it was certainly not written for dramatic production.

13. Vernacular Literature. — The vernacular literature stands alone, both in form and in content. It shows remarkable originality of conception and probably also entirely new and typically medieval matter. While in the courtly literature prose is preeminent, in the vernacular literature poetry both in quantity and quality takes the first place. Though a few preliminary attempts were known (proverbs. acclamations addressed by the people to the emperor, etc.), longer Greek vernacular works were written donn only from the 12th century onward; at first poems. most of nhich were cast in political verse. Toward the close of the 15th century rhyme came into use. The subjects treated in this vernacular poetry are exceedingly diverse. In Constantinople a mixture of the learned and the popular language was first used in poems of admonition, praise and supplication. To this oldest class (12th century) of vernacular works belongs the Spaneas, an admonitory poem in imitation of the letter of Pseudo-Isocrates addressed to Demonicus; a supplicatory poem composed in prison by the chronicler Michael Glycas; and several begging poems of Theodore Prodromus (Ptochoprodromus). In the succeeding period erotic poems began to be written, such as the so-called Rhodian love songs and the story of Ptocholeon. the wise old man who saved his royal master from disasters by his miraculous knowledge. Long epic poems. in which are treated such subjects as the legends of Troy, of Achilles and of Alexander. form a separate group. To these may be added romances in verse after the manner of the romances written in the artificial classical language, e g., *Callimachus* and Chrysorrhoe, *Belthandrus* and Chrysantsa, *Lybistrus* and Rhodamne, also romances in verse after the western pattern such as *Phlorius* and *Platziaphlora* (the old French story of *Flore* et *Blanchefleur*), *Imberius* and *Margarona* and *Apollonius* of Tyre. The well-known stories from the *Physiologus* (see BESTIARY) about animals. plants and stones were put into political verse in this period. and other animal tales in political verse were also popular: *Pulologus* (a book of birds), a history of animals, both satirical in intent, and a version of Reynard the Fox which relates the adventures of an ass, a wolf and a fox. Other satirical poems are the *Sachlikis,* which originated in 15th-century Crete. and its imitation by Markus Depharanas, also Cretan in origin. There are also several legendary and historical poems in which famous heroes and historical events are celebrated; for instance. poems on the exploits of Belisarius (Justinian I's general), the fall of Constantinople (1453), the taking of Athens (1458), the devastating campaign of Timur, the Chronicle of the Morea (the history of the Frankish government of the Peloponnese. 1204–92). the battle of Varna (1444) and the plague in Rhodes in 1498. The chief of these is the great heroic epic of Digenes Akritas, preserved in several versions, the oldest of which, a linguistic mixture of popular and literary language, dates from the 10th century. There is no doubt, however, that this epic originated among the people and was spread by folk singers before it was written down; large parts of it can still be recited by aged and illiterate people. Digenes Akritas represents the bold frontier warrior (akrites) on the Euphrates frontier in the 8th–10th centuries. The conversion of the emir indeed betrays Byzantine piety. and there are numerous oriental touches. But the emir's son. Digenes Akritas, in his feeling for nature and strong family affections has much in common with the Greek palikar of the klephtic ballads (see below). In these respects the poem may be regarded as the forerunner of such works as the great Cretan national romance, the Erotokritos (see below) and as forecasting much that is best in modern Greek popular poetry. (K. K.; F. Do.)

III. MODERN (AFTER 1453)

1. Language. — After the capture of Constantinople by the Turks in 1453, the destruction of Greek national life and the almost complete effacement of Byzantine civilization naturally involved a more or less complete cessation of Greek literary production in the subjected regions. Learned Greeks found refuge away from their native land; they spoke the languages of foreign peoples and, when they wrote books, they often used the languages of those peoples. though most of them also wrote in Greek.

It is, however. a mistake to regard 13-53 as a sharp dividing line betn-een Byzantine and modern Greek literature. As shown above, the germs of modern Greek popular poetry can be detected as early as the 10th century in the epic cycle of Digenes Akritas. and still more in the Greek verse romances of the 13th and 14th centuries. More directly a result of the conquest by the Franks is the chronicle of Leontios Makhairas, which deals with Cyprus in the 15th century. Here again the Greek vernacular language is employed. Italian influence had a predominating share in the production of the flourishing Cretan literature of the 16th and 17th centuries described below. The literary debt of modern Greece to the crusaders should not be overlooked. Among other things, they were responsible for the introduction of rhyming verse.

Modern Greece has inherited two literary styles—the consciously classical. known as the *katharevousa*, and the really living popular, known as the *demotiki*. Both have been greatly promoted by the invigorating influence of Italian and French literature. In the progress of these two literary streams the demotic movement of the 1880s reached a turning point when a group of young and gifted writers, the most important of whom was Kostis Palamas (1859–1943), founded the so-called "new school of Athens." This school was a reaction against the dead and conventional classical language and the flabby exuberance of the Greek romantics. In 1888 Ioannes Psycharis (1854–1929) became the leader of the movement with the publication of his famous book *To taxidi mou* (ostensibly a series of traveling impressions, but really intended to awaken the linguistic coriscience of the Greeks). The battle flared up, and a number of distinguished critics, scholars and writers joined the struggle, which broadened into a reaction against the dead weight of the whole classical tradition, and advocated a return of Greek art and literature to contemporary life. This was greatly helped by the study of modern Greek folklore. then promoted by Nikolaos Politis (1852–1942), and by the researches of Konstantinos Paparrhigopoulos (1815–91) into medieval and modern Greek history. The battle ended with the decisive victory of the popular language, the *demotiki*, for all writings of an imaginative character. Even in works of science and in official documents its influence became increasingly felt.

The classical language was unsuited for the production of a really living drama. Hence, although numerous plays were written in the 19th century both in verse and in prose, only two names of older dramatists need be mentioned. Dimetrios Vernardakis (1834–1907) and Spyridon Vasiliadis (1844–74). The employment of the demotic and the choice of themes relating to contemporary life gave plays fresh vitality and did much toward the foundation of a national drama. G. Xenopoulos was the inaugurator of this. Together with him mention should be made of I. Kambysis (1872–1902), S. Melas (1883–), T. Moraitinis (1875–), N. Laskaris (1868–1945), P. Horn (1881–1941), D. Bogris (1890–), T. Synadinos. A. Terzakis (1906–) and G. Theotokas. A number of distinguished Greek poets like K. Palamas, A. Sikelianos and N. Kazantzakis have also written for the theatre, but their plays are more notable for their lyrical than for their dramatic qualities.

It is convenient to treat poetry and prose in two different sections, since few writers have distinguished themselves in both.

2. Poetry.—From the fall of Constantinople till the War of Greek Independence (1821–29) the most developed and personal, though not the most arresting, poetry appeared in Greek lands occupied by the Franks. The beginnings of modern Greek lyric poetry can be traced to Rhodes and Cyprus, then under the rule of the Knights Templar and the Lusignans.

Cretan Literature.—It was in Crete. however, that the most vigorous and remarkable literature flourished in the 16th and 17th centuries. when the island was under Venetian occupation; this was brought to a premature close by the Turkish capture of Candia in 1659. The progress made in versification can be traced from the unpolished, rhymed 15-syllable political lines of Georgios Choumis in his paraphrase of Genesis arid Exodus,' written early in the 16th century, to the finished handling of the same metre by Vikentios Kornaros in his great romantic poem *Erotokritos*, which probably dates from the middle of the 17th century and describes the trials and sorrows of two lovers, Erotokritos and Aretousa, whose love story is finally crowned with a happy ending. Though based on a French work, *Paris et Vienne*, which Kornaros probably knew through an Italian version, the *Erotokritos* has many purely Greek and local Cretan elements and can be fairly called "the national poem of Crete." In connection with this should be mentioned an interesting series of Cretan dramas. The best known, though not the best, of these is the *Erophili* of Georgios Chortatzis, inspired by G. B. Giraldi's *Orbecche* and written *c.* 1600. It describes the tragic history of the love of Panaretos, adopted at an early age into the court of King Philogonos of Egypt, for the princess Erophili, which results in the violent death of all three principal characters. These Cretan plays also include comedies, such as the *Stathis* and *Fortounatos* (17th century) which, though in the main borrowed from Italian and ultimately going back to Plautine and Terentian comedy, are interesting for the introduction of local characters and colouring. But the real gems of the Cretan drama are the pastoral comedy *Gypat-is* and the mystery play *Thysia tou Abraam*, on the sacrifice of Abraham, also based on an Italian model, the *Isach* (1586) by L. Groto. Both are anonymous. though Kornaros has been supposed by some modern scholars to be the author of the mystery play. The *Gyparis* dates from *c.* 1600 and describes in a masterly and humorous manner the conversion to love of two shepherdesses, who had previously scorned it. In many respects it is extraordinarily modern. The *Thysia tou Abraam*, though in form a mystery play, is really a highly sympathetic study of family life. It is said to have been printed as early as 1535, but this may well be a mistake for 1635.

Crete possesses an interesting series of popular songs, and in connection with these a charming pastoral poem. *I oraia voskopoula.* It is usually coupled with the name of Nikolaos Drymitinos. who published the version he selected in 1627. The language of this attractive Cretan literature has naturally incorporated a good many Venetian words, but its general character is that of a vigorous native tongue with a number of peculiar Cretan forms and idioms. Had Crete not been captured by the Turks in 1660, the course of the whole of modern Greek literature would probably have been quite different.

Folk Songs and Klephtic Ballads.—In those parts of the Greek world under Turkish domination. the only noteworthy poetry is to be found in the folk songs and the klephtic ballads (the klepht was an armed Greek living as a free man and an outlaw). The roots and subject of many of these go back to the Byzantine era and one, the *Chelidonisma*, has even been traced as far back as Greek antiquity. Greek folk songs fall into three main divisions: (1) The historical folk songs, treating of historical events as they caught the imagination of the people. The Akritic ballads. as sung in Asia Minor, the Aegean islands and Cyprus. the laments on the fall of Constantinople and certain klephtic ballads are among the most notable of this group. (2) The songs of everyday life, *i.e.*, love songs, lullabies, marriage songs, working songs, dirges and carols. Here strong family feeling predominates. Death is personified in the form of Charos who struggles with his victim, is sometimes worsted, but as a rule triumphs in the conflict. (3) The *paralogis*, short narratives of a swift epic character, often almost summaries of folk traditions or folk tales. Some of the most beautiful and vivid verse written in Greek is to be found in the folk songs and the klephtic ballads. Most of the latter date from the 18th century and are excellent examples of an entirely spontaneous poetry composed in popular language and in the 15-syllable verse, rhymed and unrhymed. They are pervaded with the spirit of the forests and the mountains and, like so much of Greek popular poetry, personify trees. rocks and rivers. Even the mountains sing the prowess of the klephts, bewail their death and comfort the disconsolate wife or mother. Klephtic ballads have been a source of constant inspiration and rejuvenation to modern Greek poetry.

The Phanariotes.—The 18th century witnessed: side by side with the folk songs, the development of a different type of literature in the urban and cultivated society of the Phanariotes (the Greeks who gathered round the ecumenical patriarch in Constantinople). This can be seen as an endeavour to continue the classical Byzantine tradition and to link it with the great literatures of the west, notably that of France. Until the 1830s very little poetry of any value was produced from this source. But mention should be made of Kaisarios Dapontis (1714–74), whose long works of a moralizing and religious character, especially *Kathreptis* ton gynaikon ("Mirror of Ladies") and Kipos *Chariton* ("The Garden of Graces"), were praised and imitated by his contemporaries; of Rhigas (1757–98), whose patriotic poetry enjoyed widespread popularity; and also of Athanasios Christopoulos (1772–1849) and Ioannis Vilaras (1771–1823). in whose writings the influence of the Anacreontics and the 18th-century French drawing-room bucolics can be clearly seen. Vilaras is of particular interest, because the application to his verse of the extreme linguistic ideas expressed in his book Romeiki glossa led him to link personal lyric poetry with the folk-song tradition.

The Greek Romantics.—The liberation of Greece from the Turks (1828) made the capital of the new kingdom the centre of all Greek political and intellectual life. The Phanariotes moved first to Nauplia and then to Athens, mingling with the Greeks who came from the west to their newly freed country, and with the leading families that had fought and distinguished themselves during the War of Independence. In this mixed and unsettled society the romantic school of Athens flourished; its founder and leading spirit was Alexandros Soutsos (1803–63). He studied in Paris, where he came under the influence of the French romantics, but his exuberant and patriotic writings never succeeded in capturing the spirit of his models. As a satirist, however, he is often terse and vigorous. The influence he exercised upon Greek poetry was felt for many years. The other main representatives of the earlier days of the romantic school of Athens, his brother Panagiotis boutsos (1806–68), Alexandros Rizos Rangavis (1809–92), Georgios Zalokostas (1805–58), Theodoros Orphanidis (1817–86), Elias Tantalidis (1818–76) and Ioannis Karasoutsas (1824–73), though their poetry varies in quality and character, are all slaves of a boundless romanticism, use mainly the *katharevousa* as their language and are painstakingly patriotic. Among them Rangavis is perhaps the most striking figure. A man of extraordinary fertility of mind. he achieved considerable charm in the classical style. His works include odes, hymns. ballads, narrative poems, tragedies and comedies and several prose works. Achilles Paraschos (1838–95) is the leading figure in the last period of the school. Alfred de Musset, Victor Hugo and Lord Byron were his idols, but the rhetorical profuseness and mock-heroic patriotism of his verses prevent him from ever rising to their level, though a spark of true poetry is often evident. His brother Georgios Paraschos (1822–86) and his contemporaries Angelos Vlachos (1838–1920), Alexandros Vyzantios (1841–98), Dimitrios Paparrigopoulos (1843–73) and Georgios Vizyiinos (1849–96) were all overshadowed by his reputation, in spite of the greater sincerity and more delicate technique evident in many of their writings.

The School oj the Ionian Islands.—.Another school of poetry, parallel to the romantics of Athens, flourished in the Ionian islands, which were under British rule till 1864. Its founder and greatest representative was Dionysios Solomos (1798–1857), a native of Zante. Like others of the Ionian aristocracy of his day he was practically bilingual, and, having received his education in Italy, wrote his first poems in Italian. He soon, however, developed a preference for Greek. His early works in Greek were short lyrics, but the War of Independence stirred him to more ambitious projects. As the years passed, his philosophic approach to art and life deepened and expressed itself in verses of great delicacy and balance, unsurpassed in modern Greek. From the hymn of liberty (the first stanzas of which became the Greek national anthem) to Hoi elevtheroi *poliorkimenoi* ("Free Besieged"), which sings of the heroic resistance and sally at Missolonghi, the development of a highly spiritual nature can be traced. Unfortunately most of his mature work is known only from fragments, since his temperamental instability seems to have prevented him from finishing any of his major works. In the struggle that continued from Byzantine days between the katharevousa and the demotiki as the language of literature, Solomos marks a turning point. For, by choosing the latter, he pointed the way which Greek poetry was to follow after the demotic movement of the 1880s. Moreover, he introduced a number of western metrical forms (the sestina, the ottava rima, the *terza rima*, etc.), thus freeing Greek poetry from the monotony of the 15-syllable political verse mainly in use previously. Of the other poets of the Ionian school, Georgios Tertsetis (1800–74), Ioulios Typaldos (1814–83), Gerasimos Markoras (1826–1911) and Lorentzos Mavilis (1860–1912) must be mentioned, but undoubtedly Andreas Kalvos (1792–1869) and Aristotelis Valaoritis (1824–79) are the most distinguished. Kalvos drew his inspiration from the Greek classics and indulged in an austere and moralizing poetry and in a classicizing form of language, without exercising any notable influence on subsequent literature. Valaoritis. on the other hand, though deeply romantic and often too grandiloquent, was greatly admired by his contemporaries and is one of the authors who influenced Kostis Palamas in adopting the spoken tongue as the language of poetry. Thus Valaoritis became the link that connects the Ionian school with the new school of Athens.

The *New* School of Athens.—The feeling that Greek poetry, by employing the stilted *katharevousa* and by indulging in the weaker side of the romantic movement, was heading for utter sterility stirred a group of young poets to form about 1880 the new school of Athens. They aspired to become Greek Parnassians, masters of a restrained and objective art, but at the same time drawing their inspiration from contemporary Greece and using the living idiom. The central figure of this new school was Kostis Palamas (1859–1943), a man of versatile talent and wide reading. His many important poetic works portray modern Greek life, the continuity of Greek history and the social and spiritual convulsions of the late 19th and early 20th centuries. The long philosophic poem Dodecalogos tou Gyftou, perhaps his greatest achievement, shows the gypsy musician, symbol of freedom and art, gradually deepening into the patriot, the Greek and, finally, into the "Hellene," citizen and teacher of the world. His powerful epico-lyric work I *flogera* tou Vasilia and his collection of lyrics have established his reputation throughout the western world, and his influence upon all subsequent Greek literature has been profound. In poetry his distinguished contemporaries Georgios Drosinis (1859–1952), Ioannis Polemis (1862–1922) and Kostas Krystallis (1868–94), as well as his immediate successors Ioannis Gryparis (1871–1942), Kostas Chatzopoulos (1871–1920), Miltiadis Malakasis (1870–1943), Lambros Porfyras (1879–1932), Sotiris Skipis (1881–1951) and Z. Papandoniou (1877–1940), all acknowledged their debt to the leader of the school. It is the poets of this school who have explored the expressive and metrical possibilities of the spoken idiom and who introduced symbolism and free verse into Greek poetry, which has greatly enriched and enlivened it in the course of the 20th century. Of the women writers of the new school of Athens, Myrtiotissa (Theoni Dracopoulos; b. 1883), Aimilia S. Dafni (Aimilia T. Zoiopoulos; 1887–1941) and Maria Polydouri (1905–30) are noteworthy for the elegance and passion of their verses.

After Palamas, the most important figure in modern Greek poetry is undoubtedly Angelos Sikelianos. His vigorous verse has its roots in the new school of Athens, but his thought followed a different and often more obscure course. Greek nature and history are seen in the light of a Dionysiac mysticism. His rich incisive diction brings landscape and human form in clear-cut relief before the eyes.

The one great Greek poet who remained untouched by the influence of Palamas and the new school of Athens was Konstantinos Kavafis. An Alexandrian both by birth and by spiritual inclination, his main theme was the tragic glory of Hellenistic Greece and its decadence. But in his work historical memories and personal experiences were inextricably blended. In no other Greek poet is the tragedy of life so sensually expressed or sensuality felt more tragically, although the tragic outlook is relieved by exquisitely lyrical and often ironical passages. His writings, because of their reflection of modern tendencies in western culture, have been universally acknowledged.

Of the many other poets who wrote in Greece after the end of World War I, four only can be mentioned here: Kostas Karyotakis (1897–1928), whose pessimistic and often sarcastic poems are most arresting; George Seferis (1900–), a genuine symbolist, who records with true poetic touch the fate of modern man; the "surrealist" Odysseus Elytis (b. 1911), whose lines are full of the light and colour of the Aegean islands; and Nikos Kazantzakis, better known as a novelist, who is also the author of a formidable "epic" poem 33,333 lines long, *Odyssey.* Its hero, a modern Odysseus, wandering in the world of thought, seems to be haunted by the idea of nihilism. The size and style of the work are overwhelming, but there are long passages of great beauty and a use of language of extreme wealth and vigour.

Modern Greek poetry is mainly lyrical, and little satirical and hardly any dramatic verse of merit has been written. The satire of Andreas Laskaratos (1811–1901) and Georgios Souris (1853–1919)—who created a peculiar form of political satire in his weekly paper *Romios*—must be recorded, but it has lost much of its flavour.

3. Prose.——After the fall of Constantinople Greek scholars helped to spread the knowledge of Greek to the west and stimulated the study of ancient philosophy. Encouragement was given to Greek culture in the 16th and 17th centuries by the Ecumenical Patriarchate of Constantinople, by the founding of schools in Constantinople, Bucharest and Jassy (Rumania) and by the printing of works in Greek by the hospodars (rulers) of Walachia. In the 18th century this educational work was continued and modern Greece owes a debt of gratitude to the Greek clergy, to the great Phanariote families of Constantinople and also to wealthy Greek merchants, who fostered schools and issued educational works in Greek from the printing presses of Venice. Trieste and Vienna. 'This work had an important influence in preparing the Greeks for their emancipation from Turkey. Most of the literature of this period was theological, but a good many books of an educational character were also produced. Representative names are those of the ecclesiastics Elias Meniatis (1669–1714) from Cephalonia, who lived and wrote in Venice; and Kikephoros Theotokis (1736–1800) and Eugenios Vulgaris (1716–1806), both natives of Corfu, who wrote in the literary language in defense of Greek Orthodoxy, but also produced works of mathematics, physics, geography, archaeology and philosophy in addition to translations. These men rnay seem to lack originality and their language may be on the whole artificial, but their work was of inestimable value to the Greek people in the dark conditions surrounding them at the time. The greatest name, however, among the forerunners of the Greek revival is that of Adamantios Korais (1748–1833) who, though he spent most of his life in Paris, exercised an enormous influence on his Greek contemporaries, partly by his unwearying issue of editions of classical Greek authors accompanied by stirring patriotic introductions, and partly by his efforts to reform the written language by assimilating the literary tongue with the living idiom of modern Greece.

From the Liberation to 1888.—In the first decades that followed the liberation of Greece, prose was confined mainly to journalism and scholarship. The few writers of creative literature turned to the west for their models and were attracted first by Sir Walter Scott, whose reputation was paramount on the continent at the time, and later by Alexandre Dumas the Elder, some of nhose works were translated into modern Greek by Ioannis Skylitsis (1819–90). This accounts for the popularity in Greece of the historical novel between the years 1821 and 1888. Its most distinguished representatives, all of whom used a more or less austere *katharevousa*, were Alexandros Rizos Rangavis, Emmanouil Rhoidis (1835–1904), Spyridon Zambelios (1813–81) and Dimitrios Vikelas (1835–1908). Three novels call for special mention: Rangavis' *Avthentis tou Moreos* ("Lord of the Morea"), dealing with the Frankish occupation of the Morea, Rhoidis' vivid historical-satirical novel about Pope Joan (1865) and Vikelas' *Loukis Laras* (1879), an attractive romance dealing with the massacre of Chios in 1822. In addition, the short story in the *katharevousa* was cultivated in this and the subsequent period by a number of writers, perhaps the most important of whom are Georgios Vizyinos (1848–94) and Ioannis Kondylakis (1861–1920).

The same period witnessed the development of a remarkable classical style by certain distinguished scholars. Two works of major importance stand out: the history of the Greek revolution by Spyridon Trikoupis (1788–1873) and the history of the Greek nation by Konstantinos Pnparrigopoulos (1815–91), both of which are not only based on independent research arid scholarly accuracy but also are written in a balanced and flowing style. Alongside them may be mentioned the writers of memoirs of the Greek War of Independence, and especially Gen. Ioannis Makryiannis (1797–1864), who writes in a vivid and personal demotic idiom and shows a keen perspicacity and objectivity.

The 20th Century.—With the publication in 1888 of *To taxidi mou* by Ioannis Psycharis (1854–1929) and the development of the demotic movement, modern Greek prose underwent a momentous change. For the outcome of the resulting long and bitter linguistic and literary battle was complete victory for the use of the vernacular not only in poetry but also in all prose works of an imaginative character. The writers of that period, helped by the researches in modern Greek folklore of Nikolaos Politis (1852–1921), turned to their "living roots" for inspiration. finding them in the life of the Greek village. Greece in the 1880s was still mainly inhabited by agricultural and seafaring communities, and had no large towns, with the possible exception of Athens. So the character of this new prose, which turned to the Greek countryside for inspiration, became preponderantly "pastoral," and this tendency continued till the turn of the century, when a more developed urban life made itself felt. A forerunner of the pastoral trend can be found in Pavlos Kalligas (1814–96), the distinguished jurist, whose novel *Thanos Vlekas* (183'5) described in an austere *katharevousa* the unsettled conditions of the Greek countryside in the days following the liberation of Greece. But the novel found no successors till after the 1880s when Alexandros Papadiamantis (1851–1911) and Andreas Karkavitsas (1866–1923) distinguished themselves with their tales of villagers and fisherfolk. Papadiamantis. a native of Skiathos, is undoubtedly the greatest modern Greek short-story writer. In a personal and slightly archaic idiom he examined the psychology of the simple island people and described some moving incidents in their lives. His *Fonissa,* one of the outstanding books in modern Greek literature, is more of a short novel than a long short story, and deals with an old woman of Skiathos who suffered so much herself and saw her daughters and all the women of the island so full of misery that she decided to kill all baby girls she could lay her hands on. The short stories of Karkavitsas, though different in texture, are of an almost equal emotional power. But his greatest achievement is his realistic novel *Zitianos* ("The Beggar"). Another important contemporary work is the biographical novel of Konstantinos Theotokis (1872–1923), *Zoï kai thanatos tou Knrabela,* notable for its forceful realism and psychological insight. The "pastoral" short story also flourished in the hands of G. Drosinis (1859–1952), A. Eftaliotis (1849–1924), J. Vlachogiannis (1867–1945), C. Christovasilis (1861–1937), A. Travlandonis (1867–1943). D. Tangopoulos (1860–1926) and Z. Papandoniou (1877–1940). The great social and economic changes Greece underwent at the end of the 19th century soon found reflection in its literature. The expanding middle classes and the ensuing development of city life fostered the development of an "urban" literature hitherto unknown. This was also aided by Greek translations of French novels on big-city life, notably those by Émile Zola. Thus the urban novel was introduced into Greek literature by two writers of very different background and genius: first by Psycharis, whose cosmopolitan background was most appropriate for the development of such a literary genre, and second by Gregorios Xenopoulos (1867–1951j, the gifted and prolific writer from Zante. The novels of Psycharis (the most successful of which is *To Oneiro tou Yianniri;* 1897) undoubtedly exercised a great influence upon contemporary Greek writers, but they are faulty in construction, the heroes never come to life and the deep egotism of the author makes them difficult to enjoy. Xenopoulos, on the other hand, who had to earn a living out of his writing, serialized many of his works in Athenian newspapers, and so too often had to pander to the taste of his readers. His two best sellers were *Foteini Sandri* (*O kokkinos Vrachos*) and *Stella Violanti*. Psycharis and Xenopoulos were followed in their urban writings by Konstantinos Christomanos (1867–1911; the friend and secretary of the empress Elizabeth of Austria-Hungary), whose *Kerenia koukla* is full of delicacy and true feeling. At the same time Kostas Chatzopoulos (1871–1920) gave Greek literature its one symbolist novel before 1920, *Fthinoporo* ("Autumn"; 1917).

The end of World War I saw the rise of a group of young writers such as D. Voutieridis, Petros Pikros, Thrasos Kastanakis, Nikos Nikolaidis and Photis Kondoglou, who paved the way to the prose writers of the 1930s, when prose in the vernacular achieved maturity and novels of more than national significance appeared for the first time in Greek. Only a few of many important writers can be mentioned here. The first was Stratis Myrivilis, who took the literary scene by storm with his book *Zoï en tapho*, a series of war impressions from the Macedonian front in the form of letters from a dead friend of the author to a girl in Lesbos. Myrivilis writes in a lively and robust demotic, in which dialectal and lyrical elements abound. His second and more mature novel, *Daskala me ta chrysa matia*, connected with the Asia Minor campaign which ended in the Greek defeat of 1922, was followed by many shorter stories of power and originality. His long novel *Panagia gorgona* (1955) treats of the life of a group of Greek refugees from Asia Minor in a small village of Lesbos and concludes what modern Greek literary criticism calls the "war trilogy" of Myrivilis. Like Myrivilis, Elias Venezis (1904–) made his appearance with a striking book on his life as a prisoner of the Turks in 1922–23, called *Noumero 31328*. Other important longer and shorter publications followed, the most significant of which was his long novel *Aiolia*, full of childhood memories from Asia Minor. The style of Venezis is less arresting than that of Myrivilis, and his mood on the whole more nostalgic, but clarity, beauty and humanity abound in his writings. One of the most gifted authors of the 1930s was Kosmas Politis (P. Taveloudis; 1888–), who in his *Eroica* (1938), a book on the actions and reactions of a gang of children, as well as in his later novels *Lemonodasos* and *Gyri*, proved himself a master of the long narrative. His psychological analysis of his heroes and his descriptions of natural beauty rank high in modern Greek literature. Mention should also be made of Georgios Theotokas, whose long novel *Argo* (1936), together with his many other writings—essays, short stories, travel books, plays—show him to be a writer of ability acd versatility and one of the best handlers of a flowing and simple demotic. Other authors include A. Petsalis, A. Terzakis, P. Prevelakis, M. Karagatsis, T. Stavrou and Kleareti-Dipla Malamou.

After World War II the prewar generation remained the models for younger writers of both poetry and prose. Their continuing influence is exemplified in the striking achievement of Nikos Kazantzakis, who at an advanced age and after a long literary career — lyric and epic poetry, travel books, dramas, philosophic and critical essays — turned to the novel and achieved international recognition. His novels show outstanding creative powers and a full mastery of his medium. Most of them have been translated into the leading European languages. In spite of certain crudities, Kazantzakis is one of the great masters of Greek demotic Prose, whose wealth and vigour he deeply explored.

Real literary merit was in many instances achieved by the *Chronografema*, a column in certain Athens newspapers treating of some daily event in a humorous or lyrical manner. In the hands of writers like P. Nirvanas (Petros Apostolides; 1886–1937) or S. Melas (1883–) it transcended the boundaries of journalism, but again no new name deserves mention. A certain lack of originality in the younger generation was perhaps due to the unsettled condition of the country during the aftermath of the German, Italian and Bulgarian occupations and the civil war which caused such ravages in the 1940s. Of the authors who began to write after World War II, however, M. Lymberaki, A. Angeloglou, A. Kabbatzis. R. Roufos and S. Plaskovitis are the most notable.

See article GREEK LANGUAGE and articles on individual authors. See also references under "Greek Literature" in the Index volume. (CE. A. T.)

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GREEK MUSIC (ANCIENT). The literature of Greco-Latin antiquity and the Church Fathers, the plastic and graphic representations and the findings of archaeology indicate an ancient Greek musical culture extending over more than 2.000 years.

History. — Heroic Age (c. 2000–c. *1100 B.C.*).--The first Greek-speaking European peoples reached Greece about 2000 B.C., doubtless bringing their folk music with them. Greece thenceforth gradually came under the Minoan (Cretan', influence, with its Aegean and Egyptian elements. and about 1550 this influence promoted the first distinctively Greek culture, the Mycenaean. Greece early obtained from the Mediterranean area both instruments and musical and dance forms. Mycenaean remains include fragments of a lyre of Cretan type, while a smaller lyre (Phoenician type) and a bronze trumpet indicate Asiatic influence. Musical life was characterized by a strong ritual element.

Dark Age (c. *1100*–c. 850 *B.C.*).—The Mycenean and Minoan cultures suddenly declined with the invasion of the Dorians from Asia Minor, and myths indicate extensive new foreign influences. The legend in which the Greek Apollo days the Phrygian Marsyas embodies a memory of the early Greek preference for the lyre, the instrument of the Xpollo cult, above the *aulos* or reed pipe, a more emotional instrument associated with the cult of the wine-god Dionysus. The precedence of lyre over pipe would seem to foreshadow the supremacy of reason in the artistic life of classical times. The Asiatic influence was nonetheless substantial. Tradition says the Phrygian Olympus (c. 900 B.C.) introduced the dactylic metre. the enharmonic genus, the aulos and melody patterns called *nomos* (pl. *nomoi*).

Early Classical Period (c. 850–c. 600 *B.C.*).—From Homer's time. Greek music was closely based on poetry. Poet-musicians, the professional bards of noble families, chanted epics in recitative style, accompanying themselves on the cithara (lyre). The *nomos* on a prescribed melody pattern gave rise to solo (non-recitative) vocal compositions that were cyclic in form without strophic repetitions, had a prescribed number of movements and were accompanied by the reed pipe or the lyre. There was also a purely instrumental *nomos* for the reed pipe, with descriptive associations. The dithyramb was originally a strophic melody sung by Dionysus worshipers. It developed into a choral genre c. 600 B.C., when it was sung and danced to the reed pipe by a circular chorus of 50 men and boys. Hymns and dances were also performed chorally in other cults, and at weddings and funerals, and were sometimes accompanied by the bardic lyre. Music also figured in the competitive festivals: the Olympia from 776 B.C. and later the Delphic Pythia, the Spartan Carnea and the Panathenia. From the 7th century. after the Homeric epics were committed to writing, poets turned to more popular themes sung to a smaller lyre called *lyra,* whence modern "lyric" poetry derives its name: others wrote for choral performance. Important among lyric poet-musicians were Archilochus of Paros (fl. 716–676 B.C.), Tyrtaeus (fl. till 668), Alcaeus (fl. from 611), Sappho (fl. c. 600) and Anacreon (550–465).

Classical Period (c. *600*–c. 400 *B.C.*).—Greek culture now created the classical drama, developed certain basic attitudes to music and reached its zenith in Athens. The plays were essentially musicodramatic works written by poet-musicians, but descended from the cult rituals. *Tragoedia* (tragedy) means literally "goat song." after the ritual of the Dionysian dithyramb. while comedy kept the latter's ritual trappings (masks, etc.). 'Ihe drama was at first mainly choral, though the chorus also gave a semicircular dance (*orchesis*) on that part of the stage called *orchestra.* The single actor was earlier the leader of the dithyrambic dance choir. A second actor was introduced by Aeschylus (525?–456) and a third by Sophocles (495?–406). The spoken dialogue alternated with solo songs (with lyre) or choruses (unaccompanied, or with lyre or aulos).

Music, with the other arts, was regarded as inspired by the nine Muses. The Greek word *mousike* had two meanings: first, it meant the culture of the intellectual faculties. which, with *gymnastike,* or bodily culture, provided a liberal education; and second—a meaning more comparable with the modern one—it signified the poetic text, its melody and the accompanying dance. The morally uplifting influence of music was taught by the school of Pythagoras (c. 585–c. 479), which thought it possible. by means of sensual harmony, to re-establish the primary intellectual harmony of the soul; *i.e.,* the harmony inhabiting the heavens before animating human bodies. Hence the doctrines of the harmony of the spheres. the *ethos* or characteristic influence of the various musical modes and the efficacy of numbers.

Late Antiquity (c. 400 B.C. to the Fall of *the* Roman *Empire* in the *West,* A.D. *476*).—The 4th century B.C. saw the emergence of Greek science and the first formulations of music theory. The most practical approach was that of Aristoxenus (*fl.* late 4th century B.C.), while Euclid (c. 300) expounded Pythagorean theory and Plato (427–347) wrote on important musical themes. Theory received further serious attention only from the 1st century A.D., the most important work being that of Ptolemy, the neo-Pythagorean mathematician and astronomer (2nd century A.D.). Before the first theory was written, however, music and poetry had begun to diverge, and the styles of Aristophanes (c. 450–c. 385 B.C.), Miletus (d. c. 400) and Philoxenus (430–380) show a progressively popular trend, after which drama rapidly degenerated into pantomime.

The only surviving examples of Greek music belong to this late period, and it is little indeed compared with survivals from other arts. Of about 20 possible fragments, written variously in a "vocal" and an "instrumental" notation. two remain unauthenticated and three or more are probably Byzantine reconstructions (*see* BYZANTINE MUSIC). Of the remainder. three are important: the two Delphic hymns to Apollo, carved on marble at Delphi (late 2nd century B.C.), and the epitaph of Seikelos for his wife, chiseled on a tomb at Tralles (Aidin), Turk. (1st century B.C. or later). The rest, in papyri, are to be seen in Cairo, Berlin. Oslo, Michigan and Oxford; the oldest fragment of all, a few choral lines from Euripides' Orestes (408 B.C.), is in the Rainer papyrus in Vienna (3rd–2nd century B.c.).

Forms **and** Principles **of** Composition. — The fragmentary relics hardly allow structural analysis, though certain fundamental principles of construction are known: poetic metre, verbal contour and musical time.

The units of poetic metre (feet comprising short and long syllables) fell into three main groups, exemplified by the dactyl – ∪ ∪; *iamb* ∪ – (*cf. trochee* – ∪); and *paeon* – ∪ ∪ ∪ . The equivalent musical units comprised short and long notes: duple J ♫, 2/4; triple ♪J (or ♩ ♪), 3/8; and *multiple* ♩. ♩, 5/8, as found respectively in the "hymn to Helios," "hymn to the muse" and "first Delphic hymn."

Declaimed poetry also had verbal contours — inherent tonal elements represented by the three speech accents: *acute* (rising). *grave* (falling) and *circumflex* (rising followed by falling, or level) —which *melopoeia,* the Greek art of melody making, aimed to enhance.

The two principles. poetic metre and tonic accent. are seen in combination in the "hymn to Helios." with its strictly anapaestic metre and 12 out of 16 acute accents matched by a rising melodic contour.

Further! Greek poetry, conceived without any dynamic stress of its own, could hardly escape the influence of the accompanying instruments and dance, which, by their very nature. required strong and weak beats. or musical time. Thus the noisy *thesis* (downbeat) of the choral dance leader's foot clapper was inevitably followed by a silent *arsis* (lifting). Moreover, in postclassical times music already imposed its own formal patterns on poetic structure: the four metrically different lines of the "epitaph of Seikelos" are equally adjusted to a melody in 12/8 time. According to Dionysius of Halicarnassus, the *Orestes* of Euripides went still iurther toward purely musical form: its melody did not rise and fall with the speech accents; it was identical in two rhythmically paired strophes.

The Greek arts, whether plastic or dramatic, favoured linear form, hence rhythm took precedence over elements of colour. In music the latter were no doubt represented by occasional decorative two-note chords plucked on the lyre, by a drone on one of the *aulos* pipes accompanying the melody on the other, and by the accompaniment of a vocal melody in heterophonic variation. But the single line of melody remained paramount, and its intervals were classified in Greek music theory.

Theory. — The Greek. referred their music to the intervals of an octave (diapason), fifth and fourth, and they knew all the intervals of western music and more besides. The interval of a fourth was the practical unit of their tonal space, and when divided into four notes it was known as a tetrachord. Of these notes the outer two were fixed, the inner two movable; and the position of the latter determined one of three *genera* whose intervals (reading downward) were: tone, tone, leimma ("remainder" of the interval of a fourth after the subtraction of two tones) in the *diatonic*, as in the "epitaph of Seikilos"; minor third. semitone, semitone in the *chromatic;* and ditone, quarter tone. quarter tone in the *enharmonic*, as in the Orestes fragment. Still finer intervals were classified in subgenera called *chroai* ("shades").

Three primary (diatonic) modes correspond to the three possible (descending) orders in which the intervals of the tetrachord run: Dorian (tone, tone. leimma). Phrygian (TLT) and Lydian (LTT). Such structures occur respectively in the "second Delphic hymn," "epitaph of Seikelos" and an instrumental piece from J. F. Bellerman's *Anonymous* (of late date). Two tetrachords joined together formed a *harmonia* (octave scale). and in the diatonic genus the seven such scales in use (with notes reading downward, and as on the white keys of the piano but allowing for differences in tuning) were as follows: a to A, Hypodorian (Aeolian); g to G, Hypophrygian (Ionian); f to F, Hypolydian; e to E. Dorian; d to D. Phrygian; c to C, Lydian; and b to B, an Hyperdorian. These *harmoniai* are called "modes" today, but they were only the scaffolding for the true modes (*tropos*, pl. *tropoi*) or melodic styles or contours (perhaps comparable with the Indian raga [see INDIAN MUSIC] and Arabic *maqam*), each with its particular *ethos*, or characteristic effect. A five-note scale was also early introduced into Greece from Asia. It is found as late as the "second Delphic hymn."

To embrace all the notes of the seven *harmoniai* in each of their three genera within the compass of a single octave. the Greeks had a theoretical scale of 21 sounds ("greater perfect system"); the seven *harmoniai* they related to each other in a continuous two-octave scale (disdiupason) ; for modulation they used an 11-note series ("lesser perfect system") ; and to bring any scale within the limited compass (that of the Dorian *harmonia*) of the lyre, they had a transposing system.

The surviving musical fragments well illustrate certain aspects of classical theory and yet show differences that suggest only a frail link with the music of classical times. To what extent the theory represents musical practice at any one period may be legitimately questioned? for the theorists often disagree among themselves. with considerable confusion in terminology.

Instruments. — Ancient Greece appears never to have had a developed instrumental art. The role of its few instruments — all derived from non-Greek sources — was the accompaniment of poetry and the dance.

Strings. — The all-important national lyre existed in preclassical forms: *phorminx,* citharis, *chelys,* and in classical forms: *cithara* (professional), lyra (lyric poets, amateurs). *barbiton.* The harp was played by women: *magadis* (large), *pectis* (smaller), *psalterion* (later).

Wind.—The reed pipe (*aulos*), usually double and next in importance after the lyre, played *nomoi* and accompanied dithyramb and drama. The syrinx (shepherd's panpipe) was played to the flocks, and the *salpinx* (straight metal trumpet) had a military function. The *hydraulis* (water organ, Alexandria. 3rd century B.C.) became more popular in Rome.

Percussion Instruments.—These were introduced with the Dionysus and Cybele cults: *tympanon,* hand-beaten frame drum (Mediterranean) ; *crotala,* hand clappers; *croupala,* foot clappers; and *cymbala*, cymbals.

Heritage. — Though nothing remains of ancient Greek musical practice and few instruments survive. the influence of classical theory was wide and lasting. The Greek empire carried it to Egypt and the Asiatic coasts, and possibly as far as India. In early Christian times the Gnostics used the Greek scale in their incantations, and Byzantium adopted the Greek modes (see BYZANTINE MUSIC). The Romans acknowledged Greek musical leadership and transmitted Creek theory to Europe through Boethius (*c.* 480–524 A.D.), and the early church drew upon its modes. But Islam is the principal heir to Greek theory through the Persians, Arabs and Turks, whose writings further influenced Europe from the 9th century.

Thus Greek music, itself the heir to so much from the world's three most ancient civilizations. helped to create that of at least three more. See also AULOS; LYRE.

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(P. C.-Ho.)

GREEK RELIGION.

The religion of the ancient Greeks is no longer absurdly abused nor foolishly idealized. and can be seen clearly for what it was. It contained savage and barbarous elements as well as elements of civilization, although the savagery and barbarism are still sometimes exaggerated. It was creedless, developing without any authoritative writing like the Bible or the Koran. and without any inflexible tradition to hamper or to guide it. It varied from age to age, from place to place and probably also from class to class, being now more backward, now more advanced, but always retaining certain characteristics. It was, first, an anthropomorphic polytheism, the worship of a number (not very large) of gods, thought of as human in form and largely human in mind. These gods were neither passionless nor without characteristics seen by the developed ethics of philosophy as moral faults. But as the history of this worship covers some 2,000 years, it can be seen that ideas, even popular ideas. on these matters were somewhat variable. The gods were normally, though not always, clear-cut figures, made concrete by poetry and art and surrounded by a large mythology. This. however. was not a body of dogma; the worshiper might believe; disbelieve or alter it to his taste.

The Greek religion was for the most part (but *see* MYSTERY) completely free from otherworldliness. It was a religion of everyday life. which sought for temporal blessings such as good crops. deliverance from enemies, health, or peace within the community. In historical times at least it was in its most conspicuous form an affair of the state, although family cult never ceased to exist, and individual religion developed strikingly as the importance of the Greek city-states declined from the 4th century B.C. onward.

Origins. — The people who in historical times called themselves Hellenes (Greeks) came to Greece from an unknown district, perhaps by way of Asia Minor. They brought with them only one deity whose name and native origin are certain: namely Zeus. It is likely that they also had a corn-goddess. whether or not they already called her Demeter. and she may by then have had a daughter. Kore ("the maiden"). The Greeks probably had additional names of deities such as Pluton ("the rich one"). who may well have been the deity of the earth's wealth, *i.e.,* of its crops. Only later. perhaps. was he identified with Hades, the god of the dead, an older form of whose name is Aides. perhaps meaning "the unseen." In any case Hades is not a god of the living. who therefore do not worship him. The dead likewise are no longer in the charge of the gods worshiped on earth. and presumably do not worship them. Similarly, the name Helios (Halios. Eelios) refers not only to the visible sun but also to the sun-god. He had no cult in Greece proper, however, nor had Selene, the moon; gods of the heavens are no concern of people who move on the earth. Zeus is a deity of the weather-sky, that is, of meteorological phenomena such as rain and snow. No other god or goddess of any importance has a name demonstrably Greek. Kronos' name is certainly un-Hellenic; Apollo's yields no convincing Greek etymology. Athena is a pre-Hellenic goddess. adopted by the incoming Greeks in

Mycenaean times as the protectress of their chieftains' castles. Artemis, or Artamis, has a name possibly connected with *artamŏs*. This word, however, means "slaughterer" or "butcher," whereas Artemis is a huntress, a helper in childbirth and on occasion the sender of sudden and painless death to women. The name Hera, if Greek, is the feminine form of *hērōs*, a nobleman or gentleman; it thus means "lady"—a title, not a proper name. The name of Hermes (Hermeias) may be etymologically connected with *hĕrma*, stone or rubble; he may have begun as the power haunting cairns put up to mark holy spots or to delimit paths, but this is uncertain. Ares is stated by the Greeks themselves to be Thracian; in any case, the origin of his name is obscure. Aphrodite is certainly oriental. Persephone (her name has several forms) assuredly is not of Greek origin. Hecate comes from Caria, Hephaestus from the volcanic regions of Asia Minor, and Dionysus is a later arrival of Thracian or Thraco-Phrygian origin. There remain only a few minor powers. The Muses (Mousai) are supposed to derive their name from hypothetical Montiai, meaning "prompters" or "reminders." Pan (Pa-on, "feeder") is the little god of Arcadian goatherds. There are also the Nymphs ("nymph" means marriageable young woman or bride) and their like. It is not known when the cult of any of these powers began.

Some of the gods composing the classical pantheon were taken from the cults existing in the regions invaded by the Greeks. This occurred through the characteristic Greek power of adapting and naturalizing foreign influences, and there was little or no realization of the different origins of the gods, The great civilization of Minoan Crete had an elaborate religion, an outstanding feature of which was the worship of goddesses. Clear traces are to be found also of gods who are born, grow to maturity and die, probably every year, with the growth and decay of the seasonal vegetation. Both those elements influenced Greek cult and myth. In Greece proper are to be found deities with names that are not Greek and that show the characteristic suffixes (found also in place-names, etc.) of the pre-Greek language. Examples are *-nth-*, as in Hyakinthos. *-na-*, as in Athena, and *-ss-*, as in Phersephassa (Persephone). Also in Greece are fairly clear traces of an ancient cult of one or more goddesses. There is an ingenious modern theory that one of these, probably an earth goddess, was named or nicknamed "Da" (a word occurring in classical Greek as an ejaculation). It is contended that this syllable blended with Greek elements to compose two or three divine names, as in Demeter or Damater, "mother Da," and Posei-da-on, "husband of Da." For Poseidon was not originally a sea-god, nor were his earliest worshipers acquainted with the sea. He was a deity of the waters which fertilize the soil, and also, for some obscure reason, a god of horses.

It has been said that these deities are usually anthropomorphic. However, there are traces, probably very early. of their having taken bestial shape. Hera is *boōpis* in Homer; the word probably meant, to the poet, that she had large, cowlike eyes. It could, however, mean "cow-faced," and it is relevant that Hera's priestess Io is said to have been changed into a heifer either by the goddess or by Zeus. Athena is *glaukōpis*, a word used by Homer and other writers to mean "gray-eyed" or '(bright-eyed"; but the bird with which Athena is associated, a kind of owl, is called *glaux*, and the epithet may originally have meant "owl-faced." Poseidon is said occasionally to have taken the form of a horse, while Zeus and Dionysus appeared under various animal guises. The latter commonly manifested himself as a serpent or a bull; a hymn sung in his honour at Elis actually calls him "noble bull." But such cases as these are comparatively rare and abnormal. In any event they have nothing to do with totemism, a wholly non-European phenomenon, but are examples of theriolatry, which is found in many parts of the world (*see* H. J. Rose, *Primitive Culture* in *Greece*, p. 47 ff.).

Growing knowledge of the near east gradually reveals the extent to which the early Greeks were influenced by the cults and beliefs of the great oriental civilizations bordering their district. It is justifiable to say, at least, that some Greek myths were related to certain myths current among these peoples, for example, the Hittites. Egyptian and other foreign influences probably entered Greece by way of Crete, but details are still lacking with regard to this and other aspects of the early history of the eastern Mediterranean. The place of origin of the worship of Apollo, for instance, is still unknown, although it is certain that he had connections with Asia (*see* W. K. C. Guthrie, *The Greeks and Their Gods*, p, 74 ff.). A popular and sometimes locally important cult was that of the heroes, literally gentleman; *i.e.*, powerful and worshipful ghosts of real or imaginary men (sometimes women, *heroinai*), the most famous being Heracles. Minor and half-forgotten ("faded") gods were often confused with these beings. (*See* L. R. Farnell, *Greek Hero-Cults.*)

Development.—At some time earlier than the earliest evidence, earlier, that is, than the Homeric poems, the Greeks had combined most of their deities into one divine clan, the head or "house-father" of which was Zeus. Zeus was represented as the begetter of most of the younger deities, and as being himself the son of Kronos and the husband and brother of Hera. His position is that of a chieftain of the heroic age among his relatives and vassals. But this does not mean that he was the chief god in the cult of every community. At Athens, for instance, his festivals, which had increased in number to include some that were not his originally. were dwarfed in importance by those of Athena. Greek worship throughout the Archaic and Classical periods was essentially communal, although nothing prevented an individual from approaching any deity he chose on his own behalf. Every family had its observances, including the worship of the hearth-goddess Hestia, who scarcely achieved the status of a personal deity but always maintained close relations with the sacred fire from which she came. The larger groups, whether supposedly of kin, like the phratries or clans, or merely local, like the demes (townships) into which Attica was divided, had also their own worship; but the most important and impressive rites were naturally those conducted by the state. The nearest approach to a common governing religious body was the oracle of Apollo at Delphi; and even that, though it lent its sanction to innovations on occasion, was often content to tell inquirers that they would be well advised to "worship according to ancestral custom." The oracle had neither a recognized orthodoxy to enforce, nor a disciplined and obedient clergy to support it in any state that might prove recalcitrant. If Apollo were directly and materially concerned, strong measures might indeed be taken. The four "sacred" wars were all fought, nominally at least, in consequence of violation of the god's rights to certain territories; but this was hardly more than vindication of the divine proprietor's lawful claims. In general Delphi confined itself to giving advice. The inquirer, if he rejected this, did so at his own risk, and numerous tales pointed the moral that his consequent peril was real; but the effectiveness of such warnings depended on the degree of respect in which the oracle was held.

Under such a system, the nature of the cults and their distance from savagery varied greatly. In Arcadia and similar backward districts the simple people might perform archaic or grotesque ritual around a shapeless block of stone or a plank of wood, called perhaps only by some such laudatory epithet as "the good god." In a centre of culture, such as Athens, however. the holy places would be marked by stately and beautiful temples, each the dwelling of a deity represented, perhaps, by an ancient cult-statue, but probably also by a masterpiece of sculpture.

The ritual would be orderly and elaborate, comprising hymns, prayers and sacrifices. The hymns were often written by celebrated poets and musicians, although prayer does not seem often to have taken the form of long and invariable liturgical texts. Sacrifice might involve the killing of many beasts before the temple and a general feast on their meat. Normally there would be a procession for the carrying of sacred objects and the leading of victims for sacrifice. w

It is evident that the reactions of those present would vary from simple trust that the time-honoured ritual would win the favour of the deity to deep reflection upon the nature of the po er addressed, or oi divinity itself. From the latter point of view. different deities were very variously adaptable to the growing interest in ethical and theological speculation. After Zeus himself, Apollo, whose title Phoebus. "pure one." represented his concern with purifications. was thought to be sympathetic to a developed and enlightened morality; anecdotes and alleged oracles were current in support of this idea. Artemis, originally in all probability a mother-goddess, developed into a sort of personification of chastity; Athena became wisdom in person. On the other hand. many minor deities such as Pan, the Nymphs, or Hermes showed no moral development, at least in normal Greek thought. The unpopular Ares. too. remained simply a god of violent death and destruction, usually from war. but sometimes from other causes such as plague. The forms of worship were, as usual, conservative, and retained some features obviously dating from early days and comparatively low stages of culture; but even they tended to shed characteristics that advancing morality regarded as objectionable. The practice of human sacrifice, for instance, is attested by numerous legends, by an occasional ritual simulacrum of manslaughter and by the substitution, certain in some cases, merely probable in others. of an animal victim for one originally human. The actual rite was very occasionally revived in historical times; but the idea of human sacrifice became so repugnant to general sentiment that it was practically abandoned from about the 6th century B.C.

The general attitude of the Greek toward his gods was respectful but not servile. Like many Europeans, he would on occasion jest with the objects of his worship. The "Homeric" hymn to Hermes bears witness to this trait, with its humorous tales of Hermes' early rogueries. So does the comic appearance of Dionysus, Heracles and other popular deities on the Attic stage, as in the *Frogs* of Aristophanes.

Personal Religion. — The very fact that the great public cults were managed by city-states gave them a certain artificiality. They were in many cases originally connected with 'the operations of farming. and therefore belonged to those times of the year at which these operations took place. But the festivals were regulated by the state calendar and this by no means always corresponded with the real seasons. Thus, for example. a ceremony connected with plowing might be held when no farmer was actually plowing his fields. Country dwellers, no doubt, found some compensation for this defect in the worship of their little local powers such as the Nymphs; but, even so. the greatest and most conspicuous forms of worship must have seemed somewhat detached from real life.

In addition to this feeling there was a growing idea that the destiny of the individual was of importance, at least to him. and that the state cults existed rather for the benefit of the community. Hence the immense popularity. from about the end of the jth century B.C., of the cult of Asclepius, whose powers were exerted on behalf of individuals seeking cure for their diseases rather than to avert some public calamity as was the office, for example, of Apollo. There were also the movements such as Orphism (*see* ORPHEUS), which made eschatological speculations regarding the individual, and the philosophic schools. not least that of Platonism. with their ideas on ethics. the government of the universe and the destiny of the soul. Ethics were not divorced from the conventional worships. but those involved no moral code that might direct conduct in detail. All these tendencies toward regard for the individual were reinforced in Hellenistic times by the passing of the old city-states as important political units. This rendered the ordinary man much more helpless in public affairs than his ancestors had been. The geocentric theory of the universe, too, imperfect though it was, made the earth an insignificantly small place. while astrology. which was generally believed in. represented man as the victim of mechanical and irresistible fate. It is no wonder that in early Hellenistic days the cult of Tyche (Chance, Fortune) was widespread both in public and in private. and that later any system promising relief to man's helplessness was sure of adherents. Broadly speaking, such systems were of two kinds. both depending on knowledge, or *gnosis,* alleged to be supernatural and revealed (though Gnosticism, as such. is the name given to a Christian heresy). The first kind of system was the mystery religion. Mysteries were usually. though not always, of oriental origin, and claimed to secure for their initiates the favour of a particular deity. Isis or Mithra for example. who would care for their well-being. especially after death. Such patrons. being gods, were. according to the generally received theory, exempt from the centripetal influence of the stars. being above and beyond them, and thus beyond the reach of fate. The second system was the higher form of magic. "theurgy." which actually constrained the deities to help their clients. The lower forms of magic were also very popular. These aimed at compelling minor powers. notably the *biaiŏthanatoi* (ghosts of violently and prematurely deceased persons), to help the sorcerer in the desired way, for example. by revealing the future to him, by winning for him the favours of influential persons. by tormenting his enemies or by laming the horses he had bet against. One of the reasons for the ultimate triumph of Christianity over the more respectable of its rivals was the fact that, being unencumbered by fantastic myth and ritual of uncivilized origin. it dealt with the eschatological and other spiritual needs of the time in a more rational manner than did its rivals. What was left of Greek rationality contributed a logical and coherent theology to the new religion. The most stubborn opposition to Christianity came from the simple and unreflective worship of the countryside which had behind it the force of ancestral custom. Compromises were numerous; for example. the cult of Asclepius was replaced by that of miracle-working saints, and the small shrines of the little rustic deities by those of Christian powers. Indeed. traces of the old worship are still found in popular customs in Greece and other countries.

See also articles on individual deities.

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(H. J. R.)

GREELEY, HORACE (1811–1872). U.S. newspaper editor and political leader. was born near Amherst. N.H., Feb. 3, 1811. He was the eldest of the five children of Zaccheus Greeley, a poor farmer. Horace had an irregular schooling, but his precocity and an interest in printing became evident at an early age. In 1826 he entered the office of the *Northern Spectator* in East Poultney. Vt., where he remained for five years as an apprentice. Then, after visiting his parents. who had moved to Erie county in Pennsylvania, he went to New York to seek his fortune. He was then 20 years old. His New England background had given him a conditioning in religious piety. moral fervour and political conservatism. This last. together with the difficulties his family experienced in the depression of 1819–22, made him an ardent supporter of Henry Clay's protective tariff policies.

After a year and a half as a journeyman printer in New York. Greeley and an associate set up a small printing establishment. In 1834 Greeley became senior editor of a new literary magazine. the *Sew Yorker.* In 1836 he married Mary Youngs Cheney, a strong-minded schoolteacher. The *Sew I'orker* struggled along. never out of debt. through the depression that followed the panic of 1837. Gradually its editor's interest centred on political journalism.

Ardently patriotic. humanitarian in sentiment, but distrustful of radical solutions for the ills of society and disdainful of Jacksonian democracy. Greeley became a liberal Whig. His views, expressed in the *Sew Yorker,* caught the eye of New York state's Whig political boss, Thurlow Weed, who employed him to issue a campaign weekly, the *Jeffersonian,* in 1838, and a similar weekly, the *Log Cabin,* in the presidential campaign of 1840. These publications substantially aided the Whig cause in New York state, and marked the beginning of Greeley's political partnership with Weed and William H. Seward, governor of New York.

Greeley's success with the *Jeffersonian* and the *Log Cabin* encouraged him to a more ambitious newspaper venture. On April

10. 1841. he started the *New York Tribune,* a daily Whig paper dedicated to reform, economic progress and the elevation of the masses. The *Tribune* set a high standard among the papers of its day in news gathering. intellectual interest and moral fervour. It found a good clientele in New York city and a tremendous circulation as a weekly in the hinterland. Its editorial columns became a potent political influence.

For several years Greeley worked closely with Weed and Seward in liberalizing the Whig party in New York state and in exerting an influence upon Whig national politics. He helped make Seward governor in 1838 and played a part in elevating him to the U.S. senate in the winter of 1848–49. He aided Weed in battling for the antirenters, who opposed the perpetual leases that dated back to the colonial period. and against the conservative Whigs. But differences between Greeley and the other members of the triumvirate were always cropping up. They found him obstinate, mercurial and lacking in political sense, this last being especially evident when he was a member of the U.S. house of representatives for a few months in 1848–49. In his turn. he chafed over the political realism that led Weed to champion Gen. Zachary Taylor's nomination for president in 1848, and became increasingly bitter over the failure of his partners to support him for high public office. In 1854 he determined to take an independent course in politics and dissolved the partnership.

The *Tribune* had taken an antislavery stand in the 1840s. but became violent in its opposition to slavery in the next decade. Greeley was dubious about the Compromise of 1850 (*q.v.*), especially its fugitive slave law, but he blew hot and cold on the measure as a whole. The Kansas-Nebraska act of 1854 provoked his bitterest moral condemnation. He took a prominent part in organizing the Republican party in 1854–55, and supported its nominee, John C. Frémont, for president in 1856. He and his paper were now anathema among the slaveholders. He was publicly caned by Congressman Albert Rust of Arkansas in 1856 and threatened with violence if he ever entered the south. He constantly fed the rising antislavery excitement in the north, bitterly attacking the Dred Scott decision of 1857, the slave trade and southern manners and morals.

Greeley helped defeat Seward for the Republican presidential nomination in 1860. This started a feud with Weed that went on for years. The *Tribune*'s editor preferred the conservative Edward Bates of Missouri as a presidential candidate, and had no enthusiasm for Lincoln. He did, however, support the latter in the campaign of 1860.

As secession materialized after Lincoln's election, Greeley's position became obscure. He urged letting "the erring sisters depart in peace," apparently believing that absence of coercion would gain time and best guarantee the maintenance of the Union. His opposition to any compromise with slavery extension remained firm, but his dread of war was obvious.

Greeley pursued an erratic course during the Civil War. He early became convinced that, for military, social and economic reasons, the abolition of slavery was essential, and joined the radicals in urging emancipation. But he also wanted the war brought to a speedy end, and was greatly distressed by Union defeats and the mounting cost of the struggle in lives and treasure. This distress, together with his continued lack of confidence in Lincoln, produced fitful moods of defeatism. At times he was ready to restore the "Union as it was," never more so than in the summer of 1864 when he became involved in sterile peace negotiations with Confederate commissioners in Canada. Greeley opposed Lincoln's renomination in 1864, but as the end of the war came clearly in sight his spirits rose. He looked forward hopefully to the reconstruction of a nation entirely free.

Greeley's motto for reconstruction of the Union was "Universal Amnesty and Impartial Suffrage." This drew fire, for different reasons, both from the radical Republicans and the supporters of Pres. Andrew Johnson. Popular opinion in the North turned against Greeley when he signed the bail bond of Jefferson Davis. This ruined the theretofore large sale of his history of the Civil War, *The American Conflict.*

Greeley's interest in politics and political preferment remained keen after the war was over. Zealous for a large measure of Negro equality. he supported the 14th and 15th amendments and urged the impeachment of President Johnson. Repeatedly he sought state and national office. but was never elected. He supported Grant's campaign for the presidency in 1868. though without enthusiasm. He finally became convinced that Grant's attempt to maintain radical reconstruction in the south was a failure. He was also irritated by the administration's refusal to cut military expenditures and resume the redemption of paper money with gold or silver coin, and felt that Grant was thwarting his ambitions in New York state. Greeley broke away from the Republican party, joined the dissenters known as the Liberal Republicans, and accepted nomination for the presidency by them and by the Democrats in 1872.

In the dreary campaign of 1872 Greeley was so mercilessly attacked that, as he said, he scarcely knew whether he was running for the presidency or the penitentiary. Overwhelmed by the strain of the campaign, exhausted by his vigil at the bedside of his dying wife, harried by his debts and by the decline of his influence in the *Tribune* office, Greeley sank into a deep depression and died Nov. 29, 1872.

Horace Greeley was a strange mixture of liberalism and conservatism. A liberal nationalist, he believed in the inevitability of human progress and in America's leadership in the movement toward human freedom. He was for years an advocate of Fourierism (*see* FOURIER. [FRANÇOIS MARIE] CHARLES) and in the 1840s spent time and money in attempts to establish Utopian socialist communities. He urged a variety of educational reforms, and was an unrelenting foe of liquor: tobacco, gambling, prostitution and capital punishment. Personally generous, he also advocated using the power of government to promote the general welfare. He urged free common-school education and championed producers' co-operatives. He was always sympathetic with European struggles against despotism. On the other hand, his basic tendencies were conservative. He did not trust the wisdom of the proletariat, and had only scorn for such radical reformers as Frances Wright and Robert Dale Owen. Fourierism appealed to him because it mas a reform that promised all things to all men. rich and poor alike. His sympathies inclined more toward capital than toward labour, and he opposed woman suffrage.

Greeley was quick-tempered, and his judgment was often faulty. His desire for public office amounted to an obsession. But he was warmhearted, and his patience with his eccentric wife was exemplary. His clarity of utterance and the fervour of his convictions combined to produce some of the finest editorials in the history of American journalism. He was one of the great moral leaders of the United States and the greatest newspaper editor that has appeared on the American scene.

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(G. G. V. D.)

GREELEY, a city and the seat of Weld county, in northern Colorado, U.S., 53 mi. N.E. of Denver, at an elevation of 4.637 ft.. is the trading centre of an irrigated agricultural region. Production includes sugar beets and livestock, and food processing and canning are the principal industries. The city is the seat of the Colorado State College of Education (established in 1889).

Greeley was founded in 1870 as a co-operative agricultural colony by Nathan C. Meeker (1817–79), agricultural editor of the *New York Tribune,* with the active support of Horace Greeley, after whom it was named. Organized as a joint stock company in New York, the Union Colony purchased land, recruited colonists and transported them to the new settlement. They wrote into the charter and the land deeds a prohibition of intoxicating beverages. The town was organized ,in 1571 and incorporated as a city in 1885. In 1951 the city adopted the council-manager form of government. For comparative population figures *see* table in COLORADO: *Population.* (L. R. HA.)

GREELY, ADOLPHUS WASHINGTON (1844–1935), U.S. soldier, scientist and arctic explorer, was born at Newburyport, Mass., on March 27, 1844. Enlisting as a volunteer in the

Federal army he fought throughout the Civil War, rising from private to the rank of brevet major. After the war he joined the regular army as a lieutenant in the signal service becoming, in 1887, chief signal oflicer with the rank of brigadier general. During the first polar year. 1882–83, he commanded the United States station in Lady Franklin bay. the most northerly station for meteorological and magnetic observations. His party consisted of 24 officers and men of the U.S. army. and the station. Fort Conger. was built in latitude 81" 44' N. In addition to scientific observations, sledging parties reached latitude 83° 24' N. and explored the interior of Ellesmere Island. discovering Lake Hazen and reaching the west coast at Greely fjord. The relief ships failed to reach Fort Conger in 1882 and 1883 so the station was abandoned according to plan in Xug. 1883 and the party moved south, reaching Cape Sabine on Oct. 15. Shelters were improvised and the party faced a winter of 250 days before help could be expected. with rations for only 40 days. When the rescue party reached them on June 22. 1884. there were only seven survivors. Greely returned to army duties and pursued a distinguished career in Alaska, the Philippine Islands and elsewhere. He died on Oct. 20. 1935.

Greely published works on meteorological. electrical and geographical subjects. His main works were *Three Years oj Arctic Service* (1886); *American Weather* (1888); *Handbook of Polar Discoveries,* 3rd ed. (1925); *Handbook of Alaska* (1909); *Reminiscences oj Adventure and Service* (1927); and *The Polar Regions in the Twentieth Century* (1929). (L. M. Fs.)

GREEN, CHARLES (1785–1870), the most famous of Victorian balloonists, was born in London on Jan. 31, 1785. After leaving school. Green joined his father as a fruiterer, but left to take up ballooning as a profession, his first ascent being in 1821; between that date and 1852 he made over 500 ascents. On his first ascent, he introduced coal gas for ballooning as a cheaper substitute for hydrogen, a practice thereafter followed by most areonauts. His most outstanding achievement was the voyage in 1836 from Vauxhall gardens. London. across Europe to Weilburg in Nassau. Ger. Taking Monck Mason and Robert Hollond (who paid for it). Green completed this journey of about 480 mi. nonstop in 18 hours, a long-distance balloon record for trips out of England not beaten until 1907. Green also planned, but never attempted. an Atlantic crossing. The small working model of his proposed balloon. flown in 1840. incorporated the first mechanically driven propeller ever to power an aircraft. He died in London on March 26. 1870. (C. H. G.-S.)

GREEN, DUFF (1791–1875), U.S. political journalist, member of Pres. Andrew Jackson's inner circle of advisers and diplomatic agent. was born in Woodford county. Ky., Aug. 15. 1791. After education at a local academy he taught school, studied medicine and served in the War of 1812. He then became a U.S. government surveyor and mail contractor in Missouri. He studied law in his spare time. entered politics and served in the Missouri constitutional convention of 1819 and later in both houses of the state legislature. In 1823 he purchased the *St. Louis Enquirer* which. under his editorship, supported Andrew Jackson for president the following year.

In 1826 Green moved to Washington, D.C., where he established and edited the *Gnited States Telegraph* as the chief journalistic organ of the Jacksonian Democrats. After Jackson's election as president in 1828 Green was appointed printer to congress and became a member of Jackson's inner circle. the so-called "kitchen cabinet." He exerted considerable influence on the policies of the Jackson administration until he broke with the president in 1831 to support John C. Calhoun. In 1837 and 1838 he edited *The Reformer*, a free trade and state rights paper in Baltimore. Md., and in 1840, as editor of *The Pilot,* he supported the Whig candidates. William Henry Harrison and John Tyler. When Tyler became president after Harrison's death in April 1841 he appointed Green as his unoflicial representative to England where Green was warmly received by the English free traders. His articles in English papers on banking and currency. American business and internal improvements. the Anti-Corn Law league and English interests in Texas were n·idely read.

Green returned home in 1844 and founded and edited *The Republic,* a New York paper that advocated free trade, the building of roads and other internal improvements, civil service and postal reform, and the acquisition of Oregon, Texas and California. Later the same year President Tyler appointed Green as U.S. consul to Galveston, Tex. Green also went to Mexico and reported that that country would not surrender any territory to the United States. His letters concerning English antislavery activities in Texas helped precipitate the movement for the annexation of Texas that led in 1846 to war between the United States and Mexico.

Green had meanwhile become interested in several business enterprises, including coal and iron mines, canals, railroads and telegraph lines. He built a portion of the East Tennessee and Georgia railroad, acquired extensive ironworks in Tennessee and organized several railroads in Georgia. He formulated plans for financing railroad construction through government mail contracts, bonds and land grants. He secured charters for a Southern Pacific railroad and organized the Pennsylvania Fiscal agency, chartered by Pennsylvania in 1859, for constructing the road. but the secession crisis brought the work to a full stop. Though an opponent of secession: Green threw in his lot with the Confederacy and ran his ironworks at Jonesboro, Tenn., under contract with the Confederate government.

Green spent his last years writing books and pamphlets on finance, currency and other economic issues. and in trying unsuccessfully to recover his interests in the Pennsylvania Fiscal agency. The Pennsylvania legislature in 1864 had converted it into the Crédit Xlobilier of America (*q.v.*), which built the Union Pacific railroad. Green died at his home in Dalton, Ga.. on June 10, 1875.

See Fletcher *M*. Green, "Duff Green, Militant Journalist of the Old School," *Am. Hist.* ***Rev.***, vol. lii, pp. 247–264 (1947). (F. M. G.)

GREEN, GEORGE (1793–1841), English mathematician, who made contributions to mathematical physics, was born on July 14, 1793, at Sneinton, near Nottingham. He went into his father's business as a miller and his mathematics were practically self-taught. It was probably for this reason that Green used unusual methods of his own in solving the physical problems in which he was interested. In 1828 he published by subscription. at Nottingham, his *Essay on the Application of Mathematical Analysis to the Theory oj Electricity and Magnetism.* In this memoir he generalized and extended S. D. Poisson's electric and magnetic investigations. He introduced the term "potential," and used what is now known as Green's theorem to investigate its properties in the case of magnetic and electric fields. This memoir was practically unknown until Lord Kelvin had it reprinted in 1846; it was followed in 1832 and 1833 by papers on the laws of equilibrium of fluids, on attractions in n-dimensional space and on the motion of a fluid agitated by vibrations of a solid ellipsoid. At the age of 40 he went to Cambridge where he was fourth wrangler in 1837. He was elected to a fellowship at Caius college in 1839, but poor health compelled him to return to Sneinton, where he died on March 31, 1841.

His collected papers, *The Mathematical Papers of the Late George Green,* were edited by N. M. Ferrers (1871).

GREEN, HENRIETTA HOWLAND (1835–1916), known as Hetty, U.S financier, was born in New Bedford, Mass., Nov. 21, 1835. A fortune had been acquired by her family from shipping and trading interests. Her father, Edward Mott Robinson, and her aunt, Sylvia Ann Howland, both died in 186j and by their mills she received an estate valued at $10,000,000. Her shrewd personal management of her holdings and keen financial ability increased the size of her fortune and for a long period she was reputedly the richest woman in the United States. When she died July 2. 1916, at New York city, her son and daughter received from her an estate exceeding $100,000,000 in value. (H. J. SG.)

GREEN, JOHN RICHARD (1837–1883), English historian, the author of a popular social history of England. He was born at Oxford, Dec. 12, 1837, and educated at Magdalen College school and Jesus college. He took orders on leaving Oxford and in 1865 became the incumbent of St. Philip's, Stepney. His health, however, could not withstand the demands made upon it by this task and when offered the librarianship at Lambeth in

1869, he accepted. He held this post until shortly before he renounced orders in the autumn of 1877. Meanwhile Green had begun to write: between 1867 and 1874 he was a frequent contributor to the *Saturday Review* and from 1869 he was engaged on his *Short History oj the English People* (1874), which was an immediate success. requiring five reprints during 1875, and later expanded into a four-volume work (1877-So). Green was constantly a victim of ill-health and he died at Mentone, March 7, 1883. He had married. in 1877, Alice Stopiord, herself a historian, who was president of the Historical association, 1915–18, and was nominated to the Irish senate in 1922.

Green's reputation as a serious historian has suffered from the very popularity of his *Short History*. This work, which gave a liberal interpretation to the course of English history, and was deliberately written in a vivid and colourful prose style, possessed the inevitable defects of any attempt to compress the history of a nation into a single volume, and does not reveal Green as the careful and scientific historian that he was. In fact, his later books, *The Making* of *England* (1882) and *The Conquest oj England* (1883), mere valuable contributions to historical knowledge and through his friendship with W. Stubbs and E. A. Freeman he shares an interesting place in the development of English historiography.

GREEN, MATTHEW (1696–1737), English poet and author of *The Spleen* (1737; mod. ed. 1936), a gently satirical verse epistle describing "How I do myself demean. In stormy world to live serene." Little is known of him except that he was born and died in London, was a clerk in the customhouse and wrote occasional verse for the entertainment of his friends. *The Spleen* charms by its sincerity. ease and neatness of expression, in particular its apt use of literary allusion, the precision of its metaphors and the skillful handling of the octosyllabic couplet. Addressed to one of his friends, it was printed with a preface by another, and other minor poems were added in later editions. *The Grotto*, Green's only other considerable poem, was privately printed in 1733, and reprinted in *The Spleen and Other Poems,* ed, by R. K. Wood (192j), and in Hugh l'Anson Fausset's *Minor Poets of the 18th Century* (1930).

GREEN, THOMAS HILL (1836–1882), English philosopher. the typical English representative of what was in his time called Neo-Kantianism or Neo-Hegelianism. was born on April 7, 1836. at the rectory of Birkin. Yorkshire. He was educated at Rugby and at Balliol college. Oxford, of which he was. in 1860. elected fellow. His life thenceforth was devoted to teaching in the university: from 1878 until his death (at Oxford on March 26. 1882) he was White's professor of moral philosophy. His lectures form the substance of his two most important works: viz.. the *Prolegomena to Ethics* and the *Lectures on the Principles of Political Obligation,* published posthumously.

English philosophical thought in the third quarter of the 19th century was dominated by the naturalism of Herbert Spencer and by the sensationalism of J. S. Mill. Green reacted unfavourably to both. holding that the former precludes a satisfactory account of human action and the latter a satisfactory account of human knowledge. His metaphysics begins by raising again the question of man's relation to nature. To ask "What is man'" is. he argued, to ask "What is experience?" for experience means that of which I am conscious. The facts of consciousness. which alone we are justified in asserting to exist, are valid evidence for whatever is logically involved in them. Now the chief characteristic of man is *self*-consciousness. The simplest mental act, the act of sense-perception. is never merely a change, physical or psychical. but the consciousness of a change and of a distinction between the self and the object. Knowledge consists. in its simplest equally with its most complex constituents. of the work of the mind. To know is to relate. The assumption of John Locke and David Hume that the work oi the mind is arbitrary because not "given to" man is unjustified by the results oi exact science. with the distinction. universally recognized. which such science draws between truth and ialsehood, between the real and "mere ideas." This (obviously valid) distinction logically involves the consequence that the object of knowledge is an intelligible ideal reality, a system of thought relations. The existence of this ideal whole presupposes a "principle which renders all relations possible and is itself determined by none of them"; an eternal self-consciousness which knows in whole what we know in part. To God the world *is*, to man the world *becomes.*

The business of moral philosophy, according to Green, is to apply to the sphere of social life the results of the metaphysician's investigation into man's nature. The presupposition of ethics is the spiritual nature of man. Self-reflection reveals human capacity, human function. with, consequently. human responsibility. It brings out certain potentialities in the realization of which man's true good must consist. The idea of some "end" or "good," which man presents to himself as desirable for the realization of his true self, constitutes motive; and the determination to realize the seli in some definite way constitutes an "act of will," which is neither arbitrary nor externally determined. The identification of the self with such a motive is a self-determination, which is at once both rational and free. Freedom is not a supposed ability to do anything but the power to identiiy one's self with that true good which reason reveals as *one's* true good. This good consists in the realization of personal character; hence the final good—that is, the moral ideal, as a whole—can be realized only in some society of persons who, while retaining their individuality, find this perfection attainable only when their separate individualities are integrated as part of a social whole. Society is as necessary to form persons as persons are to constitute society.

'There is a natural transition from these ideas to Green's political philosophy. Moral goodness cannot be limited to the cultivation of self-regarding virtues, but consists in the attempt to realize in practice that moral ideal which self-analysis has revealed to us as *our* ideal. From this arises the ground of political obligation: the institutions of political or civic life are the concrete embodiment of our moral ideas and are valuable according as they develop the moral character of individual citizens. It is obvious that the final moral ideal is not realized in actually existing civic institutions; but the same analysis which demonstrates this deficiency points the direction for a true development. Hence arises the conception of rights and duties which ought to be maintained by law, as opposed to those actually maintained, with the further consequence that it may become occasionally a moral duty to rebel against the state in the interest of the state itself; that is, in order better to subserve that function which constitutes the *raison d'être* of the state. The state does not consist in any definite concrete organization formed once for all. It represents a "general will" which is a desire for a common good. Its basis is not an external coercive authority but the spiritual recognition, by the citizens, of that which constitutes their true nature. "Will, not force. is the basis of the state."

Green's teaching was, directly or indirectly, the most potent philosophical influence in England during the later part of the 19th century; the critical side of his work was especially effective. His constructive doctrines, however, though widely accepted at the time of publication, mere presently judged not merely to contain unresolved difficulties but also to be altogether too imprecise in formulation and argument to warrant serious consideration. By 1950 Green's purely philosophical impact was negligible. He retained. however, a considerable reputation in the field of politics. both because of the effects of his own activities in public life. which helped to bring the English universities into closer touch with practical affairs, and because of his efforts to reformulate the doctrines of political liberalism in a way which laid less stress on the negative rights of the individual and more on positive action by the state. His address on "Liberal Legislation and Freedom of Contract" (1881; *Works,* vol. iii) gives early expression to some of the main ideas which underlay the setting up of the 20th-century "welfare state."

Apart from the introduction to his edition of Hume (1874), Green's main works were all published posthumously: *Prolegomena to Ethics* (1883) was followed by the collected *Works,* 3 vol. (1885–88), vol. iii containing an extensive memoir by R. L. Settleship.

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GREEN, VALENTINE (1739–1813), British engraver, was born at Halesowen. He became a pupil of a line engraver at Worcester, and in 1765 he migrated to London and began work as a mezzotint engraver. He became a member of the Incorporated Society of Artists in 1767, and an associate engraver of the Royal Academy in 1775. During his career he produced about 400 plates after portraits by Sir Joshua Reynolds and other British artists, and by many old masters. He was one of the first to apply mezzotint to the translation of pictorial compositions and portraits.

GREEN, WILLIAM (1873–1952), U.S. labour leader, for many years president of the American Federation of Labor, was born March 3, 1873, at Coshocton, O. He was educated in public schools and began as a young man to interest himself in labouring conditions in Ohio coal mines. From 1900 to 1906 he was a subdistrict president of the United Mine Workers of America, and from 1912 to 1924 international secretary-treasurer of that union.

In 1913 he was appointed a member of the executive council of the American Federation of Labor. He was elected president of the A.F. of L. on Dec. 19, 1924, and was thereafter re-elected for many successive terms. After the formation of the Committee for Industrial Organization (later the Congress of Industrial Organizations) in 1935, he fought a bitter duel with John L. Lewis for leadership of U.S. labour. Later the C.I.O. broke away from the A.F. of L., not to be reunited with it until three years after Green's death, which took place on Nov. 21, 1952, at Coshocton, O.

GREENAWAY, KATE (1846–1901), English artist and book illustrator, known for her very original and charming children's books, was born in London March 17, 1846. She began to exhibit drawings in 1868, and her first published illustrations appeared in such magazines as *Little Folks*. In 1879 she produced her first successful book, *Under the Window*.

Then followed *The Birthday Book*, *Mother Goose*, *Little Ann*, and other books for children, which had an enormous success and became very highly valued. "Toy-books" though they were, these little works created a revolution in book illustration; they were praised by John Ruskin (*Art of England* and *Fors Clavigera*), by Ernest Chesneau and Arsène Alexandre in France, by Richard Muther in Germany, and by leading art critics throughout the world. In 1890 Miss Greenaway was elected a member of the Royal Institute of Painters in Water Colours, and in 1891, 1894 and 1898 she exhibited water-colour drawings, including illustrations for her books, at the gallery of the Fine Art society (by which a representative selection was exhibited in 1902). Miss Greenaway's use of the quaint costume of the beginning of the 19th century lent humour to her fancy and so captivated the public taste that it has been said that "Kate Greenaway dressed the children of two continents." From 1883 to 1897, with a break only in 1896, she issued a series of *Kate Greenaway's Almanacs*. Although she illustrated *The Pied Piper of Hamelin* and other works, the artist preferred to provide her own text. She had great charm of character, but was extremely shy of public notice. She died at Hampstead, London, on Nov. 6, 1901.

See M. H. Spielmann and G. S. Layard, *Life of Kate Greenaway* (1905).

GREENBACK PARTY, a minor U.S. political party that flourished during the period 1874 to 1884 following the hard times brought on by the panic of 1873. Initially called the Independent National party, it gave prime emphasis to the idea, expressed in its first platform (1876), that "United States notes, issued directly by the Government and convertible on demand into U.S. obligations (bonds) bearing a rate of interest not exceeding one cent a day on each $100, and exchangeable for U.S. notes at par, will afford the best circulating medium ever devised." Peter Cooper (*q.v.*), its presidential candidate in 1876, received 81,740 popular votes. Two years later the party merged with various labour groups and changed its name to the Greenback Labor party, winning in the congressional election of 1878 more than 1,000,000 votes and electing 14 congressmen. With the prospect of becoming a major party, the Greenbackers in 1880 broadened their appeal and adopted a platform calling, in addition to their money reform, for the abolition of the national banking system, the establishment of an 8-hour day, an end to the "importation of Chinese serfs," the regulation of interstate commerce, the adoption of a graduated income tax, unrestricted suffrage, the curbing of congressional committees and the regulation of "gigantic land, money and railway corporations." Despite this strategy, however, it received only 308,578 votes for its presidential candidate James B. Weaver and elected only eight congressmen. Four years later the Greenbackers and the Anti-Monopolists joined in the short-lived People's party and supported Benjamin F. Butler, who won only 175,370 votes. The Greenback Labor party then disintegrated. Many of its supporters later joined the Populist party.

From a broader perspective the Greenback party reflects, on a smaller scale, the same concern over "honest money" that marked Jacksonian democracy in the 1830s and the Bryan campaign in 1896. (J. A. V.)

GREENBACKS, a popular designation for a form of paper money in the United States, so named from the green colour used on the notes. Greenbacks, or U.S. treasury notes, were first issued in 1862 under authority of the act of Feb. 25, 1862. By this and two later acts of congress the secretary of the treasury was empowered to issue $450,000,000 in noninterest-bearing notes. U.S. notes were also known as "legal tenders" although they were not legal tender for all purposes. In 1870 the U.S. supreme court ruled in the case of *Hepburn* v. *Griswold* that congress had no constitutional authority to make greenbacks legal tender for contracts entered into before the act was passed. This decision was reversed in the Legal Tender cases (*Knox* v. *Lee* and *Parker* v. *Davis*) of 1871 after Pres. Ulysses S. Grant had appointed two new justices to the court.

The issues of greenbacks provided substantial revenue for the national government during the American Civil War, although they rapidly depreciated. The value of the notes in terms of gold declined to an average of 39 cents during July and August 1864, and remained at less than 90 cents until 1876. As the secretary of the treasury gradually accumulated a redemption fund in gold, their value rose in terms of gold. By 1879 greenbacks were made redeemable in gold. The quantity then outstanding amounted to approximately $347,000,000, and since that time the amount outstanding has remained at this figure with minor fluctuations. United States notes were made receivable in payments of customs duties on June 17, 1930, and became full legal tender under the act of May 12, 1933, as amended by public resolution no. 10 of June 5, 1933.

During the latter part of the 19th century, a minor political movement with inflationary aims took the name of Greenback party (*q.v.*) and nominated candidates for president, vice-president and a few other offices.

See W. C. Mitchell, *A History of the Greenbacks* (1903). (A. Kp.)

GREEN BAY, a city and the seat of Brown county, in northeastern Wisconsin, U.S., where the Fox river empties into Green bay, an inlet of Lake Michigan, is 112 mi. N.W. of Milwaukee.

The first European in the area was Jean Nicolet, who arrived from Canada in 1634. Nicolas Perrot began to trade on the site of De Pere in 1668, and Claude Allouez, a Jesuit, founded a mission there in 1669; from that time on white men probably always lived in the vicinity. The French built a fort at the mouth of the river in 1717, and this spot became the heart of a small French-Canadian community that handled furs from a large area until after the War of 1812. Its most distinguished figure was a famous 18th-century Indian fighter, Charles de Langlade. The fur trade finally expired about 1845. (*See* also Wisconsin: *History*.)

An American community began when the U.S. army built Ft. Howard in 1816 within the present limits of Green Bay. The first village plat was laid out in 1829, and Wisconsin's earliest newspaper, the *Green Bay Intelligencer,* appeared in 1833. Later, Brown county came to have large numbers of Germans, Belgians and Dutch. In the period from 1890 to 1910, the population increased from 9,069 to 25,236. It more than doubled in the following years, increasing to 52,735 by 1950; in 1960 it was 62,888. The Green Bay standard metropolitan statistical area (Brown county). pop. (1960) 125,082: includes the city of De Pere, 5 mi. S. of Green Bay, and the towns of Preble (parts of which were annexed to Green Bay in 1941 and 1943) and Allouez.

In the second half of the 20th century Green Bay hnd the largest wholesale distributing business in the state after Milwaukee and Madison. Its harbour received more than 3.000.000 tons of waterborne shipping a year. Its factories produce cheese, beet sugar, wood pulp and paper products, lumber, furniture and machinery. From 1919 the city supported a professional football team: the Green Bay Packers.

At West De Pere the Roman Catholic Order of St. Norbert (the Premonstratensian order) founded St. Norbert's college in 1898. A liberal arts college, it became coeducational in 1952.

(W. F. RY.)

GREENCASTLE, a city of western Indiana, U.S., near the Eel river about halfway between Indianapolis and Terre Haute; the seat of Putnam county. (For comparative population figures *see* table in INDIANA: *Population.*)

The city is in a bluegrass region which makes heavy shipments of grain and livestock. Dairying is also extensively carried on. Industries include lumber, zinc and steel mills and a bottling works. Limestone and other stones are also quarried in the vicinity and there is a large cement plant.

Greencastle was settled about 1820, laid out in 1822 and chartered as a city in 1861. It is the seat of DePauw university, a nonsectarian institution founded in 1837 by Methodists as Indiana Asbury university, after Francis Asbury (1745–1816), first bishop of the Methodist Episcopal Church consecrated in America. It was renamed in 1884 in honour of Washington C. DePauw (1822–87), a glass manufacturer, whose liberal gift of funds in 1883 permitted the university to remain open in a time of financial distress. In addition to the college of liberal arts. which still retains the Asbury name. DePauw has a school of music, founded in 1884, and a school of nursing (1955).

GREEN DRAGON *(Arisaema dracontium)*, a North American plant of the arum family (Araceae), found chiefly in low woods from Maine to Ontario and Minnesota and southward to Florida and Texas. It is a fleshy perennial rising from a cluster of acrid corms and bearing a single large leaf, $\frac{3}{4}$ ft. to 4 ft. long, which is divided into 5 to 17 oblong leaflets, and a single flower stalk (scape) ending in a spadix with a short basal flower-bearing portion and long. slender tip, sometimes 7 in. long. protruding beyond the green. tubular but not hooded ensheathing spathe. The fruit. a cluster of orange-yellow berries. ripens in the autumn. Because of its inconspicuous flowering parts, though abundant in many parts of its range. it is much less known thnn its showy relative. the jack-in-the-pulpit (*q.v.*). *See* ARACEAE; CALLA; GOLDEN CLUB.

GREENE, GEORGE WASHINGTON (1811–1883), U.S. historian. mas born at East Greenwich, R.I., on April 8, 1811, the grandson of Maj. Gen. Nathanael Greene. He entered Brown university, Providence, R.I., in 1824 but left in his junior year because of ill-health. He was in Europe during the next 20 years, except in 1833–34, when he was principal of Kent academy at East Greenwich. and was the U.S. consul in Rome from 1837 to 1845. He was instructor in modern languages at Brown university (1848–52); and in 1871–75 was nonresident lecturer in American history at Cornell university. He died at East Greenwich on Feb. 2, 1883. His works include *Historical View of the American Revolution* (1865); *Life of Nathanael Greene* (1867–71); *The German Element in the War of American Independence* (1876); and a *Short History of Rhode Island* (1877).

GREENE, GRAHAM (1904–). English novelist. journalist and playwright, whose outstanding powers as a storyteller are frequently devoted to the theme of the conflict between good and evil. was born at Berkhamsted, Hertfordshire. on Oct. 2, 1904. and was educated at Berkhamsted school and at Balliol college. Oxford. He became a Roman Catholic in 1926. His first three novels, *The Man Within* (1929), *The Name of Action* (1930) and *Rumour at Nightfall* (1931), showed the influence of Robert Louis Stevenson. Joseph Conrad and Virginia Woolf, but with the "entertainments" *Stamboul Train* (1932) and *Gun for Sale* (1936) and the novels *It's a Battlefield* (1934) and *England Made Me* (1935) he achieved an individual style. The reputation earned with *Brighton Rock* (1938), a study of the corruption of youth, enabled him in *The Power and tlze Glory* (1940), *The Heart of the Matter* (1948) and *The End of the Affair* (1951) to explore more deeply his favourite themes: the hunted man; the superiority of a knowledge of good and evil over a belief in mere right or wrong; and the operation of human and divine love in a fallen world. With *The Quiet American* (1955), a novel of political intrigue in Indochina. and *Our Man in Huvann* (1958), Greene left his familiar religious themes. In conjunction with *The Burnt-Out Case* (1961) he published the notes on a trip to the Congo (1959) from which it was written, entitled *In Search of a Character* (1961). Greene's first drama, *The Living Room* (1953), which uses an Ibsenesque technique of progressive revelation, was an immediate success, as were *The Potting Shed* (1957) and *The Complaisant Lover* (1959). He also published several children's stories (with Dorothy Craigiej, the travel books *Journey Without Maps* (1936) and *Lawless Roads* (1939), and critical essays in *The Lost Childhood* (1951).

GREENE, MAURICE (*c.* 1695–1755), English organist and composer known for his church music. Born in London. he was a chorister at St. Paul's cathedral, becoming organist there in 1718. In 1727 he was organist and composer to the Chapel Royal and in 1730 he mas elected professor of music at Cambridge university. In 1732 he composed what is probably his finest work—the oratorio *The Song of Deborah and Barak* on a text by John Hoadly, hrst published in 1956. In 1735 he became master of the king's Band of Music, cornposing new year and birthday odes, many of which were unfortunately lost. His *Forty Select Anthems* (1743) was long a standard work. Many of them have been republished in the 20th century. In 1750 he began a collection of old English church music that formed the nucleus of *Cathedral Music* published by his pupil William Boyce. He died in London on Dec. 1, 1755. A prolific composer, Greene shows both contrapuntal skill and musical scholarship. Among his instrumental works later republished are harpsichord pieces, orchestral overtures and organ voluntaries.

See R. Graves, "The Forty Anthems of Maurice Greene" in *The Musical Times* (Jan. 1950). (CS. CH.)

GREENE, NATHANAEL (1742–1786), American general, son of a Quaker farmer and smith, was born at Potowomut, in the township of Warwick, R.I., on Aug. 7 (not, as has been stated, June 6), 1742. At Coventry, R.I., where he went in 1770, he was the first to urge the establishment of a public school. In the same year he was chosen a member of the legislature of Rhode Island. to which he was re-elected in 1771, 1772 and 1775. He sympathized strongly with the Whigs and in 1774 joined the local militia. At this time he began to study the art of war. His zeal in attending to military duty led to his expulsion from the Society of Friends.

In 1775, in command of the contingent raised by Rhode Island, he joined the American forces at Cambridge, and on June 22 was appointed a brigadier by Congress. To him Washington assigned the command of the city of Boston after it was evacuated by Howe in March 1776. On Aug. 9, 1776 he was promoted to be one of the four new major generals and was put in command of the Continental troops on Long Island, but severe illness prevented his taking part in the battle of Long Island. Greene was placed in command of Ft. Lee, and on Oct. 25 succeeded Gen. Israel Putnam in command of Ft. Washington. Greene ordered Col. Magaw, who was in immediate command, to defend the place until he should hear from him again. and reinforced it to meet Gen. Howe's attack. Nevertheless, the blame for the losses of Fts. Washington and Lee was put upon Greene. but without his losing the confidence of Washington. who assumed the responsibility. At Trenton Greene commanded one of the two American columns: he commanded the reserve at Brandywine, and was prominent in the battle of Germantown, though his troops arrived late.

At the request of Washington, on March 2, 1778, he accepted the office of quartermaster general (succeeding Thomas Mifflin), and succeeded with it as well as anyone could under the circumstances, meanwhile continuing to command troops in the field. In August he resigned the office of quartermaster general, after a struggle with Congress over the interference in Army Administration by the Treasury board. On Oct. 4 he succeeded Gates as commander-in-chief of the Southern army, and took command at Charlotte, N.C., on Dec. 2. The army was weak and badly equipped and was opposed by a superior force under Cornwallis. Greene decided to divide his own troops, thus forcing the division of the British as well. This strategy led to Gen. Daniel Morgan's victory of Cowpens, S.C., Jan. 17, 1781, and to the battle at Guilford Court House, N.C., March 15, in which after having weakened the British troops by continued movements, Greene was defeated indeed, but only at such cost to the victor that Tarleton called it "the pledge of ultimate defeat." Three days after this battle Cornwallis withdrew toward Wilmington. Greene allowed Cornwallis to march north to Virginia and then turned swiftly to the reconquest of the inner country of South Carolina. This, in spite of a reverse sustained at Lord Rawdon's hands at Hobkirk's Hill (April 25) he achieved by the end of June, the British retiring to the coast. Greene then gave his forces a six weeks' rest, and on Sept. 8, with 2,600 men, engaged the British under Lieut. Col. James Stuart at Eutaw Springs; the battle, although tactically drawn, so weakened the British that they withdrew to Charleston, where Greene penned them during the remaining months of the war. Greene's Southern campaign showed remarkable strategic features that remind one of those of Turenne, the commander whom he had taken as his model in his studies before the war. He excelled in dividing, eluding and tiring his opponent by long marches, and in actual conflict forcing him to pay for a temporary advantage a price that he could not afford.

South Carolina and Georgia voted Greene liberal grants of lands and money. On the Georgia estate, Mulberry Grove, 14m. above Savannah, he settled in 1785, after twice refusing (1781 and 1784) the post of secretary of war, and there he died of sunstroke on June 19, 1786.

BIBLIOGRAPHY.—See the Life of *Nathanael Greene* (1867–71), by his grandson, George W. Greene, and the biography (1893), by Brig. Gen. F. V. Greene, in the "Great Commanders Series." His letters are in the University of Michigan library.

GREENE, ROBERT (1558?–1592), was one of the most popular English prose writers of the later 16th century, Shakespeare's most successful predecessor in romantic comedy, evidently the first writer in England who succeeded. at least for a short time, in deriving a livelihood from his dramatic and prose works, and one of the earliest English autobiographers.

Greene was probably born at Norwich, Norfolk, where he was baptized on July 11, 1558. He matriculated at St. John's college, Cambridge, on Nov. 26, 1575, as a sizar (which shows that his parents were not wealthy), received the B.A. degree in 1578, and became M.A. in 1583 from Clare hall, where he wrote the prefatory epistle to the second part of *Mamillia.* He had evidently begun already to frequent London literary circles, since the first part of *Mamillia* was entered in the Stationers' Register on Oct. 3, 1580. In 1588 Oxford conferred a degree, and thereafter Greene somewhat ostentatiously referred to himself on title pages as "Academiae Utriusque Magister in Artibus." About 1585 or 1586 he married, and had at least one child, but he soon deserted his wife and went to London. With his "jolly long red peake" he swaggered in bohemian society and, according to his own lurid accounts of his behaviour, became an intimate of cutpurses, rascals and prostitutes. Early in Aug. 1592, he tells us, he dined with his friend Thomas Nashe on pickled herring and Rhenish wine, and a month later, on Sept. 3, forsaken by his "quondam acquaintance," he died in London, attended only by a shoemaker and his wife and by his mistress. the sister of a rogue named Cutting Ball and the mother of Fortunatus Greene. On the day before his death he wrote to his "Sweet Wife" asked her to pay the bearer £10: "But for him I had perished in the streetes. Forget and forgive my wronges done unto thee, and Almighty God have mercie on my soule. Farewell till we meet in heaven, for on earth thou shalt never see me more."

Works.—Despite his early death Greene was a prolific writer and composed over 35 works between 1580 and 1592. Nashe observed that "In a night and a day would he have yarkt up a Pamphlet as well as in seaven yeare." Though his facility apparently amazed (and distressed) his contemporaries, it was a prerequisite for a man who expected to obtain an income from publication. Stationers paid small fees for manuscripts, and authors, in the absence of copyright laws, had no control over their books after they were published, profits from subsequent printings accruing to the publishers. A professional author like Greene had to write rapidly and to supply material attractive to the public. Hence, like most popular writers, Greene slavishly followed literary fashions. In his early prose writings he aped John Lyly's *Euphues,* modifying the excesses of the affected style but retaining Lyly's moral platitudes. In the later 1580s, he fashioned prose pastorals after Sir Philip Sidney's *Arcadia;* unrequited lovers penned interminable letters in balanced prose and pretended to dissect the subject of passion, though their comments have an amazingly unreal quality. Structurally these works resembled static operas; instead of conversations there were long speeches or letters (arias), there was little interaction between characters and no psychological reason for their conduct, and charming lyrics, not always organically related to the action, appeared unexpectedly, and give him a reputation also as a poet of metrical inventiveness and verbal felicity. Read aloud, as no doubt they were intended to be read, these pastoral romances were effective; like most Elizabethans, Greene had studied the precepts of classical and Tudor rhetoricians, and he and his audience both delighted in the traditional patterns and figures of speech characteristic of well-designed orations. Of these tales the most readable are *Tullie's Love* (1589), a nonhistorical account of Cicero's love for a woman of the upper class; *Menaphon* (1589), an implausible story of shepherds and shepherdesses, mistaken identities and complications which were suddenly resolved so that everything ended merrily; and *Pandosto* (1588), his finest romance and the direct source of Shakespeare's *A Winter's Tale.*

About 1590, probably because the literary climate had changed, Greene determined to abandon his lovesick heroes and heroines and to compose serious didactic works. In *Greene's Vision,* published after his death but written in 1590, he stated that Chaucer was no longer his guide, but the moral John Gower. Beginning with *Greene's Never Too Late* (1590), he related prodigal son stories, in which a youth invariably flouted the advice of his father, strutted off to sow his wild oats and then returned penitent and humble. Francesco, in *Francisco's Fortunes* (1590), abandoned his wife, succumbed to the lures of the strumpet Infida, who spurned him when he needed money, and eventually fell in with a company of actors who persuaded him to compose plays. That in these works Greene drew on his own experience is evident from two tracts printed posthumously in 1592, *Greenes Groatsworth of Wit, Bought With a Million of Repentance* and *The Repentance of Robert Greene, Maister of Artes.* The former purported to relate the story of Roberto, whose experiences were typical of Greene's other young profligates, but in the middle of his tale Greene suddenly dropped the disguise, "Heere (Gentlemen) breake I off Robertoes speach; whose life in most parts agreeing with mine." Hence the guilt of his characters and their terrors as to their prospects of salvation were his own. For Greene, particularly in his *Repentance,* blackened himself as the worst of sinners and set himself forth as an example to English youth, and particularly to his former acquaintances, Christopher Marlowe, Thomas Nashe and George Peele, who, he averred in *Groatsworth,* were destroying themselves through their immorality and jeopardizing their souls because of their atheism. These autobiographical pamphlets are perhaps Greene's most effective works, for, unlike his fiction, the story of "Robin Greene," who publicly affected bohemianism but inwardly was tormented by an uneasy conscience, is a moving study in pathos.

In the last year of his life Greene wrote a series of exposés of the Elizabethan underworld, beginning with *A Notable Discovery* *of Coosnage* (1591), in which he portrayed the deceptions of conycatchers and petty thieves. Though he asserted that he was serving a lofty patriotic function in rooting out these criminals, most of his material was not original, and the author, despite his protestations, was clearly more intent upon entertaining his readers than in reforming evil. The most successful and amusing of these tracts was *A disputation between a he conycatcher and a she conycatcher* (1592), a discussion between a male and a female thief over their respective merits in duplicity. Another noteworthy pamphlet was *A quip for an upstart Courtier* (1592), which succinctly outlined abuses in approximately 60 Elizabethan trades and professions, and which contained the celebrated attack on Gabriel Harvey and his brothers. John and Richard, probably inserted just before publication at the instigation of Nashe, who was to continue the feud with the Harveys for the next four years. In answering Greene's attack in *Foure letters and certaine sonnets* (1592), Gabriel Harvey, with accuracy but with repellent malice, supplied many details about Greene's death. The *Groatsworth of* Wit also aroused controversy, for not only did Greene urge repentance upon his three friends but also assailed "an upstart Crow, beautified with our feathers, that with his *Tygers hart wrapt in a Players hyde*, supposes he is as well able to bombast out a blanke verse as the best of you; and being an absolute *Johannes fac totum*, is in his omne conceit the onely Shake-scene in a countrey." This first reference in print to Shakespeare has evoked considerable discussion: earlier critics believed that Greene accused Shakespeare of plagiarism in **I** *Henry* VI, in which the italicized quotation appears: scholars were later of the opinion that the passage was a criticism of Shakespeare the actor, who, like many other players, rewrote the dramatist's words.

Greene's theatrical career presents numerous problems; the canon is disputed, the dates of the plays are conjectural, and his role as collaborator is a subject of much inconclusive discussion. One of his earliest plays appears to be *The Comicall Hzstorie of Alphonsus King of Aragon* (written *c.* 1588, publ. 1599), a weak imitation of Marlowe's mighty line. *The Historze of Orlando Furioso* (written *c.* 1591, publ. 1594) was an adaptation of Ariosto's poem. *A Looking Glasse for London and Englande* (written *c.* 1590, publ. 1594), written jointly with Thomas Lodge, aas a dramatic jeremiad to Englishmen, reminiscent of Lodge's *Alarum against Usurers* (1584) and Greene's own prodigal-son stories. *The Honorable Historie of frier Bacon, and frier Bongay* (written *c.* 1591, publ. 1594), though an attempt to vie with Marlowe's *Dr. Faustus*, was the first successful romantic comedy in English; here Greene for the first time realized his comic talent in drama. In *The Scottish Hzstorie of James the fourth* (written *c.* 1591, publ. 1598), probably his last play, Greene made use of one of Geraldi Cinthio's tales but drew upon native fairy lore for Oberon and Bohan, and delineated almost Wordsworthian English maidens in Dorothea and Ida. It was a uorthy forerunner of *As You Like It* and *A Midsummer Night's Dream*. As Marlowe anticipated the tragedies of Shakespeare, so in a lesser way Greene furnished a model in dramatic comedy and romance for the greatest genius of the age.

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GREENER, WILLIAM (1806–1869), English gunmaker and inventor, was born at Felling near Newcastle-on-Tyne in 1806 and began business in Newcastle in 1829. In 1844 he moved to Birmingham. His most important invention, the first expansive rifle bullet, consisted of an oval ball a diameter and a half in length, with a flat end, perforated. in which a cast metallic taper plug was inserted. *(See* AMMUNITION, ARTILLERY.) In 1843 he patented a process aith W. E. Stait for the manufacture of pencils from the hard graphite carbon deposited in the interior of gas retorts. Other valuable inventions followed, the most important being the cap rifle. *(See* SMALL ARMS. THE DEVELOPMENT OF.)

His son William Wellington Greener (1834–1921) invented the treble-wedgefast mechanism of modern shotguns in 1865—perfected in 1873.

GREENFINCH or **GREEN LINNET,** *Chloris chloris,* is a common European bird. The cock, in his plumage of yellowish-green and yellow, is finely coloured but heavily built, and his song is hardly to be commended. The hen is less brightly tinted. The species pervades almost the whole of Europe, and Northern Asia. It extends to Palestine, but is unknown in Egypt. It is. however, abundant in northwest Africa. In America, greenfinch is sometimes applied to the Texas sparrow (*Arremonops rufivirgatus*) of southern Texas and northeastern Mexico. (G. F. Ss.)

GREENHEART, one of the most valuable of timbers, the produce of *Ocotea rodioei,* family Lauraceae, a large tree, native of British Guiana and Surinam. The bark and the fruits of the tree contain bibirine, an antipyretic. Greenheart wood is of a dark green colour, sap wood and heart wood being distinguished only with difficulty. The heart wood is one of the most durable of all timbers, and its value is greatly enhanced by the fact that it is proof against the ravages of many marine borers which rapidly destroy piles and other submerged structures of most other kinds of wood.

Greenheart is one of the strongest of all woods, and has a high density, its specific gravity being about 1150. It is used for keelsons, beams, engine bearers and planking, etc., but its excessive weight makes it unfit for many purposes for which it might otherwise be suitable.

GREENHOUSE, a structure used to grow plants. The simplest greenhouse provides protection only from the extremes of hot and cold, while the greenhouse of the advanced amateur and the commercial grower tends to provide the superior plant environment necessary for the production of fruit, vegetables or flowers of market value.

The first step in obtaining this environment is location. The choice depends upon slope of land, which should be level, and upon convenience to other work areas. The placement of the greenhouse on the lot in relation to the sun is vital. In a properly situated greenhouse the sun follows a uniform path over the plants. Best growing results are obtained when the light is even and shadowless. All trees, buildings and anything else of height should be kept away from the adjacent area.

A year-round source of water for plant care is essential. In some areas it is possible to use lakes or streams; in others well water is the only source. The water must be chemically acceptable to the plants being grown. **A** water sample should be taken and a complete analysis made.

The next consideration is the style of greenhouse structure. The commercial grower uses either the span-type house or a modification called the ridge-and-furrow house. Most commonly used is the span house, in which the sides of the roof are of equal length and both side walls of equal height. The centre or the ridge of the house is generally 15 to 20 ft. high, and the rafters slope down to the sides about 8 ft. above the ground. The ridge-and-furrow house is nothing more than two or more span houses joined at the side wall. This saves money, as there are fewer walls and the heating costs are consequently less than for individual span houses totaling the same growing area. Another style of greenhouse seen in parks and large private estates is the circular conservatory house, which is more ornamental than functional in design.

The wood used in construction must be able to stand high moisture and humidity; some suitable woods are redwood, cedar and cypress. All nails, screws, pipe and other metal parts should be zinc-coated or made of aluminum or some other rust-resistant metal. The choice of glass also is important, as roughly 85% of the average greenhouse is glass. In some areas, because of strong winds, hailstorms or heavy snowfall, it is necessary to use double-weight rather than single-weight glass.

Benches or growing areas for the plants must be provided within the greenhouse. These are usually made of wood with two- or three-foot-wide walks, usually running the length of the greenhouse, between them. Most nurserymen, amateur or professional. try to keep the walk area to a minimum. In bench building, a level growing surface with drainage for excess water must be provided.

The heating system can be either steam or hot water, the choice most often depending on the size of the growing area. Since boilers for steam heat are expensive, the small grower uses the less expensive (initial cost) hot-water system. The pipes carrying steam or hot water are distributed through the house. The amount of piping needed to give an even growing temperature varies according to the climatic conditions.

The last important factor in a greenhouse is ventilation. Openings are usually near the peak of the roof — controlled by mechanical arms for easier opening and closing — or automatically operated by electricity according to temperature fluctuations.

(W. G. Mc.)

GREENLAND, which forms part of the Danish kingdom, is the world's largest island, lying mostly within the Arctic circle. Its area is 840,000 sq.mi.; 708,069 sq.mi. are ice-covered. It is situated between latitudes 59° 46' N. (Cape Farewell) and 83° 39' N. (Cape Morris Jesup) and longitudes 11° 39' W. and 73° 08' W. The extreme length of Greenland is about 1,650 mi. while its extreme breadth, at about 70° N., is nearly 800 mi. In the extreme north it is separated only by a 25-mi. wide strait from Ellesmere Island in the Canadian Arctic archipelago; a suboceanic ridge with soundings not exceeding 600 ft. connects it with North America. Greenland is thus situated on the American continental shelf. Another ridge joins northeast Greenland and Spitsbergen, and the Faeroe-Icelandic ridge unites Greenland with Iceland (across Denmark strait), the Faeroes and Scotland; both these ridges have soundings of about 2,000 ft.

PHYSICAL FEATURES

Geology. — The whole of Greenland is similar to, and probably part of, the Laurentian shield of Canada. It is a mountainous plateau in which Pre-Cambrian rocks predominate, but in the northern half of the island there are considerable areas of younger rocks. The Pre-Cambrian formations are mostly of granite and gneiss and are characterized by metamorphosed sedimentary and volcanic rocks. In the north and northeast there can be traced the continuation of the Caledonian foldings of Europe and Spitsbergen. These caused the high mountains of Peary Land and their westward continuation into Ellesmere Island, and are associated with an overthrust in the Franz Joseph fjord area on the east. Vertical faults, younger than Ordovician: occur in the north and, probably connected with them. are solfataras which are truncated cones of volcanoes without lava. The rocks underlying the solfataras are limestones containing Cambrian trilobites. Volcanic activity and much faulting took place in east Greenland at the close of the Palaeozoic period. In the Caledonian fold zone of the east a trough of Devonian rock was formed in which Old Red Sandstone and conglomerates were deposited. There are extensive Mesozoic sediments in the northeast. At about 70° N. on the east coast the lowest Mesozoic beds are Lower Triassic sandstones and shales, while later Triassic beds occur farther south on the same coast.. Jurassic beds are found only on the east between Jameson Land and Danmark harbour. Cretaceous beds occur on both east and west, but chiefly on the west where coal is found in the Cretaceous sandstones of the eastern edges of Disko Island and the borders of Nugsuakq peninsula. The abundant fossils in those rocks give clear indication of a warm temperate climate persisting until Tertiary times. Tertiary lavas, either surface flows or intrusive sills, are associated on both sides with rocks of that age and cover them in places. The sedimentary Tertiaries are chiefly sandstones with a little coal. Disko Island, Nugsuakq and Svartenhule peninsulas on the west, and Sabine and Kuhn islands and adjacent regions opposite on the east coast are the chief Tertiary basalt areas. The aftereffect of the volcanic activity in Tertiary times can be seen in warm springs in the Scoresby sound area in the east (temperature 140° F.), in the Julianehaab district in the south (104° F.) and in Disko Island 35.6°–64.4° F.).

Numerous raised beaches and terraces, containing shells of marine mollusca, etc., occur along the whole coast of Greenland, and indicate and that this large island has been raised, or the sea has sunk, in postglacial times. Their maximum elevation is about 600 ft. During recent-times Greenland has been sinking. Through exact measuring it was stated that the sinking of the land in proportion to the surface of the sea amounts to 0.4 in. a year at Godhavn. The sinking and rising of the land have made it possible to define several phases of climate in postglacial times: high arctic, arctic, high arctic, arctic, cold temperate, arctic.

Minerals. — The only known commercial source of natural cryolite is at Ivigtut and has been mined by a Danish company since 1865. Iron of meteoric and telluric origin is found on Disko Island, and from it the Eskimos got iron for their weapons. From Cape York R. E. Peary, in 1897, brought to New York city the largest nodule of meteoric origin ever found, weighing 90 tons. Graphite is abundant, particularly near Upernivik, and has occasionally been mined. Coal of poor quality is found in the district around Disko bay and is mined for Greenland's own use. Steatite or soapstone has long been used by the natives for making lamps and vessels. Copper has been observed at several places, but mining will not pay. Lead deposits, estimated at about 1,000,000 tons, were found by L. Koch in the Mesters Vig area on the east coast in 1948.

Natural Regions. — Greenland is divided into two natural regions; the ice sheet, which covers the whole of the middle of the country, and the coastal regions where the mountains rise out of the ice.

The Ice Sheet. — The interior of Greenland is covered by an enormous sheet of ice, burying all valleys and mountains far below its surface. Its area is 708,069 sq.mi., and it is by far the greatest glacier of the northern hemisphere. Occasionally there emerge lofty isolated rocks known as nunataks (an Eskimo word). The ice sheet rises in the interior to a level of about 6,234 ft. (the highest level is 10,302 ft. to the west of Scoresby sound on the east coast) and descends gradually toward the coasts or the bottom of the fjords. The biggest glacier. the Humboldt glacier. more than 62 mi. wide, terminates in the Kane basin on the north coast, rising to a height of 328 ft. **A** transverse section of the surface of the ice sheet from the west to the east coast would show a regular curve, approaching the arc of a wide circle but with greater elevation toward the east and south, where the snowfall is the heaviest. In the middle of Greenland the thickness of the ice sheet is estimated at about 4,593 ft., lying on a ground 3.000 ft. above the sea.

In the interior the surface of the ice is composed of loose dry snow, which never melts, but is transformed to ice by the pressure of the ever-increasing snow masses, which also carry the ice outward to the borders. Some of the snow is carried off the ice by the outward-blowing winds and is piled up in the valleys and on the ice-bare rims of the coasts. Near its margin the ice sheet is broken up by numerous crevasses, some of them being 100 ft. and 150 ft. deep. The steep ice-walls at the edge show a striation, called the blue bands. They are strata of compact, bright and bluish ice, formed from snow which was melted by the heat of friction when the glacier moved forward, and froze to ice.

The ice sheet of Greenland must be considered as a viscous mass which by the vertical pressure in its interior is pressed outward and slowly flows toward the coasts. There the ice converges into the valleys and moves with increasing velocity, in the form of glaciers, into the fjords, where the glaciers partly melt (the melting water running as glacier-rivers into the sea) and partly break off as icebergs. Several explorers — A. Helland (1875), K. J. V. Steenstrup, Captain Hammer (1879–80), Captain Ryder (1886–87), E. von Drygalski (1891–93) and several U.S. and Danish expeditions in later years--examined the velocity of the glaciers. The highest known velocities of glaciers averaged 97 ft. in 24 hr. and, over a shorter period, roo ft. in 24 hr. Both these velocities were measured in the Upernivik glacier (in 73" N.). There is, however, probably a great difference between summer and winter. There seem to be periodical oscillations in the extension of the glaciers and the ice sheet similar to those observed on the glaciers of the Alps and elsewhere. Numerous glacial marks, such as polished striated rocks, moraines, erratic blocks, etc., prove that the whole of Greenland. even the small islands and skerries of the coast, was once covered by the ice sheet. In the years after about

1930 the ice sheet began to recede inland due to a change of climate, and the glaciers were seen to be melting somewhat faster.

Coastal Regions.—The coasts of Greenland are deeply indented with fjords; the coasts of Melville bay and around Northeast Foreland are to some degree exceptions. The complete coastline of Greenland is estimzted at about 25,000 mi. Numerous small islands lie off the coasts. The largest is Disko (3,200 sq.mi.), off the west, at 70° N.

In some parts the interior ice-covering extends down to the outer coast; elsewhere its margin is situated farther inland, and the ice-bare coastland is deeply intersected by fjords extending far into the interior, where they are blocked by enormous glaciers which discharge icebergs into them. The west coast is the most intersected, the largest fjords being Tasermiut, Godthaab fjord, Arfersiorfik, Umanak fjord, Karrats fjord, Southern and Northern Stromfjord; the last of these has a length of 116 mi. The largest systems of fjords, however, are found on the east coast, where the Scoresby sound system has a length of about 185 mi. and a breadth of about 125 mi. Franz Josef fjord with its branch, King Oscar fjord, forms a system of fjords on a similarly huge scale. These fjords are very deep, and soundings indicate that they continue as deep submarine valleys on the coastal shelf. The fjords are drowned valleys caused by erosion and not by tectonic origin.

For 500 mi. down the east coast runs a belt of high mountains, exceeding 7,000 ft. in height; Mt. Gunnbjorn in 69° N. measures 12,300 ft. and is the highest mountain in Greenland. Along the west coast the mountains are not generally quite so high, though even there peaks of 5,000 and 6,000 ft. are not uncommon.

Climate.—Greenland lies north of the 10° isotherm and thus has a polar climate. The weather is uncertain and changes suddenly from bright sunshine to dense fog or heavy falls of snow and icy winds. The July mean at Ivigtut is 49.8' F. and at Thule 40.5° F. The January means are 18.5° F. and —21.1' F. A branch of the Gulf current flows north on the east side of Davis strait and accounts for relatively high temperatures in southwest Greenland. On the east coast temperatures are lower than on the west, for the polar current washes the coast. On the coasts, particularly the southwest, frost is rare in June, July and August, and the summer warmth is appreciable. Rainfall, which is mainly in summer, is heavy in the southwest, but light elsewhere. Snow may fall in any month of the year. In the lofty interior temperatures are always low. The Alfred Wegener expedition (1930–31) measured February mean —52.9' F. and July mean 12.8° F. The minimum temperature in the winter was −85° F. which occurred several times; the maximum temperature in the summer was 26.6' F. These low temperatures are caused by radiation from the snow surface. Over the interior lies a permanent anticyclone which is thought to be the source of many of the weather changes of the northern hemisphere. Cold winds glide outward from the inland ice and, heated by compression and blowing down valleys, sometimes give rise to warm, relatively dry, fohn winds. On the ice sheet, precipitation is slight; it is estimated at 8–10 in. a year. A change of climate set in about 1930, and the temperature of both the air and the sea has risen.

Flora and Fauna.—Of the 390 or so species of vascular plants found in Greenland about 316 probably came from America. About 50 of the rest may have been introduced by the early Norsemen and a few are survivals from the maximum glaciation. As the whole country lies north of the tree line there are no forests. but in the southwest, where the vegetation is less arctic and more abundant, there are groups of willows and birches up to ten feet in height. The birch *Betula nana* reaches its northern limit in Greenland and the mountain ash *Sorbus americana* has much the same distribution. The alder *Alnus crispa* replaces the birch inland, forming scrub more than 3 ft. high in some places. The climax communities are probably ericaceous heath consisting of *Vaccinium uliginosum, Cassiope tetragona, Empetrum nigrum,* andromeda, duarf willows, mosses and other plants. A steppe vegetation, dominated generally by *Carex supina,* is found on some level areas, while on the hillsides moss campion, saxifrages, *Pyrola grandiflora, Dryas integrifolia,* Iceland poppy and many other alpines grow among the lichen-covered rocks. Among the boulders on the beaches *Oxyria,* willow herb and *Cerastium* are found and in the marshy places *Alchemilla,* cotton grass, sedges and equisetums are common.

At Umanak (70° 40' N.) broccoli and radishes grow well; turnips. lettuce and chervil sometimes succeed, but parsley cannot be raised. At Jacobshavn (69° 12' N.), only about 15 mi. from the ice sheet, gardening succeeds well. In the Julianehaab district in the south flowering plants such as aster, nemophila and mignonette are cultivated.

The land mammals of Greenland consist of the musk ox, lemming and ermine in the north and east; reindeer, reintroduced from Scandinavia after being hunted almost to extinction; polar wolf and polar bear; and the arctic fox and arctic hare along most of the coast. The sea mammals—whales and seals—were formerly the chief food of the inhabitants. The six species of seal include *Phoca foetida* and *P. greenlandica,* which are the two commonest, and the walrus. Of the 60 species of birds breeding in Greenland, half are resident throughout the year and half are summer visitors. Of the visitors 60% come from America. Sea birds are very numerous and the northeast of the island is one of the few breeding places of the barnacle goose and the pink-foot goose. Among birds of prey are the white-tailed eagle, the Greenland falcon and the snowy owl, while the commonest land birds are the ptarmigan, snow bunting and raven. Fishing for cod, halibut, *nepisak* and shrimps is important; a shark is taken for the oil from its liver; sea trout and salmon are found in the streams and small lakes of the south. The invertebrates include crustacea, insects, mollusca, annelids and arachnids. In the west mosquitoes are a pest.

In the south a few goats, sheep and cattle have been imported. The dog is the most important domestic animal and is used for hunting and as a draught animal to haul sledges.

HISTORY

The history of Greenland is bound up with the history of arctic exploration. Since the 10th century men have not only settled on the coast but have visited and explored the island in the course of their journeys into the polar regions. It is therefore convenient to treat its history in two sections, one dealing with its discovery and exploration, the other describing its colonization and development.

DISCOVERY AND EXPLORATION

Exploration of the Coasts.—In the beginning of the 10th century the Norwegian Gunnbjorn Ulfsson (son of Ulf Kraka), is reported to have found islands to the west of Iceland. In 982 Eric the Red sailed from Iceland to find Gunnbjorn's land, and spent three years on Greenland's southwestern coasts. On his return in 985 he called the land Greenland in order to make people more willing to go there, and in 986 started again with 25 ships, of which 14 reached Greenland, where a colony was founded on the southwest coast. Communication between the Norse settlements and Norway was broken off in the 15th century, however. In the following century Danish and Norwegian expeditions tried in vain to re-establish the communication, and the rediscovery of Greenland was made by the English navigator Martin Frobisher, who landed on the west coast of Greenland in 1578. Other explorers, including Gaspar Corte-Real had meanwhile seen it, and the work of John Davis (1586–88), Henry Hudson (1610) and William Baffin (1616) afforded further knowledge of the west coast. The east coast was sighted by Hudson in about 73° 30' N. in 1607 and in 1617 by the Dutchman Joris Carolus in about 66° N. During the 17th century the coasts were probably visited by many whalers, who finished the rediscovery of the country's outline.

Exploration was impossible without bases on the coast, and was not started until 1721, when the Danish-Norwegian missionary Hans Egede founded a settlement near Godthaab on the west coast. Egede studied the nature and the people, travelling northward and southward from Godthaab, and in 1752 Peder Olsen Walloe reached a point in 61° N. on the east coast.

In the 19th century scientific exploration was accelerated. The southern west coast was mainly explored by Danes from the

Danish settlements there, but in the northern region of the west coast English and American explorers were leading. John Ross (1818) found the polar Eskimos at Cape York; E. A. Inglefield (1852) sailed into Smith sound; E. K. Kane (1853–55) worked northward through Smith sound into Kane basin, and C. F. Hall (1871) explored Kennedy strait and Robeson channels to the north of this. The first to give more accurate information of the east coast was the Scottish whaler W. Scoresby (1822) who made the first fairly trustworthy map of the coast between 69° and 75° N. Captains E. Sabine and D. Clavering visited this coast in 1823 and met the only Eskimo ever seen in this part of Greenland. The German C. Koldewey expedition reached 77° N. (Cape Bismarck) in 1870, and the duke of Orleans penetrated to about 78° 16' N. in 1905. The rest of the northern east coast was explored by the Danish L. Mylius-Erichsen—J. P. Koch expedition (1906–08), which discovered Northeast Foreland, the easternmost point. E. Mikkelsen (1909–12) mapped those regions. The southern part of the east coast was first explored by the Dane, W. A. Graah (1829–30), and other Danes, G. Holm and T. V. Garde (1883–85) and C. Ryder (1891–92) mapped respectively the coast from Cape Farewell to 65° 16' N. and the Scoresby sound. The Dane G. Amdrup (1899–1900) explored the still unknown coast between Angmagssalik and 69° 10' N., and the Swede A. G. Nathorst (1899) discovered the large King Oscar fjord.

Toward the close of the 19th century several explorers visited north Greenland, including L. A. Beaumont of the Nares expedition (1876); J. B. Lockwood of the Greely expedition (1882); and R. E. Peary on several journeys (1892, 1895 and 1901). *(See* ARCTIC REGIONS.) The Danish exploration of north Greenland began in 1910 with the foundation of the station of Thule in North Star bay (in 76° 32' N.) by K. Rasmussen. It was the base of five Danish expeditions under Rasmussen and L. Koch.

In 1924–34 expeditions under Rasmussen, Koch and Mikkelsen continued researches on the east coast, which was also explored by the English-Danish expedition under A. Courtauld and E. Munck (1935–36) and by E. Knuth's expedition in 1938–39. After World War II Koch and Knuth continued their work on the east coast. Great areas were mapped from aeroplanes.

Exploration of the Ice Cap.—Exploration of the great ice cap, or inland ice, which covers the whole of the interior of Greenland, was attempted in the 18th century, but failed, and so did E. Whymper's and R. Brown's attempt in 1867. Jens Jensen reached, in 1878, the Jensen Nunataks (5,576 ft. above the sea) about 45 mi. from the western margin in 62° 50' N. A. E. Nordenskiold penetrated, in 1883, about 80 mi. inland in 68° 20' N. and two Lapps of his expedition went still farther on skis to about 43° W., at an elevation of 6,600 ft. Peary and C. Maigaard reached in 1886 about 100 mi. inland, a height of 7,500 ft. in 69° 30' N. The Norwegian Fridtjof Nansen, with five companions, in 1888 made the first complete crossing of the inland ice, working from east to west. about 64° 25' N., and reached a height of 8,922 ft. Peary and E. Astrup, in 1892, crossed the northern part of the inland ice between 78° and 82° N. and determined the northern termination of the ice covering. Mylius-Erichsen crossed the northeastern corner of the inland ice in 1907 and E. Mikkelsen in 1910. In 1912 K. Rasmussen and P. Freuchen crossed from Inglefield gulf to Danmark fjord and back and verified that Peary Land is an integral part of Greenland and not, as supposed, separated by a strait. In 1913 the Swiss A. de Quervain, crossed the inland ice from Disco bay to Angmagssalik and J. P. Koch and A. Wegener crossed from Louise Land on the northeast coast to Upernivik on the west coast. The first crossings of the inland ice by aeroplane were made in 1931 by the German W. von Gronau from Scoresby sound to Godthaab and by the American Parker Cramer from Holstenborg to Angmagssalik.

The development of modern air traffic and the fact that Greenland weather is of fundamental importance for predicting conditions on the North Atlantic and in western Europe have meant that since about 1930 weather observations were an important reason for Greenland explorations. In 1930–31 a British expedition under H. G. Watkins made weather observations high on the inland ice 40 mi. north of the arctic circle; at the same time a German expedition under A. Wegener wintered 300 mi. farther north. In 1933 a University of Michigan and Pan American Airways group went up still farther. During World War II Allied military weather stations were at work, and after the war weather stations were to be found from south to the far north.

F. Johnstrup first advocated the foundation of a permanent geological survey of Greenland in 1944. Seven years later, in 1951, Gronlands Geologiske Undersogelse became a permanent institution.

COLONIZATION AND POLITICAL DEVELOPMENT

Early Settlement.—After discovering Greenland in 982, Eric the Red settled just north of the present Julianehaab in 986. Soon two colonies had been formed, Osterbygd in the present district of Julianehaab, and Vesterbygd, farther north, in the present district of Godthaab. At the height of their prosperity the colonists numbered about 3,000 in 280 farms. Numerous ruins indicate the location of these colonies. Somewhat later the colonists met the Eskimo farther north in the neighbourhood of Disko bay, where the Norsemen went to catch seals, walrus, etc. The Eskimo were probably migrating south at that time. Christianity was introduced by Leif Ericsson about 1000, and in 1126 Greenland got its own bishop, who lived at Gardar on Igaliko fjord. There were 12 churches, including a cathedral, a monastery and a nunnery in Osterbygd, and some churches in Vesterbygd.

Greenland was a republic until 1261, when the colonists swore allegiance to the king of Norway, who in return charged himself with supplying them with commodities. In a short time the trade became a Norwegian crown monopoly and was conducted by an annual ship (Knarren). In the 14th century the climate in Greenland deteriorated and this made it difficult to breed cattle, the colonists main livelihood. The colonists thereupon diminished in number and in the 15th century became extinct. The last vessel from Greenland returned to Norway in 1410, but vessels in the Icelandic fish trade may have visited Greenland until the end of that century. Excavations in the Norse burial grounds show 15th-century European influence in the style and texture of the clothes with little or no trace of Eskimo culture; there is no indication of absorption into the Eskimo race or of destruction by Eskimo onslaught. Skeletons which show malformation suggest extermination by excessive intermarriage and adverse conditions of life.

Recolonization.—Norway had been united with Denmark in 1380–81, and in the 16th and 17th centuries the Danish kings several times planned to resume communication with Greenland. The recolonization of Greenland was begun in 1721 with the voyage of the missionary, Hans Egede, to Godthaab. It was Hans Egede's idea that the economic activities of the colony were to be entirely subordinated to his missionary work. This, however, proved impossible, and a few years later the Danish state had to come to his assistance. Later the Greenland trade was assigned to private interests, but in 1774 it was again taken over by the state and was carried on as a government monopoly until 1951, when Greenland was opened to private Danish enterprise, the government-owned Royal Greenland Trading company still continuing its activities. During the period of the government monopoly Denmark aimed to aid the Greenlanders in cultural respects so as to enable them gradually to establish contact with the outside world without becoming subject to exploitation. Consequently Greenland was shut off from free contact with the outside world and all resources were reserved for the Greenlanders who were to sell their surplus production in return for goods required for maintaining and further developing their standard of life. Some aspects of the development may be seen from the following: the population increased from 6,046 persons in 1805 (the first census held in Greenland) to 22,581 in 1950; illiteracy was abolished; all Greenlanders became Christians, their church being Lutheran.

Establishment of Danish **Sovereignty.**—At the dissolution of the union between Norway and Denmark in 1814 Greenland mas retained by Denmark. Until 1916 Denmark's sovereignty extended only over the west coast between Cape Farewell and 74° 30' N. and the one trading station of Angmagssalik on the east coast, founded in 1894. In 1916, however, the United States declared that it had no objection to the extension of Denmark's political and economical interests to the whole of Greenland. Similar declarations were made by other countries including Great Britain, and in 1921 Danish sovereignty was extended to embrace the nhole island, which led to a dispute with Norway regarding hunting and sealing rights in the uncolonized areas of the east coast. In 1931 some Norwegian hunters, on their own initiative, occupied the east coast between 71° N. and 75° N. in the name of the Norwegian king, and after some hesitation the Norwegian government recognized the occupation. Denmark at once summoned Norway into the International Court of Justice at The Hague and in 1933 the occupation was found invalid, the premises stating that Danish sovereignty extended over both the colonized and the uncolonized areas of Greenland. In the meantime another colony had been founded on Scoresby sound on the east coast, and the privately founded colony of Thule in the far north was taken over by the government.

On April 9, 1941, a year after the German occupation of Denmark, Henrik de Kauffmann, Danish minister to the U.S., signed an agreement which made Greenland a temporary protectorate of the United States. Danish sovereignty was recognized, and the arrangement was to last oniy for the war emergency; the United States obtained the right to build bases for aircraft and radio and weather stations, and to "do any and all things necessary" to hold these positions. New York displaced Copenhagen as the key point for export and import arrangements; but local Danish officials and the existing Danish government system continued almost unaltered. Within a few months the United States was at war with Germany and was using Greenland's strategic position and resources. After World War II the communication between Greenland and Denmark was fully resumed but U.S. forces remained in some bases. On April 27, 1951, however, an agreement was signed in Copenhagen between Denmark and the United States for the joint defense of Greenland, concluded within the framework of the North Atlantic Treaty organization and replacing the provisional agreement of April 9, 1941. The naval station at Gronnedal was taken over by Denmark, but the United States and other NATO countries received certain rights of access to the port; defense areas would be established for joint operations by Denmark and the United States, the nationality of the commander being decided upon periodically by agreement. In the areas under U.S. command the United States would enjoy certain rights of use without impairing Danish sovereignty; all defense areas could be used by the ships, aircraft or armed forces of other NATO countries; U.S. forces in Greenland would respect Danish laws and administration concerning the indigenous population. In accordance with this agreement the United States, in 1951, started the establishment of a great air base at Thule in northwest Greenland. After World War II several measures were taken by the Danish government to modernize Greenland's political, social and economic life in accordance with the Greenlanders' desires and the necessity of bringing their way of life to conformity with the new epoch which had come to Greenland as a consequence of modern air strategy and air communications.

GOVERNMENT

Administration. — By an amendment to the Danish constitution (June 5, 19j3) the colonial status of Greenland was abolished. Greenland became an integral part of the kingdom of Denmark, and its inhabitants now enjoy equal political rights with all other Danish nationals. Greenland is divided into two constituencies and is represented in the Danish parliament by two members, elected by men and women who are Danish subjects — both Greenlanders and Danes living in Greenland — and are 23 or more years of age.

The administration of Greenland comes under the Danish prime minister's department, represented in Greenland by a governor *(landshovdingen)*.

For administrative purposes Greenland is divided into western, eastern and northern Greenland. Eastern and northern Greenland are under the direct administration of the prime minister's department, but councils elected by the Greenlanders perform the administrative work in western Greenland. These councils are: the Greenland council *(landsraadet)* with the governor as president; and the Greenland local councils. All government bills containing provisions solely applying to Greenland must. before submission in the Danish parliament, be placed before the Greenland council.

The right to vote at elections of councillors both to the Greenland council and to local councils is given to all who have the right to vote at parliamentary elections. Import duties procure funds required for the work assigned to the Greenland council and to the local councils.

SOCIAL AND ECONOMIC CONDITIONS

Population. — Probably in the 8th century the Eskimo immigrated to Greenland from the Canadian archipelago and then moved southward along the west coast during the Norse settlement and reached the east coast around Cape Farewell, the route by the north coast being almost impassable because of the lack of hunting grounds. The northernmost Eskimo settlement on the east coast in the Franz Josef fjord area was abandoned in the 19th century; there are only two colonies on the east coast, Angmagssalik and Scoresbysund, the latter having been founded in the 20th century. Most Eskimos live on the west coast; all have some Danish blood and are called Greenlanders. So also are the Eskimos on the east coast and in the far north; but in the far north one may still meet the pure Eskimo race. For an account of their customs and culture, *see* the article ESKIMOS. Both Danish and the Eskimo language are spoken.

From the beginning of the Danish colonization in 1721 until 1951 Greenland was closed territory, the only Danes there being officials and a very few private citizens. From 1951 Greenland mas opened to Danish subjects, and a number of Faroese and a few Danish fishermen settled there. Immigration presents great difficulties, however, due, *inter alia,* to a shortage of housing.

The native population of Greenland on Dec. 31, 1950, numbered 22,581, of whom 20,754 lived on the west coast, 1,489 on the east coast and 338 at Thule. At the same date there were 1,061 Danes in Greenland. The average birth rate during the period 1945–49 was 41.g; the average mortality rate was 25.5.

Religion, Education, Communications. — For ecclesiastical purposes Greenland is reckoned in the province of the bishop of Copenhagen. All settlements have schools, generally under native teachers, of whom there are more than 200. In 1951 there were 3 kindergartens, 163 primary schools with 4,156 pupils, 3 postprimary schools with 71 pupils, 1 secondary school with 13 students, 1 seminary with 9 students, 4 technical schools with 43 pupils, 1 commercial school with 15 pupils and 15 evening schools with 500 students. In 1951, 244 young Greenlanders mere undergoing training in Denmark. In 1951 there was a radio station at Godthaab, 12 movie theatres, a duplicated daily newspaper at Godthaab and a printed weekly newspaper, edited by a Greenlander and a Dane and published by the Greenland council and the Greenland department.

Social Services. — Greenland has a free health service, paid for by the Danish government and run mainly by doctors and nurses trained in Denmark. There are 17 medical stations with hospitals or infirmaries and 3 childrens' sanatoria. The commonest disease is tuberculosis against which a crusade was launched in 1953.

There is an old-age pension scheme for those over 55 who are no longer capable of supporting themselves and their families, and schemes for the care of children and for public relief. These are paid for and administered by the Greenlanders themselves.

Agriculture, Industry and Trade.—The original main trade of Greenland was hunting, especially seal hunting. After World War I seal hunting was, however, greatly reduced,, partly because of the change in climate and partly because of overintensive hunting. The change in climate at the same time created suitable conditions for fishing, particularly for cod which became the main trade oi Greenland. This change in the structure of Greenland's trades from hunting and domestic economy to fishery with a view to exports and the consequent introduction of a monetary economy has affected the traditional mode of habitation. Instead of living in scattered settlements, the people have tended to gather together into places where there are good harbours, repair shops, facilities for the purchase of goods and opportunities ior the sale of fish, and fish stores and canneries. This has meant that bigger towns have grown up and has given greater opportunities for building better houses, so that wooden houses have replaced the old-fashioned mud and snow cabins.

Although fishing has become the main trade, hunting is still important. In 1951–52, 11,000 sealskins, 6,000 fox furs, zoo walrus hides, roo polar bear pelts, 103,000 wolf-fish skins and 77 metric tons of eiderdown and feathers were exported. The export of fish products numbered 6,765 metric tons of salted and dried fish, 970 metric tons of blubber,. 390 metric tons of shark's liver, 458 metric tons of cod liver, 12 metric tons of medicinal cod-liver oil, 7 metric tons of sperm oil, 152 bbl. of salted sea trout, 497 bbl. of salted halibut and 150,000 tins of canned shrimps. There are 3 canneries, a deep-freezing plant and 82 fishery stations, where the codfish is made into salted fish. The Greenland fishermen numbered 2,200 with 406 motor boats in 1951.

Only a few stretches of land on the southwest coast can be utilized for sheep farming, cattle farming on a small scale and other animal husbandry of secondary importance. Grass is grown and dried for winter feed, and most sheep farmers grow vegetables for their own consumption. The stock of sheep numbered, in 1951, 14,000; there also were 7j Iceland horses, 40 goats, about 50 head of meat cattle and about 2,000 hens. In 1952, 300 tame reindeer were transported from Norway to Greenland to start reindeer husbandry.

Mining operations are carried on at Qutdligssat (coal) and Ivigtut (cryolite). In 1950–51 the output of the coal quarry amounted to 5,566 metric tons. At the cryolite quarry 110,000 metric tôns were produced, half of which went to Denmark and most of the rest to the United States. For mining of the lead deposits discovered in cast Greenland, a Dano-Swedish-Canadian company, Det Nordiske Mineselskab A/S (Nordic Mining Co., Ltd.) was set up in 1952, 55% of the share capital being in Danish hands. Greenland's first power plants began operations in 1949 and in 1952 seven diesel plants were operating, supplying about 1,600,000 kw.hr. a year.

In 1951 the government trading monopoly, administered in Copenhagen by a government board, was abolished, and so was the previous price policy. Previously several goods (for instance, certain foodstuffs and implements) were sold to the Greenland population at prices lower than the actual cost prices, whereas the prices paid to the Greenlanders for their products in periods of boom were somewhat lower than prices in the open world market. After 1951 the price level was adjusted to the world market level. This would encourage Greenland trade. To counteract the detrimental effect of a drop in prices of Greenland products, a Greenland Price Equalization fund was established. A Greenland Trade Loan fund was also established to promote Greenland trade and industry and increase exports by loans or subsidies to individuals or companies. Ships of all nations were to be allowed to call at Greenland. The right to fish in Greenland territorial waters was, however, still reserved for persons residing in Greenland and Danish subjects who had received special permission. In 1951 about 200 fishing vessels of Danish or Faroese nationality called at the fishery harbour Faringehavn. Four Danish commercial companies and one Faroese carried out trade in addition to the Royal Greenland Trading company of the previous government monopoly, which continued its trade in competition with the privately owned companies.

The value of goods imported into Greenland in 1951–52 amounted to 36,000,000 Kr.; the value of goods exported from Greenland in the same period was 49,475,989 Kr.

Finance. — Before World War II the Danish state had an annual deficit of about 1,000,000 Kr. on the administration of Greenland. After the war the deficit increased because of modernization programs a: it amounted in 1951–52 t 32,500,000 Kr., revenue being 22,300,000 Kr. .d expenditure 54,800,000 Kr. The budget ior 1953 estimated revenue at 32,271,000 Kr., expenditure at 44,779,200 Kr.

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GREENLEAF, SIMON (1783–1853) U.S. legal educator, whose principal work, a *Treatise on the Law of Evidence* (3 vol., 1842–53) became a classic, was born at Newburyport, Mass., Dec. 5, 1783. He was educated at the Latin school there, read law with Ezekiel Whitman, and was admitted to the bar in 1806. The first reporter of the supreme court of Maine (1820), he was appointed Royall professor at the Harvard law school in 1833, succeeding Joseph Story (*q.v.*) as Dane professor of law and head of the school in 1846. The 16th edition of his *Treatise* (vol. 1) was prepared by John Henry Wigmore, who was thus led to his own monumental work in evidence.

Greenleaf, a noted practising lawyer, also wrote *A Collection of Cases Overruled, Denied, Doubted or Limited in Their Application* (1821) and *Examination of the Testimony of the Four Evangelists* (1846). He drafted the original constitution of the Independent Republic of Liberia. He died on Oct. 6, 1853, in Cambridge. Mass. (A. L. LN.)

GREEN MONKEY, a west African representative of the guenons, technically known as *Cercopithecus aethiops sabacus*. It is olive green above, with white whiskers and yellow tail.

GREEN MOUNTAINS are a part of the Appalachian system of North America extending from the Massachusetts border northward through the centre of the state of Vermont to the Canadian line. For two-thirds of the length of the state the range is only slightly broken, forming a water-parting between the streams which flow west or northwest into Lake Champlain or the Hudson river and those flowing southeast into the Connecticut river; but farther north the range is cut deep by the valleys of the Winooski and Lamoille rivers. The ranges, about 30 mi. wide in southern Vermont, narrow down to 1 mi. wide at Mount Mansfield and broaden again to the north. The crest line is generally more than 2,000 ft.; 32 summits are more than 3,000 ft.; and the following peaks exceed 4,000 ft.: Mt. Mansfield 4.393 ft., Killington peak 4,241 ft., Lincoln 4,013 ft. and Camel's Hump 4,083 ft. Smuggler's Notch, just north of Mt. Mansfield, is one of Vermont's wonders. There is a rocky wooded canyon with walls of solid rock on either side rising almost perpendicularly 1,000 ft. or more; the massive chin of Mt. Mansfield towers majestically 3,000 ft. above. The entire range, except four of the highest peaks, is heavily wooded with spruce, maple, beech and birch; a fact which probably suggested the name.

The region is made accessible to tourists by railways, highways, and within the mountains, by the "Long Trail" of the Green Mountain club which traverses the entire length of the range.

See W. C. O'Kane, *Trails and Summits of the Green Mountains* (1926); *Guide Book of the Long Trail*, 10th ed. (1935); and T. W. Dale in the *Annual Report of the U.S. Geological Survey* (1894–95).

GREENOCK, large and parliamentary burgh and seaport, Renfrewshire, Scotland. on the south shore of the Firth of Clyde, 23 mi. W.N.W. of Glasgow by road or rail, 21 mi. by the river and firth. Pop. (1961) 74,578. The town has a water frontage of nearly 4 mi. and rises gradually to the hills behind, in which are situated, about 2 mi. distant, Loch Thom and Gryfe reservoir, sources of the town's water supply. The older streets and buildings are on the comparatively level tract beside the firth. At the west end a fine esplanade extends from Princes pier to Fort Matilda, on the boundary between Greenock and Gourock. Shipyards stretch to Port Glasgow, 3 mi. E. At Greenock is the well-known anchorage, "the Tail of the Bank."

Public buildings include the municipal buildings; the McLean museum containing paintings by Sir James Guthrie, who was born in Greenock in 1859, and other artists; the custom house on the old steamboat quay; the sheriff courthouse; and the' Watt institution founded in 1837 by a son of the famous engineer James Watt, who was born in Greenock in 1736. The Watt institution buildings house the Watt scientific library and the Greenock library. The Watt Memorial School of Engineering, Navigation, Radio and

Radar stands on the site of the inventor's birthplace. The old North Kirk (1591), with its pre-Raphaelite windows, was moved to Seafield in connection with a proposed extension of the shipyards. A large cemetery in the southwestern district contains the tomb of Burns's "Highland Mary" removed in 1920 from the North Kirk graveyard. Parks and open spaces include Wellington park, Well park in the heart of the town, Whin hill and Lady Alice and Lady Octavia parks.

Greenock is under a town council consisting of 27 members including provost, bailies and councillors. There is a resident sheriff-substitute. It is a parliamentary burgh, represented by one member. The staple industries are shipbuilding, engineering, sugar refining (1765), worsted and woollen manufacturing and production of aluminum ware.

Greenock-built vessels have always been esteemed, and many warships and passenger liners have been constructed in the yards. Other industries include the manufacture of engines, marine and otherwise; the making of sailcloth, ropes, casks and barrels; and tin-printing. Ships and machinery are the chief exports and sugar the chief import. The first harbour (finished in 1710) has been periodically added to and improved and there are seven tidal harbours, Garvel graving dock and other dry docks, and the James Watt dock, the entrances to which are closed by caissons to keep in 30 ft. of water at low tide. The quay walls are more than 3 mi. in length.

In the early 17th century Greenock was a fishing village of one row of thatched cottages. In 1635 it was erected by Charles I into a burgh of barony under a charter granted to John Shaw, the government being administered by a baron-bailie, or magistrate, appointed by the superior. Its commercial prosperity received great impetus from the treaty of Union (1707), under which trade with America and the West Indies rapidly developed. The American Revolution suspended progress for a brief period, but revival set in in 1783 and within the following seven years shipping trebled in amount. Meanwhile Sir John Shaw by charter (dated 1741 and 1751) had empowered the householders to elect a council of nine members, which proved to be the most liberal constitution of any Scots burgh prior to the Reform act of 1832, when Greenock was raised to the status of a parliamentary burgh with the right to return one member to parliament. The town was considerably damaged by air action during World War II. On Lyle road above the town a cross of Lorraine and anchor commemorates the French sailors who lost their lives in the battle of the Atlantic.

GREENOUGH, HORATIO (1805–1852), U.S. sculptor, critic and author, was born in Boston, Mass., on Sept. 6, 1805. As a youth he was encouraged t~ study art by his family and by the painter Washington Allston. In 1824, on graduating from Harvard, he went to Italy for two years of study, and after returning to Boston he went again to Italy in 1829 to remain there until his final return to the U.S. in 1851. His principal works as a sculptor are both in Washington, D.C.: the statue of George Washington, designed to be placed in the rotunda of the U.S. capitol (now in the Smithsonian institution), and the group called "The Rescue," placed at the east entrance of the capitol. Greenough was the first American to receive an important commission for sculpture from the U.S. government and the first American sculptor of his time to go to Italy to study sculpture.

Greenough's principal importance today rests almost entirely upon his few brief essays on art because in them he outlined the basic ideas of the theory of functionalism which has had so much influence, especially on modern architecture. These essays were originally printed in 1852 in Greenough's book, *Travels, Observations and Experiences of a Yankee Stonecutter.* In 1947 they were reprinted with the title *Form and Function.* Greenough died in Somerville, Mass., on Dec. 18. 1852.

His younger brother, RICHARD SALTONSTALL GREENOUGH (1819–1904), was also a sculptor. His most famous work is the statue of Benjamin Franklin in Boston.

See Charles R. Metzger, *Emerson and Greenough* (1954); Albert T. E. Gardner, *Yankee Stonrcutters* (1945). (A. T. G.)

GREEN RIBBON CLUB, THE, had its meeting-place at the King's Head tavern in Chancery lane, and was originally known as the "King's Head club." Founded about the year 1675 as a resort for members of the political party hostile to the court, the name was changed about 1679 to the Green Ribbon club, in reference to the bow or "bob" of green ribbon which the members were in the habit of wearing in their hats, as a badge convenient for mutual recognition in street brawls. The president was either Lord Shaftesbury or Sir Robert Peyton, M.P. for Middlesex, who afterwards turned informer. Roger North tells us that "they admitted all strangers that were confidingly introduced, for it was a main end of their institutions to make proselytes, especially of the raw estated youth newly come to town." Thomas Dangerfield (*q.v.*) supplied the court with a list of 48 members of the Green Ribbon club in 1679; and although Dangerfield's numerous perjuries invalidate his unsupported evidence, it receives some confirmation from a list given to James II by Nathan Wade in 1685 (Harleian mss. 6845), while a number of more eminent personages are mentioned in *The* Cabal, a satire published in 1680, as also frequenting the club. Among those who appear to have been members are the duke of Monmouth, Halifax, Shaftesbury, Buckingham, Macclesfield, Cavendish, Bedford, Herbert of Cherbury; Scroop, Mulgrave and Shadwell; Falconbridge, Henry Ireton and Claypole; and rogues of the type of Dangerfield and Oates. An allusion to Dangerfield, notorious among his other crimes and treacheries for a seditious paper found in a meal-tub, is found in connection with the club in *The Loyal Subjects' Litany,* in which occur the lines—

From the dark-lanthorn Plot, and the Green Ribbon Club
From brewing sedition in a sanctified Tub,
Libera nos, Domine.

The genius of Shaftesbury found in the Green Ribbon club the means of constructing the first systematized political organization in England. North relates that "every post conveyed the news and tales legitimated there, as also the malign constructions of all the good actions of the government, especially to places where elections were depending, to shape men's characters into fit qualifications to be chosen or rejected." The club was responsible for promoting the Exclusion bill; and the popish plot was deliberately stimulated by members who went about in silk armour, supposed to be bullet proof, and carrying in their pockets the weapon of offence invented by Stephen College and known as the "Protestant flail." In the general election of Jan. and Feb. 1679, the Whig interest throughout the country was managed and controlled by a committee sitting at the club in Chancery lane; and the agitation of the petitioners in 1679 was engineered there. The petitions were prepared in London and sent down to every part of the country, where paid canvassers took them from house to house collecting signatures with an air of authority that made refusal difficult. The great "pope-burning" processions in 1680 and 1681. on the anniversary of Queen Elizabeth's accession, were also organized by the club. They ended by the lighting of a huge bonfire in front of the club windows; and, as they proved an effective means of inflaming the religious passions of the populace, it was at the Green Ribbon club that the *mobile vulgus* first received the nickname of "the mob." The activity of the club was, however, short-lived. The fiasco of the Exclusion bill damaged its influence, and after the flight of Shaftesbury, the confiscation of the City of London's charter, and the discovery of the Rye House plot. in which many of its members were implicated, it declined rapidly. In 1685 John Ayloffe, who was found to have been "a clubber at the King's Head tavern and a green-ribbon man," was executed in front of the premises on the spot where the "pope-burning" bonfires had been kindled; and although the tavern was still in existence in the time of Queen Anne, the club which made it famous did not survive the accession of James II. The precise situation of the King's Head tavern, described by North as "over against the Inner Temple gate," was at the corner of Fleet street and Chancery lane, on the east side of the latter thoroughfare.

See Roger North, *Examen* (1740); Anchitell Grey, *Debates of the House of Commons, 1667–84*, vol. viii (1769); Sir John Bramston, *Autobiography* (1845); Sir George Sitwell, *The First Whig* (Scarborough, 1894).

GREEN RIVER, the name of several U.S. rivers.

The GREEN RIVER, rising in the Wind River range of west-central Wyoming, flows southward until forced to detour around the bulk of the Uinta range into northwestern Colorado. There the Green enters Flaming gorge on the northern flank of the Uintas and continues into the Canyon of Ladore where it cuts through ancient red quartzites in the eastern edge of the Uinta uplift before it receives the Yampa in Pat's Hole (Echo park), Colorado. Leaving the Uintas at Split Mountain gorge in Dinosaur National monument, Utah, the Green continues southward through deep canyons cut into the Colorado plateau. It enters the Colorado river south of Moab, Utah, at Deadhorse Point.

Because of the youthful nature of the narrow, steep-walled canyons, there are only limited areas of extensive flood plains that can be developed through irrigation along the river itself. Within the 45,000 sq.mi. drainage basin of the Green, however, more than 500,000 ac. were under irrigation before the completion of the dam across the Flaming Gorge canyon. The Green supplies about 45% of the total water of the Colorado at the confluence of the two rivers, flowing about 4.793.000 ac.ft. per year, but is navigable only by special shallow-draft river boats and then only at high water.

The GREEK RIVER. which rises near Kings Mountain in central Kentucky. flows for 360 mi. generally westward through a well-defined gorge, then northwestward to the Ohio, which it enters just above Evansville, Ind. It receives the waters of Echo river, which flows underground through Mammoth cave. and drains numerous other underground caverns. Deepening of the channel of the Green to nine feet, dams and locks below Mining City dam allow small river boats to navigate a total of 200 mi. of the lower course through the western coal fields.

The GREEN RIVER, which rises in Lee county in north-central Illinois, enters Rock river east of Moline. Much of its broad, flat valley is swampy or artificially drained. Silted and sluggish, it is avoided by the Illinois-Mississippi barge canal, which parallels it for about 15 mi.

There are also two smaller Green rivers, one rising in the Cascade range of Washington and the other in the Green mountains of Vermont. (C. N. C.)

GREENSAND. A geological term having a double significance. Among the sedimentary rocks it is used to indicate a sand or sandstone with abundant grains of glauconite (*q.v.*). Greensand is mined in Maryland and New Jersey. It is used primarily as a water softening agent and finds some use as a soil conditioner and as a source of potassium.

Stratigraphically the name is used for several subdivisions of the Cretaceous system in England.

GREENSBORO, a city in the heart of the Piedmont region in north central North Carolina, U.S., is 75 mi. N.W. of Raleigh. Established in 1808 as the seat of Guilford county. it was named for Gen. Nathanael Greene, commander of American Revolutionary forces at the battle of Guilford Court House. Fought in hlarch 1781 near the city, the battle is commemorated there by a national military park.

The early settlers of Greensboro included Scottish Presbyterians from northern Ireland, German Calvinists and Lutherans and English Quakers. The population, which increased from 3.317 in 1890 to 10,035 by 1900. was 19,861 in 1920, 53,569 in 1930 and 74,389 in 1950. In 1960 it was 119.574. The population of the Greensboro-High Point standard metropolitan statistical area (Guilford county) was 246,520 in 1960. (For comparative population figures see table in NORTH CAROLINA: *Population.*)

Greensboro was chartered as a city in 1870 and in 1921 adopted council-manager government.

The city became an agricultural and trading centre and an important insurance headquarters; it is also a large wholesale distributing point and an industrial nucleus with more than 250 active plants, producing over 130 manufactured products in the second half of the 20th century.

Institutions of higher education in Greensboro include the Agricultural and Technical College of North Carolina, established in 1891 as a coeducational land-grant college for Negroes; Bennett college, a liberal arts school for women, founded in 1873 by the Methodist Episcopal Church as a coeducational school below college level and reorganized in 1926 as a Negro woman's college; Greensboro college, chartered in 1838 as a woman's college, opened in 1846 and coeducational from 1956; Greensboro division of Guilford college, a coeducational community institution, chartered in 1948 as the Greensboro Evening college but merged in 1953 with Guilford college, which borders Greensboro's city limits; Immanuel Lutheran college for Negroes (founded in 1903 and moved to Greensboro in 1905); and the woman's college of the University of North Carolina, a liberal arts school originally chartered in 1891. Bennett and Greensboro colleges each enrolled about 500 students; the Greensboro division of Guilford college, over 1,000; the Immanuel Lutheran college about 100; and the Agricultural and Technical college and the woman's college of the state university, each more than 2,600. William S. Porter (O. Henry) (1862–1910) was born in Greensboro. (E. S. AR.)

GREENSBURG, a city of southwestern Pennsylvania. U.S., and the seat of Westmoreland county since 1785, 27 mi. S.E. of Pittsburgh. was named for the American Revolutionary War general Nathanael Greene. It is within an area abounding in natural gas and bituminous coal; its inhabitants are employed largely in industries producing coke, brick, automobile tires, plumbers' supplies and steam fittings.

The first court to convene west of the Alleghenies opened in the nearby village of Hannastown in 1773. When a Seneca Indian raid destroyed that village the county government was moved to Greensburg. Within three miles of the route taken by the army of General Forbes in its march to Fort Duquesne in 1758 and on the Pennsylvania state road opened in 1784, the city from its earliest years was near Pennsylvania's major east-west transportation arteries. In 1852 the railroad reached the city. It was incorporated as a borough in 1799 and became a city in 1928. For comparative population figures see table in PENNSYLVANIA: *Population.*

Seton Hill college (a Roman Catholic school for women) was founded there in 1883 and became a four-year college in 1918. (J. A. RE.)

GREENSHANK (*Tringa* nebularia), one of the largest of the sandpipers. The long olive-coloured legs of this species distinguish it from two allied species (*T. totanus* and T. erythropus) having red legs and called redshanks. The greenshank is a native of the northern parts of the old world. but in winter it wanders far to the south from South Africa to Australia. Almost as bulky as a woodcock, it is of a more slender build. It breeds in Scotland, Norway, Sweden and Finland, and then to Kamchatka. The name is also used for the little greenshank (T. stagnatilis), of southern Russia to northern Mongolia, rather like the lesser yellowlegs (T. *flavipes*) of Canada. See REDSHAKK.

GREENSTONE, in geology, term used by many of the earlier writers to indicate fine-grained dark-coloured and often considerably decomposed and altered basic igneous rocks, either intrusive or extrusive. It is still—like "felsite" (*q.v.*)—a useful word in descriptive field geology. since it indicates the appearance and general character of the rock, but does not imply anything definite as to its exact nature and composition, which may be determined later by laboratory methods. For discussion of the latter, see PETROLOGY: *Methods of Investigation.*

GREENVILLE, largest city in the delta of the Yazoo and Mississippi rivers. in western Mississippi, U.S., is the most important port on the west side of the Mississippi river between Memphis, Tenn., and Vicksburg, Miss. (95 mi. S.). There is a $6,000,000 bridge across the Mississippi at Greenville. Old Greenville, an extinct town formerly south of the present city, became the seat of Washington county in 1827. Part of the old settlement caved into the river and the remainder of the town was burned by Federal troops during the American Civil War. During Reconstruction the new town was established at its present site, which was formerly Blantonia plantation; thereafter it was the county seat. The original incorporation of the town occurred in 1870; its charter as a city dates from 1886.

Greenville is surrounded by rich agricultural delta land which produces the bulk of the world's long staple cotton. Diversification brought substantial production of corn, oats, rice, soybeans and alfalfa, and there are herds of beef cattle and hogs. Principal manufacturing industries include agricultural chemicals, rugs, woodworking and metal products.

Like the entire delta area along the Mississippi river, the city is protected by huge levees. In 1927 a break in the levee north of Washington county inundated a 7,500-sq.mi. area around Greenville, producing one of the most devastating floods ever to hit the delta. Federal flood-control projects have prevented the recurrence of such floods. The *Greenville Delta Democrat-Times* was established in 1888; its editor Hodding Carter won a Pulitzer prize in 1946.

For comparative population figures *see* table in MISSISSIPPI: *Population.* (J. K. B.)

GREENVILLE, a city and seat of Greenville county in northwestern South Carolina, U.S., is on the Reedy river, about 100 mi. S.W. of Charlotte, N.C. First settled in the 1760s, the county of Greenville was created in 1786 with its seat at the village of Pleasantburg, a name soon changed to Greenville and so incorporated in 1831. Located in the foothills of the Blue Ridge mountains, Greenville prior to 1860 was a summer resort for many low-country planters. As western terminus of the Greenville and Columbia railroad it served as commercial centre for the piedmont and for entry into the nearby Appalachian mountains. Greenville provided strong opposition to nullification in 1832 and secession in 1860. Notable among unionists was Benjamin F. Perry, Greenville editor and later governor. After the Civil War, water power of the Reedy river was utilized to develop manufacturing that became the chief economic activity of the area.

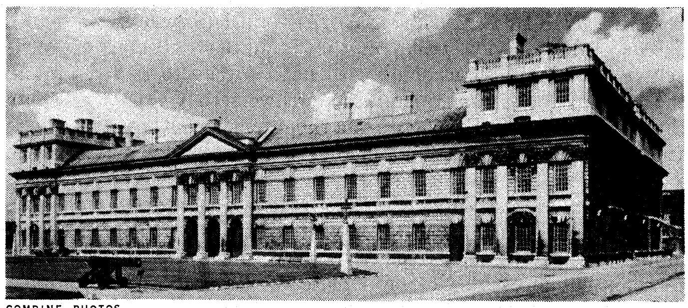
The population of the city was 8,607 in 1890 and 11,860 in 1900. It almost doubled by 1920 (23,127) and increased from 29,154 to 34,734 in the decade 1930–40; it was 58,161 in 1950 and 66,188 in 1960. The population of the standard metropolitan statistical area (Greenville county) was 209,776 in 1960. Chartered as a city in 1868, Greenville established council-manager government in 1951.

The city leads the state in retail sales volume and in manufacturing. Textile mills dominate industry although there was considerable growth by the second half of the 20th century in the chemical industry, food distribution, metal industries and industrial suppliers.

Greenville is the home of Furman university, opened in 1827 as a theological school at Edgefield and moved to Greenville in 1851 (Baptist, coeducational, about 1,300 students), and Bob Jones university, established in 1927 (nondenominational coeducational school emphasizing Bible study, about 2,000 students). There is a state park on Paris mountain $4\frac{1}{2}$ mi. from the city at an elevation of 2,054 ft. (L. P. J.)

GREENWICH, a southeastern metropolitan and parliamentary borough of London, bounded on the north by the river Thames, east by Woolwich, west by Deptford and south by Lewisham, part of the boundary between it and the latter being the Dover road (originally the Roman Watling street) running across Blackheath. The borough is connected with Poplar to the north by a foot tunnel to the Isle of Dogs, and to the neighboyrhood of the docks by the Blackwall tunnel, the lowest on the river. Pop, (1951) 89,846. Area 6 sq.mi.

The parish church is dedicated to St. Alphege, archbishop of Canterbury, who was martyred there by Danish raiders in 1012. The medieval building was replaced by the present one in 1718, Nicholas Hawksmoor being the architect and John James completing the tower. As a result of damage in World War II, the interior (the work of Sir James Thornhill and Grinling Gibbons) was redecorated. In the church are buried Gen. James Wolfe and Thomas Tallis the musician (d. 1585). Gibbons' work may also be seen at Morden college, originally an almshouse for "decayed Turkey merchants," built by Sir Christopher Wren about 1695. Other noteworthy buildings are the town hall, built of brick in a modern style, opened in 1939; the Ranger's house, originally the home of Lord Chesterfield (c. 1750); the Paragon (*c.* 1790); the Manor house (*c.* 1700); the Presbytery (*c.* 1630); and Charlton



COMBINE PHOTOS

ROYAL NAVAL COLLEGE, GREENWICH. THE QUEEN ANNE BUILDING

house (1612), the largest Jacobean building in London.

The most notable group of buildings is that formed by the Royal Naval college, the National Maritime museum and the Royal observatory. In 1423 Humphrey, duke of Gloucester, purchased the manor of Greenwich, enclosed what was later the park (185 ac.) and built a watchtower on the site of the present observatory. On his death the manor reverted to the crown, so that tenure of land from the crown "as of the manor of East Greenwich" became a formula in American colonial charters from that of Virginia in 1606. Humphrey also built a house named Placentia which was extended by the Tudor sovereigns into a royal palace running along the river bank. It was a favourite residence of Henry VIII (who was born there). He added a banqueting hall, armoury and tilt yard. There he married Catherine of Aragon, Anne Boleyn and Anne of Cleves; and his daughters Mary and Elizabeth were born there. Though James I did not use the palace he commissioned Inigo Jones to build the Queen's house, completed for Henrietta Maria in 1637; it was the first building in the Palladian style in Britain. After being used as the residence of the ranger of Greenwich park, the house was converted into a naval school in 1806 and the two wings joined to the original building by colonnades were added. In 1937, four years after the school had left, these were opened as the National Maritime museum.

The Tudor palace having fallen into disrepair, Charles II commissioned John Webb to design a new palace, of which only the present King Charles block mas built. In 1694, as a thank offering for the naval victory at La Hogue, William and Mary asked Wren to convert this into a naval hospital on the pattern of Chelsea hospital for soldiers. Wren had already built the observatory on the site of Humphrey's tower in 1675. He then designed the largest twin-domed baroque building in England, to accommodate 2,700 pensioners. Sir John Vanbrugh and Hawksmoor were responsible for the construction of the building, which was opened in 1705. The frescoes in the Painted hall were completed by Thornhill in 1726; the decoration of the present chapel (dating from 1789) is the work of James Stuart and William Newton, the original chapel having been burned in 1779. In 1873 the hospital was converted into the Royal Naval college, the infirmary (built by Stuart in 1764) being granted to the Seamen's Hospital society.

Astronomical work at the observatory began to be transferred in 1948 to Hurstmonceux (*q.v.*); but the public dial showing civil time and the prime meridian mark, from which all countries have reckoned longitude since 1884, can still be seen.

Two inns on the water front, the Ship and the Trafalgar, were famous in the 19th century for whitebait dinners. The former was bombed and its site is now occupied by the "Cutty Sark" clipper, preserved as a tribute to the merchant service in the days of sail. (C. C. L.)

GREENWICH, a township of southwestern Connecticut, U.S., and a prosperous suburb of New York city which is 28 mi. S.W., has been called the gateway to New England. Founded on Long Island sound in 1640 by the New Haven colony agents Robert Feaks and Capt. Daniel Patrick, who purchased land from four sachems for 25 English coats, it soon came under Dutch rule and finally, in 1650: under Connecticut's jurisdiction. During the American Revolution British troops under Gen. William Tryon overran Greenwich and looted freely. In organizing the town's defense Gen. Israel Putnam narrowly escaped capture by galloping down a precipice. After the war the little port town resumed its steady growth, reaching 3,790 in 1820, 6,522 in 1860, over 12,000 in 1900 and 40,835 in 1950; the population was 53,793 in 1960. (For comparative population figures *see* table in CONNECTICUT: *Population.)*

Greenwich capitalized upon its convenient location for commuters to New York city and is noted for its woods and hills rising gently from six miles of attractive coast line. Industries include the manufacture of marine engines, electrical generators, pumps, boats and sails, industrial felt, precision instruments, small castings, machine tools and magazine printing. Under strict zoning since 1927, the town has fine residential areas and high-ranking public and private schools. There are two large public libraries and a museum. Many authors and artists reside in the town. Public recreational facilities include three municipal beaches. over 400 ac. of parks, 300 mi. of bridle paths and a nature preserve. In 1933 the town adopted a representative town-meeting system of government. (A. E. V. D.)

GREENWOOD, FREDERICK (1830–1909), an English journalist and man of letters, was born in London. In 1862, when Thackeray resigned the editorship of the *Cornhill,* Greenwood became joint editor with G. H. Lewes. In 1864 he was appointed sole editor, a post which he held until 1868. Greenwood then conceived the idea of an evening newspaper, which, in addition to the news, should contain authoritative and impartial articles by outside contributors on literature, art and public affairs. Canning's *Anti-Jacobin* and the *Saturday Review* of 1864 were the joint models he had before him. The idea was taken up by George Smith, and the *Pall Mall Gazette* mas launched in Feb. 1865, with Greenwood as editor. Within a few years he had come to exercise a great influence on public affairs. His views ripened from what mas described as philosophic Liberalism into Conservatism. It was on the suggestion of Greenwood that Beaconsfield purchased in 1875 the Suez canal shares of the Khedive Ismail. It was characteristic of Greenwood that he declined to publish the news of the purchase of the shares in the *Pall Mall* before the official announcement was made.

Early in 1880 the *Pall Mall* changed owners, and the new proprietor required it to support Liberal policy. Greenwood at once resigned his editorship, but in May a new paper, the *St. James's Gazette,* was started for him by Henry Hucks Gibbs (afterward Lord Aldenham), and in the new paper Greenwood was a pungent critic of the Gladstone administration (1880–85) and an independent supporter of Lord Salisbury. His connection with the *St. James's Gazette* ceased in Aug. 1888, when the paper changed hands. The *Anti-Jacobin,* which he started in 1891, lasted for only a year. Toward the end of his life his political views reverted in some respects to the Liberalism of his early days. He died at Sydenham on Dec. 14, 1909.

GREENWOOD, JOHN (d. 1593), English Puritan and Separatist (the date and place of his birth are unknown), was educated at Corpus Christi college, Cambridge. By 1586 he mas the recognized leader of the London Separatists, many of whom had been imprisoned at various times since 1567. Greenwood was arrested early in Oct. 1586, and the following May mas committed to the Fleet prison. During his imprisonment he wrote some controversial tracts in conjunction with his fellow-prisoner Henry Barrowe. He was certainly at large in Sept. 1592, when he was elected "teacher" of the Separatist church. Meanwhile he had written (1590) "An Answer to George Gifford's pretended Defence of Read Prayers." On Dec. 5 he was again arrested; and the following March was tried, together with Barrowe, and condemned to death on a charge of "devising and circulating seditious books." After two respites, one at the foot of the gallows, he was hanged on April 6, 1593.

See B. Brook, *Lives of the Puritans* (1813) ; H. M. Dexter, *The Congregationalism of the Last Three Hundred years* (1880) and *The England and Holland of the Pilgrims* (1905) ; F. J. Powicke, *Henry Barrow and the Exiled Church of Amsterdam* (1900).

GREENWOOD, in northwest Mississippi. U.S., 100 mi. N. of Jackson and 134 mi. S. of Memphis, Tenn., is the largest city between those two points and is the seat of Leflore county. In 1834 John Williams traveled up the Yazoo river and settled close to the junction of the Tallahatchie and Yalobusha rivers. That place soon became an important shipping point for cotton on its may down the Yazoo and the Mississippi rivers to New Orleans. Williams' Landing was incorporated as a city in 1844 under the name of the last great Choctaw chieftain, Greenwood Leflore, who was a wealthy cotton planter and slaveholder. Greenwood is a Mississippi delta community where Negroes and nhites live in approximately equal numbers. (For comparative population figures *see* table in MISSISSIPPI: *Population.)* Primarily a trading centre, Greenwood is the home of diverse industries and it has grain elevators with a total storage capacity of almost 1,000,000 bu.

(E. H. Hs.)

GREETING CARD, an illustrated message that expresses, either seriously or humorously, affection, good will, gratitude, sympathy or other sentiments. Greeting cards are usually sent by mail in observance of a special day or event and can be divided into two general classifications, seasonal and everyday. Seasonal cards include those for Christmas, New Year's day, St. Valentine's day, St. Patrick's day, Easter, Mother's day, Father's day, graduation. Halloween and Thanksgiving day. Everyday cards include those commemorating birthdays, anniversaries. births or religious occasions, and cards of condolence. congratulations or friendship. as well as get-well cards, gift cards, *bon voyage* cards and thank-you cards.

The exchange of greeting cards in the United States is on a scale far beyond that in any other country although all English-speaking countries practise the custom to some degree and its popularity is growing in European and South American countries. In the latter 1950s nearly 300 greeting-card publishers in the U.S. annually produced about 5,000,000,000 cards having a wholesale value of about $275,000,000—a sixfold increase in volume in two decades. Approximately half of the total were Christmas cards; one-fourth were cards for other seasonal occasions; and one-fourth for everyday occasions. About $150 000,000 was expended annually for postage stamps on greeting cards.

Greeting cards are usually of stiff paper or cardboard but some are made of cloth, leather, Celluloid, vellum, metal and even wood, clay, cork or other materials. Size is determined by common usage, the availability of suitable envelopes, ease of mailing and the system of grading according to price and quality. Extreme exceptions are an inscribed grain of rice presented in 1929 as a Christmas greeting to the prince of Wales and a Christmas card sent to Pres. Calvin Coolidge in 1924 that was 21 × 33 in. The imprinted messages on cards may vary in length from a brief word or two to 100 words or more in prose or verse.

The exchange of illustrated greetings among friends dates from ancient times. In Egypt the new year was celebrated by the exchange of symbolic presents, such as scent bottles and scarabs inscribed *au ab nab* ("all good luck"). The Romans exchanged *strenae,* originally branches of laurel or olive, frequently coated with gold leaf. Symbols of seasonal good will, such as a Roman lamp impressed with the figure of Victory surrounded by *strenae,* were inscribed *Anno novo faustum felix tibi sit* ("May the new year be happy and lucky for you"). The acknowledgment of the new year with exchanges of good will continued in Europe through the early days of Christianity. In the 15th century master wood engravers produced inscribed prints which had the same intent as the modern Christmas and New Year's cards. One of these, by Master E. S., shows the Christ child with halo before a cross and holding a scroll on which appears *Ein guot selig ior* ("A good and happy year"). During the 18th and early 19th centuries copperplate engravers were producing prints and calendars for the new year, and greetings by organizations, merchants and tradesmen were common.

The valentine is also regarded as a forerunner of the greeting card. Its history is related to pre-Christian Rome when boys drew the names of girls from a love urn on the feast of the Lupercalia, Feb. 15. The custom was introduced to England by the Romans and continued through the Christian era. In order to adapt the practice to Christianity the church transferred it to the feast of St. Valentine, a bishop of Rome who was martyred on

Feb. 14, 270. The paper valentine with inscribed sentiment dates from the 16th century and the first printed valentine may have been the frontispiece of *A Valentine Writer*, a book of verses that offered assistance to the inarticulate and was issued as early as 1669. By 1800 hand-painted copperplates by such artists as Francesco Bartolozzi were in demand. These were followed by woodcuts and lithographs, all in quarto size, some further embellished with an embossed frame. With the introduction of penny postage and envelopes in England in 1840 the exchange of valentines increased and the use of lace paper, delicately ornamented, became popular. In the U.S. crude woodcut valentines were produced by Robert H. Elton and Thomas W. Strong of New York but gave way to the lace-paper delicacies imported from England. The less expensive creations of Esther Howland of Worcester, Mass., first appeared in 1850.

Recognized as the first Christmas card is one designed in England by J. C. Horsley in 1843 for his friend Sir Henry Cole. An edition of 1,000 copies was placed on sale at Felix Summerly's Home Treasury office in London. It was printed by lithography on stiff cardboard, $5\frac{1}{8} \times 3\frac{1}{4}$ in., in dark sepia and hand coloured. The design shows a family party in progress, beneath which is the greeting, "A Merry Christmas and a Happy New Year to You." Inside panels, formed by a rustic trellis, are representations of Christmas charity. A similar card was designed by W. M. Egley and produced as an etching in 1848. While this card is more elaborate its design suggests a relationship to the Cole-Horsley card. The same may be said of a U.S. Christmas card of the same period designed by R. H. Pease of Albany, N.Y., which bore the inscription, "Pease's Great Varety Store in the Temple of Fancy." Sentiment cards (approximately $3 \times 1\frac{1}{2}$ in.) were also exchanged and collected in the U.S. from 1830 to the Civil War period and many have survived, among them an "expanding heart" Christmas present or greeting card in purse form dating from about 1850, which may be one of the first U.S. Christmas cards.

Greeting-card production in commercial quantities started in 1860, the first offerings being valentines with applied Christmas ornaments and verses. These were followed by embossed or lithographed letter sheets and envelopes in multiple colours with matching cards. The latter were actually visiting cards with holiday sentiments, similar to the sentiment cards so popular earlier in the U.S. Visiting cards, which date in Europe from the 16th century, had long been used also to carry messages of affection, respect or condolence. A card with its corner bent gave the comforting assurance of personal interest. Early commercial greeting cards bore illuminations copied from manuscripts in the British museum. There were also small cards with embossed frames, similar to the visiting cards but bearing illustrations of robins and children. These were issued in sets of six and were collected and mounted in albums or scrapbooks. The cards also appeared in booklet form, attached to make a strip.

The colourful printed card ran a parallel course with the lace-paper valentine. One of the English publishers, Marcus Ward & Co., employed Kate Greenaway as a designer. Her productions, in sets of from two to six, were used for more than one occasion, the same designs being frequently used for Christmas, New Year's day, St. Valentine's day, birthday and everyday. Some of the designs appeared as book illustrations and others were used in annual four-subject calendars.

Louis Prang of Boston is called the "father of the American Christmas card." He started with sets of album cards (flora, birds, animals, etc.) and continued with Civil War scenes by Winslow Homer. He also printed advertising and visiting cards with floral designs and in 1875 added seasonal greetings. These were an immediate success. Prang cards were among the best in the market and were much admired abroad. He instituted design competitions in 1880, a practice continued later in England by Raphael Tuck and in the U.S. with Hallmark Cards Art awards. Prang's business flourished until 1895 when a decline of greeting-card production in England and the U.S. resulted from overwhelming competition from European printers whose product was so inexpensive that it could not be ignored. Cards were delivered in blank form and sentiments were applied by local printers, the same design being used for several purposes. From 1900 to World War I the greeting-card business was practically a German monopoly.

The U.S.-made greeting card reasserted itself about 1910 and was given enormous impetus by World War I with its resultant increase in transiency, a situation that was repeated during World War II. In the intervening years the custom of exchanging cards on both seasonal and everyday occasions became firmly established in the United States. U.S. greeting-card manufacturers also assumed world leadership during this period and brought many innovations to the design and manufacture of cards in the realm of novelties, animation, three-dimensional effects and visual and sound effects.

In the period after World War II, a new type of humorous greeting, usually called "studio" or "contemporary" cards, was popularized. The cards are distinguished mainly by the line drawings in modern art style with which they are illustrated and a brittle, ludicrous type of humour. Although humour from the beginning has gone hand in hand with sentiment as a greeting-card theme, studio cards constitute the most important single development in the field in recent times. They are thought to have originated in Greenwich Village art studios but their distribution spread through retail outlets in all parts of the U.S. and even abroad. While it is estimated that 80% of all greeting cards were formerly sent by women, the advent of the studio card has drawn an increasing number of men to the practice of exchanging cards.

Traditional greeting cards retained their lead in popularity, however, and serious sentiments continued to outsell the humorous. A shopper engaged in the selection of a greeting card at the stationery counter of a retail store may have as many as 1,000 different cards from which to choose. Foreign-language cards are produced for both domestic use and for export in a dozen languages. Fine art from both old masters and contemporary artists is reproduced on Christmas cards in increasing volume, and both original art and written sentiments are frequently commissioned by U.S. manufacturers from well-known artists and writers.

See also VISITING CARD.

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GREGOIRE, HENRI (1750–1831), French revolutionist and constitutional bishop of Blois, son of a peasant, was born at Vého near Lunéville, on Dec. 4, 1750. Educated at the Jesuit college at Nancy, he became curé of Embermenil and a teacher at the Jesuit school at Pont-à-Mousson. In 1783 he was crowned by the academy of Nancy for his *Éloge de la poésie,* and in 1788 by that of Metz for an *Essai sur la régénération physique et morale des Juifs.* He was elected in 1789 by the clergy of the bailliage of Nancy to the states-general, where he became conspicuous in the group of deputies of Jansenist or Gallican sympathies who supported the Revolution. He presided at the permanent sitting of 62 hours while the Bastille was being attacked by the people, and made a vehement speech against the enemies of the nation. He subsequently took a leading share in the abolition of the privileges of the nobles and the church. Under the new civil constitution of the clergy, to which he was the first priest to take the oath (Dec. 27, 1790), he was elected bishop by two *départements.* He selected that of Loire-et-Cher, taking the old title of bishop of Blois, and for ten years (1791–1801) ruled his diocese with exemplary zeal. In the first session of the National Convention (Sept. 21, 1792) he proposed the abolition of the kingship, asserting that "kings are in the moral order what monsters are in the natural." On Nov. 15 he demanded the king's trial, and was elected president of the Convention. During the trial of Louis XVI, being absent on a mission for the union of Savoy to France, he wrote a letter urging the condemnation of the king, but omitting the words *à mort;* and later proposed in the Convention that the penalty of death should be suspended.

When on Nov. 7, 1793, Gobel, bishop of Paris, resigned his episcopal office at the bar of the Convention, Grégoire refused to abjure either his religion or his office. His courage won the day and the hubbub subsided in cries of "Let Grégoire have his way!" Throughout the Reign of Terror. in spite of attacks in the Convention and in the press. he appeared in the streets in his episcopal dress and daily read mass in his house. Xfter Robespierre's fall he spoke in support of the reopening of the churches on Dec. 21, 1794. He initiated measures for restraining vandalistic fury against monuments of art, and devoted his attention to the reorganization of the public libraries and technical education. On the establishment of the new constitution. Grégoire was elected to the council of 500, and after the 18th Brumaire he became a member of the corps législatif, then of the senate (1801). He took the lead in the national church councils of 1797 and 1801, but was opposed to Napoleon's policy of reconciliation with the Holy See, and after the signature of the concordat he resigned his bishopric (Oct. 8, 1801). He voted with the minority in the senate against the proclamation of the empire, but he was subsequently created a count of the empire and officer of the Legion of Honour. During the later years of Napoleon's reign he traveled in England and Germany. but returned in 1814 and was concerned in the overthrow of the empire.

Grégoire, as a revolutionist and a schismatic bishop. was an object of double loathing to the clerical and ultraroyalist faction. He was expelled from the institute and forced into retirement. but his influence was still felt and feared. His work, *De la constitution française de l'an 1814* (1814), in which he commented on the charter from a Liberal point of view. reached its fourth edition in 1819. In that year he was elected to the lower chamber by the *département* of Isère. By the powers of the quadruple alliance this event was regarded as of the most sinister omen, and the question was even raised of a fresh armed intervention in France under the terms of the secret treaty of Aix-la-Chapelle. Louis XVIII decided on a modification of the franchise: the Dessolle ministry resigned; and the first act of Decazes. the new premier, was to carry a vote in the chamber annulling the election of Grégoire. From this time onward the ex-bishop lived in retirement, occupying himself in literary pursuits. He died on May 20, 1831.

Besides several political pamphlets. Grégoire was the author of *Histoire des sectes religieuses, depuis le commencement du siècle dernier jusqu'à l'époque actuelle* (2 vol.. 1810); *Essai historique sur les libertés de l'église gallicane* (1818): *De l'influence du Christianisme sur la condition des femmes* (1821); *Histoire des confesseurs des empereurs, des rois, et d'autres princes* (1824); *Histoire du mariage des prêtres en France* (1326). *Grégoireana, ou résumé général de la conduite, des actions, et des écrits de M. le comte Henri Grégoire,* preceded by a biographical notice by Cousin d'Avalon, was published in 1821; and the *Memoires . . . de Grégoire,* with a biographical notice by H. Carnot, appeared in 1837 (2 vol.).

GREGORAS, NICEPHORUS (*c.* 1290–1360), Byzantine scholar and statesman, was born at Heraclea in Pontus. He early settled in Constantinople in the household of his patron and teacher Theodore Metochites. He won the favour of Andronicus II. but was in disfavour for a short time when Andronicus n-as deposed by his grandson Andronicus III. On the elder Andronicus' death (1332) Nicephorus was again used in diplomatic missions and was appointed to treat with papal legates for the reunion of the Greek and Latin churches (1333). His reputation as a scholar stood high, and he publicly disputed with the Calahrian monk Barlaam. His opposition to the teaching of the hesychasts (*see* HESYCHASM), which was supported by Gregorius Palanias and by the emperor John VI Cantacuzenus. and recognized at the synod of 1351, brought him imprisonment in the monastery of the Chora in Constantinople. He was freed in 1355 by John V Palaeologus after John VI's abdication.

Nicephorus' many writings cover a wide range. The *Historia Romaike* ("Roman History"). which covers 1204 to 1359, supplements and continues the work oi George Pachymeres: it defends his point of view in the ecclesiastical controversy and is directed against John VI Cantacuzenus. His works include extensive correspondence; lives of his uncle John. metropolitan of Heraclea, and of various saints; funeral orations; and philosophical, scientific and literary treatises and commentaries. including suggestions for reforms in the calendar very similar to those introduced by Gregory XIII (1582).

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GREGORIAN CALENDAR or NEW STYLE CALENDAR, the calendar substituted in March 1582 by Pope Gregory XIII for the ancient church calendar. which was founded on two erroneous suppositions. namely, that the year contains $365\frac{1}{4}$ days and that 23j lunations are exactly equal to 19 solar years. The Gregorian calendar was introduced into Spain. Portugal and part of Italy the same day as at Rome: France and Germany followed and it was subsequently adopted in almost all Christian countries. For the computation of the Greporian calendar *see* CALENDAR.

GREGORIAN MUSIC. The most famous division of the ecclesiastical monodic music of the early and medieval church, which is comprehensively known as plain song or plain chant. This is so called because of the part which Pope Gregory I (d. 604) took in reforming and standardizing it.

See GREGORY (SAINT GREGORY, surnamed the Great); MUSIC (sec 3): PLAINSONG.

GREGOROVIUS, FERDINAND (1821–1891), German historical writer best remembered for his history of Rome. was born at Niedenburg. Jan. 19. 1821. His work is the fruit of the fascination which Italy (his home during 1852–74) exerted upon him. His *Geschiclzte der Stadt Ront im Mittelalter* (8 vol.. 1859–72; Eng. trans., 1894–1900), is inaccurate in places and has been superseded. but retains value for its colour and vitality. He wrote a companion *Geschichte der Stadt Athen im Mittelalter* (2 vol., 1889) and planned a book on Jerusalem. Other works include *Wanderjahre in Italien* (j vol.. 1856–77) and *Lucrezia Borgia* (1874). He died in Munich. May 1, 1891.

See J. Honig, *Ferdinand Gregorovius,* 2nd ed. (1944).

GREGORY, SAINT, THE ILLUMINATOR (c. 260–330), the "Apostle of Armenia," the greatest though not the first missionary to his nation. and organizer of its distinctive national Christian tradition. Under his influence King Tiridates, formerly a persecutor. accepted Christianity and proclaimed Armenia a Christian nation about 303. Later legends confuse rather than clarify Gregory's reputation; they make him a Parthian noble, long imprisoned for the faith in a well by Tiridates, and connect him with an exiled Roman virgin, later martyr, Ripsime, and the (later) ecclesiastical centre of Armenia at Etchmiadzin. Gregory's church was in communion with the Greek Church through a special connection with the see of Caesarea, where he was consecrated to the episcopate, and it used Greek or Syriac, not yet Armenian, as its ecclesiastical language. But it possessed strong distinctive features, including a custom of hereditary succession in the episcopate which lasted for some time. Gregory's successor as *catholicos* (primate) was his son Aristakes. who took part in the Council of Nicaea in 325, and brought the Nicene creed to Armenia. Gregory is said to have died as a hermit some years later. His feast day is Sept. 30. *See* also ARMENIAN CHURCH.

BIBLIOGRAPHY.—A good account and discussion of sources may be found in Bardenhewer, *Geschichte der altkirchlichen Literatur,* vol. v, pp. 182–185 (1932). *See* also Butler-Thurston. *Lives of the Saints;* H. Gelzer, *Die Anfänge dev armenischen Kirche* (1895); M. Ormanian, *The Church of Armenia,* ch. 3–4, 2nd rev. ed. (1955). (E. R. HY.)

GREGORY, SAINT, OF NAZIANZUS (*c.* 329–*c.* 389), surnamed Theologus, one of the four great fathers of the Eastern Church. was born at or near Nazianzus, Cappadocia, where his father. also named Gregory. had lately become bishop. Xfter studying at the two Caesareas. Alexandria and Athens. he was induced by Basil (*q.v.*) to share his religious seclusion in Pontus, and there prepared the *Philokalia,* a sort of chrestomathy compiled with Basil's help from the writings of Origen. Gregory was ordained about 361, and though made bishop of Sasima, a small village near Tyana. about 372, he seems to have lived at Nazianzus, assisting his aged father, upon whose death (374) he retired to Seleucia in Isauria for some years. Toward 378–379 the small remnant of the orthodox party in Constantinople requested him to undertake the resuscitation of their cause, so long borne down by the Arians. His success was immediate, the famous five discourses on the Trinity delivered there earning for him the distinctive appellation of *theologus*. With the arrival of Theodosius in 380 came the visible triumph of the orthodox cause. The metropolitan see was then conferred upon Gregory, and after the assembling of the second ecumenical council in 381 he received consecration from Meletius. In consequence, however, of a spirit of discord which appeared at his promotion, he soon resigned his dignity and withdrew into retirement. The rest of his days were spent partly at Nazianzus in ecclesiastical affairs, and partly on his neighbouring patrimonial estate at Arianzus. His festival is celebrated in the Greek Church on Jan. 25, and in the western on May 9.

Gregory's extant works, which consist of poems, epistles and orations, were published by Hervagius (1550); by Billius (1609, 1611); by Caillau (1840) and by Migne in *Patrol. Graec.*, vol. 35–38. The *Theological Orations* (ed. by A. J. Mason) appeared separately at Cambridge in 1899. Of the poems, which include epigrams, elegies and an autobiographical sketch, the *editio princeps* is that of Aldus (1504). Partial English translations were made by Drant (1568), by Boyd (1836) and by Newman. A translation of selected orations and letters appeared in *Tlze Library of Nicene Fathers*, vol. 7.

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GREGORY, SAINT, OF NYSSA (*c.* 331–*c.* 396), one of the four great fathers of the Eastern Church, and younger brother of Basil the Great. was born probably at Neocaesarea. In 371 or 372 he was ordained by Basil to the bishopric of Nyssa, a small town in Cappadocia, and there parted from his wife Theosebia. who became a deaconess. His strict orthodoxy concerning the Trinity and the Incarnation made him peculiarly obnoxious to the Arians. and in 375 the synod of Ancyra, convened by Denietrius, the Arian governor of Pontus, condemned him for alleged irregularities in his election and in the administration of the finances of his diocese. In 376 he mas exiled! and did not return until the publication of the edict of Gratian in 378. Shortly afterward he took part in the synod which met at Antioch in Caria to consider the Meletian schism. At the council of Constantinople in 381. he was a conspicuous champion of orthodoxy, and in 382 he was commissioned to set in order the churches of Arabia: in connection with which mission he also visited Jerusalem. In 394 he mas present at the synod held in Constantinople under the presidency of Nectarius to settle ecclesiastical disorders in Arabia. The exact date of Gregory's death is unknown. His festival is observed by the Greek Church on Jan. ro, and by the west on March 9.

Gregory of Nyssa was not so able an administrator as his brother Basil, nor so magnificent an orator as Gregory of Nazianzus, but he excelled them both as a speculative and constructive theologian. His teaching. though strictly trinitarian. shows considerable freedom, and in many points, affinities with Origen, as in his Christology and his doctrine of final restoration.

Gregory's numerous works may be classified under five heads: (1) Treatises in doctrinal and polemical theology: the most important of which are that *Against Eunomius,* which defends the Nicene creed against Xrianism and vindicates the character of Basil: the *Catechetical Oration* in defense of Christianity against pagans and Jews; *On Faith,* against the Arians; *On Common Notions,* in explanation of the terms in current employment with regard to the Trinity; *Ten Syllogisms,* against the Manichaeans; *To Theophilus,* against the Apollinarians; *Against Fate* and *De anima ct resurrectione.* (2) Practical treatises! including the tracts *On Virginity* and *On Pilgrimages* and the *Canonical Epistle* upon the rules of penance. (3) Expository and homiletical works, including the *Hexaëmeron,* and the discourses On *the Creation* of *Man, On the Titles of the Psalms, On the Sixth Psalm, On Ecclesiastes.* (4) Biographical, consisting chiefly of funeral orations. (5) Letters.

The works were edited by Fronton le Duc (1615, 1618 and 1638), by Migne, *Patrol. Graec.*, vol. 44–46 and by W. Jaeear (1921 *et seq.*). G. *H.* Forbes edited the *Hexaemeron* and the *De opificio hominis* (1855 and 1861), and F. Oehler the *Opera dogmatica* (1865). There have been numerous editions of single treatises, *e.g.*, the *Oratio catechetica* (J. *G.* Krabinger, 1838; J. H. Srawley, 1903), and Eng. trans. of the Letters and select works in *The Library of Nicene Fathers,* vol. 5 (1893). Monographs cited in Hauck-Herzog's *Realencyk.* vii.

GREGORY, SAINT, OF TOURS (538–594), historian of the Franks, was born in the chief city of the Arverni (the modern Clermont-Ferrand) on Nov. 30, 538. His real name was Georgius Florentius. but he was called Gregory after his maternal great-grandfather, the bishop of Langres. Gregory belonged to an illustrious senatorial family, many of whose members held high office in the church and bear honoured names in the history of Christianity.

His father having died while Gregory was still young, the boy was taken to Clermont-Ferrand to be brought up by his uncle Gallus and by his successor, Avitus, and there he received his education. Among profane authors he read the first six books of the *Aeneid* and Sallust's history of the Catiline conspiracy, but his education mas mainly religious. The principles of religion he learned from the Bible, Sulpicius Severus and some lives of saints, but to patristic literature and the subtleties of theology he remained a stranger. In 563. at the age of 25, he was ordained deacon. Falling seriously ill. he went to Tours to seek a cure at the tomb of St. Martin. At Tours he lived with Euphronius, and so great was the young man's popularity that, on the death of Euphronius in 573, the people unanimously designated him bishop.

At that time Tours belonged to Austrasia, and Ring Sigebert hastened to confirm Gregory's election. After the assassination of Sigebert (575), the province mas ruled by Chilperic for nine years. during which period Gregory displayed the greatest energy in protecting his town and church from the Frankish king. He had to contend with Count Leudast, the governor of Tours; despite all the king's threats, he refused to give up Chilperic's son Merovech, who had sought refuge from his father's wrath at the sanctuary of St. Martin; and he defended Bishop Pretextatus against Chilperic, by whom he had been condemned for blessing the marriage of Merovech and hlerovech's step-aunt. Queen Brunhilda. In 580 Gregory was himself accused before a council at Berny of using abusive language against Queen Fredegund, but he cleared himself of the charge by an oath and was acquitted. On the death of Chilperic, Tours remained for two years (584–85) in the hands of Guntram, but when Guntram adopted his nephew Childebert, Sigebert's son, it again became Xustrasian. This change was welcome to Gregory, who often visited the court. In 586 he was at Coblenz, and on his return to Yvois (the modern Carignan) visited the stylite Wulfilaic; in 588 one hears of him at Rletz and also at Chalon-sur-Saône, where he was sent to obtain from King Guntram the ratification of the pact of Andelot; in 593 he was at Orleans, where Childebert had just succeeded his uncle Guntram. In the intervals of these journeys he governed Tours with great firmness, repressing disorders and reducing the monks and nuns to obedience. He died in 594, on Nov. 17, which is kept as his feast day.

Gregory left many writings, of which he himself gives an enumeration at the end of his *Historia Francorum.* He mentions here ten books of history, which are discussed below; seven books of miracles, which are divided into the *De gloria martyrum,* the *De virtutibus sancti Juliani,* four books of *Miracula sancti Martini,* and the *De gloria confessorum,* the last dealing mainly with confessors who had dwelt in the cities of Tours and Clermont; a *Vitae patrum* which consists of biographies of bishops, abbots and hermits belonging to Gaul; a commentary on the Psalms which is lost, except for the preface and the titles of the chapters; and a treatise *De cursibus ecclesiasticis,* discovered in 1853, which is a liturgical manual for determining the hour of divers nocturnal offices by the position of the stars.

Gregory also wrote the oldest extant Latin version of the story of the Seven Sleepers of Ephesus (*q.v.*), probably taken from a Syriac source.

His most important work, however, is the *Historia Francorum*, which is divided into three parts. The first four books, which were composed at one time, cover the period from the creation of the world to the death of Sigebert in 575. The first book, which is a mere compilation from the chronicles of St. Jerome and Orosius, is of no value. The second book, from 397 to 511, deals with the invasions of the Franks, and is based on the histories of Sulpicius Alexander and Renatus Profuturus Frigeridus, now lost; on the catalogues of the bishops of Clermont and Tours; on some lives of saints, *e.g.*, Remigius and Maxentius, now lost; on the annals of Arles and Angers, now lost; and on legends, either collected by Gregory himself from oral tradition, or cantilenes or epics written in the Latin and Germanic languages. In the third and fourth books the earlier part is based on materials collected from men older than himself; of the later events he was himself an eyewitness. The fifth and sixth books, up to the death of Chilperic (584), deal with matters within his own experience. The first six books are often separate in the manuscripts; and it was these alone that were used by the chronicler Fredegarius in his abridgment of Gregory's history. To the first six books Gregory subsequently added chapters on the bishops Salonius and Sagittarius, and on his quarrels with Felix of Nantes. The authenticity of these chapters has been undeservedly attacked by Roman Catholic writers. Books vii to x, from 584 to 591, were written in the form of a diary; of each important event, as it occurred, he inserted an account in his book. The last six books are of great historical value.

Gregory was at great pains to be an impartial writer, but in this he was not always successful. His devotion to Austrasia made him very bitter against, and perhaps unjust to, the sovereigns of Neustria, Chilperic and Fredegund. As an orthodox Christian, he had no good word for the Arians. He excuses the crimes of kings who protected the church, such as Clovis, Clotaire I and Guntram, but had no mercy for those who violated ecclesiastical privileges. This attitude, no doubt. explains his hatred for Chilperic. But if Gregory's historical judgments are suspect, he at least concealed nothing and invented nothing; and his judgments can be corrected by his own narrative. (C. PF.)

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GREGORY, the name of 16 popes and one antipope.

GREGORY I THE GREAT, SAINT (*c.* 540–604), pope from 590 to 604, one of the four greater Doctors of the Western Church, was born in Rome of a patrician family that had already given one pope to the church. In j73 he appears to have been holding the imperial office of prefect of Rome. Feeling drawn to the religious life, he resigned his post and allocated his estates to the endowment of six new monasteries in Sicily and of one, the famous abbey of St. Andrew (which he established in his family residence on the Clivus Scauri, now the Coelian hill), in Rome. Here he himself withdrew to live as a monk according to the Benedictine rule. He was dragged unwillingly from this retirement by Pelagius II, who made him a deacon and. in 579, dispatched him as *apocrisiarius* (resident ambassador) to the imperial court in Constantinople. After some years there, he returned to his monastery on the Coelian to live as a member of the community, apparently declining to accept the abbacy. In 590 Pelagius II died of the plague, and the clergy and people unanimously chose Gregory as his successor. He tried to escape the office by petitioning the emperor not to ratify the election; but his letter was intercepted by the prefect of the city, and he was consecrated on Sept. 3, 590. He never ceased to regret the lost tranquillity of the monastic life.

Gregory ascended the papal throne at a critical time. Gregory of Tours, a contemporary observer, described the panic atmosphere prevailing in Rome at the time of the election. The disaster of floods, followed by plague, was darkened by the Lombard peril at the gates. The exarch of Ravenna had insufficient forces at his disposal to give protection. In this crisis, Gregory took command and stepped into the place which the imperial power had abdicated. He assumed control of the militia, repaired the walls and aqueducts and fed the starving populace from the granaries of the church. The Lombard king Agilulf, advancing to lay siege to Rome, was bought off (593). and in 598 Gregory concluded an independent peace with him. Having delivered the Italian churches from the ravages of the Lombards, Gregory placed the temporal prosperity of the Roman Church on a firm basis by a re-organization of the vast estates in Italy, Sicily and Gaul which constituted the patrimony of St. Peter. Through his efforts, the papacy emerged as a great political and social power.

In the administration of the Roman Church and of the suburbican province, extending from Tuscany to Sicily, of which the pope was metropolitan, Gregory showed himself from the outset a strict disciplinarian. Clerical celibacy was enforced, offending prelates were deposed. and the canonical election of bishops was safeguarded by the scrutiny of papal visitors. Each year the bishops of the suburbican province were obliged to attend a provincial synod at Rome. Only the Sicilian hierarchy were excused on account of distance and allowed to meet under their own arrangements.

In the Western Church as a whole, Gregory's activity tended to extend the prestige and authority of the Roman see: Rome, threshold of the Apostles, was by divine right "head of all the churches"; and the decrees of councils would have no binding force "without the authority and consent of the Apostolic See." In Africa. he intervened with the imperial exarch to prevent the spread of Donatism and to maintain the Numidian bishops' right of appeal to Rome. He worked, though with limited success, to arrest simony and the laicization of the church in Gaul. He congratulated the Visigothic king of Spain on his conversion from Arianism and dispatched the pallium to Bishop Leander of Seville. Of his missionary enterprises, the most important was the dispatch of Augustine, prior of his own monastery of St. Andrew, to the heathen English in 596. After receiving a report that the mission had opened with spectacular success and that more than 10,000 of the English had been baptized on Christmas day, 597, Gregory sent reinforcements led by Mellitus and Paulinus. In 601 he conferred the pallium on Augustine, associating with it for the first time the right to create new episcopal sees.

An important feature of Gregory's work was his endeavour to spread the Benedictine rule, which he regarded as the most nearly perfect pattern for the monastic life. His biography of St. Benedict (the second book of the *Dialogues)* enjoyed great popularity and did much to encourage devotion to the rule. Considering, however, that monastic life was not compatible with pastoral duties, he decreed that any monk who received an ecclesiastical cure should lose his place in the monastery.

Gregory's reputation as one of the four classical Doctors of the Western Church rests mainly on his homilies on Ezekiel and on the Gospels. his *Moralia in Job* and his *Liber Regulae Pastoralis*. The homilies were preached to the clergy and people of Rome. The commentary (*Moralia*) on Job, begun as a series of conferences for the monks who had accompanied him to Constantinople, was finished when he was pope. In theology a pupil of St. Augustine of Hippo. Gregory was a master of "spiritual" exegesis, and the *Moralia* exercised a lasting and pervasive influence on mediaeval Bible studies, both as a fundamental textbook of moral theology and as a methodology: taught by it, exegesis concerned itself above all else with the "typical" (allegorical) and moral senses of Scripture and gave scant attention to the literal meaning. The Liber Regulae Pastoralis, which expounds the qualities needful for the pastoral office, likeuise enjoyed a wide diffusion, being translated into Greek and later, by King Alfred, into West Saxon.

Gregory's name is associated also with the reshaping of the liturgy and chant of the church. His authorship of the Gregorian sacramentary and antiphonal has been disputed; but there seems to be no reason to doubt the statement of his 9th-century biographer, John the Deacon, that Gregory revised the Gelasian sacramentary. It was a copy of Gregory's revised sacramentary which Pope Adrian I dispatched to Charlemagne. Subsequent amendments, however, make it difficult to establish the authentic Gregorian text. Similarly the assertion of Ecgbert of York (732–766) that Gregory compiled an antiphonal for the cantors at Rome seems worthy of credit. Gregory died on March 12, 604, and was buried in the portico of St. Peter's. In the present basilica, his remains rest in the chapel of Clement VIII.

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GREGORY II, SAINT, pope from 715 to 731, succeeded Constantine I, whom he had accompanied to Constantinople in 710. To spread Christianity in Germany, Gregory gave special encouragement to the mission of St. Boniface, whom he consecrated bishop in 722. He was a staunch adherent of the eastern Roman empire, which still exercised sovereignty over Rome, Ravenna and some other parts of Italy, and he impeded as far as possible the progress of the Lombards. He came into conflict, however, with the emperor Leo III the Isaurian, c. 726, on account of the excessive taxation of the Italians and, later, on account of his iconoclastic edicts. Leo endeavoured to rid himself of the pope by violence, but Gregory, supported by the people of Rome and by the Lombards, eluded the emperor and died peacefully on Feb. 11, 731.

GREGORY III, SAINT, pope from 731 to 741, condemned the iconoclasts at a council convened at Rome in 731 and, as Gregory II had done, stimulated the missionary labours of St. Boniface, on whom he conferred the pallium. He was the first pope to appeal to the Franks for aid against the Lombard king Liutprand.

GREGORY IV, pope from 827 to 844, is chiefly remembered for his attempted mediation in the quarrels between Lothair and Louis the Pious. He supported Lothair against Louis, and his presence in Lothair's camp was responsible for the general desertion of the emperor on the Liigenfeld (Field of Lies, 833) The institution of the feast of All Saints is usually attributed to this pope. He died on Jan. 25, 844.

GREGORY V (Bruno of Carinthia), pope from 996 to 999, a great grandson of the emperor Otto the Great. Until the council of Pavia (997) his rival was the antipope John XVI, whom the people of Rome, in revolt against the choice of the youthful emperor Otto III, had chosen after having expelled Gregory. His most memorable acts were those arising out of the contumacy of the French king, Robert, who submitted after a sentence of excommunication. Gregory died suddenly, not without suspicion of foul play, in Feb. 999.

GREGORY VI (Johannes Gratianus), pope from 1045 to 1046. As archpriest of St. John before the Latin Gate, he had earned a reputation for learning and probity, and in 1045 he bought the pontificate from his unworthy godson Benedict IX, seemingly in order to save the papacy from worse scandals. At a council held by the emperor Henry III at Sutri in 1046, he was accused of simony, deposed and banished to Germany. He died in 1048.

GREGORY VII (HILDEBRAND), SAINT, pope from 1073 to 1085, was born at Soana in Tuscany. *c.* 1015–20. In early youth he went to Rome and was educated at the abbey of St. Mary on the Aventine and at the Lateran palace. The statement that he came of humble parents derives from hostile sources. His education at the Lateran, the favour and confidence shown him by successive popes, the fact that he had an uncle who was abbot of the aristocratic monastery of St. Mary on the Aventine and his own early advancement to the government of the famous house of St. Paul's Outside the Walls all point to an illustrious and powerful family connection. It has been argued with much probability that he belonged to the great Tusco-Roman family of Ildebrandi-Stefaneschi (Aldobrandeschi). It is likely that, while at St. Mary's. he took monastic vows, for his enemies later charged him with being a renegade monk. As papal chaplain, he followed the deposed pope, Gregory VI, to Germany (May 1047) and was treated at the German court with special regard. He returned to Rome in the train of Bishop Bruno of Toul, who became the great reforming pope Leo IX (1048–54). Leo appointed Hildebrand subdeacon of the Roman Church (a distinction made by some historians between Gregory's appointment to the subdeaconate and to the cardinalate is based on a misunderstanding: the terms "cardinal subdeacon" and "subdeacon of the Roman Church" are used interchangeably at this period for the same office) and guardian of the abbey of St. Paul's Outside the Walls, where he first displayed his reformatory zeal. Toward the end of the pontificate he was dispatched to France as legate in connection with the Berengarian controversy. Sent to Germany in 1057 to obtain ratification of the election of Stephen IX, he returned in time to play a leading part in the election of Nicholas II (1058). He was appointed archdeacon of the Roman Church (*i.e.,* head of the Roman clergy) by Nicholas in 1059; and during this pontificate and that of Alexander II (1061–73) he was the dominating personality in the curia.

On April 22, 1073, the day after Alexander's death, Hildebrand was elected pope and took the name of Gregory VII. The validity of Gregory's election has been impugned by some historians on the ground that the procedure did not conform to the electoral decree of 1059. The vote of the cardinals was preceded and possibly influenced by the acclamation of the people. Moreover, it is not clear that the cardinal bishops took the primary part assigned to them by the electoral law, although the official record is ambiguous on this point. Nevertheless, the election was not challenged at the time, and Hildebrand was carried to the papacy by unanimous agreement.

During his years in the curia, Gregory had absorbed the ideas concerning ecclesiastical reform advanced by such men as St. Peter Damiani and Humbert, cardinal bishop of Silva Candida; and he had seen the prestige and authority of the papacy raised to a new level by Leo IX and by Nicholas II. He thus brought to the papacy a deep sense of mission: he would exalt the primacy which belonged to the Roman see by divine right, and by this means he would reform the church in all its members. His doctrine of the primacy is summarized in the 27 propositions called *Dictatus Papae* (1075). These propounded the divine origin of the Holy See and defined the powers entrusted to it by God. the Roman pontiff alone is rightly called universal (ii); he alone can depose or absolve bishops (iii); it is granted to him to depose emperors (xii); no synod can be called general without his assent (xvi); the judgments of all are subject to his correction (xviii), but he is judged by none (xix); the Roman Church has never erred, and, as Scripture testifies, it shall not err for ever (xxii). Probably this much-debated document, inserted in the papal register at the time of the synod of 1075, was intended by Gregory to provide a schema for the canonists who were then undertaking the researches which, at the end of the pontificate, were to produce such great compilations as that of Anselm of Lucca.

Although in Gregory's view the *imperium* was subordinate to the sacerdotium, he did not envisage any conflict with the empire. He had inherited from Alexander the dispute with Henry IV over the appointment to the see of Milan, but the rebellion of Saxony in Aug. 1073 made Henry eager to come to terms with the new pope, and Gregory gladly grasped the opportunity of pursuing his reforms with the co-operation of the emperor. The Gregorian reforms were inaugurated by the Roman synod of Lent of 1074: clerks who had obtained any benefice by a simoniacal transaction were to be deprived; married clerks and those guilty of fornication were to be disqualified from exercising their sacred functions; and legates were appointed to execute this legislation. But the attempt to enforce the decrees met with stiff resistance from the German Church, while in France they were blocked by King Philip I, for whom the traffic in bishoprics was too lucrative to be surrendered without a struggle. This failure converted Gregory to a more radical policy, and he determined to strike at the root of the abuses, namely at the lay control of spiritual offices by means of investiture (see INVESTITURE). In the Roman synod of 1075, he suspended a number of recalcitrant German bishops and published an investiture decree forbidding ecclesiastics to receive any spiritual office from the hand of a layman.

The investiture decree made a struggle with the emperor inevitable, for the great ecclesiastical principalities formed one of the keystones in the structure of imperial government, and Henry jealously guarded his right to nominate and invest bishops who were mighty vassals as well as pastors of the church. The struggle broke out over the archbishopric of Milan, to which Henry nominated Tedald, ignoring the existence of the pope's nominee Atto. This challenge Gregory could not ignore. He demanded the withdrawal of Henry's candidate. But Henry, who had crushed the Saxon rebellion at Hohenburg (June 9, 1075), was now prepared for a trial of strength. A national assembly was hastily summoned to meet at Worms on Jan. 24, 1076, at which 24 German bishops and the archbishops of Mainz and Trier subscribed an act declaring Gregory deposed, and Henry invited the Romans to choose another pope. Imperial envoys crossed into Lombardy and procured a similar act of deposition from the Lombard bishops in the synod of Piacenza. These decisions were conveyed to the pope in the Lenten synod of 1076 by Roland of Parma. The message provoked such an outburst of anger in the assembly that the envoy's life was only saved by Gregory's personal intervention. On the following day Gregory read an act deposing Henry, releasing his subjects from their oaths of allegiance and declaring him excommunicate. So for the first time the 12th proposition of the *Dictatus Papae* was realized.

Events in Germany at first worked for Gregory. The news of the papal sentence caused a growing number of the bishops to desert Henry, and the feudal opposition seized the chance to attack the royal despotism. In a meeting at Tribur (Oct. 16, 1076) the princes discussed the election of another king, and it was agreed to invite the pope to preside at a national assembly at Augsburg, where Henry should face his accusers. It was in order to forestall this danger that Henry secretly crossed the Alps and made his famous appearance before the castle of Canossa, where the pope was staying, on Jan. 25, 1077. After Henry had waited barefoot outside the gates for three days, Gregory readmitted the penitent to the fold. By this timely repentance Henry saved his throne and threw his enemies into confusion. But the German princes were bent on the destruction of the Salian dynasty and proceeded to the election of Rudolph of Swabia as antiking (March 1077). Thus a civil war was unleashed on Germany from which the monarchy never completely recovered. Both sides invoked Gregory's judgment, but neither showed any eagerness to facilitate his entry into Germany. When at last both Henry and Rudolph had been induced to admit a legatine inquiry. the tide of war had turned in Henry's favour, and he prevented the requisite assembly from meeting. In these circumstances, in the synod of 1080, Gregory renewed the excommunication and deposition of Henry and acknowledged Rudolph to be king. Rudolph. however, was already beaten, and on Oct. 15, 1080, he was mortally wounded in battle. Henry's answer to the papal sentence was the council of imperial bishops at Brixen (June 25, 1080) which declared Gregory deposed and elected in his place Archbishop Guibert of Ravenna, who assumed the name of Clement III.

In the spring of 1081 Henry entered Italy in triumph. Gregory, foreseeing the worst, had fallen back on an alliance with the Norman freebooters of southern Italy (treaties of Ceprano, 1080). Henry's army appeared before Rome on May 21, 1081, and a series of sieges culminated in the fall of the city on March 21, 1084. Three days later the antipope Clement III was enthroned in the Lateran; and on Easter Sunday he crowned Henry as emperor. Gregory, still holding out in the castle of St. Angelo, was relieved by the unexpected arrival of his Norman allies under Robert Guiscard. This intervention enabled him to escape, and he retired to Salerno, where he died on May 25, 1085.

The Gregorian program of reform demanded for its success an increasing degree of centralization in the government of the church: the bonds between Rome and the local churches must be drawn tighter. This was achieved by the holding of synods (which, except in years of crisis, met annually at Rome) and by the extensive use of legates. The Roman synods brought together not only the suburbican clergy but also the clergy of distant provinces, as in 1075, for example, when the German bishops were summoned to attend. The synods were a means by which reformatory legislation was promulgated: thus the decrees relating to simony and clerical discipline. first published in the synod of 1074, were re-enacted in that of 1078; and the decree forbidding lay investiture, published in the synod of 1075, was re-enacted in the assemblies of 1078 and 1080—on. the last occasion with the extension of ecclesiastical sanctions to the lay donors of spiritual benefices as well as to the recipients. With the same purpose in view, Gregory greatly extended the use of legates: in addition to temporary ad *hoc* commissions, permanent legates or vicars apostolic were now appointed to a number of territories, a member of the local hierarchy often being selected. By these expedients Gregory endeavoured to ensure that his reformatory decrees were published and enforced. The increasing activity of papal legates tended inevitably to diminish the powers of primates and metropolitans, whose place at the head of provincial councils was often taken by a papal representative. A further link between the local churches and Rome was strengthened by Gregory's insistence that metropolitans should come in person to collect the pallium from the tomb of St. Peter.

Gregory's claim to feudal suzerainty over a number of territories stands apart from the question of spiritual obedience. It was not a novel claim, being based on a practice already well established, by which secular princes seeking the protection and favour of the Roman see offered their lands as fiefs to the papacy and became papal vassals. The princes of Norman Sicily. of Croatia-Dalmatia and of Kiev acknowledged Gregory's suzerainty in this way. By appealing to precedents Gregory also extended the temporal sovereignty of the papacy to Spain and to Hungary and attempted, though unsuccessfully, to extend it to England, which had been conquered under the papal banner.

Diplomatic studies on Gregory's Register have opened the way in recent times for a re-appraisal of his character and aims. The figure which emerges from the documents is not that of a power politician but that of a humble and deeply spiritual man, oppressed by the greatness of his task but drawing strength from a lively faith in God. A more worldly man would not have absolved Henry at Canossa and thrown away the hard-won advantages of two years. But Gregory was a pastor first and a statesman afterward. He did not live to see the conclusion of his work. His doctrine of papal theocracy was carried to its logical consummation by the great popes of the 13th century; but his most enduring achievement is to be found in the new standards of pastoral zeal and spirituality which, as a result of his reforms, gradually penetrated and transformed the whole church. Though Gregory was never formally canonized, his cult was authorized at Salerno by Paul V in 1609, and his feast was extended to the whole church in 1728.

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GREGORY VIII, antipope from 1118 to 1121, had been archbishop of Braga. Suspended by Paschal II in 1114 on account of a dispute with the Spanish primate and papal legate, the archbishop of Toledo, he went to Rome and regained favour to such an extent that he was employed by the pope on important legations. He opposed the extreme Hildebrandine policy, and. on the refusal of Gelasius II to concede the emperor's claim to investiture, he was proclaimed pope by Henry V on March 8. 1118. He was excommunicated by Gelasius II in April 1118 and by Calixtus II at the synod of Reims (Oct. 1119). He died in exile at the convent of La Cava.

GREGORY VIII (Alberto de Mora), pope from Oct. 21 to Dec. 17, 1187, a native of Benevento and Praemonstratensian canon, successively cardinal deacon of Sant' Adriano al Foro, cardinal priest of San Lorenzo in Lucina and chancellor of the Roman Church, was elected to succeed Urban III. He died at Pisa while engaged in making peace between the Pisans and the Genoese in order to secure their help in the new crusade which he was urging for the recovery of Jerusalem.

GREGORY IX (Ugolino of Anagni), pope from March 19, 1227, to Aug. 22, 1241, was born at Anagni into the family of the counts of Segni. He was related in the third degree to Innocent III. After studying theology at Paris, where he was a regent master in that faculty, he studied law at Bologna. Innocent III appointed him papal chaplain, cardinal deacon of St. Eustace and, in 1206, cardinal bishop of Ostia. As a cardinal. he was instrumental in obtaining recognition for the first Rule of St. Francis. He was employed as papal legate in Germany and northern Italy under Innocent III and Honorius III and succeeded the latter in the papacy.

As Innocent III had done, Gregory held that the church exercised an eminent domain over the secular power and set his face against the efforts of the emperor Frederick II to reconstitute an Italian empire. He excommunicated Frederick for neglecting his crusading vows (Sept. 29. 1227) and, to bring him to submission. dispatched an army into the Regno di Sicilia (Naples) and encouraged insurrection in Germany. Under the treaty of San Germano (1230) Frederick made important concessions regarding the immunities of the Sicilian church. After a few years of uneasy peace, Frederick embarked on his design to restore imperial authority in Lombardy. After a crushing victory over the Lombard league at Cortenuova (1237), he invaded the Patrimony of St. Peter and laid claim to the sovereignty of Rome. Gregory's answer to this threat was the second excommunication of Frederick in March 1239. Both sides invoked European opinion, Gregory summoning a general council for Easter 1241. But the Pisan fleet, in Frederick's pay. attacked the Genoese transports bringing the bishops to the council, most of whom fell into the emperor's hands. Gregory died on Aug. 22, 1241, as Frederick was preparing the assault on Rome.

Alarmed by the spread of the Catharist heresies in France. Germany and Italy, Gregory had transferred the task of prosecuting heresy from the diocesans to a regular papal Inquisition which he entrusted to the Dominicans (1233). A scholar himself, he was an active patron of the universities. The bull *Parens Scientiarum* (1231) finally established Paris university as an independent corporation. In 1233 Gregory founded a new university at Toulouse. He permanently enriched the canon law by commissioning the Dominican, Raymond of Pennaforte, to compile an authoritative collection of all the decretals which had appeared since the time of Gratian. This compilation, in five books, known as *The Decretals of Gregory IX*, was promulgated in 1234.

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GREGORY X (Teobaldo Visconti), pope from Sept. 1, 1271, to Jan. 10, 1276, was born at Piacenza *c.* 1210 and became archdeacon of Liège. Elected pope while accompanying Edward of England on a crusade, he was consecrated on March 27, 1272. He summoned the 14th general council at Lyons in 1274, for the purpose of considering the Eastern schism, the condition of the Holy Land and the abuses in the church. The Greeks were persuaded to consent to a union for the time being, and Rudolph of Habsburg renounced at the council all imperial rights in the states of the church. Gregory issued the constitution determining for the first time the form of conclave at papal elections. He was on his way to Rome to crown Rudolph, whose election he had done much to procure, when he died at Arezzo on Jan. 10, 1276.

GREGORY XI (Pierre Roger de Beaufort), pope from Dec. 30, 1370, to March 27. 1378. born in the Limousin in 1329, was made canon of Rodez and of Paris at the age of 11 and was created cardinal-deacon of Sta. Maria Nuova at 19 by his uncle, Clement VI. He studied law at Perugia under the famous jurist Baldo Ubaldi. As pope, at Avignon, he showed himself an enthusiastic reformer of the religious orders and a vigorous prosecutor of heresy. He revitalized the Inquisition in Provence, in Germany and in Spain and ordered the English authorities to investigate the doctrines of John Wycliffe. In the political field, his efforts to bring about a lasting peace between France and England and to aid the Eastern Christians against the Turks were fruitless. The rebellion of the papal states, incited by Florence, in 1375, impressed on him the urgency of restoring the papacy to Rome. The rebellion was savagely suppressed by Cardinal Robert of Geneva, and on Sept. 13, 1376, disregarding the opposition of the cardinals and of the French court. Gregory sailed from Avignon. He entered Rome on Jan. 17, 1377, but died on March 27 of the following year. Gregory was a learned and zealous pope, and his untimely death was a disaster for the church.

GREGORY XII (Angelo Corraro or Correr), pope from Nov. 30, 1406, to July 4, 1415, was born of a noble family at Venice about 1325. Successively bishop of Castello, Latin patriarch of Constantinople, cardinal priest of San Marco and papal secretary, he was elected to succeed Innocent VII under the express condition that, should the antipope Benedict XIII at Avignon renounce his claim. he also would renounce his, so that the long schism might be terminated. As pope, he announced his readiness to comply with Benedict's suggestion that he should meet him at Savona, but King Ladislaus of Naples brought the negotiations to nought. Gregory had promised not to create more cardinals, and when he did so, in 1408, his former cardinals deserted him and, with the Avignon cardinals, convoked the council of Pisa, which deposed both popes on June 5, 1409, and elected Alexander V on June 26. Gregory, still supported by Naples. Hungary and Bavaria and by Rupert, king of the Romans, found protection with Ladislaus and, in a synod at Cividale del Friuli, banned Benedict and Alexander. John XXIII, having succeeded to the claims of Alexander in 1410, concluded a treaty with Ladislaus, by which Gregory was banished from Naples on Oct. 31, 1411. The pope presented his resignation to the council of Constance on July 4, 1415, which, in recognition of his service, named him cardinal-bishop of Porto. He died at Recanati on Oct. 18, 1417. (C. H. LE.)

GREGORY XIII (Ugo Boncompagni), pope from 1572 to 1585, was born on Jan. 7, 1502, in Bologna, where he studied and later taught law at the university. In 1539 he went to Rome, where his abilities won him various employments. He was prominent in the Council of Trent from '1562 to 1563, was made cardinal in 1565 and was appointed legate to Spain in the same year. His service there made him acceptable to King Philip II, and on May 13, 1572, he was elected unanimously to succeed Pius V. His papacy witnessed the beginning of the militant period of the Counter Reformation. Since, after the victory of Lepanto (1571), further endeavours to unite Christendom against the Turks broke down, Gregory turned his attention from the infidel to the heretic. Employing his abilities as an administrator and a lawyer to obtain the reversion of papal lands where the title was defective, he used the money accruing from this policy to support those secular rulers or pretenders who were willing to stand by the traditional religion. Philip II was encouraged to turn his attention from the Mediterranean to the Netherlands and to Ireland, where it was hoped that Elizabeth I could be successfully attacked. Gregory also subsidized the Catholic league in France. Nowhere did his policy enjoy a clear-cut triumph, and papal diplomacy became increasingly subjected to the interests of Spain, which in the opinion of Philip II demanded not an aggressive but a defensive policy. So the first of the Catholic counteroffensives died away. Gregory is popularly remembered for his reform of the Julian calendar in 1582 *(see* CALENDAR). He also produced in 1582 a revised edition of the *Corpus juris canonici,* upon which he had himself worked as a cardinal. The tradition, begun by Paul IV, whereby the pope's private life should at least appear to be irreproachable, was cemented by Gregory's personal practice over 13 years. He died on April 10, 1585.

GREGORY XIV (Niccolò Sfondrati), pope from 1590 to 1591, was born in Cremona on Feb. 11, 1535, became a cardinal in 1583 and was elected to the papacy on Dec. 5, 1590. He aided the Catholic league in France and excommunicated Henry of Navarre, threatening his adherents with the ban; the effect of his intervention was to rally the moderate Catholics to support of Henry and hasten his conversion. Gregory died Oct. 15, 1591.

GREGORY XV (Alessandro Ludovisi), pope from 1621 to 1623, was born on Jan. 9, 1554, in Bologna, where he taught. He was made archbishop of his native place and cardinal by Paul V, whom he succeeded as pope on Feb. 9, 1621. He aided the emperor in the Thirty Years' War and the king of Poland against the Turks and endorsed the claims of Maximilian of Bavaria to the electoral dignity. Gregory founded the Congregation of the Propaganda, encouraged missions, fixed the order to be observed in conclaves and canonized Ignatius Loyola, Francis Xavier, Philip Neri and Theresa of Avila. He died on July 8, 1623.

GREGORY XVI (Bartolommeo Alberto, otherwise Mauro, Cappellari), pope from 1831 to 1846, was born at Belluno on Sept. 18, 1765, and entered the order of the Camaldoli. Soon after the restoration of Pius VII, he became vicar-general of the Camaldoli, councillor of the Inquisition, prefect of the Propaganda, examiner of bishops and, in 1825, cardinal. On Feb. 2, 1831, he was chosen to succeed Pius VIII. His pontificate was spent in an endeavour to combat the rising forces of liberalism and nationalism, and he was for long dismissed by historians as an intransigent reactionary; but the 20th century has done much to rehabilitate Gregory. He was not as intransigent as his manner, developed during a long career in the cloister, made him appear. Thus he negotiated the re-establishment of the concordat with Prussia allowing Catholic priests to officiate at mixed marriages and so ended a five-year deadlock, which had involved the imprisonment of the archbishop of Cologne (1840). In ecclesiastical affairs. Gregory was much more of a reformer than a reactionary. His papacy saw the reorganization of the hierarchy, the reform of old orders and the foundation of new ones, together with the introduction of the conception of vocation in the recruitment for the regular clergy and the expansion of missions in pagan countries. Indeed, a reactionary policy was no longer a feasible proposition after the revolutions of 1830 had all but completed the destruction of the old conception of the alliance between throne and altar begun by the French Revolution. The choice for the church now lay between two different conceptions of liberty: should it. as F. de Lamennais suggested, ally itself with the people against the state in order to obtain freedom for all. or should it seek to escape from the control of the state while still retaining its monopoly over the spiritual welfare of the people by developing ultramontane ideas, by increasing the authority of the international papacy? By his condemnation of Lamennais in 1832, by his opposition to the ideas of the romantics, Gregory took the decision which eventually ensured the triumph of ultramontane ideas Yet in taking this stand he was out of sympathy with the political forces of his time, especially with those of the Risorgimento in Italy. When he died, on June 1, 1846, these forces were threatening the very existence of the papal states, and such was the alarm felt by the cardinals that, although they were all of Gregory's creation, they hastened to elect a liberal sympathizer to succeed him as Pius IX.

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GREGORY, ISABELLA AUGUSTA, LADY (1852–1932), Irish playwright and author, was born on March 5, 1852, the youngest ddughter of Dudley Persse of Roxborough, County Galway. In 1881 she married Sir William Gregory, a well-known Irish M.P. She produced many plays, essays, volumes of folklore, versions of ancient sagas and romances concerning early Irish heroes, and did much to popularize the Anglo-Irish dialect of English as spoken in the west. She translated for the Abbey theatre several of Moliere's plays into this dialect under the title of *The Kiltartan Molière* (1910). Her work as playwright and director of the Abbey theatre, in association with W. B. Yeats, was extremely fruitful. This theatre was opened in 1904 and Lady Gregory told its story in *Our Irish Theatre* (1914). Sir Hugh Lane, whose life she wrote, *Hugh Lane's Lije and Achievement* (1921), was her nephew. Lady Gregory died on May 22, 1932.

Among Lady Gregory's other works are: *Cuchulain of Muirthemne* (1902); *Gods and Fighting Men* (1904); *The Kiltartan History Book* (1909); *Irish Folk History Plays* (1912); *The. Golden Apple* (1916); *The Kiltartan Poetry Book* (1919); *The Dragon* (1920).

See also Lennox Robinson (ed.), *Lady Gregory's Journals, 1916–30* (1946).

GREGORY, JAMES (1638–1675), Scottish mathematician and astronomer, famous in his day as inventor of the Gregorian reflecting telescope, was educated at the grammar school of Aberdeen and at Marischal college of that city. In 1663 he published his treatise *Optica promota,* in which he described his great invention. About 1665 he went to the University of Padua, where he studied for some years, and in 1667 published *Vera circuli et hyperbolae quadratura,* in which he discussed infinite convergent series for the areas of the circle and hyperbola. In 1668 he published also at Padua *Geometriae pars universalis,* in which he gave a series of rules for the rectification of curves and the mensuration of their solids of revolution. He was professor of mathematics successively at the universities of St. Andrews (1669–74) and Edinburgh (1674–75). *James Gregory: Tercentenary Memorial Volume* (ed, by H. W. Turnbull; 1939) contains Gregory's letters and posthumous manuscript and shows that he had anticipated several mathematical discoveries in number theory and differential calculus; *e.g.,* Taylor's expansion.

Gregory died at Edinburgh in Oct. 1675. (O. OE.)

GREGORY THAUMATURGUS, SAINT *(c.* 213–*c.* 270), Greek church father, was born of noble pagan parents at Neocaesarea in Pontus. He studied law, but at Caesarea met Origen (*q.v.*) and became his convert (A.D. 233). He was consecrated bishop of his native town about 240 and, in spite of the Decian persecution, converted nearly the whole city during his office of 30 years. He was active at the first synod of Antioch (264–265), which condemned the heresies of Paul of Samosata (*q.v.*). His feast day is Nov. 17. His later fame was due to the stories of miracles which grew up around his missionary labours, hence the surname Thaumaturgus ("wonder-worker").

Gregory's works, which include the *Panegyricus in Origenem, Metaphrasis in Ecclesiasten, Epistola canonica* and *Expositio fidei,* throw light on the personality and method of Origen, on the organization of the church in Pontus and on Gregory's Trinitarian doctrine. approaching the Nicene type.

Editions of his works were published by G. Voss (1604) and others, and are reprinted in J. P. Migne, *Patrologia Graeca,* vol. x.

See O. Bardenhewer, *Geschichte der altkirchlichen Literatur,* vol. ii, pp. 315–332 (1914), for full bibliography; also Schaff-Herzog, *Encyclopedia of Religious Knowledge.* (E. R. HY.)

GREIFENBERG (GRYFICE), a town in the former Prussian province of Pomerania, on the Rega, 45 mi. N.E. of Stettin (Szczecin) on the railway to Kolberg (Kolobrzeg), after 1945 in Szczecin province, Pol. The official Polish name is Gryfice. Pop. (1950) 8,737. It has two ancient gateways and its church of St. Mary dates from the 13th century. Manufactures of cement, sugar and bricks are carried on.

Greifenberg possessed municipal rights as early as 1262, and in the 14th and 15th centuries had a considerable shipping trade, but it decayed during the Thirty Years' War.

GREIFSWALD, a town in the *Bezirk* (district) of Rostock, German Democratic Rep. (East). until 1945 in the former Prussian province of Pomerania, on the Ryk. 3 mi. from its mouth on the Baltic, and 20 mi. S.E. from Stralsund by rail. Pop. (1959 est.) 46.302. Greifswald was founded about 1240 by traders from the Netherlands. In 1250 it received a town constitution and Liibeck rights from the duke of Pomerania. In 1270 it joined the Hanse towns. It remained in the possession of the Swedes after the peace of Westphalia. In 1713 it was desolated by the Russians; and it came into the possession of Prussia in 1815.

The industries include the manufacture of surgical instruments and machinery (particularly for agriculture). and the commerce in the export of corn, wood and fish. Greifswald is, however, best known for its university, founded during the year 1456 and famous for its faculty of medicine.

GREISEN, a modification of granite found in the tin districts of Cornwall and Saxony, consisting essentially of quartz and white mica, and characterized by the absence of feldspar and biotite. In the hand specimen the rock has a silvery glittering appearance from the abundance of lamellar, or layered, crystals of muscovite, but many greisens have much of the appearance of a paler granite. The commonest accessory minerals are tourmaline, topaz, apatite, fluorspar and iron oxides; a little feldspar more or less altered may also be present and a brown mica which is biotite or lithionite. The tourmaline in section is brown. green. blue or colourless, and often the same crystal shows many different tints,. The white mica forms mostly large plates with imperfect crystalline outlines. The quartz is rich in fluid enclosures. Apatite and topaz are both colourless and of irregular form.

Greisen occurs typically in belts or veins intersecting granite. At their outer edges they pass gradually into the granite. The transition between the two rocks is perfectly gradual, a fact which shows that the greisen has been produced by alteration of the granite. Vapours or fluids rising through the fissure have been the agents which effected the transmutation. They must have contained fluorine, boron and probably also lithium, for topaz, mica and tourmaline, the new minerals of the granite. contain these elements.

The alumina for these minerals is supplied by the biotite and feldspar of the granite, but it is noteworthy that albite is not replaced by the soda white mica, paragonite. The change is pneumatolytic, induced by the vapours set free by the granite magma when it cools. Probably the rock was at a relatively high temperature at the time.

A similar type of alteration, the development of white mica, quartz and tourmaline, is found sometimes in sedimentary rocks around granite masses.

Greisen is closely connected with schorl rock both in its mineralogical composition and in its mode of origin *(see* SCHORL). The latter is a pneumatolytic product consisting of quartz and tourmaline, and often contains white mica, thus passing by all stages into greisen. Both of these rocks frequently carry small percentages of tin oxide (cassiterite) and may be worked as ores of tin, and the central filling of the fissure often contains much wolframite, the chief ore of tungsten, as in Cornwall, Saxony, Tasmania and other centres of tin mining. (J. S. F.; X.)

GREIZ, a town of Germany in the *Bezirk* (district) of Gera, on the White Elster river, 66 mi. by rail south of Leipzig. Pop. (1959 est.) 39,319. Greiz (formerly Grewcz) is apparently a town of Slav origin. From the 12th century it was governed by *advocati* ***(Vogte),*** but in 1236 it came into the possession of Gera, and in 1550 of the younger line of the house of Plauen. It was ravaged by fire in 1494 and in 1802. It became famous for its woolen goods.

GRENADA, an island and colony, former Windward Islands colony, of the West Indies, lies between 12° 30' and 11° 58' N. and between 61" 20' and 61° 35' W.; it is 90 mi. N. of Trinidad. In shape oval, it is 21 mi. long, 12 mi. broad at its maximum and has an area of 120 sq.mi. Including the island of Carriacou, a dependency in the Grenadines (*q.v.*), the area of the colony of Grenada is 133 sq.mi.

A mountain range traverses the island, and spurs from its centre form picturesque and fertile valleys. Highest point of the island is Mt. St. Catherine (2,756 ft.). Land in the southeast and northwest is devoted to cultivation and cattle raising. The island is of volcanic origin with raised limestone beaches in the extreme north. Red and grey sandstones, hornblende and argillaceous schist are found in the mountains, porphyry and basaltic rocks also occur; sulfur and fuller's earth are worked. In the centre, at the height of 1,740 ft. above the sea, is the Grand Etang, a circular lake, 25 ac. in extent, occupying the site of an ancient crater. Near it is a large sanatorium. In the northeast is a larger lake, Lake Antoine, also occupying a crater, almost at the sea level. The island is watered by several short rivers, mainly on the east and south; there are numerous fresh water springs, as well as hot chalybeate and sulfurous springs. The southeastern coast is much indented with bays. The temperature is equable and epidemic diseases are rare. In the low country the average yearly temperature is 82° F., but it is cooler in the heights. The rainfall is heavy. in some parts 200 in. a year. The rainy season lasts from May to December. but refreshing showers frequently occur during other parts of the year. The average annual rainfall at St. Georges is 79.07 in.. and at Grand Etang 164 in. Excellent climate and good sea-bathing have made Grenada a health resort. The soil is mainly of volcanic origin, and produces cocoa and spices, especially nutmegs. Other exports, principally to Great Britain, the United States and Canada. are bananas, lime products and cotton; small quantities of sugar and fruits are also produced. Erosion of the soil was a major problem in the 1950s. Elementary education was offered free in government and state-aided denominational schools; the government maintains a secondary school and subsidizes others. Grenada's legislative council was reconstituted in 1937, and again in 1951. In 1945 the office of administrator replaced that of colonial secretary, and adult suffrage was introduced in 1951. From that year the legislative council was comprised of the administrator (president with only a casting vote), two ex officio members, three nominated members and eight elected members. The governor of the Windward Islands was required normally to act with the advice of the executive council, which included colonial officials and representatives of the legislative council. In 1958 the colony became a member of the short-lived West Indies federation. The population of the colony was 88,677 (1960), most of them Negroes of African descent; there were small numbers of mulattoes and East Indians and whites. The Carib race, aboriginal inhabitants of Grenada, is quite extinct. The British government financed means to combat malaria and yaws, the principal diseases infecting the population and to spread health education.

The capital of the colony, St. Georges (pop. 1957 est. 5,632), in the southwest. is built upon a lava peninsula jutting into the sea and forming one side of its landlocked harbour. It is surrounded by an amphitheatre of hills, up the sides of which climb the red-brick houses of the town. At the extremity of the peninsula is Fort George, built in 1705–06, no longer used for military purposes. The ridge connecting the fort with Hospital Hill is tunnelled to give access to the two parts of the town lying on either side. There are four other towns—on the west coast Gouyave. or Charlotte Town, and 4 mi. N. of it Victoria, or Grand Pauvre; on the north coast Sauteurs; and Grenville, or La Baye, at the head of a wide bay on the east.

History.—Grenada was discovered in 1498 by Christopher Columbus. who named it Conception. Neither the Spanish nor the British, to whom it was granted in 1627, settled on the island. The governor of Martinique, Du Parquet, purchased it in 1650, and the French were well received by the Caribs. whom they afterward exterminated with great cruelty. In 1665 Grenada passed into the hands of the French West India company, and was administered by it until its dissolution in 1674, when the island passed to the French crown. Cocoa. coffee and cotton mere introduced in 1714. During the wars between Great Britain and France, Grenada capitulated to the British forces in 1762. and was formally ceded next year by the treaty of Paris. The French, under Comte Charles d'Estaing, recaptured the island in 1779, but it was restored to Great Britain by the treaty of Versailles in 1783. A rebellion against the British rule, instigated and assisted by the French, occurred in 1795, but was quelled by Sir Ralph Abercromby the next year. The emancipation of the slaves took place in 1837; by 1877 it was deemed necessary to introduce East Indian labour. Grenada, with cocoa as its staple, grown principally by peasant landholders, did not experience similar depression to that which overtook the sugar-growing islands of the West Indies.

See *Grenada Blue Book* and *Colonial Report* (annuals).

GRENADES, small explosive or chemical missiles used for attacking enemy troops, vehicles or fortified positions at close range. When designed to be thrown by hand they are called hand grenades, and when adapted for launching from a rifle or carbine, rifle grenades *(see* below). The term was also applied originally to any explosive shell fired from a gun. Most varieties of hand grenades are cheap and easy to manufacture and can be used effectively by troops with little training. Despite the steady 20th-century trend toward highly complicated instruments of war, the lowly grenade maintained its position as a valuable infantry weapon.

"Grenade" probably derived from the French word for pomegranate because of the resemblance to that fruit of early grenade shapes. In later years grenades were nicknamed "pineapples" because of the bulbous shape and rough exterior of the World War I models *(see* fig. 1), though they were in fact more nearly the size of a lemon. The rough exterior of the cast-iron grenade used during the first half of the 20th century was intended to make the case break into fragments about the size of a half lump of sugar when the explosive charge was detonated, but it did not always have that effect. Over the years grenades of many different shapes and sizes appeared, some spherical, others egg-shaped, still others cylindrical. One flat type with a handle resembled a hairbrush. and another was built like a wooden potato masher. Although there are historical references to grenades weighing as much as 6 lb., most have been much lighter, usually about $1\frac{1}{2}$ lb.

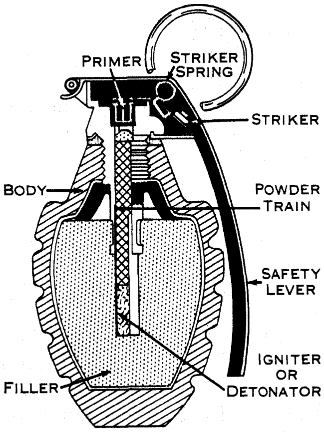

FIG. 1.— CROSSSECTION OF A HAND GRENADE (FRAGMENTATION TYPE) SHOWING PRINCIPAL PARTS

Grenades probably came into use as early as the 15th century and were found to be particularly effective when exploded among troops in the ditch of a fortress during an assault. So important did grenades become in European armies of the 17th century that soldiers specially selected for strength and courage were trained as grenadiers (*q.v.*). But, after about 1750, grenades were virtually abandoned as the range and accuracy of firearms increased. lessening the opportunities for close combat. They did not come back into use on an important scale until the siege of Port Arthur during the Russo-Japanese War (1904–05).

Hand Grenades.—In the trench warfare of World War I (1914–18) both sides found hand grenades and rifle grenades effective in attacking enemy positions. The German army was well supplied with grenades of many shapes and sizes at the start of the war and took the Allies by surprise with its grenade attacks. After resorting to makeshifts such as the "jam pot," a tin can filled with an explosive and scraps of iron, the British army developed and used large quantities of the Mills grenade, often called the Mills bomb, both for hand and rifle launching. It was shaped like a pineapple, and its fuze was activated by a spring-driven lever fitted close to the outside of the grenade. Before throwing the grenade, the soldier removed a safety pin, meanwhile holding the lever in place with a firm grip until the grenade left his hand. The delay train of the fuze was usually set for four or five seconds. long enough for the missile to reach its target but not so long as to permit the enemy to pick it up and throw it back again. Contact grenades that exploded when they struck their target were also employed but proved less safe and effective than those with time fuzes.

During World War II a wide variety of hand grenades appeared, including many improvised forms such as the "Molotov cocktail," a gasoline-filled bottle with a lighted wick in its top. It was often thrown at tanks to set them on fire. The standard fragmentation or defensive grenade of the U.S. army at the start of World War II was similar to the Mills grenade. It consisted of a serrated cast-iron body holding about 2 oz. of blank powder, the whole weighing 22 oz. Blank powder of the kind used to load small arms blank cartridges had been adopted in the mid-1920s because TNT shattered the case into fragments that were considered too small to be effective. But blank-powder grenades proved unsatisfactory in combat and were replaced in 1943 by TNT grenades. The standard hand grenade could be thrown about 35 yd. and the normal effective range of fragments was 10 yd. in all directions, though stray fragments might fly much farther. More than 50,000,000 were produced for the U.S. army in World War II.

During the Korean conflict, when grenades were freely used by both sides, the U.S. army adopted a new type of fragmentation hand grenade, smaller and lighter than the earlier model and with a smooth outer surface. The grooved body was abandoned because experience had shown that, when filled with a high explosive such as TNT, it did not result in effective fragmentation. The new smooth-case grenade contained a powerful explosive, threw out many fragments in a regular pattern and was far more effective than the older pineapple variety.

Offensive grenades are of a different type and of less importance. As they depend for effect on an explosive blast over a small area rather than flying fragments, troops using them continue to advance while throwing grenades before them. The blast effect is naturally greatest in a confined area such as a trench or pillbox. The body of the offensive grenade has usually been cylindrical in shape, like a huge firecracker, and made of pressed paper with sheet metal end pieces. Larger than the fragmentation grenade, it contains 6 or 7 oz. of TNT but still weighs less than 1 lb. in all. It has sometimes been employed as a demolition device or fitted with a special fuze and concealed to form a booby trap to blast an unwary soldier who happened to move the object it was attached to.

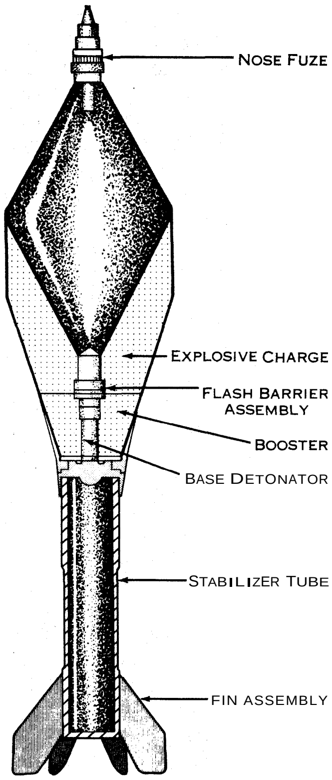

FIG. 9.— CROSS SECTION OF U.S. ANTITANK RIFLE GRENADE

Chemical Grenades.— Smoke grenades, similar in construction to offensive grenades, are used to lay down a local smoke screen to hide troop movements or for other tactical purposes. *(See* SMOKE: IN WARFARE.) For signaling to planes or to ground troops, smoke grenades come in a variety of colours. Illuminating grenades, as their name implies, put forth a short burst of light that may reveal the enemy's position at night. Incendiary grenades contain a mixture for starting fires, while other types of chemical grenades contain tear gas or other chemical agents. *(See* CHEMICAL WARFARE.) Tear gas grenades are used by police to disperse mobs or to force fugitives to come out into the open.

Rifle Grenades.— There are in the Tower armouries specimens of flintlock muskets used for grenade projection as early as the 17th century, but they were apparently not very successful. When grenades were revived in the early 1900s, efforts were made to project them from rifles and thus increase their range. The commonest practice was to attach to the hand grenade a metal rod that fitted tightly into the muzzle of the rifle and was ejected by firing a blank cartridge, Improved grenade launchers that could be fitted to the muzzles of standard rifles came into use during World War II. They permitted firing grenades without damage to the rifle, resulted in more accurate fire and launched the standard hand grenade to a distance of 100 to 200 yd., filling the gap between the ranges of hand grenades and small mortars.

Grenades designed specifically for rifle launching generally have long, streamlined bodies, with fins at the rear to stabilize their flight (*see* fig. 2). One of the most important new types in World War II was the antitank rifle grenade designed for close, point-blank fire at armoured vehicles. It contained a special armour-piercing explosive known as a "shaped charge." With such a grenade a foot soldier could knock out a tank if he got close enough for a good shot. It was as an outgrowth of early efforts to devise an antitank rifle grenade that the bazooka rocket was developed. *See* also BAZOOKA.

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GRENADIER. The military employment of grenades (*q.v.*) necessitated the recruitment of men of exceptional physique to hurl them, but at the outset such troops were not organized in special units. The mid-17th century witnessed the formation within the battalion of special companies of powerfully built men to serve as grenadiers; they wore a mitre-shaped headdress of cloth or fur, this being more appropriate to the action of throwing the grenade than was the contemporary broad-brimmed hat. Grenadiers were more particularly employed in siege and trench warfare, and were armed with a heavy hatchet with which to cleave their way through barricades and other obstructions. After the gradual decline in the employment of the grenade in the 18th century, grenadiers were retained as storm troops, proudly taking the right of the battalion line on parade. Despite the depressive effect on the morale of the remainder of their units, the grenadiers from several line regiments—like the light companies—were frequently formed into special service battalions; this process was eventually rationalized by Sapoleon, who recruited whole formations of these exponents of a specialized type of fighting. In the British army the brigading of grenadier and light companies as special task forces remained common practice until about 1858. The gradual adoption throughout Europe of the four-company battalion progressively encouraged the recruitment of separate grenadier formations, but their duties had come to differ little from those of the ordinary regiments of the line. Horse grenadiers made a fugitive appearance in both the British and the Belgian forces. In World War I battalion subunits were trained in both the throwing of hand grenades and the firing of rifle grenades. In later years, the grenadier disappeared as a special type of infantryman, for nearly all ground combat troops were trained to use grenades. (R. C. H.)

GRENADINES, a chain of islets (about 600) in the Windward Islands group, West Indies. They stretch for 60 mi. from N.E. to S.W. between St. Vincent and Grenada. Some are a few square miles in extent, others are merely rocky hummocks. For purposes of administration they are divided between St. Vincent and Grenada. The total population of the St. Vincent group, according to the 1946 census, was 4,479; area, 17 sq.mi. Because of lack of water it is only slightly cultivated, but game is plentiful. Admiralty bay, on the west side, is a safe and commodious harbour. Carriacou, attached to Grenada, is the largest of the group, 7 mi. long, 2 mi. wide and 13 sq.mi. in extent. Pop. (1946) 6,495. A ridge of hills, rising to an altitude of 700 ft., runs from N.E. to S.W. There are two good harbours on the west coast, Hillsborough bay on which stands Hillsborough, the chief town, and Tyrell bay, farther south. The island is thickly populated, the Negro peasantry occupying small lots and working on the *métayage* system. Cotton and cattle are the chief exports.

GRENFELL, GEORGE (1849–1906), English Baptist missionary and explorer of the Congo, was born at. Sancreed, near Penzance, on Aug. PI, 1849, and educated at Birmingham. In 1874 he was sent, with Alfred Saker, by the Baptist missionary society to the Cameroons, where for some years he explored the rivers inland. In Jan. 1878 he joined the Rev. T. J. Comber in exploring the lower Congo. In 1884 he made an independent survey of the Congo up to the equator, at a point 18° E. longitude. From 1884 to 1887 he made five further voyages. In 1891 he acted as Belgian plenipotentiary in the Portuguese negotiations for the settlement of the frontier of the Lunda. In 1900 he began to explore the Aruwimi river and by Nov. 1902 had reached Mawambi. Grenfell died at Basoko on July 1, 1906.

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GRENFELL, SIR WILFRED THOMASON, (1865–1940). British medical missionary, was born on Feb. 28. 1865 at Parkgate, Cheshire. He was educated at Marlborough and Oxford, where he took the degree of M.D., and studied medicine at the London hospital under Sir Frederick Treves. At his suggestion Grenfell, in 1889, joined the Royal National Mission for Deep Sea Fishermen and for three years cruised with it in the North sea as medical missionary. As a result of this experience he was chosen by the mission to start a pioneer service to the fishermen of the Labrador coast of Newfoundland, and left England on June 15, 1892. in the ketch "Albert." In his first two months Grenfell treated 900 patients, the beginnings of an immense work of relief along the Labrador coast. He won the confidence of fishermen and Eskimos by his selfless devotion to their welfare. In 1900 he was presented with the hospital ship "Strathcona." His dauntless journeys by dog sled and his adventures in the icy Labrador seas caught the imagination of generous friends in Canada. the U.S. and Britain. His hospital and children's home at St. Anthony's became the base of the Labrador work of the International Grenfell association of which Grenfell was superintendent. Through Grenfell's work the needs of the fishing communities of Labrador for schools. institutes and general welfare were also more adequately met by the government. He was created K.C.M.G. in 1927, and retired to his home on Lake Champlain in 1935. His books include *A Labrador Doctor* (1920).

See W. M. Comber, *Wilfred Grenfell, the Labrador Doctor* (London, 1950). (C. N.)

GRENOBLE, the ancient capital of the Dauphiné, a former province of southeastern France, and town of the *dkpartement* of Isère, 75 mi. by rail southeast from Lyons. Pop. (1954) 111,054. It was one of the most strongly fortified cities in Europe. Built at a height of 702 ft., the greater and newer part of the town rises on the left bank of the Isère and has wide thoroughfares and modern buildings. The original town (of but small extent) was built on the right bank of the Isère at the southern foot of the Mont Rachais, which is covered by a succession of ancient fortresses 885 ft. above the town.

Grenoble is the seat of a bishopric, founded in the 4th century. It was formerly a suffragan of Vienne and is now in the ecclesiastical province of Lyons. The most remarkable building is the late 1jth-century Palais de Justice, on the site of the old palace of the Parlement of the Dauphiné. Opposite is the church of St. André (13th century), formerly the chapel of the dauphins of the Viennois. The cathedral church of Notre Dame is a building dating in part from the 11th century. The church of St. Laurent is the oldest in the city (11th century) and has a crypt dating from Merovingian times. The town library has a rich collection of manuscripts (7,000) and printed books (250,000 vol.) which in great part belonged till 1793 to the monastery of the Grande Chartreuse. There is an art gallery, well known for its modern paintings, and a natural history museum containing geological specimens from Dauphine and Savoy. The university, which includes an *école supérieure d'électricité* and provides courses for foreign students, is a notable institution.

Grenoble occupies the site of Cularo, a village of the Allobroges, fortified by Diocletian and Maximian at the end of the 3rd century. Its present name is a corruption of Gratianopolis, in honour of Gratian (4th century). After passing under the power of the Burgundians (c. 440) and the Franks (532) it became part of the kingdom of Provence (879–1032). On the breakup of that kingdom a long struggle for supremacy ensued between the bishops of the city and the counts of Albon, the latter winning in the 12th century, taking the title of Dauphins of the Viennois in the 13th century. In 1349 Grenoble was ceded with the rest of the Dauphiné to France, but retained its municipal privileges. In 1562 it was sacked by the Protestants, but in 1572 the firmness of its governor saved it from a repetition of the massacre of St. Bartholomew. In 1590 Lesdiguikres (*q.v.*) took the town in the name of Henry IV and constructed its fortifications, quays, etc. In 1788 the attempt of the king to weaken the power of the *parlement* of Grenoble roused the people to arms, and the "day of the tiles" (June 7, 1788) is memorable for the defeat of the royal forces. In 1790, on the formation of the *département* of the Iskre, Grenoble became its capital. Grenoble was formerly much subject to floods, especially from the Drac. One of the worst took place in 1219, while that of 1778 was known as the *ddluge de la Saint Crépin.* The main industry is the production of turbines and electrical machinery for hydroelectric power plants. The making of kid gloves is less important than in former times. Other articles produced are cement, liqueurs, linen goods, leather goods and carved furniture. (M. PT.)

GRENVILLE, SIR BEVIL (1596–1643), Royalist soldier in the English Civil War was born on March 23, 1596, in St. Withiel, Cornwall, and was educated at Exeter college, Oxford. As member of parliament, first for Cornwall, then for Launceston, Grenville supported Sir John Eliot and the opposition, and his intimacy with Eliot was lifelong. In 1639, however, he appears as a royalist going to the Scottish War in the train of Charles I. The reasons of this change of front are unknown, but Grenville's honour was above suspicion. He was a valuable recruit to the royalist cause, being, says Clarendon, "the most generally loved man" in Cornwall. Under the command of Sir Ralph Hopton, Sir Bevil fought at Bradock Down and at Stratton (May 16, 1643) where the earl of Stamford was routed by the Cornishmen; he led one of the storming parties which captured Chudleigh's lines. Grenville was killed at the head of the Cornish infantry as it reached the top of the hill on July 5, 1643, at Lansdowne, near Bath, where stands a monument to him.

His son JOHN (1628–1701), created earl of Bath in 1661, was also a prominent royalist.

GRENVILLE, GEORGE (1712–1770), English statesman, second son of Richard Grenville and Hester Temple, and younger brother of Lord Temple, was born on Oct. 14, 1712. He was educated at Eton and at Christ Church, Oxford, and trained for the bar. In 1741 he entered parliament as member for Buckingham, and as one of the "cousinhood" of Grenvilles, Temples and Pitts in opposition to Robert Walpole. In 1744 he became a lord of the admiralty in the Pelham administration, and in 1747 a lord of the treasury. In 1754 he was appointed treasurer of the navy under the duke of Newcastle, and was dismissed the following year, along with William Pitt, for attacking Newcastle's foreign policy. He returned to the post in 1756 under Pitt and the duke of Devonshire, and resigned when Pitt and Lord Temple were dismissed the following year. In the same post again in the war ministry of Pitt and Newcastle in 1758, during the Seven Years' War, he improved the administration of the department. When Pitt and Temple resigned in 1761 Grenville remained in office and became leader of the house and secretary of state under Lord Bute. In 1763 he formed a ministry of his own, and became chancellor of the exchequer. This ministry was of importance because it saw the prosecution of John Wilkes, the passing of the Stamp act which precipitated conflicts between Britain and the American colonies, and the imposition of commercial duties which added to the discontent. Grenville retained office for two years, despite the hostility of George III, but his ministry was replaced by Rockingham's in 1765. He never again held office and died on Nov. 13, 1770.

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GRENVILLE, SIR RICHARD (1542–1591), English naval commander, was born of an old Cornish family in June 1542. He fought with the imperial army against the Turks in Hungary (1566–68). Next he took part in suppressing a rising in Munster (1568–69). Then, between 1573 and 1575, he and his friends were busied with a project which "was the first to put into shape the idea of an English empire in the southern seas" (A. L. Rowse, see *Bibliography).* They prepared an expedition to discover Terra Australis—the great continent that was believed to stretch diagonally across the southern Pacific—and to locate the western, Pacific, end of the North-West Passage. The voyage was not made, for the government was unwilling to endanger good relations with Spain, newly restored by the 1573–74 agreements. However, Grenville's twin purposes were to figure prominently in the original avowed aims of Sir Francis Drake's great voyage of 1577–80. For the next ten years, and again in 1587–88, Grenville was chiefly occupied in local affairs and in organizing the military defense of western England. In 1585, however, he commanded for his cousin, Sir Walter Raleigh, the fleet of seven vessels carrying colonists to Roanoke Island in the present North Carolina, and captured a Spanish vessel on his way back. In 1586 he carried provisions to Roanoke, and, finding the colony deserted, left a few men to maintain possession. After the defeat of the Armada, he went again to Ireland, where he had a considerable interest in the plantation of Munster.

In 1591, when Lord Thomas Howard was sent to intercept the homeward-bound treasure fleet of Spain, Grenville was sent with him as second in command on board the "Revenge," a ship of 500 tons which had been commanded by Drake against the Armada. At the end of August Howard, with 13 ships and 2 or 3 pinnaces, lay at anchor to the north of Flores in the Azores. On the 31st he received news that a Spanish fleet of 53 vessels was bearing up to meet the treasure ships. Being hopelessly outmatched, Howard gave orders to weigh anchor and stand out to sea. But, for some reason, the "Revenge" was delayed, and cut off from her consorts by the Spaniards. Grenville, though he could perhaps have escaped to the westward, resolved to try to break through the Spanish line. His ship was becalmed under the lee of a huge galleon, and after a hand-to-hand fight lasting 15 hours against 15 Spanish ships and a force of 5,000 men, the "Revenge" with her 190 men was captured. Grenville was carried on board the Spanish flagship and died a few days later. His exploit is commemorated in Tennyson's poem "The Revenge."

See A. L. Rowse, *Sir Richard Grenville of the Revenge* (London, Toronto, 1949). (R. B. WM.)

GRENVILLE, SIR RICHARD, BART., cr. 1630 (1600–1658), English royalist, grandson of the famous seaman of the same name, entered the army and served under Buckingham at Cadiz and in the La Rochelle expedition. He was ruined by lawsuits with his wife and her relations, and imprisoned. He escaped to Germany, returning to England to join the king's army against the Scots in 1639. From 1642 to 1643 he served in Ireland. On his return to England he was rearrested but, after joining the parliamentary army, soon made his way back to the king's side and servtd in the west of England. Many charges of abuse of power, misappropriation of war funds and insubordination were made against him, and in Jan. 1646 he was arrested. He then went to the Netherlands and was with Charles II in exile. until he had to leave the court after bringing accusations against Edward Hyde, afterward earl of Clarendon. He died in 1658 and was buried at Ghent.

Grenville's *Single Defence Against All Aspersions of All Malignant Persons* is printed in the Works of George Granville, Lord Lansdowne (London, 1736). *See* also Clarendon, *History of the Rebellion,* ed. by W. D. Macray, 6 vol. (Oxford, 1888) ; and R. Granville, *The King's General in the West* (London, New York, 1908).

GRENVILLE, THOMAS (1755–1846), English bibliophile, was born on Dec. 31, 1755. He was, with one interval, a member of parliament from 1780 to 1818, and for a few months during 1806 and 1807 president of the board of control and first lord of the admiralty. He is more famous as a book collector than as a statesman; he bequeathed his large and valuable library to the British Museum, where it is still preserved under his name.

He died in London on Dec. 17, 1846.

A catalogue of the Grenville library was published by H. J. Payne and H. Foss, *Bibliotheca Grenvilliana* (3 vols., 1842–48).

GRENVILLE, WILLIAM WYNDHAM GRENVILLE, BARON (1759–1834), English statesman, youngest son of George Grenville, was born on Oct. 25, 1759, and educated at Eton and Christ Church, Oxford. In Feb. 1782 Grenville was elected member for the borough of Buckingham, and in the following September he became secretary to his brother, Earl Temple, lord lieutenant of Ireland. He left office in June 1783, but in December he became paymaster-general of the forces under William Pitt, and in 1786 vice-president of the committee of trade. In 1787 he was sent on a mission to The Hague and Versailles with reference to the affairs of Holland. In Jan. 1789 he was chosen speaker of the House of Commons, but vacated the chair in the same year on being appointed secretary of State for the home department; about the same time he resigned his other offices, but he became president of the board of control, and in November 1790 was created a peer as Baron Grenville. In 1791 he was transferred to the foreign office, retaining his post at the board of control until 1793. Although his ability was appreciated by Pitt, the two often differed on important matters. In Feb. 1801 he resigned office with Pitt because George III. would not consent to the introduction of any measure of Roman Catholic relief, and in opposition he gradually separated himself from his former leader. When Pitt returned to power in 1804 Grenville refused to join the ministry unless his political ally, Fox, was also admitted thereto; this was impossible and he remained out of office until Feb. 1806, when, after Pitt's death, he became the nominal head of a coalition Government. Though unfortunate in its conduct of foreign affairs, this ministry deserves to be remembered for its passage of the act abolishing the slave trade (1807). Its influence, however, was weakened by the death of Fox. and in consequence of a minute drawn up by Grenville and some of his colleagues the king demanded from his ministers an assurance that in future they would not urge upon him any measures for the relief of Roman Catholics. They refused to give this assurance and in March 1807 they resigned.

Lord Grenville never held office again, although requested to do so on several occasions. He continued to take part in public life, supported Roman Catholic emancipation, and, during the remaining years of his active political career, which ended in 1823, he generally voted with the Whigs. He died on Jan. 12, 1834.

See the *Dropmore MSS.* for Grenville's correspondence, and the report on this publication by the Historical Manuscripts Commission.

GRENZMARK (Grenzmark Posen-West Preussen), Germany, an administrative district (*Regierungsbezirk*) of the Prussian province of Pomerania. From 1919 to 1939 it comprised what remained to Germany of the former provinces of Posen and West Prussia, with an area of 2,991 sq.mi. and a population in 1925 of 136,919. After Hitler's conquest of Poland in 1939, it was extended to include the former lands of Germany; Polish families were deported, and their houses and farms given to German-speaking settlers, many of whom were uprooted in the Baltic provinces and "brought home to the reich." The area of the enlarged Grenzmark was 4,421 sq.mi., and the population (1939) 478,521. The district is a low plateau, highest in the north, covered with glacial and related deposits, and dotted with small lakes. It is agricultural and pastoral, the chief crops being cereals and potatoes. and the industries are brewing and the manufacture of agricultural machinery and starch. A little tobacco is grown and manufactured, while there is some trade in timber and leather.

GRESHAM, SIR THOMAS (1519–1579), London merchant, the founder of the Royal Exchange, was descended from an old Norfolk family, and was the son of Sir Richard Gresham, a London merchant knighted by Henry VIII. He went to Caius college, Cambridge, and was apprenticed for eight years to his uncle, Sir John Gresham In 1543 he was admitted a member of the Mercers' Company, and went to the Low Countries, where he lived for some years, carrying on business and acting as an agent for Henry VIII. In 1551 owing to the mismanagement of Sir William Dansell, "king's merchant," Gresham was called in to advise the English Government. He was allowed to apply his own methods, many of them quite arbitrary and unfair, for raising the value of the pound sterling on the "bourse" of Antwerp, and in a few years nearly all Edward VI.'s debts were discharged. Except for a short period during Mary's reign, he remained financial agent of the crown until he was obliged to leave Antwerp on March 19, 1567, on the outbreak of the war in the Low Countries. He was at the time on embassy to the duchess of Parma at Brussels. He continued his business as merchant and financial agent of the Government, though living in London. Elizabeth kept Lady Mary Grey a prisoner in his house from June 1569 to the end of 1572.

In 1565 Gresham proposed to the court of aldermen of London to build at his own expense a bourse of exchange, if they would purchase a suitable piece of ground. He reimbursed himself by letting out the upper part of the building as shops. He died on Nov. 21, 1579. The bulk of his property was bequeathed to his widow with the stipulation that after her decease his residence in Bishopsgate street, and the rents accruing from the Royal Exchange should be vested in the hands of the corporation of London and the Mercers' Company for the purpose of instituting a college in which seven professors should lecture on astronomy, geometry, physic, law, divinity, rhetoric and music. The lectures were given in the original building from 1597 until 1768 when it was converted into an excise office. The Royal Exchange was then used for them until the present building was erected in 1843.

A notice of Gresham is contained in Fuller's *Worthies* and Ward's *Gresham Professors;* but the fullest account of him, as well as of the history of the Exchange and Gresham College is that by J. M. Burgon in his *Life and Times of Sir Thomas Gresham* (2 vols., 1839). *See* also a *Brief Memoir of Sir Thomas Gresham* (1833); *The Life of Sir Thomas Gresham, Founder of the Royal Exchange* (1845); and F. R. Salter, *Sir Thomas Gresham, 1518–1579* (1925).

GRESHAM, WALTER QUINTON (1832–1895), American statesman and jurist, was born near Lanesville, Ind., on March 17, 1832. He spent two years in an academy at Corydon, Ind., and one year at the Indiana State university at Bloomington, then studied law, and in 1854 was admitted to the bar. He was active as a campaign speaker for the republican ticket in 1856, and in 1860 was elected to the Indiana house of representatives. In 1861 he became colonel of volunteer infantry; in 1862 he commanded a brigade, and in 1863 he was appointed brigadier-general of volunteers. In 1864 he commanded a division in Sherman's Atlanta campaign, and before Atlanta, on July 20, he received a wound which forced him to retire from active service, and left him lame for life. In 1865 he was breveted major-general of volunteers. After the war he practised law at New Albany, Ind., and in 1869 was appointed by President Grant U.S. district judge for Indiana. In April, 1883, he succeeded Timothy O. Howe (1816–83) as postmaster-general in President Arthur's cabinet, taking an active part in the suppression of the Louisiana lottery, and in Sept. 1884, succeeded Charles J. Folger as secretary of the treasury. In the following month he resigned to accept an appointment as U.S. circuit judge. Gresham was a candidate for the republican presidential nomination in 1884 and 1888. Gradually, however, he grew out of sympathy with the republican leaders and policy, and in 1892 advocated the election of the democratic candidate, Grover Cleveland, for the presidency. From March 7, 1893, until his death at Washington on May 28, 1895, he was secretary of State in President Cleveland's cabinet.

GRESHAM'S LAW, in economics, the name suggested in 1857 by H. D. Macleod for the principle of currency which may be briefly summarized—"bad money drives out good." Macleod gave it this name, which has been universally adopted, under the impression that the principle was first explained by Sir Thomas Gresham in 1558. In reality it had been well set forth by earlier economic writers, notably Oresme and Copernicus. Macleod states the law in these terms: the worst form of currency in circulation regulates the value of the whole currency and drives all other forms of currency out of circulation. Gresham's law applies where there is underweight or debased coin in circulation with full-weight coin of the same metal; where there are two metals in circulation, and one is undervalued as compared with the other; and where inconvertible paper money is put into circulation side by side with a metallic currency. *See* further BIMETALLISM; MONEY.

GRESSET, JEAN BABTISTE LOUIS (1709–1777), French poet and dramatist whose narrative poem *Ver-Vert* (1734), describing with wit tinged with malice the adventures of a parrot, decorously brought up in one convent, when he visits another, was an immediate and lasting success. Born at Amiens, Aug. 29, 1709, Gresset was brought up by Jesuits and, a brilliant pupil, was encouraged to enter the society in 1726. He studied at Paris and taught in a number of Jesuit schools, but was meanwhile writing light occasional verse. In 1734 he published *Ver-Vert*, which made him famous, and followed it by *Le Carême impromptu* and *Le Lutrin vivant*. Returning to Paris in 1735 for a year's study of theology, he wrote there *La Chartreuse* and *Les Ombres:* these lively accounts of life in a Jesuit college, precise and pointed in detail. led first to his banishment to the provinces and then to his expulsion from the order: he had not yet taken his final vows and the anticlerical tendency of his poetry was rather the result of natural frivolity and a keen eye for absurdity exercised in the only world he knew than of deliberate impiety. He returned to Paris and was warmly received, being granted an official pension. In 1740 he wrote *Edouard III*, the first French tragedy in which a murder was enacted on the stage. Other plays were the verse comedies *Sidnei* (1745) and his dramatic masterpiece, *Le Méchant* (1747), a witty exposé of *salon* life, instantly successful and highly praised for its pithy dialogue. He was admitted to the Académie francaise in 1748. In 1749 he retired to Amiens, where he was offered official employment at the Académie, and where he married. He came to regret his literary career, and although he continued to write, in 1759 he renounced his work for the theatre in a *Lettre sur la comédie*. He died at Amiens, June 16, 1777. His poem. *Le Parrain magnifique,* written in 1758, remained unpublished until 1810.

See J. Wogue, *J. B. L. Gresset* (1894).

GRESSMANN, HUGO (1877–1927), German Old Testament scholar who was a prominent advocate of the religio-historical approach, was born in Mölln, Lauenberg, on March 21, 1877. After attending the University of Göttingen he was *Privatdozent* at Kiel (1902–06), where he wrote his first important book, *Der Ursprung der israelitisch-jüdischen Eschatologie* (1905), influenced by the methods of Hermann Gunkel's form criticism and by the *Religionsgeschichtliche Schule,* which applied to the Bible lessons learned from the history of comparative religion. In this work and in his posthumously published *Der Messias* (1929) Gressmann advanced the new theory that eschatology was not a late phenomenon in Israel but pre-exilic, and its popular form can be traced in many Old Testament passages. His works show the insights into the history and geography of Palestine gained by his association with the Deutsches Evangelisches Institut für Altertumswissenschaft in Jerusalem, which he visited in 1906 before going as professor to Berlin in 1907. After *Altorientalische Texte und Bilder* (1909; 2nd ed., 1926–27) he wrote *Die älteste Geschichtsschreibung und Prophetie Israels* (1910; 2nd ed., 1921) and *Die Anfange Israels* (1914; 2nd ed., 1922), both forming volumes of Gunkel's *Schriften des Alten Testaments.* Gressmann's other important works were *Moses und seine Zeit* (1913) and *Die Lade Jahves* (1920). He died in Chicago, Ill., while on a lecture tour, April 6, 1927.

See Zeitschrift für die Alttestamentliche Wissenschaft, vol. 5, pp. 1–xxiv (1927) for memoirs of Gressmann and vol. 69, pp. 211–228 (1957) for a list of his works. (A. S. K.)

GRETNA GREEN, a village in Gretna civil parish, Dumfriesshire, Scot., $9\frac{1}{2}$ mi. N.W. of Carlisle and $23\frac{1}{2}$ mi. E.S.E. of Dumfries by road, and $\frac{3}{4}$ mi. from the Sark river, there the dividing line between England and Scotland. The railway station at Gretna is on the English side. Pop. of Gretna village (1951) 2.057. It has long been famous as the goal of eloping couples seeking hasty marriage. Until 17.54, the date of Lord Hardwicke's act, such marriages had commonly been performed in the Fleet prison in London, but after that date runaways were obliged to cross the border, as it formerly sufficed under Scots law for couples merely to declare their wish to marry before witnesses. At Gretna Green the ceremony was usually performed by the blacksmith, although any person might officiate, and the tollhouse, the inn or (after 1826) Gretna hall were the scenes of many such weddings. As many as 200 couples were married at the tollhouse in a year. In 1856 the law required one of the contracting parties to reside in Scotland for three weeks before marrying, and after the Marriage (Scotland) act, 1939, these irregular marriages were abolished on July 1, 1940. During World War I a temporary manufacturing township for the provision of cordite was created on a tract of land about 10 mi. long and from 1 to 2 mi. wide, with Gretna Green in its centre. This land was sold in 1924. About 3 mi. N.E. is the site of the battle of Solway Moss, where in 1542 the English defeated the Scots under James V.

GRÉTRY, ANDRÉ ERNEST MODESTE (1741–1813), France-Belgian composer who was a prominent figure in the development of the *opéra comique.* Born at Liège on Feb. 11, 1741. he was a chorister at the church of St. Denis at Liège and studied the violin with Nicolas Rennekin and Henri Moreau. Having become acquainted with Italian music through visits of Italian musicians, he received in 1760 a grant to study at the Collège Liègeois in Rome. In Italy he worked with G. B. Casali and G. B. Martini, producing an intermezzo, *La Vendernmatrice,* in Rome in 1765. In 1766 he was in Geneva, where he wrote a French *opéra comique, Isabelle et Gertrude,* based on a tale of Voltaire. and in 1767 he settled in Paris, producing *Le Huron,* again on a tale of Voltaire, the following year. Two further works followed, *Lucile* and *Le Tableau parlant,* and thenceforth Grétry's position as the leading composer of *opéras comiques* was established. Between 1770 and 1803 he produced about 50 stage works, mostly *opéras comiques* written for the Comkdie Italienne but including some larger-scale works produced at the Paris Opéra. His best works are *Zémire et Azor* (1771), *L'Amant jaloux* (1778), *L'Épreuve villageoise* (1784) and *Richard Coeur de Lion* (1784), the last containing an aria, "Ô Richard, 6 mon roi, l'univers t'abandonne." which acquired significance during the French Revolution. His works were less often given after 1789, but he served the new regime faithfully and became inspector of studies of the Paris conservatoire. He died at Montmorency, near Paris, on Sept. 24, 1813. Grétry's music has great charm and vitality and reveals an undoubted melodic gift. Occasional revivals of his stage works in the 20th century were invariably successful. His ballet nlusic has a grace matched by few other 18th-century composers. Forty-nine volumes of his dramatic works were published by the Belgian government between 1883 and 1957.

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GREUZE, JEAN BAPTISTE (1725–1805), French genre and portrait painter, was born at Tournus. in Burgundy. on Aug. 21, 1725, of a poor family. His precocious desire to paint and draw was not well received, but his father was eventually persuaded t~ send him as a pupil t~ Charles Grandon, a portrait painter in Lyons. Grandon's talent mas limited and the greatest service he performed for Greuze was to give him access to his collection of Dutch and Flemish engravings and to take him with him to Paris in the early 1750s. There Greuze enrolled at the academy and was befriended by the painter J. Sylvestre and the sculptor J. Pigalle. Greuze first exhibited at the Salon of 1755 and won an immediate success with his crowded and uplifting work "Un père de famille expliquant la Bible à ses enfants" (Dresden). Although Greuze's attention at this period was fixed on a simpler and more traditional type of genre painting in which the influence of 17th-century Dutch masters is clearly apparent (*e.g.*, "L'Écolier endormi," Montpellier), the congratulations he received for this faintly bogus morality turned his head and established the lines of his future career.

In Sept. 1755 he left for Italy; he lived there for two years, one of the few artists of the 18th century to remain impervious to the almost fatal attraction of Italian painting. In 1759 he became acquainted with Diderot who encouraged his inclination toward melodramatic genre, and throughout the 1760s Greuze reached ever new heights of popular acclaim with "L'Accordée de Village" (1761, Louvre), "La Mort du Paralytique" (1763, Leningrad) and the drawings "Le Fils Ingrat" and "Le Fils Puni" (1765, Lille).

These were undoubtedly fertile years, for Greuze was also painting portraits whose worth has not declined, and a certain number of those allegories of girls lamenting the loss of their sparrows with which his name is indissolubly linked. Stimulated by his success to a mood of almost hysterical pride which antagonized all those with whom he came into contact, Greuze in 1769 presented a dreary classical piece entitled "Sévère et Caracalla" (Louvre) which was to entitle him to be admitted to the Academy as a history painter. This claim was rejected, and in the storm of resentment which followed, Greuze resigned from the Academy and for the next 30 years exhibited his works to the public in his own studio.

Throughout the 1770s Greuze was kept busy painting moralities of an increasingly minatory nature ("Le Fils Puni," 1778. Louvre; "La Mauvaise Belle-Mkre." 1781) and was visited by many foreign dignitaries, notably the grand duke Paul Petrovich of Russia who commissioned from him a number of works. But his income was precarious, and by 1785, when he was reduced to painting bloated studies of girls, his once considerable talent was exhausted. He died in the Louvre on March 4, 1805, in great poverty.

Greuze abused his very real gifts in an attempt to give the public what it wanted. His large genre pictures, which are badly painted, were rapturously received by a public whose tastes had been formed by the novels of Samuel Richardson and Jean Jacques Rousseau. He is today remembered for his studies of girls in a state of calculated disarray; his fine portraits, his magnificent drawings are neglected. He had few pupils but many imitators and in his own lifetime was partially ruined by the vogue for sentimental genre painting which he himself had inaugurated.

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GREVILLE, CHARLES CAVENDISH FULKE (1794–1865), whose diary remains the outstanding source for the history of British politics in the first half of the 19th century, was a distant cousin of Lord Warwick and, through his mother, the grandson of the 3rd duke of Portland (*q.v.*), who was twice prime minister. Greville was born on April 2. 1794. Through his grandfather, Greville was appointed to the reversion to the secretaryship of Jamaica when he was seven, a sinecure which was abolished in his lifetime. though he was recompensed with the emoluments until his death.

When he mas ten he was given the reversion to the clerkship of the privy council. He was educated at Eton and at Christ Church, Oxford, but he left without a degree in 1814 to work as private secretary to the secretary for war, Lord Bathurst. He became clerk of the privy council when he was 27, and he discharged the duties of this office for nearly 40 years. This work brought him into close touch with the royal family and the leading public men of the time, and gave him a clear insight into public affairs, though he regretted that his work precluded him from taking part in politics.

Starting somewhat spasmodically when he left Oxford, but with increasing regularity after 1818, Greville kept a diary recording all important political events, embellished with an extremely shrewd (though not always eulogistic) commentary on individuals. He wrote his diary at the time of the events he described. read it through regularly in after life, but did not materially vary what he had originally written.

The last entry was made in Nov. 1860 "with a full consciousness of the smallness of the interest or value" of the diary, a view not shared by posterity.

Another occupation of Greville's — his guidance of the policy of the *Times* of London — emerges from the official history of that journal published between 193j and 1952. His advice and suggestions were courted by successive editors; sometimes contributions from him were published over the pseudonym "C"; he also wrote obituaries of a few very eminent men.

He published several pamphlets, those on the corn laws (1846) and the precedence of Prince Albert (1840) meeting with considerable success.

Greville was a well-known personality on the turf. As a young man he managed the racing stables of George IV's brother, the duke of York. Later he raced in partnership with Lord George Bentinck and then with the duke of Portland. He once won the St. Leger, and he was unlucky not to win the Derby in 1845. He often laments in his diary the time he wasted in racing. Greville sold his horses in 1855. He was known as "Punch" and, behind his back, because of a rather sombre manner, as the "Gruncher." He never married.

At intervals between 1874 and 1887, his successor at the privy council, Henry Reeve, published the diary with many excisions and a certain softening of the text. It was widely enjoyed, though the publication was generally thought premature. In 1927 P. W. Wilson published further selections from the diary, using the copy made by Reeve. This copy is now in the Bodleian library at Oxford; the original manuscript is in the British museum. In 1938 a verbatim edition was published, edited by Lytton Strachey and Roger Fulford. (R. T. B. F.)

GRÉVIN, JACQUES (1538–1570), French poet and dramatist whose plays introduced classical forms into French drama, and also the author of medical treatises on antimony and poisons. He was born at Clermont-en-Beauvaisis in 1538 and became a doctor of medicine of Paris university. A friend and disciple of Ronsard and Du Bellay, he wrote love sonnets, *L'Olimpe* (1560) to Nicole Estienne, satirical sonnets, *La Gklodacrye* (1560), and was an innovator in drama, claiming to follow the precepts of Aristotle and Horace. His comedies imitate the regular form of Plautus and Terence but have a contemporary subject and Parisian setting. Their tone is licentious. *La Trésorière* was performed at the Collkge de Beauvais in 1559. *Les Esbahis*, and his regular tragedy, *Cksar* (based on Plutarch and on Muret's Latin tragedy), were also performed there and published in his *Théâtre* (1561). After the Conspiracy of Amboise (1560), Grévin, being a Protestant, fled to England, where he was received in audience by Elizabeth I. He soon returned to France but later went to Antwerp. He finally took refuge with the duchess of Savoy (Margaret of France), who made him her physician and counselor.

He died at her court in Turin on Nov. 5, 1570.

See Grévin's *Théâtre complet et poésies choisies*, ed. by L. Pinvert (1922); L Pinvert, *Jacques Grévin* (1899). (M. G. M.)

GRÉVY, FRANÇOIS PAUL JULES (1807–1891), French statesman, president of the republic, was born at Mont-sous-Vaudrey, Jura, on Aug. 15, 1807. An advocate by profession, and a strong republican, he was deputy for Jura to the constituent assembly (1848). Foreseeing the election of Louis Bonaparte as president. he proposed to vest the executive power in the president of the council, elected and removable by the assembly; *i.e.*, the suppression of the office of president of the republic. He mas consequently excluded from public life until 1868, when he took a prominent place in the Republican party.

Grévy was president of the national assembly (Feb. 16, 1871, to April 2, 1873), president of the chamber of deputies (1876–79) and, on the resignation of Marshal MacMahon, president of the republic (Jan. 30, 1879). He was an excellent president, but unfortunately, after accepting (Dec. 18, 1885) a second term of office, a serious scandal arose by the exposure of the traffic in the decorations of the Legion of Honour carried on by his son-in-law, Daniel Wilson. Grévy was not directly implicated, and did not fully realize his situation. Resignation was forced on him (Dec. 2, 1887).

He died at his native place on Sept. 9, 1891.

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GREW, NEHEMIAH (1641–1712). English plant anatomist and physiologist who shares with M. Malpighi the credit for laying the foundations of the science of plant anatomy, was baptized at Mancetter, Warwickshire, on Sept. 26, 1641. He graduated from Pembroke hall. Cambridge, in 1661, and took his M.D. at Leyden in 1671. He first practised medicine at Coventry, but soon moved to London. In 1672 he published his *Anatomy of Vegetables Begun*, which Malpighi had translated into Latin, and in 1673 his *Idea of a Phytological History*. Grew had been elected a fellow of the Royal society in 1671, and in 1681, at the society's request. published *A Catalogue and Description of the Natural and Artificial Rarities . . . Preserved at Gresham College.* To this was appended *The Comparative Anatomy of Stomachs and Guts Begun,* being several lectures read before the Royal society in the year 1676. This last is said to be one of the most remarkable studies of the 17th century, and seems to involve the first use of the term "comparative," so favoured since that time. In 1682 Grew's famous *Anatomy of Plants* appeared. In this work. Grew was the first to point out that stamens are male organs, though he himself attributed the discovery to Sir Thomas Millington.

Grew died in London on March 25, 1712. His collection of seeds and plants was bought by Sir Hans Sloane.

GREY, ALBERT HENRY GEORGE, 4TH EARL (1851–1917), British administrator, the son of Gen. Charles Grey, Queen Victoria's private secretary, and grandson of the 2nd earl, the prime minister, was born on Nov. 20, 1851; he was educated at Harrow and at Trinity college, Cambridge, where he graduated with a first class in law and history in 1873. As his uncle, the 3rd earl, had no children! Albert Grey was the heir-presumptive to the earldom. He sat in parliament as a Liberal, first for South Northumberland and then for the Tyneside division, from 1880 to 1886. He was an enthusiastic social reformer and a whole-hearted imperialist. He was one of the 93 dissentient Liberals who by voting against the Liberal government decided the fate of the Home Rule bill of 1886. He lost his seat in the ensuing general election and did not reappear in parliament till he succeeded his uncle in the earldom in 1894. The interval had been largely filled with travel—chiefly along the byways of the British empire.

He was appointed in 1895, after the Jameson raid, administrator of Rhodesia in succession to Jameson. There he became a close friend and ardent admirer of Cecil Rhodes, and on returning to England he joined in 1899 the board of the chartered company.

He went as governor general to Canada in 1904, and his term of office was twice prolonged, until Oct. 1911. After his return to public life in England, he devoted himself to propaganda in favour of imperial federation and proportional representation.

Grey showed much interest in agriculture and endeavoured to assist licensing reform by the foundation of the Public House trust.

He died at Howick, Northumberland, on Aug. 29, 1917, leaving, by his wife Alice Holford, a son who succeeded him in the earldom.

See Harold Beebie, *Albert, **Fourth** Earl* **Grey**, *a Last* **Word** (1917).

GREY, CHARLES GREY, 2ND EARL (1764–1845), English statesman. closely associated with the passing of the great Reform bill in 1832, was the eldest surviving son of Gen. Sir Charles Grey, afterward 1st Earl Grey, and was born at Fallodon, near Alnwick, on March 13, 1764. General Grey (1729–1807), who was a younger son of the house of Grey of Howick, had already begun a career of active service which, like the political career of his son, covered nearly half a century. In 1801 he was rewarded by Henry Addington with a peerage, as Baron Grey of Howick, being created in 1806 Earl Grey and Viscount Howick.

Young Grey was returned for Northumberland in 1786 and came forward as a vigorous assailant of the government of William Pitt. He was hailed by the opposition. and associated with Charles James Fox, Edmund Burke and Richard Brinsley Sheridan as a manager in the Warren Hastings impeachment. Grey became the trusted lieutenant of Fox, whom he was destined to succeed in the leadership of the party. As time went on, some differences arose between the two men on the conduct of the war, but there mas never any open breach, and their personal relations remained those of close friendship. Grey was a pioneer of parliamentary reform. He joined in founding the Society of Friends of the People for promoting the reform of the franchise, he presented their petition to parliament. and in 1793 he moved the reference of this petition to a parliamentary committee. Fox did nothing to discourage this activity, but he did not support it. At a later date Grey passed some rather bitter criticism on the society, but at the time he had no doubts on the opportuneness of the agitation. Pitt suppressed the movement with a strong hand. In 1797 Grey again introduced proposals for parliamentary reform and. when these were rejected, promoted the foolish Secession. Since the parliament did not properly represent the nation and refused to reform itself, the opposition announced its intention of "seceding." or systematically absenting itself from parliament. This movement was originated by Grey. Lord Lauderdale and the duke of Bedford. Pitt easily defeated the secession manoeuvre?and Grey himself reappeared to protest against the Act of Union with Ireland: moved by his interest in Irish affairs.

When Pitt died in Jan. 1806 the All the Talents ministry was formed under Grenville, with Fox as foreign secretary and Grey (from April 1806 to Nov. 1807 styled Viscount Howick) as first lord of the admiralty. On Fox's death. in the following September, Grey became foreign secretary and leader of the house of commons. When the cabinet proposed to concede a portion of the Catholic claims, the king demanded of it an undertaking never to propose similar measures again. This was refused, and the Grenville-Grey cabinet retired in March 180;. In the same year Grey's father died. and Grey went to the upper house. Opposition united Grey and Grenville for a time. but the parties finally split on foreign policy. When Napoleon returned from Elba in 1815, Grenville followed the traditions of Pitt and supported the ministry in at once renewing hostilities. Grey followed those of Fox and maintained the right of France to choose its own governors and the impossibility of checking the reaction in the emperor's favour. Grenville and Grey gradually drifted apart. Grey was in a small minority in opposing the suspension of the Habeas Corpus act in 1817, and the part which he took in 1820 in opposing the bill for Queen Caroline's divorce, though it won for him the respect of the nation, sealed the exclusion of himself and his few friends from office during the king's life. When in 182; Grey came forth to denounce the ministry of George Canning. he declared that he stood alone in the political world. He scarcely exaggerated, for most of the Whigs followed the marquess of Lansdowne and supported Canning's and Lord Goderich's governments.

In 182j Grey seemed to stand forth the solitary and powerless relic of an extinct party. In 1830 that party was restored to its old numbers and activity, supreme in parliament. popular in the nation, and with Lord Grey at its head, The duke of Wellington's foolish declaration against parliamentary reform (Nov. 2, 1830) suddenly deprived him of the confidence of the country, and a coalition of the Whigs and Canningites became inevitable. Grey was sent for by William IV on Nov. 16, 1830. and formed a coalition cabinet, pledged to reform. The question of the place to be offered to the indispensable Lord Brougham (*q.v.*) nearly wrecked his cabinet making, but the king in the end consented to Brougham's taking the lord chancellorship. Grey then appointed a committee of four to study the question and prepare a moderate measure of reform. Grey himself was an old-fashioned Whig and, when he took office, did not foresee how far he would go in reform. But now, faced with a formidable agitation! he saved the country from revolution by driving through a bold measure. In his view a reform sweeping enough to give general satisfaction would restore the aristocracy's popularity and ensure its continued pre-eminence. He called the bill "the most aristocratic measure that ever was proposed in parliament."

The second reading (March 23, 1831) of the first Reform bill was carried in the commons by a majority of one. An opposition amendment mas also carried, however, and on April 22 parliament was dissolved. The second reading of a new bill was carried in the new parliament (July 7) by a majority of 136. When the bill had at length passed the commons after months of debate, it was Grey's task to introduce it to the lords. It was rejected (Oct. 8) by a majority of 41. Grey had the prudence and courage to remain in office, with the intention of introducing a third Reform bill in the next session. The last months of 1831 were the beginning of a political crisis such as England had not seen since 1688. The two extreme parties. the "ultra-radicals" and the "ultra-tories." were ready for civil war. Between them stood the ministry and the majority of intelligent, peace-loving Englishmen.

The new bill contained substantial alterations but was no less efficient than the old. The second reading of the third bill in the commons was passed in December by a majority of 162. On April 9, 1832, Grey moved the second reading in the lords. A sufficient number of the opposition temporized, and the second reading was allowed to pass by a majority of nine. The intention was to mutilate the bill in committee. On May 7 Lyndhurst secured a motion to postpone certain clauses by a majority of 35 against the government. Grey now reluctantly asked the king to give authority for the creation of peers to swamp the opposition. He greatly disliked demanding a creation; indeed but for his reluctance the demand would probably have been made months earlier; there was now no alternative. But William IV, at first favourable to reform, was alienated by the violent state of opinion. He rejected the proposal of his ministers and accepted their resignation on May 9, 1832. The duke of Wellington undertook the hopeless task, in which Sir Robert Peel declined to join, of constructing a ministry that would pass a restricted or sham Reform bill. After a week of the profoundest agitation throughout the country, the king, beaten and mortified, was forced to send for Grey and Brougham. He now angrily and reluctantly yielded to the creation of peers. The threat was sufficient, the necessary number of peers abstained, and the bill became law.

Grey took but little part in directing the legislation of the reformed parliament. Never anxious for power, he had executed the arduous task of 1831–32 rather as a matter of duty than of inclination, and he found an opportunity of retiring over the renewal of the Irish "coercion" bill. It became clear in the discussion on the bill that Lord Althorp, the leader of the house of commons, was privately opposed to retaining certain clauses which it was his duty to push through the house. Lord Althorp resigned, and Grey, who was now 70, resigned also (July 8, 1834). He was succeeded as premier by Lord Melbourne, who persuaded Lord Althorp to return to his post and to proceed with the bill in its milder form.

During most of his remaining years Grey continued to live in retirement at Howick, where he died on July 17, 1845, in his 82nd year.

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GREY, SIR GEORGE (1812–1898), British colonial governor and statesman, only son of Lieutenant-Colonel Grey of the 30th Foot, was born in Lisbon on April 14, 1812, eight days after the death of his father at the storming of Badajoz. He passed through Sandhurst with credit, and received his commission in 1829. His lieutenancy was dated 1833, and his captaincy 1839, in which year he sold out and left the army. In 1836 the Royal Geographical society accepted his offer to explore the northwest region of West Australia, and accordingly he landed at Hanover bay at the end of 1837. The surrounding country he found broken and difficult, and his hardships were aggravated by the tropical heat and his ignorance of the continent. In a skirmish with the natives, in which he was speared near the hip, he showed great courage, and put the assailants to flight, shooting the chief, who had wounded him. After a brave endeavour to continue his journey his wound forced him to retreat to the coast, whence he sailed to Mauritius to recruit. Next year he again essayed exploration, this time on the coast to the north and south of Shark's bay. He had three whale-boats and an ample supply of provisions, but by a series of disasters his stores were spoilt by storms, his boats wrecked in the surf, and the party had to tramp on foot from Gantheaume bay to Perth, where Grey, in the end, walked in alone, so changed by suffering that friends did not know him. In 1839 he was appointed governor-resident at Albany, and during his stay there married Eliza, daughter of Admiral Spencer, and also prepared for publication an account, in two volumes, of his expeditions.

In 1840 he returned to England, to be immediately appointed by Lord John Russell to succeed Colonel Gawler as governor of south Australia. Reaching the colony in May 1841, he found it in the depths of a depression caused by mismanagement and insane land speculation. By rigorously reducing public expenditure, and forcing the settlers to quit the town and betake themselves to tilling their lands, and with the opportune help of valuable copper discoveries, Grey helped the infant colony to emerge from the slough. In 1845, when the little settlements in New Zealand were involved in a native war, he was sent to save them. The Maori chiefs made their submission. The governor gained the veneration of the Maori tribes, in whose welfare he took a close personal interest, and of whose legends and myths he made a valuable and scholarly collection, published in New Zealand in 1855 and reprinted thirty years afterwards. Grey presently became involved in harassing disputes with the colonists, who organized an active agitation for autonomy. In the end a constitution, partly framed by Grey himself, was granted them, and Grey, after eight years of despotic but successful rule, was transferred to Cape Colony.

In south Africa Grey thwarted a formidable Kaffir rebellion in the eastern provinces, and pushed on the work of settlement by bringing out men from the German Legion and providing them with homes. He gained the respect of the British, the confidence of the Boers, the admiration and the trust of the natives. The Dutch of the Free State and the Basuto chose him as arbitrator of their quarrels. When the news of the Indian Mutiny reached Cape Town he strained every nerve to help Lord Canning, despatching men, horses, stores and £60,000 in specie to Bombay. He persuaded a detachment, then on its way round the Cape as a reinforcement for Lord Elgin in China, to divert its voyage to Calcutta. Finally, in 1859, Grey almost reached what would have been the culminating point of his career by federating South Africa. Persuaded by him, the Orange Free State passed resolutions in favour of this great step, and their action was welcomed by Cape Town. But the colonial office disapproved of the change, and when Grey attempted to persevere with it Sir Edward Bulwer Lytton recalled him. A change of ministry during his voyage to England displaced Sir Edward Bulwer Lytton. But though the duke of Newcastle reinstated Grey, it was with instructions to let federation drop.

In 1861 the colonial office sent him as governor to New Zealand, where an inglorious native war in Taranaki had just been succeeded by an armed truce. Grey did his best to avert war, but it came in 1863, and spread from province to province. Ten thousand regulars and as many colonial riflemen were employed to put it down. The imperial troops were badly handled, and Grey, losing patience, became involved in bitter disputes with their commanders. As an example to the former he himself attacked and captured Weraroa, the strongest of the Maori stockades, with a handful of militia, a feat which delighted the colonists, but made him as much disliked at the war office as he now was at Downing street. Moreover, Grey had no longer real control over the islands. New Zealand had become a self-governing colony, and though he vindicated the colonists generally when libellous imputations of cruelty and land-grabbing were freely made against them in London, he crossed swords with his ministers when the latter confiscated 3,000,000 acres of tribal land belonging to the insurgent Maori. Yet a condition of something like tranquillity had been reached in 1867, when he received a curt intimation from the duke of Buckingham that he was about to be superseded. The colonists bade farewell to him in 1868 in an outburst of gratitude and sympathy; but his career as a colonial governor was at an end. Returning to England, he delivered many able speeches advocating what later came to be termed Imperialism, and stood for Newark.

Discouraged, however, by the official Liberals, he withdrew and turned again to New Zealand. In 1872 he was given a pension of £1,000 a year, and settled down on the island of Kawau, not far from Auckland, which he bought, and where he passed his leisure in planting, gardening and collecting books. In 1875. on the invitation of the Auckland settlers, he became superintendent of their province, and entered the New Zealand house of representatives. He became premier of New Zealand in 1877. Manhood suffrage, triennial parliaments, a land-tax, the purchase of large estates and the popular election of the governor, were leading points of his policy. All these reforms, except the last, he lived to see carried; none of them were passed by him. For the fifteen years after the fall of his ministry in 1879 he remained a solitary and pathetic figure in the New Zealand parliament, respectfully treated, courteously listened to, but never again invited to lead. In 1894, he left New Zealand, and made his home in London, where he died on Sept. 20, 1898.

Lives of Sir George Grey have been written by W. L. and L. Rees (1892), Professor G. C. Henderson (1907) and J. Collier (1909).

(W. P. RE. ;X.)

GREY, HENRY GEORGE GREY, 3RD EARL (1802–1894), was an English statesman, born Dec. 28, 1802, at Howick. Northumberland, eldest son of the 2nd Earl Grey (*q.v.*). As Viscount Howick, he sat in the house of commons for Winchelsea, 1826–30, for Higham Ferrers, 1830–31, for Northumberland, 1831–41, and for Sunderland, 1841–45, when he succeeded his father. He became undersecretary for the colonies in his father's ministry in 1830. He belonged to the more advanced party of colonial reformers; sharing the views of Edward Gibbon Wakefield on questions of land and emigration. and he resigned in 1833 from dissatisfaction that slave emancipation was made gradual instead of immediate. In 1835 he entered Lord Melbourne's cabinet as secretary at war, but in 1839 he again resigned, disapproving of the more liberal views of some of his colleagues. He became secretary for war and the colonies in 1846, and the six years of his administration effected a revolution in the relations between England and its colonies. Grey was the first minister to proclaim that the colonies were to be governed for their own benefit as well as for that of England; the first systematically to accord them self-government so far as then seemed possible; and the first to introduce free trade into their relations with Great Britain and Ireland. The concession by which colonies were allowed to tax imports from the mother country *ad libitum* was not his; he protested against it, but was overruled. His greatest success was in Canada, where his appointment of Lord Elgin as governor general and wise support of Elgin's policy led to the recognition of responsible government (1847). He also drafted constitutions for the Australian colonies and for New Zealand, but the latter proved unworkable and had to be suspended, leaving the conduct of affairs in the masterful hands of Sir George Grey (*q.v.*). His policy in the West Indies and Ceylon was criticized as repressive, and he aggravated the difficult situation in the Cape Colony by an ill-judged attempt to settle convicts there. He resigned with his colleagues in 1852 and never again held office. In retirement he wrote a history and defense of his colonial policy in the form of letters to Lord John Russell, a dry but instructive book *(Colonial Policy of Lord John Russell's Administration,* 1853).

During the remainder of his long life, he exercised a vigilant criticism of public affairs. His principal parliamentary appearances were when he moved for a committee on Irish affairs in 1866, and when in 1878 he passionately opposed the policy of the Beaconsfield cabinet in India. He died at Howick on Oct. 9, 1894.

GREY, LADY JANE (1537–1554). for nine days queen of England, was the great-granddaughter of Henry VII. She was the daughter of Henry Grey, marquess of Dorset by his wife, Lady Frances Brandon, daughter of Princess Mary of England by her second marriage with Charles Brandon, duke of Suffolk.

She was born at Bradgate, Leicestershire in Sept. 1537. Her parents bestowed more than ordinary care upon her education, and she became the marvel of the age for her acquirements. She spoke and wrote Greek and Latin with an accuracy that satisfied even such critics as Roger Ascham and her tutor John Aylmer, afterward bishop of London. She also acquired some knowledge of at least three oriental tongues, Hebrew, Chaldee and Arabic. In his *Schoolmaster* Xscham records her devotion to her studies and the harshness she experienced from her parents. Learning was her solace: in reading Demosthenes and Plato she found a refuge from domestic unhappiness. When she was nine years old Thomas, Lord Seymour, obtained her wardship, and induced her parents to let her stay with him, even after the death of his wife, Queen Catherine Parr, by promising to marry her to his nephew, King Edward VI. Lord Seymour, however, was attainted of high treason and beheaded in 1549. Jane returned to her studies at Bradgate.

But the duke of Somerset was beheaded three years after his brother, and, the dukedom of Suffolk having become extinct by the deaths of Charles Brandon and his two sons, the title was conferred upon the marquess of Dorset, Jane's father. Jane was now constantly at court. Northumberland, who was all-powerful, endeavoured to secure his position by family alliances. His fourth son, Lord Guildford Dudley, was accordingly wedded to Lady Jane Grey on May 21, 1553. The bride went to live with her husband's parents, whom she disliked, and the misery of her marriage brought on a severe illness. The match had the full approval of Edward VI, who was now persuaded by Northumberland to break through his father's will and make a new settlement of the succession to the crown in favour of Lady Jane and her heirs. The document was witnessed (June 21) by the signatures of all the council and of all but one of the judges; but those of the judges were obtained only with difficulty by threats and intimidation.

Edward VI died on July 6, 1553, and it was announced to Lady Jane that she was queen. She was 16 years of age. The news was a most unwelcome surprise; she fainted and for some time resisted all persuasions to accept the fatal dignity, but eventually she yielded. The better to mature their plans the cabal had kept the king's death secret for some days; Queen Jane's proclamation was issued on the tenth. Mary, however, had received early intimation of her brother's death, and, retiring from Hunsdon into Norfolk, gathered around her the nobility and commons of those parts. The army with which Northumberland went to oppose her began to melt away. In London many of the councillors met at Baynard's castle, revoked their former acts as done under coercion and caused the lord mayor to proclaim Queen Mary. which he did (July 19) amid the shouts of the citizens. The duke of Suffolk told his daughter that she must lay aside her royal dignity; she replied that she relinquished most willingly a crown that she had only accepted out of obedience to him and her mother, and her nine days' reign was over.

Lady Jane and her father were committed to the Tower; but Suffolk procured a pardon. Lady Jane, her husband Dudley and others were arraigned for high treason at the Guildhall (Nov. 14). She pleaded guilty and was sentenced to death. The execution of the sentence was suspended, but the participation of her father in the Wyat rebellion sealed her fate. She and her husband were beheaded on Feb. 12, 1554, her husband on Tower Hill, and herself within the Tower an hour afterward, amid universal sympathy and compassion.

See Sir N H Nicolas, *Literary Remains of Lady Jane Grey* (London, 1825); R Davey, *The Nine Days' Queen* (London, 1909).

GREY, ZANE (1875–1939), U.S. writer of western fiction, was born in Zanesville, O., on Jan. 31. 1875. He practised dentistry in New Tork (1898–1904). In the latter year he published privately a story of pioneer life. *Betty Zane,* based on a journal by a maternal ancestor. Col Eb Zane. *The Spirit of the Border,* also based on Zane's notes. became a best seller. Grey wrote 54 novels. of which over fifteen million copies were sold. Most popular nas *Riders of the Purple Sage* (1912). Grey died at Altadena, Calif., on Oct. 23 1939 (F L. MT)

GREYHOUND RACING: *see* DOG RACING.

GREYMOUTH, a seaport of New Zealand, the principal port on the west coast of South Island, in Grey county. It stands on the small estuary of the Grey or Mawhera river, has a good harbour and railway communication with Hokitika to the south, Christchurch to the east and Westport to the north. The district is both auriferous and coal-bearing. The timber, wool and flax trade is well developed.

Pop (1961) 8,881.

GREY OF FALLODON, EDWARD GREY, 1ST VISCOUNT (1862–1933), English statesman, was educated at Winchester and at Balliol college, Oxford, and succeeded his grandfather, the 2nd baronet, at the age of 20. Sir Edward Grey entered the house of commons as Liberal member for Berwick-on-Tweed in 1885. He was a disciple of Lord Rosebery, and in the 1892–95 Liberal ministry he was undersecretary for foreign affairs. Outside of foreign affairs he played only a small part in the period of Liberal opposition between 1895 and 1905. When Campbell-Bannerman's cabinet was formed in Dec. 1905, he became foreign minister.

Grey had previously announced that the Liberal government would maintain Lord Lansdowne's policy of an ***entente*** with France and an alliance with Japan, and during the general election of Jan. 1906 he said that, if war were forced on France, which was being pressed by Germany about Morocco, he believed British public opinion would rally to France's support. In 1907 he concluded a convention with Russia about Persia, by which the integrity of that country was to be maintained, but Britain recognized that Russia had rights and interests in the northern zone and Russia recognized Britain's in the southern zone.

In 1908—the year in which Herbert Asquith, an intimate friend of Grey, became prime minister—the European situation was considerably modified by the assertion in October by Prince Ferdinand of the independence of Bulgaria and his assumption of the title of king, and the simultaneous annexation of Austria-Hungary of Bosnia and Hercegovina, which it had administered under the treaty of Berlin. These strokes of policy moved the indignation of both the Russian people and the Russian government; but the German emperor announced that he would stand by his Austrian ally in "shining armour." Grey, though he protested against the infraction of the public law of Europe, was unable to promise Russia anything more than diplomatic support. Grey's main preoccupation was British relations with Germany, which dispatched at the beginning of July 1911, the gunboat "Panther" to the northwest African coast at Agadir, to protect, it was alleged, German interests. In view of this further attempt to test, and if possible loosen, the ***entente,*** he issued a warning through Lloyd George that Britain intended at all hazards to maintain its place among the powers. The warning sufficed to make Germany lower its tone, and subsequently Grey explained to parliament that the foreign policy of the government was a continuation of Lord Lansdowne's and had got rid of the constant trouble with France and Russia; that British friendship with these powers, far from constituting a hostile encirclement of Germany. afforded a guarantee that none would pursue an aggressive policy toward it; but that, when a nation had the biggest army and was increasing its already big navy, it was natural that other powers should be apprehensive.

While a section of Radicals and Labour men were suspicious of Grey's policy. public opinion in general (including the Conservative opposition) supported him. In the following year he received the Order of the Garter, an unusual distinction for a commoner. In the meantime, nothing would content the German government but an absolute pledge of neutrality by Britain if Germany were engaged in war—a pledge which Grey naturally could not give.

As soon as Grey heard of the Austrian ultimatum delivered at Belgrade on July 23, 1914, he realized at once that Russia could not allow Serbia to be crushed Acting in the face of a lukewarm or hostile Germany, he indefatigably proposed various schemes for conciliation and conference; but Austria on the expiry of the time-limit of 48 hr. declared mar on Serbia. Hopeful negotiations which had been begun directly between Russian and Austria were wrecked by a German ultimatum to Russia to countermand its mobilization; and on Monday. Aug. 3, Germany declared war on France.

Grey with a cabinet rallying, with few exceptions, to his view, made an appeal in the house of commons on Aug. 3 for public and parliamentary support to a policy of action. The speech finally decided a wavering public opinion; with the exception of some Radicals and extremist Labour men, all parties, including the Irish Nationalists, accepted the necessity of war. Grey demanded next day that Germany should respect the neutrality of Belgium, and, on the German refusal, England went to war.

Much of his time and attention was occupied by difficult questions arising out of the blockade of Germany and the consequent interference with the trade of neutrals. Public opinion in Great Britain constantly complained that the blockade was not enforced with sufficient strictness; while the United States, as the principal neutral, harassed the British government by repeated notes, denouncing the methods of the British navy as unnecessarily prejudicial to U.S. trade and contrary to international law.

Credit must be given to Grey for facilitating, in the early summer of 1915, the entry of Italy—until May 3 a member of the Triple Alliance—into the war against the Central Powers. His warnings, however, failed to prevent Bulgaria from taking the field against the Allies in the autumn of the same year.

In July 1916 an affection of the eyes, made it advisable that he should have as much relief from work as possible, and he accepted a peerage. When a few months later, in December, Asquith was succeeded in the premiership by Lloyd George, failing eyesight and political comradeship both united to determine him to bring his 11 years' tenure of the foreign office to a close. He had served for a longer consecutive period than any predecessor, and in his official methods he carried out his own precept—that foreign policy required not striking effects or bold strokes but careful steering. With the exception of a three months' mission in 1919 to the U.S. to deal with questions arising out of the peace, he did not emerge from his retirement until 1922. It was the time of the decadence of the coalition government and Lord Grey urged that it was not trusted and should come to an end, which happened within a few months; he was also anxious to resuscitate the Liberal party. In foreign affairs he pressed for the re-establishment of good relations with France, and for the arrangement of an inclusive peace pact, beginning with France. When such a pact was concluded at Locarno in 1925 he welcomed it. The cause to which he devoted most of his energy was that of the League of Nations. In Aug. 1928 Lord Grey was elected chancellor of Oxford university. He died Sept. 7, 1933. (G. E. B.; X.)

See Viscount ***Grey, Twenty-Five Years,*** *1892–1916,* 2 vol. (1925); H. Lutz, ***Lord Grey und der Weltkrieg (1927;*** English trans. by E. W. Dickes, 1928).

GREY OF WILTON and **GREY OF RUTHYN.** The first Lord Grey of Wilton was SIR REYNOLD DE GREY (d. 1308) of Wilton, Herefordshire, and of Shirland, Derbyshire, who was summoned to parliament as a baron in or before 1290. From him descended successive generations of Lords Grey of Wilton, none of whom achieved distinction until WILLIAM (d. 1562), 13th lord, came of age in 1529. He held commands in France under Henry VIII, was a leader of the English army which defeated the Scots at the battle of Pinkie (1547) and helped to suppress the west country rebellion (1549). Imprisoned (1551) as a friend of the fallen Protector Somerset and afterward implicated in the attempt (1553) to put Lady Jane Grey on the throne, he was pardoned by Queen Mary and was entrusted with the defense of Guines. In Jan. 1558 he was forced to surrender the town to the French. He later served in Scotland and besieged Leith in May 1560 His son ARTHUR (d 1593), 14th lord, fought in France and Scotland with his father. As lord deputy in Ireland (1580–82) he reduced the Irish rebels to submission, but was afterward charged with having ordered the massacre of about 500 Italians and Spaniards at Smerwick (Nov. 1580). While in Ireland Grey was served as secretary by Edmund Spenser, and it is perhaps he nho figures as Artegall in the Faerie Queene. He was a commissioner for the trial of Mary, queen of Scots (1586). His son THOMAS (d 1614), 15th and last lord. became involved in the Bye plot and in Nov. 1603 forfeited his honours and was imprisoned in the Tower until his death. With him the male line of the family came to an end, but the title was revived (1784), in the archaic form Grey de Wilton, for a descendant of his sister BRIDGET (d. 1648). SIR THOMAS EGERTON (d. 1814), who was created Viscount Grey de Wilton and earl of Wilton (1801). The barony expired at his death.

In 1282 Edward I rewarded Reynold, Lord Grey of Wilton, for his services in the Welsh wars with a grant of the lordship of Ruthyn, Denbighshire. JOHN (d 1323), 2nd lord of Wilton, settled Ruthyn on his younger son, ROGER (d 1353), who in 1325 was summoned to parliament as LORD GREY OF RUTHYN. Roger's grandson REYNOLD GREY (d 1440), 3rd lord, was appointed lieutenant (1402) in north Wales to deal with the Welsh rebels, but was himself captured by Owen Glendower and was afterward ransomed. He was succeeded by his grandson EDMUND GREY (d. 1490), who deserted to the Yorkist cause while in command of the royal vanguard at the battle of Northampton (1460). He soon found favour with Edward IV, who appointed him treasurer of England (1463) and created him earl of Kent (1465). The title descended with the earldom of Kent until 1639 (*see* KENT, EARLS AND DUKES OF) and the barony passed to the families of Longueville (1639), Yelverton (1676), Rawdon-Hastings (1858), Clifton (1887) and Butler-Bowdon (1939). Edward Grey. a younger son of Reynold, 3rd Lord Grey of Ruthyn, married Elizabeth Woodville, afterward queen of Edward IV.

See Arthur Grey, *A Commentary of the Services and Charges of William, Lord Grey of Wilton, KG.*, ed. by P. de M. Grey Egerton (1847). (C. D R.)

GREYTOWN or SAN JUAN DEL NORTE, a port of Nicaragua on the Caribbean sea, at the mouth of the northern channel of the delta of the San Juan river, close to the Costa Rican border Pop. (1959 est.) 413. Greytown was once the chief port of Nicaragua on the Caribbean, and between 1850 and 1870 when the route across Nicaragua was the most comfortable and luxurious line of travel between eastern United States and California, was the terminus of the Atlantic steamers and the starting point of the river boats which carried travellers up the San Juan river, and across Lake Nicaragua, whence they took a 12-mi. stage ride to the Pacific port of San Juan del Sur, to continue their journey to San Francisco.

Bluefields was also, during the period of the British protectorate over the Mosquito coast. the leading port and the chief residence of the English; the name by which the town was still known in modern times, Greytown, is the English designation, the official Nicaraguan name being San Juan del Norte.

The loss of its prime position as a port was caused by the shifting sands of the San Juan river, which virtually closed the northern delta entrance and left the Costa Rican and border channels the chief means of entry and exit to the river. In 1850, the channel at Greytown was 25 ft deep, but by 1875 it had decreased to 5 ft., eliminating the site as a port of entry for seagoing vessels.

The harbour of San Juan del Norte was discovered by Columbus. and was linked with the traffic into Nicaragua by Capt Diego Machua, who in 1529 sailed down the San Juan river from the lake.

In 1796, San Juan was made a port of entry by Spanish royal charter, and new defenses were built just prior to the Independence, in 1821. The British seized the port in 1848, by virtue of their protectorate over the Mosquito coast, and held it until 1860, when, following the Treaty of Managua, the territory was turned over to Nicaragua.

GRIBEAUVAL, JEAN BAPTISTE DE (1715–1789), French artillery general, was born at Amiens on Sept. 15, 1715. He entered the French royal artillery in 1732, and in 1752 became captain of a company of miners. He was lent to the Austrian army on the outbreak of the Seven Years' War, and served as a general officer of artillery. After his return to France he was made inspector of artillery, but he had to wait until 1776 before he became first inspector and was able to carry out the reforms in the artillery arm which are his chief title to fame. *See* ARTILLERY; and for full details Gribeauval's own *Table des constructions des principaux attirails de l'artillerie . . . de M. de Gribeauval,* and the *règlement* for the French artillery issued in 1776.

See Henntbert, *Gribeauval, lieutenant-général des armées du roy* (1896).

GRIBOYEDOV, ALEXANDER SERGEYEVICH (1795–1829), Russian dramatic author, was born on Jan. 4, 1795, at Moscow, where he studied at the university from 1806 to 1812. He then obtained a commission in a hussar regiment, bat resigned it in 1816. The next year he entered the civil service. and in 1818 was appointed secretary of the Russian legation in Persia, whence he was transferred to Georgia.

He had commenced writing early. and had produced on the stage at St. Petersburg (Leningrad) in 1816 a comedy in verse, translated from the French, called *The Young Spouses,* which was followed by other pieces of the same kind. But neither these nor the essays and verses which he wrote would have been long remembered but for the immense success gained by his comedy in verse. Gore' *ot uma*, or *The Mischief of Being Clever* (Eng. trans. by B. Pares. 1925). A satire upon Russian society, or, as a high official styled it, "A pasquinade on Moscow," its plot is slight, its merits consisting in its accurate representation of certain social and official types — such as Famousov, the lover of old abuses, the hater of reforms; his secretary, Molchanin, servile fawner upon all in office; the aristocratic young liberal and Anglomaniac, Repetilov; contrasted with whom is the hero of the piece, Tchatsky, the ironical satirist, just returned from the west of Europe, who exposes and ridicules the weaknesses of the rest, his words echoing that outcry of the young generation of 1820 which reached its climax in the military insurrection of 1825, and was then sternly silenced by Nicholas. Griboyedov wrote this play during his stay at Tiflis (where he had come, on leave. in 1821) as diplomatic secretary to General Ermolov. *Goré ot uma* is undoubtedly one of the great comedies of European literature. He spent the summer of 1823 in Russia, completed his play and took it to St. Petersburg. There it was rejected by the censorship. Many copies were made and privately circulated, and Griboyedov read it to literary circles in St. Petersburg and Moscow, but the first edition was only printed in 1833, four years after his death. Only once did he see it on the stage, when it was acted by the officers of the garrison at Erivan.

He returned to Georgia to General Ermolov's headquarters, in 1825, and after the revolt of Dec. 14 was arrested as a notorious liberal and sent to St. Petersburg, where he succeeded in exculpating himself. He returned to serve with his relative Count Paskievitch-Erivansky during a campaign against Persia, negotiated the peace of Turkmanchai (Feb. 20, 1828) and took the treaty to St. Petersburg.

He considered devoting himself to literature and commenced a romantic drama, *A Georgian Night.* But he was suddenly sent to Persia as minister-plenipotentiary to supervise the execution of the treaty. Soon after his arrival at Tehran the Russian embassy was stormed because of the refuge given there to Russian subjects from Persian harems. Griboyedov was killed during this attack (Feb. 11, 1829).

GRID, in a vacuum tube such as is used in electrical communication, is an electrode having openings through which the electron stream, between cathode and anode, may pass. The relative potential of the grid controls the current flowing between the anode and the cathode.

GRID LEAK, is a resistor, usually of very high resistance, used in association with a condenser and connected directly or indirectly between the cathode and the grid of a vacuum tube in a radio receiving set.

GRIEG, EDVARD HAGERUP (1843–1907), Norwegian composer, was born on June 15, 1843, in Bergen, where his father, Alexander Grieg, was English consul. The Grieg (formerly Greig) family were of Scottish origin, the composer's grandfather having emigrated after Culloden. His mother, Gesine Hagerup, belonged however, to a pure Norwegian peasant family; and it is from her that Grieg appears to have derived his musical talent. She began to give her son lessons on the pianoforte when he was six and his first composition, "Variations on a German melody." was written at the age of nine. In the autumn of 1858, at the recommendation of Ole Bull (*q.v.*), young Grieg entered the Leipzig conservatorium, where he came under the influence of the Mendelssohn and Schumann Romantic school. From Leipzig he went, in 1863, to Copenhagen where he studied for a short time with Niels Gade and Emil Hartmann, both composers representing a sentimental strain of Scandinavian temperament, from which Grieg emancipated himself in favour of the harder inspiration of Richard Nordraak. "The scales fell from my eyes," said Grieg afterward of his acquaintance with Nordraak. "For the first time I learned through him to know the northern folk tunes and my own nature. We made a pact to combat the effeminate Gade-Mendelssohn mixture of Scandinavianism, and boldly entered upon the new path along which the northern school at present pursues its course." A kind of crusade in favour of Norwegian national music resulted, and in the winter of 1864–1865 Grieg founded the Copenhagen concert-society Euterpe for the production of the works of young Norwegian composers. During the winters of 1865–66 and 1869–70 Grieg was in Rome where he met Franz Liszt, who played his piano concerto at sight from the manuscript and gave it his enthusiastic approbation. In the autumn of 1866 he settled in Christiania. In 1872 the Royal Musical academy of Sweden made him a member; in 1874 the Norwegian Storthing granted him an annual stipend of 1.600 kronen. In 1888 he played his pianoforte concerto and conducted his "two melodies for strings" at a Philharmonic concert in London, and visited England again in 1891, 1894 and 1896. He died at Bergen on Sept. 4, 1907.

As a composer Grieg's strength lies in his strong nationalistic colouring, in his exquisite lyrical feeling and in his command of the picturesque and romantic, as exemplified in his lovely and world-famous music to Ibsen's *Peer Gynt*, or in the suite for stringed orchestra, *Aus Holbergs Zeit*, and hardly less so in the equally beautiful and well-known piano concerto. As regards his songs they may be said to be generally the more spontaneous the more closely they conform to the simple model of the *Volkslied*. Yet the much sung *Ich liebe dich* is a song of a different kind, which has hardly ever been surpassed for the perfection with which it depicts a strong momentary emotion; while such other familiar examples as *Solvejg's Lied* and *Ein Schwann* are equally beautiful and characteristic.

Bulow called Grieg the "Chopin of the North," and the phrase may pass though the range of appeal and the quality of the inspiration in Chopin are considered far greater; nor did the national movement inaugurated by Grieg show promise of great development. He may be regarded rather as the pioneer of a musical mission which was perfectly carried out by himself alone.

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GRIEG, (JOHAN) NORDAHL BRUN (1902–1943), Norwegian writer, who combined strong patriotic feelings with a wide cosmopolitan outlook, was born at Bergen on Nov. 1, 1902. After studying literature and languages in Oslo and later in Oxford he combined extensive traveling with journalism, and a strong social conscience was already evident in his first books, the sea poems *Rundt Kap det gode Haab* ("Round the Cape of Good Hope"; 1922), influenced by Kipling, and the novel *Skibet gaar videre* (1924; Eng. trans., *The Ship Sails on*, 1927).

Grieg's love for Norway, especially northern Norway, was expressed without reserve in the poems *Norge i våre hjerter* ("Norway in Our Hearts"; 1929). After publishing six highly personal essays on Keats, Shelley, Byron, Rupert Brooke, C. H. Sorley and Wilfred Owen, *De unge døde* ("The Young Dead Ones"; 1932), he spent two years in Moscow (1932-34). There his social consciousness turned communist. Russian theatre and above all the technique of the cinema inspired his most powerful social play, *Vår ære og vår makt* ("Our Honour and Our Power"; 1935). When Germany occupied Norway in 1940, Grieg escaped to Britain and in his war poems became the leading voice of free Norway. He was killed while on a bombing raid over Berlin on Dec. 2, 1943.

Collected works: *Samlede Verker*, 7 vol. (1947); *Samlede dikt* (1948). *See* also Harald Engberg, *Nordahl Grieg og Tidens Drama* (1946); Kjølv Egeland, *Nordahl Grieg* (1953). (To. S.)

GRIEN, HANS: *see* BALDUNG, HANS.

GRIERSON, SIR GEORGE ABRAHAM (1851-1941), Anglo-Irish linguist, notable for his researches into the languages of India, was born Jan. 7, 1851, at Glanageary, County Dublin, of an Anglo-Irish family of publishers and printers. He acquired his first taste for Indian languages at Trinity college, Dublin, where he took prizes in Sanskrit and Hindi. He qualified for the Indian civil service in 1871 and arrived in Bengal in Oct. 1873.

Grierson spent the next 26 years mostly in Bihar and western Bengal, where he held various posts as magistrate and collector of revenue.

Grierson's first book *Bihar Peasant Life* (1885) contains vast information on the language, techniques, usages and superstitions of the peasantry among whom he had lived. This book was followed by numerous monographs published in *The Indian Antiquary* and in *The Journal of the Asiatic Society of Bengal*, as Grierson's researches spread to Hindi, to the northwestern Dardic languages, which he termed Pisaca, and to Kashmiri. In 1898 he was appointed superintendent of the *Linguistic Survey* of India, a work which engaged his attention from 1898 to 1928, and in which he had the assistance of the Norwegian linguist Sten Konow. The *Survey* in 19 folio volumes furnishes vocabularies for 364 languages and dialects of India. For most of these a skeleton grammar and brief texts are given as well.

Grierson had also a deep interest in Indian popular literature and Indian religion.

Grierson was knighted in 1912, and received the honour of Order of Merit in 1928. A bibliography of his numerous works appears in the *Bulletin of the London School of Oriental and African Studies* for 1936. A brief memoir of his life has been printed in the *Proceedings of the British Academy*, vol, xxviii.

(D. H. H. I.)

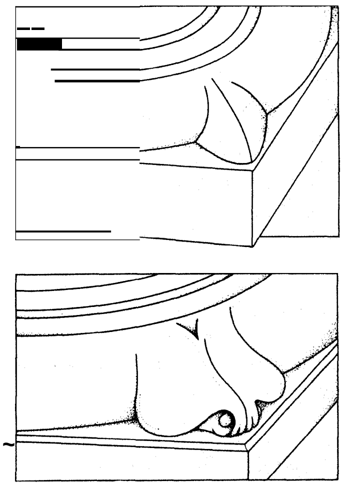
GRIERSON, SIR JAMES MONCRIEFF (1859–1914), British soldier, was born at Glasgow on Jan. 27, 1859, and joined the royal artillery in 1877. Noted from the outset as an exceptionally keen student of his profession, from 1896 to 1900 he was military attaché at Berlin. As a colonel he was with Lord Roberts during the advance from Bloemfontein into the Transvaal; but he was then transferred to China to act as British military representative on the staff of Count Waldersee, commander in chief of the Allied forces against the Boxers. In 1904 he was appointed director of military operations. He commanded the 1st division at Aldershot from 1906–10, and was in 1912 put in charge of the eastern command.

On the outbreak of World War I, Sir J. Grierson was selected for the command of the 2nd army corps. He proceeded to France, but died suddenly on Aug. 17, 1914.

See D. S. Macdiarmid, *Life of Sir James Moncrieff Grierson* (1923).

GRIESBACH, a German watering place in the *Land* of Baden-Wiirttemberg, in the valley of the Rench, 1,800 ft. above the sea, 6 mi. W. of Freudenstadt in Wiirttemberg. It is celebrated for its saline chalybeate waters which were used as early as the 16th century. Pop. (1959 est.) 948. From 1665 to 1805 Griesbach was part of the bishopric of Strasbourg.

GRIFFE, in architecture, a small ornament, generally triangular, which fills the space between the round torus of a column base and the square corner of the plinth below; sometimes known as a spur.



FROM VIOLLET LE DUC, "DICTIONNAIRE RAISONNE DE L'ARCHITECTURE FRANÇAISE"

TOP. BASE FROM THE 11TH CENTURY. BOTTOM: BASE FROM PARIS CATHEDRAL

The use of the griffe is particularly characteristic of the later Romanesque period; it usually takes the form of a group of leaves or a single curling leaf. Grotesque animals are occasionally found.

GRIFFENFELDT, PEDER, COUNT (PEDER SCHUMACHER) (1635–1699), Danish statesman, was born at Copenhagen on Aug. 24, 1635, of a wealthy trading family. He was a precocious child, and received an excellent education. In 1654 Schumacher was sent abroad to complete his studies. From Germany he proceeded to the Netherlands, staying at Leiden, Utrecht and Amsterdam, and passing in 1657 to Queen's college, Oxford, where he lived three years. In the autumn of 1660 Schumacher visited Paris, shortly after Cardinal Mazarin's death, when the young Louis XIV first seized the reins of power. Schumacher seems to have been profoundly impressed by the administrative superiority of a strong ,centralized monarchy; and, in politics, as in manners, France ever afterward was his model. The last year of his travels was spent in Spain, where he obtained a thorough knowledge of the Castilian language and literature. On his return to Copenhagen, in 1662, Schumacher found the monarchy established on the ruins of the aristocracy. He secured the protection of Kristoffer Gabel, the king's confidant, and in 1663 was appointed the royal librarian. A friendship with the king's bastard, Count Ulric Frederick Gyldenlove, consolidated his position. In 1665 Schumacher obtained his first political post as the king's secretary, and the same year he composed the memorable *Kongelov.*

On the death of Frederick III (Feb. 9, 1670) Schumacher was the most trusted of all the royal counselors. He alone was aware of the existence of the new throne of walrus ivory embellished with three silver life-sized lions and of the new regalia, both of which treasures he had, by the king's command, concealed in a vault beneath the royal castle. Frederick III had also confided to him a sealed packet containing the *Kongelov,* which was to be delivered to his successor alone. Schumacher had been recommended to his son by Frederick III on his deathbed. When, on Feb. 9, 1670, Schumacher delivered the *Kongelov* to Christian V, the king bade all those about him withdraw, and after being closeted an hour with Schumacher, appointed him his "Obergeheimesekreter." His promotion was rapid. In July, 1670, he was ennobled under the name of Griffenfeldt; in November: 1673, he was created a count, a knight of the Elephant and, finally, imperial chancellor. In the course of the next few months he gathered into his hands every branch of the government.

On May 25, 1671, the dignities of count and baron were introduced into Denmark "to give lustre to the court"; a few months later the order of the Danebrog was instituted as a fresh means of winning adherents by marks of favour. Griffenfeldt was the originator of these new institutions. To him monarchy was the ideal form of government. But he had also a political object. Griffenfeldt saw that, in future, the first at court would be the first everywhere. He promoted trade and industry by the revival of the *Kammer Kollegium,* or board of trade, and the abolition of some of the most harmful monopolies. Both the higher and the provincial administrations were reformed and centralized; and the positions and duties of the magistrates, who now also received fixed salaries, were exactly defined. In the last three years of his administration, Griffenfeldt gave himself entirely to the conduct of the foreign policy of Denmark. He aimed at restoring Denmark to the rank of a great power by carefully nursing her resources, and in the meantime securing and enriching her by alliances, which would bring in large subsidies while imposing a minimum of obligations. This policy demanded: first, peace, especially peace with Denmark's most dangerous neighbour. Sweden; and, secondly, a sound financial basis, which he expected the wealth of France to supply. Next, Denmark was to beware of making enemies of France and Sweden at the same time. An alliance on fairly equal terms between the three powers would, in these circumstances, be the consummation of Griffenfeldt's "system"; an alliance with France to the exclusion of Sweden would be the next best policy; but an alliance between France and Sweden, without the admission of Denmark, was to be avoided at all hazards. But, despite Griffenfeldt's open protests and subterraneous countermining, war was actually declared against Sweden in 1675, and his subsequent policy seemed so obscure and hazardous that his enemies found an opportunity to destroy him.

On March 11, 1676, Griffenfeldt was arrested in the king's name and conducted to the citadel, a prisoner of state. On May 3 he was tried by an extraordinary tribunal of ten dignitaries, and conducted his own defence on a variety of charges. For 46 days before his trial he had been closely confined in a dungeon without lights. books or writing materials. Every legal assistance was illegally denied him. Nevertheless he proved more than a match for his accusers. But he was condemned to degradation and decapitation. The primary offence of the ex-chancellor was the taking of bribes, which no twisting of the law could convert into a capital offence. while the charge of treason had not been substantiated. Griffenfeldt was pardoned on the scaffold, his sentence being commuted to lifelong imprisonment. Denmark's greatest statesman lingered out his life for 22 years in a lonely state prison, first in the fortress of Copenhagen, and finally at Munkholm on Trondhjem fiord. He died at Trondhjem on March 12, 1699.

See also DENMARK : *History.* (R. N. B.; X.)

GRIFFES, CHARLES TOMLINSON (1884–1920), U.S. composer of impressionistic music of pronounced melodic and harmonic originality, was born at Elmira, N.Y., Sept. 17, 1884. He studied piano in Berlin in 1903–07 but decided to compose. He returned to the U.S., took a position as music teacher in a school for boys at Tarrytown, N.Y., and wrote in his spare time. His works, all highly coloured, showed a succession of influences by German, French, Italian, Russian, American Indian and oriental sources. His best-known works include *The Pleasure Dome of Kubla Khan,* a symphonic poem after Coleridge; *Sho-Jo* and *The Kairn of Koridwen,* dance dramas; *The White Peacock,* an orchestral tone poem, and Sonata for piano. He died in New York city on April 8, 1920.

GRIFFIN (O'GRIOBTA, O'GREEVA), **GERALD** (1803–1840), Irish novelist and dramatic writer, was born at Limerick. Having written a tragedy, *Aguire,* which was highly praised by his friends, he set out in 1823 for London with the purpose of "revolutionizing the dramatic taste of the time by writing for the stage." In spite of the recommendations of John Banim, he had a hard struggle. *The Noyades,* an opera entirely in recitative, was produced at the English Opera house in 1826; and the success of *Holland Tide Tales* (1827) led to *Tales of the Munster Festivals* (3 vol., 1827), which were still more popular. In 1829 appeared his fine novel, *The Collegians,* afterward successfully adapted for the stage by Dion Boucicault under the title of *The Colleen Bawn.*

Griffin followed up this success with other novels, and a number of lyrics touched with his native melancholy. But he became doubtful as to the moral influence of his writings, and sought admission into a society of the Christian Brothers at Dublin, in Sept. 1838, under the name of Brother Joseph. He died at Cork of typhus fever on June 12, 1840. Before adopting the monastic habit he burned all his manuscripts; but *Gisippus,* a tragedy which he had composed before he was 20, accidentally escaped destruction, and in 1842 was put on the Drury Lane stage by Macready with great success.

GRIFFIN (GRIFFON or GRYPHON), a composite creature with lion body, winged or wingless, and bird (usually eagle) head. The name is from the Greek *gryps* via the Latin *gryphus.* Like the sphinx (*q.v.*), the griffin is a favourite motif in decorative arts in the ancient near east and classical lands. Probably originating in the Levant in the 2nd millennium B.C., it occurred on seals and ivories all over western Asia by about 1500 B.C.; it was common in Crete around the same time and by the 14th century B.C. was known in Greece also. The Asiatic griffin has a crested head, while the Minoan and Greek griffin usually has a mane of spiral curls. It may be recumbent or seated on its haunches, often paired with a sphinx; occasionally it acts as a beast of prey, leaping on another animal, but it may itself be the victim of a predator. The large griffins painted on the throne room wall of the palace of Minos in Crete suggest a protective function for the beast.

In the Iron Age the griffin again appeared in both Asia and Greece. At Carchemish on the upper Euphrates it is carved on a palace wall of the 10th century, and Assyrian reliefs of the next three centuries show griffin-demons. It occurred in the 8th century among the cast bronzes of Urartu in the Armenian mountains and apparently traveled westward through Anatolia to Greece. From the 8th to the 6th centuries (orientalizing and archaic periods) the griffin is common on Greek metalwork and ivories and occurs also on painted vases. Greek metalworkers evolved a handsome, stylized rendering. with the beak open to show the curling tongue and the head provided with horses' ears and a large knob on top. Often griffin heads ornamented the rims of huge bronze caldrons, and similar caldrons are known from Armenia, to the Etruscan tombs of Italy. Apparently the griffin was in some sense sacred, appearing frequently in sanctuary and tomb furnishings, but its precise meaning is unknown. The few references in the ancient authors give no clear idea of the nature of the creature or its role in cult and legend. (A. Ps.)

GRIFFITH, ARTHUR (1872–1922), Irish politician, was born in Dublin on March 31, 1872 and began his working life as a printer. When the Irish party was divided over the Parnell case, Griffith, like Dublin artisans in general, sided with Parnell and against the clergy. But the rancorous quarrels which then disfigured Irish politics disgusted young men and led them to despair of success along constitutional lines. New organizations came into existence in Dublin, the most important being the Gaelic League for the revival of the Irish language. Griffith joined this movement, but his main activities were with the Celtic Literary Society, the leading figure of which was William Rooney. Over and above all these minor groups there existed the Irish Republican Brotherhood or Fenian Society, of which Griffith became a member. He went to South Africa in 1896, owing to lack of employment in Dublin, but home-sickness brought him back to Ireland in 1898. In 1899 *The United Irishman,* a weekly paper, was established.

Early Writings and Aims.—At first Rooney counted for more in the new movement than Griffith, for he possessed that personal magnetism in which Griffith was lacking; yet after his death in 1901, the paper strengthened rather than weakened. No such journalism had appeared in Dublin since the time of Young Ireland. It was savagely political; but its politics had an idealism which was foreign to the agrarian revolution. Griffith cared passionately for the things of the mind; his own writing had the beauty of trenchant steel; and he welcomed contributions from the best writers in Ireland, W. B. Yeats, "A. E." and the rest. No contributor expected to be paid, for all knew that Griffith himself lived on a pittance.

Griffith's aim was both destructive and constructive. He sought first to divert his countrymen from the attempt to win self-government through parliamentary action at Westminster, and secondly to persuade them to work for it in their own country. Although all his intimate associates were Fenians, he recognized that the majority of Irish Nationalists did not think separation from Britain possible. He therefore resigned membership of the I.R.B., and aimed at winning over the separatists to work for a parliament in Ireland united to that of England only by the link of the Crown. As a means to this end, he proposed passive resistance and an appeal to moral force. Payment of taxes was to be refused. Members elected to parliament were to absent themselves from Westminster, and to sit in Ireland as a council and govern only by the assent of the nation. Tribunals were to be set up to which cases should be brought.

Rise of Sinn Féin.—This policy was first publicly announced at a meeting in Dublin in Oct. 1902. The body which met called itself Cumann na nGaedheal or "Society of the Gaels." But the name chosen to represent their policy was Sinn Féin, "Ourselves"—Irish words which in their proverbial use mean roughly "Stand together." The name was soon transferred from the policy to its adherents. Candidates were put forward at municipal elections and by 1906 there were 14 Sinn Féiners on the Dublin corporation. But Griffith's propaganda was mainly confined to the capital; and in 1907 a member of the Irish party, who resigning his seat, stood for re-election as a Sinn Féiner, was defeated.

The new policy at first did not make much headway. Resistance to taxation proved difficult because all taxation except income tax was indirect, and a large proportion of income tax payers were unionists. The only effective forces were the personality and the pen of Arthur Griffith. His paper changed its name in 1906 when damages for libel were awarded against the *United Irishman.* That journal disappeared, and re-emerged as *Sinn Féin.* In 1907, when the Parliamentary party had suffered a reverse, *Sinn Féin* appeared as a daily paper, but this experiment soon had to be abandoned, and after another bankruptcy *Eire* became its name. Griffith wrote no books: but he published in 1905 a pamphlet called *The Resurrection of Hungary* which described how an almost vanished language had been restored to national use, and how the elected deputies of an ancient nation, through a policy of abstention from the Austrian Assembly, gained full freedom under a dual monarchy.

The Volunteer Movement.—Griffith, during these years, taught the rising generation to despise and distrust not only the methods but the character of those who were then leading the main national movement and he was not too scrupulous in his modes of attack. Yet when it became clear in 1911 that a Home Rule Bill was seriously intended, he announced his intention not to hamper Redmond. But the measure proposed was wholly unlike his ideal and he condemned it root and branch, his most furious opposition being directed against that partition of Ireland which he was later constrained to accept. In the shaping of events, neither he nor his paper counted for much till the growth of the Ulster Volunteers revived the hopes of the physical force party. Griffith supported the counter-organization of the Irish Volunteers by word and deed. He was one of those who received the rifles landed at Howth in July 1914. At the outbreak of the World War the Volunteers split, nine-tenths of them adhering to Redmond in support of the British cause but the remainder, active and determined, remained in Ireland; and Griffith's paper was their main organ. The censorship attacked it, but instead of *Eire,* there came out *Scissors and Paste,* a journal consisting of extracts from war news arranged to give an impression very unfavourable to the Allies. It was only one of many journals Griffith had founded a school, a "mosquito press" and had set the example of tenacity and courage.

The Easter Rising.—The Easter Rising of 1916 was a surprise to the majority of Irishmen. Griffith took no part in it and thereby lost influence with the extremists. But the British authorities remedied this by putting him into Frongoch, the detention camp in Wales, which became a crowded academy of Sinn Féin. Yet when, in July 1917, the prisoners were released, de Valera was chosen as their leader. Griffith proposed this election at the convention of Sinn Féin, while he himself returned to his desk, re-issuing his paper as *Nationality:* this also was suppressed and re-appeared as *Eire Og.* He was again put in jail in 1918. At the general election after the armistice, Sinn Féin swept the board outside Ulster, and Griffith's policy was put into force. The elected members (such as were not in prison) assembled as Dail Eireann, the Irish parliament. But, going beyond Griffith's plan, they declared for an Irish republic, electing de Valera as president and Griffith as vice-president. Both these men were then prisoners; but after some months the president escaped and Griffith was liberated.

Griffith as Leader.—During de Valera's absence in America, from June 1919 to the close of 1920, Griffith acted as head of the "Irish Republic." His policy now was carried out in its entirety. The elected bodies, county councils and municipalities refused to take orders from the British authorities in Dublin castle; Sinn Féin courts were set up and functioned with notable success; income tax was withheld. But these forms of passive resistance were effective only because active resistance was in progress. Griffith neither launched nor controlled the guerrilla war, to the pressure of which England finally yielded. During that struggle, power rested with Collins and other young men. Yet Griffith had still a great part to play. When the truce was proclaimed and negotiations were opened in July 1921, de Valera refused to accept the responsibility of abating the full separatist demand. Griffith thereupon undertook the leadership of the delegation which finally secured the inclusion in the treaty of the substance of Sinn Féin's original demand.

Many of those who supported him would not accept the full consequences of the treaty; and when de Valera resigned, Griffith was elected president, not of the Irish Free State, but of the republic, and the army continued to be in theory the republican army. To meet the difficulty, Griffith set up a provisional government with Michael Collins as chairman to carry on until a general election should have ratified the treaty. This resulted in an illogical division of authority, and as months passed Griffith's public utterances as president were often contradicted by the action or inaction of the provisional government. During the final diicussions with the British government in June 1922, concerning the treaty, he interviewed the leading Irish unionists and pledged himself to secure them full representation in the public life of the Free State. His conception of Ireland was less narrowly Gaelic than that of Sinn Féin in general. After the elections on June 16, when a plain verdict was given for acceptance of the treaty, the government was at last forced to take action against the mutinous section of the army. Civil war began on June 27. In July the main bodies of the irregulars were everywhere decisively beaten, and on Aug. 11 a force sent around by sea occupied Cork, the last important town to be regained. On the morning of Aug. 12 Griffith fell dead suddenly on the way to his office in Dublin. Essentially he ranks as a publicist, an educator, an inspirer of action. (S. G.)

GRIFFITH, DAVID (LEWELYN) WARK (1875–1948), U.S. motion-picture director and producer, under whose direction the camera developed into a superb instrument for the expression of emotions and ideas, was born in Oldham county, By., on Jan. 22, 1875. After various jobs in Louisville, he played small parts with the Mefert stock company (1897–99) and later toured with other stock companies. In 1907 he sold his first play, *A Fool and a Girl*, for $1,000. The production was a failure, and he then turned to the new medium of motion pictures. He was hired for a leading role in *Rescued From the Eagle's Nest* (1907) and sold several stories to Biograph studios.

In 1908 Griffith went to work as a director for Biograph, continuing until 1913 when he became associated with Mutual Films. In 1914 he began work on a film based on *The Clansman*, a Civil War novel by Thomas Dixon. It was an epochal picture. Opening in New York city in March 1915 with the title *The Birth of a Nation*, it established motion pictures both as popular entertainment and as an art. The racial aspects of the picture aroused much controversy. In 1916 Griffith released *Intolerance*, an epic sermon against injustice and despotism. With Charlie Chaplin, Douglas Fairbanks and Mary Pickford, he formed United Artists Corp. in 1919.

Among Griffith's other famous pictures were *Broken Blossoms* (1919), *Way Down East* (1920) and *Orphans of the Storm* (1922). His two talking pictures were less notable. He retired from directing in 1932.

Griffith was a genius in the art of the film. He originated or improved upon the long shot, the close-up, the pan shot, high- and low-angle shots, the moving shot, the dissolve, soft focus, cross-cutting. the flashback. night photography and back lighting. His contributions to editing and his use of tempo, scenery and crowds were equally remarkable. He died in Hollywood, Calif., on July 23, 1948. (M. S. By.)

GRIFFITHS, JOHN WILLIS (1809–1882), U.S. naval architect, creator of the first notable clipper sailing ship, was born in New York city on Oct. 6, 1809. He was apprenticed to his father's trade of shipwright, and at the age of 19 laid the lines of the frigate "Macedonia." In 1835 he suggested the ram for the bow of warships; in 1836 he published a series of articles embodying his ideas on shipbuilding in the *Advocate* at Portsmouth, Va.; in 1842 he gave a series of lectures on naval architecture in New York city and elsewhere, the first notable discourses on the subject to be given in the United States. In the same year he opened a free school for instruction in shipbuilding. In 1841 he proposed departures from the accepted standards in ship construction and in 1843 began the construction of a ship embodying his proposals for William H. Aspinmall, a New York merchant engaged in the China trade.

This ship, christened the "Rainbow" and launched in 1845, was the first renowned clipper, and introduced a new era in shipbuilding. Expressing an important tenet of modern aesthetics (announced simultaneously by his contemporary Horatio Greenough), Griffith argued that form produced in accordance with functional needs not only sails fastest and carries large cargoes, but is beautiful.

Continuing his experiments. Griffiths invented. in 1848, iron keelsons for wooden ships. and exhibited a steamboat model at the 18jr London exhibition. Three years later he built for William Norris of Philadelphia a steamer that made a record for speed betneen Havana and New Orleans.

He became coeditor and associate proprietor of the *Nautical Magazine and Naval Journal* in 1856, but upon his appointment by the U.S. government as special naval constructer in 1858, the magazine ceased publication. He then built the U.S. gunboat "Pawnee," incorporating several new features including twin screws and a drop bilge, which was one of the widest and lightest draft vessels of similar displacement ever built. Then followed a series of inventions: bilge keels to prevent rolling (1863), a timber-bending machine which he used with success in the "New Era," Boston, 1870, and triple screws for great speed (1866). He was engaged by the U.S. government in 1871–72 to erect timber-bending machinery, and in 1872 built the "Enterprise" for the government at Portsmouth. N.H. In 1879–82 he was engaged in editorial work on the *American Ship*, a New York city weekly journal. He died in Brooklyn, N.Y., on April 29, 1882.

His *Treatise on Marine and Naval Architecture*, 2 vol. (1850), was republished in England, and brought him recognition from many maritime nations. He also published *The Shipbuilder's Manual*, 2 vol. (1853); *The Progressive Shipbuilder*, 2 vol. (1875–76). (A. B.-B.)

GRIGNARD, VICTOR (1871–1935), French chemist, who shared the 1912 Nobel prize in chemistry with Paul Sabatier (*q.v.*) for his discovery of the so-called Grignard reaction. Born at Cherbourg, May 6, 1871, he studied at Lyons under Louis Bouveault and Philippe Barbier. It was Barbier who in 1898 had Grignard repeat some experiments on the preparation of a tertiary alcohol from a mixture of methyl heptyl ketone, magnesium and methyl iodide. Grignard hit upon the idea of treating the iodide mith the magnesium first, and, following older experiments of Sir Edward Frankland on the preparation of zinc alkyls, carried out the reaction in ether.

This first of the Grignard reagents was a complete success, and by 1901 Grignard was able to obtain a doctor's degree on the synthesis of acids, alcohols and hydrocarbons. Other syntheses followed, including the discovery by Grignard's pupil Émile Blaise that organometallic compounds of other metals are most conveniently prepared from Grignard reagents. Grignard became professor of organic chemistry at Nancy in 1910 and at Lyons in 1919. He died Dec. 13, 1935.

For biographical details *see* H. Gilman, *J. Amer. Chem. Soc.*, Proc. 59, 17 (1937); C Courtot, *Bull. Soc chim.* Fr., vol. 3, p. 1434 (1936); H. Rheinboldt, J. *Chem. Educ.*, 27:476–488 (1950).

GRIGNARD REAGENTS are organic derivatives of magnesium, commonly prepared by the reaction of an organic halide (RX, where R represents an organic radical and X represents chlorine, bromine or iodine) in a solvent which is usually diethyl ether. They are usefully represented by the general formula RMgX, though they have somewhat complex constitutions (*see* below). Their very high chemical reactivity makes them one of the most valuable classes of synthetic reagents, a typical and simple reaction being the formation of ethyl phenyl carbinol from benzaldehyde and ethylmagnesium bromide:

$$C_2H_5MgBr + C_6H_5CHO \rightarrow C_6H_5CH(OMgBr)C_2H_5$$
$$\xrightarrow{H_2O} C_6H_5CH(OH)C_2H_5 + MgBrOH$$

They are named after Victor Grignard (1871–1935), who developed their chemistry in 1900 and the following years. Organomagnesium compounds (R_2Mg) had first been prepared. with some difficulty, by Auguste André Thomas Cahours in 1860. Grignard's contribution, for which he was awarded the Nobel prize for chemistry in 1912, was the discovery that organomagnesium halides could be prepared, and used for a great variety of synthetic purposes, from an organic halide and metallic magnesium provided that a suitable solvent is used. The solvent is normally diethyl ether, but other solvents which share the common characteristic of donor character can also be used.

The preparation, constitution and typical reactions and synthetic applications of Grignard reagents are briefly reviewed below.

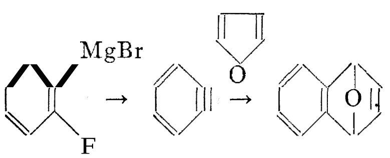
Preparation Using Ether as the Solvent. — Grignard reagents are normally prepared by the slow addition of a solution of the appropriate organic halide in ether to a stirred suspension of magnesium in the same solvent. Since Grignard reagents react very rapidly with oxygen and mith water, it is desirable that air should be excluded and that both reactants and apparatus should be dry.

Since metallic magnesium, once exposed to air, is always coated with a thin film of oxide, the reaction cannot start until this film has been broken down. The formation of a Grignard reagent is therefore slow at the beginning, but the reaction usually accelerates very markedly once an appreciable amount of reagent has been formed. One method for starting the reaction is to crush some of the metal (turnings are generally used) with a glass rod after a little halide has been added. Addition of a small crystal of iodine, or the use of magnesium which has previously been heated to about 200° C. in the presence of some iodine, are more favoured methods for starting reaction; these methods owe their efficacy to the attack of iodine on the magnesium affording ether-soluble magnesium iodide and exposing an active metal surface. Magnesium bromide and iodide also form ether-insoluble hydrates which have a most advantageous effect in further drying the ether present. A similar effect may be achieved by the use of a little ethylene dibromide, which attacks magnesium rapidly, forming ethylene and magnesium bromide. This method is especially recommended when there is any reason to suspect the dryness of the ether, and is generally preferred to the "entrainment method" whereby a particularly reactive halide such as methyl iodide or ethyl bromide is added to the magnesium along with the less reactive halide from which a Grignard reagent is desired. The disadvantage of the entrainment method is the simultaneous formation of two Grignard reagents, and later, necessarily, of two sets of products.

Organic halides vary greatly in their rates of reaction with magnesium. For example, alkyl iodides generally react very rapidly whereas most aryl chlorides react very slowly, if at all. The most reactive halides are liable to undergo side reactions such as the Wurtz reaction, or the formation of olefins by dehydrohalogenation. If a choice between a chloride, bromide and an iodide is possible, it is best to use the least reactive halide which reacts sufficiently rapidly.

The formation of Grignard reagents is a strongly exothermic reaction, so care is necessary to avoid the addition of too much halide before the reaction is well started. Halide is usually then added at a rate sufficient to maintain steady boiling of the ether. It is desirable to complete the preparation of a Grignard reagent in one operation, and the maintenance of steady boiling has the advantage that the atmosphere of ether vapour keeps air away from the reagent. If boiling is allowed to cease before the reagent is used, then an atmosphere of dry oxygen-free nitrogen should be provided.

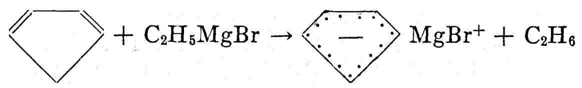
Di-Grignard reagents (XMgRMgX) have considerable synthetic value, but are obtainable as a rule only with difficulty. *Meta* and para aromatic dihalides have not been converted satisfactorily to di-Grignard reagents by any direct route, though, for example, paradibromobenzene affords paradilithiobenzene by reaction with n-butyl-lithium. *Ortho* dihalides such as o-hromoiodobenzene have afforded di-Grignard reagents which have found application in the synthesis of o-phenylene tertiary diphosphines (F. G. Mann). A peculiar complication in the case of o-dihalides is the side reaction resulting in elimination of magnesium halide and formation of the very reactive "benzyne" intermediate which immediately undergoes addition reactions (F. G. Mann, G. Wittigj, with furan for example:



Indirect methods for the preparation of Grignard reagents are not so widely used as the indirect methods for organolithium compounds. The metal-hydrogen exchange reaction is particularly useful for obtaining Grignard reagents derived from relatively acidic hydrocarbons. These hydrocarbons derive their acidity from the enhanced electronegativity of acetylenic carbon,

$$C_6H_5C{\equiv}CH + C_2H_5MgBr \rightarrow C_6H_5C{\equiv}CMgBr + C_2H_6$$

or from the formation of an aromatic from a nonaromatic system,



It is probable that both these types of Grignard reagent, the acetylenic and the cyclopentadienyl (both most useful synthetic reagents), hdve essentially ionic constitutions. Carbanions of these types are much less reactive than those derived from alkyl or simple aryl groups and do not attack ether. Acetylene itself affords a di-Grignard reagent,

$$C_2H_2 + 2C_2H_5MgBr \rightarrow BrMgC{\equiv}CMgBr + 2C_2H_6$$

but the mono-Grignard reagent has been prepared by the slow addition of ethyl magnesium bromide to tetrahydrofuran which is kept saturated with acetylene (E. R. H. Jones, L. Skatteböl and M. C. Whiting),

$$C_2H_2(\text{excess}) + C_2H_5MgBr \xrightarrow{\text{THF}} HC{\equiv}CMgBr + C_2H_6$$

Preparation Using Solvents Other Than Ether. — Grignard reagents are prepared and used in diethyl ether far more than in any other solvent. However, other solvents are preferred, (1) when high reaction temperatures are necessary; (2) when the reaction products have a volatility comparable with that of diethyl ether; and (3) when the use of ethers of more strongly donor character than diethyl ether is necessary to promote the formation of Grignard reagents from relatively unreactive halides.

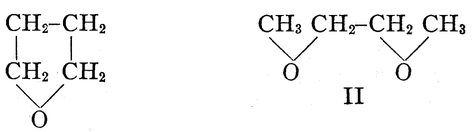
The first case is the simplest; the Grignard reagent may be prepared in ether in the usual way, the chosen reactant added, folloued by a higher boiling solvent such as benzene, xylene or di-n-butyl ether. The reaction mixture may then be heated well above the boiling point (b.p.) of ether, when much ether (but not all) will distill away. In carrying out such reactions subsequent working up is often facilitated if the ether distillate is returned to the cooled reaction mixture before the hydrolysis step.

The second case requires the absence of diethyl ether. The preparation of trimethylarsine (b.p. 50.4° C.),

$$AsCl_3 + 3CH_3MgI \rightarrow (CH_3)_3As + 3MgClI$$

is an example in which a difficult separation of the product from diethyl ether can be rendered quite easy by the use of di-n-butyl ether (b.p. 142° C.) as solvent.

The third case is perhaps the most interesting. It has been shown (H. Sormant) that vinyl halides (preferably chlorides or bromides) form Grignard reagents if the reaction is carried out in tetrahydrofuran. This cyclic ether (I) has a



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stronger donor character than diethyl ether on account of steric effects. The chelating di-ether (11), ethylene glycol dimethyl ether, also promotes the formation of Grignard reagents in difficult cases. The preferred reaction temperature is 40°–50° C. and a final concentration of just under a-molar is suitable. The use of tetrahydrofuran may be further illustrated by the formation of phenyl magnesium chloride from chlorobenzene and magnesium in that solvent; chlorobenzene does not react with magnesium in diethyl ether.

Estimation of Grignard Reagents. — The simplest method is the hydrolysis of an aliquot, the addition of a known amount of acid, followed by back-titration with alkali:

$$2RMgX + 2H_2O \rightarrow 2RH + MgX_2 + Mg(OH)_2$$

Often it is not sufficient to know on hydrolysis the total amount of alkali formed, and a few methods have been developed for measuring the amount of a specific Grignard reagent present. The most commonly used method has been reaction with carbon dioxide, followed by isolation of the resulting carboxylic acid:

$$RMgX + CO_2 \rightarrow RCO_2^-MgX^+ \xrightarrow[H_2O]{HCl} RCO_2H$$

Some reactive Grignard reagents can combine with the carboxylic salts, forming ketones after hydrolysis. This complication is reduced or avoided by adding the Grignard solution to a mixture of solid carbon dioxide and ether. There are several instances in which carbonation does not give a good indication of the amount of a Grignard reagent present, and the use of iododimethylarsine has been recommended (F. G. Mann).

$$RMgX + (CH_3)_2AsI \rightarrow RAs(CH_3)_2 + MgXI$$
$$RAs(CH_3)_2 + CH_3I \rightarrow RAs(CH_3)_3I$$

The tertiary arsine first formed may conveniently be converted into the quaternary iodide, which is insensitive to air and is usually easy to purify by crystallization.

A very useful method has been developed (H. Gilman and F. Schulze) for the detection of Grignard reagents or other reactive organometallic compounds. A small sample of the test solution is added to about an equal volume of a 1% solution of Michler's ketone in dry benzene; after hydrolysis, the reaction product is oxidized by the addition of a little 0.2% solution of iodine in glacial acetic acid. Development of a blue to green colour indicates the presence in the test solution of a Grignard reagent (or organometallic compound sufficiently reactive to add to a ketone). The test involves the formation of a di- or tri-phenylmethane-type dye. Thus phenylamagnesium bromide gives malachite green:

$$(p-Me_2N.C_6H_4)_2CO + PhMgBr \rightarrow (p-Me_2N.C_6H_4)_2PhCOMgBr$$
$$\downarrow H_2O$$
$$[(p-Me_2N.C_6H_4)_2PhC]^+I^- \xleftarrow{I_2} (p-Me_2N.C_6H_4)_2PhCOH$$

malachite green iodide

Constitution of Grignard Reagents.— Although normally given the formula RMgX, the Grignard reagents evidently have a rather complicated constitution; indeed, the more closely this has been studied the more involved has the picture become. Addition of dioxan to ether solutions of Grignard reagents results in the precipitation of dioxan complexes of magnesium halides, and subsequent evaporation of the solvents affords magnesium dialkyls, R_2Mg. This led to a suggestion that an equilibrium of the type:

$$2RMgX \rightleftharpoons R_2Mg + MgX_2 \text{ or } R_2Mg.MgX_2 \rightleftharpoons R_2Mg + MgX_2$$

is involved. Though most useful as a preparative method for the dialkyls (or diaryls), the various conclusions drawn from this reaction about the position of equilibria of the type:

$$2RMgX \rightleftharpoons R_2Mg + MgX_2$$

have been shown to be invalid.

Recent experiments indicate that scarcely any exchange takes place between Mg^xBr_2 and $(C_2H_5)_2Mg$ in ether solution, the Mg^xBr_2 being labeled with either Mg^{28} or Mg^{25}. Since the solutions obtained by mixing $(C_2H_5)_2Mg$ and $MgBr_2$ appear to be identical with the Grignard reagent prepared from magnesium and ethyl bromide, it appears that the Grignard reagent is better represented by a complex R_2Mg, MgX_2 than by RMgX.

Solutions of Grignard reagents become viscous on concentration and ether is tenaciously retained: this indicates some sort of association and also that ether is chemically combined, no doubt forming co-ordination complexes. The molecular weight of several Grignard reagents, in solutions of concentration less than molar, indicates an association of about two. Experiments on their electrical conductivity show that ionic species must be present and that magnesium is present in both anions and cations.

The electrolysis of solutions of Grignard reagents is consistent with the ion discharged at the cathode being basically RMg^+, which may be solvated or associated or both. The cathode process appears to produce free radicals, since the organic products formed are those expected to result from hydrogen abstraction (from solvent molecules) by the more reactive radicals, and from the dimerization of the more stable and long-lived radicals such as benzyl.

Experiments on the alkyl and aryl derivatives of sodium, compounds which evidently contain carbanions, show that these negatively charged hydrocarbon ions are so reactive that they rapidly attack ethers. Since Grignard reagents are often stable in ether for very long periods, carbanions cannot be present. Nevertheless, a carbon atom covalently bound to a much more electropositive magnesium atom will certainly bear at least a fractional negative charge, and most reactions of Grignard reagents are intelligible on the basis of attack of the anionic carbon atom $R_3C(\delta-)$ on the most positive part of the reactant; *e.g.,* the carbon atom of a carbonyl group $R_2\overset{\delta+}{C}=\overset{\delta-}{O}$.

REACTIONS OF GRIGNARD REAGENTS

With the exception of ethers and tert-amines there are very few organic functional groups which fail to react with Grignard reagents, though by no means all these reactions have achieved any notable importance.

Active Hydrogen.— Since such weakly acidic substances as acetylene and cyclopentadiene (see above) react with Grignard reagents, it is not surprising to find that all substances containing $-OH$, $-SH$ or $-NH$ groups also behave as'acids. For example, piperidine reacts as follows:

$$C_5H_{10}NH + CH_3MgI \rightarrow C_5H_{10}NMgI + CH_4$$

Volumetric measurement of the methane formed in such reactions is the basis of an analytical method for the determination of "active hydrogen."

Carbon Dioxide.— The formation of carboxylic acids has been mentioned earlier, in connection with the estimation of Grignard reagents:

$$RMgX + CO_2 \rightarrow RCO_2MgX \xrightarrow[H_2O]{HX} RCO_2H + MgX_2$$

Inorganic Halides.— The halides of the alkali or alkali earth metals do not react except for halogen exchange, with the further exception of the beryllium halides which afford organoberyllium compounds:

$$2CH_3MgI + BeCl_2 \rightarrow (CH_3)_2Be + MgCl_2 + MgI_2$$

This is an example of one of the most generally useful methods for the preparation of organometallic compounds. The reactions often proceed in stages, for example,

$$C_2H_5MgBr + HgBr_2 \rightarrow MgBr_2 + C_2H_5HgBr$$
$$C_2H_5HgBr + C_2H_5MgBr \rightarrow MgBr_2 + (C_2H_5)_2Hg$$

Most nonmetallic halides form organic derivatives on treatment with Grignard reagents. Thus phosphorus trichloride and phenylmagnesium bromide affords triphenylphosphine in good yield:

$$PCl_3 + 3C_6H_5MgBr \rightarrow (C_6H_5)_3P + 3MgClBr$$

The halides of metals which do not easily form organic derivatives also react with Grignard reagents, and the ultimate products of such reactions are usually consistent with the formation of unstable organometallic compounds and their subsequent decomposition. Most transition metal halides give hydrocarbons as the main organic product of reaction with Grignard reagents, the halides being in effect reduced to the metal:

$$AgCl + C_2H_5MgBr \rightarrow Ag + MgClBr + C_2H_4 + C_2H_6$$

The hydrocarbon products are usually those to be expected on the basis of the unstable organometallic intermediate decomposing to form organic free radicals, which are generally disproportionate or react with the solvent by hydrogen abstraction. Grignard reagents derived from cyclopentadiene and indene form a variety of organometallic compounds on reaction with certain transition metal halides.

$$2C_5H_5MgBr + FeCl_2 \rightarrow (C_5H_5)_2Fe + MgCl_2 + MgBr_2$$

Biscyclopentadienyliron is the most stable member of this large class of compounds, in most of which the metal atom is bound to the cyclopentadienyl ring by π rather than by a bonds.

Organic **Halides.**—Aryl and vinyl halides are not usually reactive to Grignard reagents. Alkyl halides can react in several ways and the course of reaction is not always easy to predict; several products are formed in many instances.

Only in special cases is reaction between a Grignard reagent and an organic halide a good preparative method.

Carbonyl Halides. — These usually react very rapidly to give, after hydrolysis and working up, tertiary alcohols:

$$RCOX + 2R'MgX \rightarrow RR'_2COH$$

By "reverse addition," *i.e.*, addition of the Grignard reagent to the solution of carbonyl halide, it is possible to obtain moderate yields of ketones:

$$RCOX + R'MgX \rightarrow RCOR'$$

The transference of a Grignard reagent from the vessel in which it is prepared to a dropping funnel must be carried out in an inert atmosphere and sometimes presents experimental difficulties. **A** much better method for ketone synthesis involves the addition of dry cadmium chloride to the Grignard reagent, whereby it is converted to an organocadmium compound:

$$2RMgX + CdCl_2 \rightarrow R_2Cd + MgX_2 + MgCl_2$$

Organocadmium compounds, being considerably less reactive than Grignard reagents, react only with the halogen of a carbonyl halide. The acid chloride may thus be added to the solution of cadmium compound:

$$R_2Cd + 2R'COX \rightarrow 2RCOR' + CdX_2$$

Aldehydes. — The normal product, after hydrolysis, is a secondary alcohol:

$$RMgX + R'CHO \rightarrow RR'CHOMgX \rightarrow RR'CHOH$$

Poor yields can result from condensation reactions. and by the Grignard compound acting as a reducing agent leading to primary alcohol formation.

Formaldehyde, of course, affords primary alcohols, often in rather poor yield:

$$H_2CO + C_2H_5MgBr \rightarrow nC_3H_7OH(\text{low yield}) + CH_2(OC_2H_5)_2$$
$$H_2CO + C_6H_5MgBr \rightarrow C_6H_5CH_2OH \text{ (about 70\%)}$$

The formaldehyde is commonly generated by thermal depolymerization of paraformaldehyde, or the polymer may be added to the Grignard reagent and the suspension boiled with reflux.

Ketones. — The normal reaction product is a tertiary alcohol:

$$RMgX + R'COR'' \rightarrow RR'R''COMgX \rightarrow RR'R''COH$$

The main complications of this synthesis are reduction to secondary alcohols and enolization.

Carboxylic Esters. — The reaction between esters and Grignard reagents is a common method for preparing tertiary alcohols:

$$RCO_2R' + 2R''MgX \rightarrow RR''_2COH + R'OH$$

The reactions of certain esters are of particular importance. Formic esters afford secondary alcohols, or aldehydes:

$$HCO_2C_2H_5 + C_2H_5MgBr \rightarrow (C_2H_5)_2CHOH$$
$$HCO_2C_2H_5 + C_6H_5MgBr \rightarrow C_6H_5CHO$$

Orthoformic esters (generally ethyl orthoformate) are used for the preparation of acetals or of the corresponding aldehydes:

$$HC(OC_2H_5)_3 + 2C_2H_5MgBr \rightarrow C_2H_5CH(OC_2H_5)_2$$

Cyanides. — Though rather less reactive to Grignard reagents than most substances already mentioned, cyanides are attacked in the usual way, the organic component of the Grignard reagent becoming bound to the carbon atom.

$$RMgX + R'CN \rightarrow RR'C{=}NMgX \xrightarrow{H_2O} RR'C{=}NH \xrightarrow{H_2O} RR'CO$$

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GRIGNION DE MONTFORT, SAINT LOUIS MARIE DE: *sre* MONTFORT, SAINT LOUIS MARIE GRIGNION DE.

GRIJALVA, JUAN DE (1489– or 1490–1527), Spanish explorer and nephew of Diego Velbzquez. Born in Cuéllar, Spain, Grijalva followed his uncle to Hispaniola and Cuba and was chosen by him to pursue further the explorations of Francisco Hernández de Córdoba. In April 1518 Grijalva set out with four ships and reached the island of Cozumel off eastern Yucatin. He then proceeded along the coast of Campeche, where he learned of the Aztec emperor Montezuma. He was attacked and failed to disembark. At Rio Banderas, so called by Grijalva, the Spaniards obtained the first considerable amount of gold but the appearance of many canoes made Grijalva embark again from a site close to the present Veracruz. His failure to make a settlement in the land which he had called New Spain brought him dismissal when he reached Cuba in October. Grijalva accompanied Francisco de Garay to Mexico in 1523 and later took service with Pedrarias Dávila in Panamá. Grijalva was massacred with 19 other Spaniards by Indians on Jan. 21, 1527. (U. S. L.)

GRILLPARZER, FRANZ (1791–1872), recognized, belatedly. as the greatest Austrian dramatist, was born in Vienna on Jan. 15, 1791. His father, a reticent, patriotic lawyer who attached great importance to external forms, died in debt in 1809; his markedly neurotic mother belonged to the talented musical family of Sonnenleithner. In 1807 Grillparzer entered the University of Vienna to study law but, as the eldest son, was obliged to turn to private tutoring to help his family. Later he became a clerk in the department of revenue and. in 1818, poet to the *Hofburgtheater* and clerk in the exchequer. By 1832, when he was appointed director of the exchequer archives, it was clear that he would not be promoted to high office. In 1856 he retired from government service.

In 1817 the first performance of his tragedy *Die Ahnfrau* evoked public interest. Previously he had written many dramatic fragments, mainly on historical themes, and a play in blank verse, *Blanka von Castilien,* obviously modeled on Schiller's *Don Carlos* but already embodying the principal idea of several later works—the contrast between a quiet, idyllic existence and a life of action. *Die Ahnfrau,* written in the trochaic Spanish verse-form, has many of the outward features of the then popular "fate tragedy" (*Schicksalsdrama*), but the characters are themselves ultimately responsible for their own destruction. A striking advance was the swiftly written tragedy *Sappho* (1818), which is worthy of comparison with Goethe's *Tasso.* Here Sappho's tragic fate is attributed to her unhappy love for an ordinary man and to her inability to reconcile life and art, clearly an enduring problem for Grillparzer. Work on the trilogy *Das Goldene Vlies* (1821) was interrupted by the suicide of Grillparzer's mother and by illness. This drama. with Medea's assertion that life is not worth living, is the most pessimistic of his works and offers mankind little hope. Once more the conflict between a life of meditation and one of action seems to lead inevitably to renunciation or despair.

More satisfying, both aesthetically and emotionally, is the historical tragedy *König Ottoknrs Glück und Ende* (written 1823, but because of censorship difficulties not performed or published until 182j). Here the action is drawn from .Austrian history, and the rise of Rudolph of Habsburg (the first of Grillparzer's characters to avoid guilt and tragedy) is contrasted with the fall of the tyrant Ottokar of Bohemia, so that Ottokar's fate is not presented as representative of all humanity. In another historical tragedy, *Ein treuer Diener seines Herrn* (1826, performed 1828), the self-effacement of the hero Bancban in the name of duty is not suited to theatrical representation. Grillparzer was disappointed at the reception given to both these plays and became discouraged by the objections of the censor. Although he loved Katharina Frohlich (1800–79), whom he had met in the winter of 1820–21, he felt unable to marry, possibly because of a conviction that as an artist he had no right to personal happiness. His misery during these years is reflected not only in his diaries but also in the impressive cycle of poems significantly entitled Tristia ex Ponto (1835).

Des Meeres und der *Liebe Wellen* (1831), often judged to be Grillparzer's greatest tragedy because of the degree of harmony achieved between content and form. marks a return to the classical theme in treating the story of Hero and Leander. which is, however, interpreted with a psychological insight anticipating the plays of Friedrich Hebbel and Ibsen. Hero, the priestess, who lacks a true sense of vocation, forgets her vows in her blind passion for Leander and, when her lover is ensnared to his death, she dies of a broken heart. The following of vital instincts is shown to rob the individual of inner harmony and self-possession. Der Traum ein Leben (1834) owes most. particularly in form, to Grillparzer's intensive and prolonged studies of Spanish drama, especially the plays of Lope de Vega and Calderón. This Austrian *Faust* ends happily. for the ambitious young peasant Rustan only dreams the adventures which involve him in crime and awakes to a realization of the vanity of earthly aspirations. True contentment requires acceptance of one's lot and the avoidance of guilt. Grillparzer's only comedy, *Weh* dem, der *lügt!* (1838), was a failure, despite the humour of its situations and the brilliance of its dialogue. chiefly because the theme—the hero succeeds because he tells-the truth when everyone thinks he is lying—was too subtle and too serious for comic treatment.

Grillparzer wrote no more for the stage and very little at all after the 1840s. The honours which were heaped on him in old age came too late. In 1861 he was elected to the *Herrenhaus,* his 80th birthday was the occasion for a national celebration and his death in Vienna on Jan. 21, 1872, was widely mourned. Three tragedies, apparently complete, were found among his papers. Die *Jüdin von* Toledo, based on a Spanish theme, portrays the tragic infatuation of a king for a young Jewess. He is only brought back to a sense of his responsibilities after she has been killed at the queen's command. Ein *Bruderzwist* in Habsburg, a profound and moving historical tragedy, lacks the theatrical action which would make it suitable for successful performance and is chiefly remarkable for the portrayal of the emperor Rudolph II. Grillparzer's sympathetic attitude to Rudolph is sometimes regarded as a justification of Metternich's conservatism. Much of Grillparzer's most mature thought forms the basis of the third play, Libussa, in which he foresees human development beyond the rationalist stage of civilization. Its advent is foretold by Libussa who desires a natural community guided by intuition and ruled by love. She submits, however, to the views of her practical consort Primislaus who, although unselfishly devoted to the task of building the state, understands that justice based on reason is necessary in government.

Apart from the critical studies on Spanish drama and the autobiography published after his death, Grillparzer's finest prose work is Der arme *Spielmann* (1848), the story of a poor musician who cheerfully accepts life's failures and dies through his efforts to help others, an attitude to life which is encountered elsewhere in Biedermeier literature, *e.g.,* in *Kalkstein* by Adalbert Stifter (1805–68).

Features of the Biedermeier outlook are clearly traceable in Grillparzer's work: the looking back to the great classical and romantic achievements and the painful evolution from the disillusionment of idealism to a compromise with reality. Grillparzer is unusually gifted not only as a dramatic poet but also as a playwright capable of creating dramas suitable for performance. The influence of Shakespeare, Lope de Vega and Calderón and of the productions of the popular Viennese theatre is to be seen in the details of many of his dramas. Unlike his great predecessors, Goethe and Schiller, he distinguishes between the speech of the cultured person and that of the uneducated. Also he introduces colloquialisms, humour and elements from the popular farce. Although the central dramatic conflict is often rooted in his personal problems, it is presented objectively. Grillparzer's solution is renunciation rather than acceptance. He suffered undoubtedly from the restrictions imposed by the Metternich regime, but it is probable that his unhappiness originated principally in an inability to resolve his own difficulties of character.

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(L. H. C. T.)

GRIMALD (Grimoald), **NICHOLAS** (1519–*c.* 1559), English poet, whose best-known work was contributed to the first edition of Tottel's *Miscellany,* was born in Huntingdonshire in 1519. He studied at Oxford and at Cambridge and became chaplain to Bishop Ridley. To the original edition (June 1557) of Songes and Sonettes (known as Tottel's *Miscellany*), which he may have edited, he contributed 40 poems and translations, only 10 of which were retained in the second edition (July 1557). Some of his pieces were in blank verse, in which he followed the style of the earl of Surrey. yet not without originality. He handles the metre competently and produces an occasional fine-sounding line.

His other works include two Latin tragedies—Christus redivivus (1543) and *Archipropheta* (1548)—and a translation of Cicero's De *Officiis* (1556). Grimald died about 1559.

GRIMALDI, JOSEPH (1778–1837), the "king of clowns," was born in London on Dec. 18, 1778, the son of an Italian Pantaloon player and a Columbine actress. He grew up in a world of tumblers, tightrope walkers and buffoons and was on the stage of Drury Lane at the age of two. At Drury Lane he scored his first great success as Punch in the Christmas pantomime for 1800–01, after he had already exhibited some of his finest drolleries at Sadler's Wells.

In 1806 he deserted Drury Lane for Covent Garden, where he endeared himself to London audiences as Clown in Mother Goose. When Grimaldi died in London on May 31, 1837, he left behind The Memoirs of Joseph Grimaldi, which Dickens edited (with little enthusiasm) in 1838. (A. M. N.)

GRIMALDI FOSSILS are a group of human remains from the caves carved out of a high cliff, the Baoussé-Roussé (the Red rocks), which borders the Riviera in Italian territory, 2 km. ($1\frac{1}{4}$ mi.) E. of Menton. These remains, totaling 16 individuals, were found in four caves called the Grotte des Enfants. the Grotte du Cavillon, the Barma Grande and the Baousso de Torre. They were found in excavations by E. Rivière, L. Julien, F. Xbbo and, to a greater extent, by L. de Villeneuve during his systematic excavations organized by the prince of Monaco in 1901. All were found in implementiferous Upper Paleolithic deposits (Aurignacian and Grimaldian) but at quite different levels, some being only about 6 ft. below the surface, others nearly 30 ft. and almost in contact with the adjoining Mousterian layers. They all date from the second half of the last glacial period, from about 30,000 to 40,000 years ago.

The major part of the remains are of the skeletons of very tall men of the Cro-Magnon race, of which many other specimens from the same epoch are known in Europe, and which is the ancestor of certain present-day Europeans. The skulls are elongated, with low vaults. short faces and orbits, and the bones are particularly robust. Quite different from these, the two skeletons from the lowest level of the Grotte des Enfants belong to a type of shorter stature and with facial prognathism — the race of Grimaldi which R. Verneau considered Negroid and which he thought preceded the Cro-Magnon race in this region. Verneau's ideas are often questioned because no other Negroid fossils have been found in Europe, and it seems that the prognathism of the so-called Negroids was essentially the result of a posthumous deformation; possibly they may be interpreted as primitive Cro-Magnons.

See also CRO-MAGNON MAN.

See L. de Villeneuve, M. Boule, R. Verneau and E. Cartailhac, *Les Grottes de Grimaldi* (1906–12). (H. V. V.)

GRIMKÉ, SARAH MOORE (1792–1873) and **ANGELINA EMILY** (1805–1879), U.S. antislavery crusaders and advocates of women's rights, were born in Charleston. S.C., Sarah on Nov. 26, 1792, and Angelina on Feb. 20, 1805. Both developed an early dislike of slavery. After several visits to Philadelphia, Sarah joined the Society of Friends in 1821; Angelina did the same in 1829. The sisters then moved to the north and became interested in the antislavery movement, with Angelina as the leader. After publication in the *Liberator* of her letter of approval to William Lloyd Garrison, the abolitionist leader, the sisters joined the American Anti-Slavery society. In 1836 Angelina published "An Appeal to the Christian Women of the South," in which she urged southern women to speak and act against slavery. Later in the year Sarah made a similar plea in "An Epistle to the Clergy of the Southern States."

The career of the Grimkés as antislavery speakers began when Angelina appeared before small groups of Philadelphia women in private homes. In 1836 the sisters moved to New York where both spoke to larger gatherings in churches and public halls. Their talks in New England before mixed audiences prompted a pastoral letter from the General Association of Congregational Ministers of Massachusetts against women preachers and reformers. As a result of such opposition the sisters became pioneers in the women's rights movement and were largely responsible for linking it to the antislavery crusade.

Following Angelina's marriage to the noted abolitionist Theodore Dwight Weld in 1838, both she and Sarah were expelled from the Society of Friends for breach of the "discipline." Ill-health forced Angelina shortly afterward to give up public speaking and Sarah followed her into retirement. The sisters helped Weld in the schools he started in New Jersey. The Welds and Sarah later moved to Hyde Park, Mass., where Sarah died on Dec. 23, 1873, and Angelina on Oct. 26, 1879.

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GRIMM, FRIEDRICH MELCHIOR, BARON DE (1723–1807), Franco-German critic and diplomat, whose *Correspondance littéraire* played a considerable part in the dissemination of French culture in Europe, was born on Sept. 26, 1723, in Ratisbon (Regensburg). He was educated (1743–45) at Leipzig university where he came under the influence of the professor of poetry, Johann Christoph Gottsched (*q.v.*), who was then trying to create a German drama on the French classical model. Grimm's one and only tragedy, *Banise,* was published in Gottsched's *Deutsche Schaubühne* (1743). Grimm had to make his own way in the world and he accordingly attached himself to the powerful Schoenberg family. With a sound knowledge of the French language and already strongly attracted by French civilization, he eagerly seized, in 1748, the opportunity of escorting the second son to Paris, where he was appointed in turn reader to the prince of Saxe-Gotha. secretary to the count of Friesen and, in 1755, *secrétaire des commandements* of the duc d'Orléans.

At the same time he succeeded in gaining an entry into fashionable, progressive literary and philosophical circles through his acquaintance with J. J. Rousseau (*q.v.*) who introduced him to D'Holbach, Helvétius, Denis Diderot (*q.v.*) and, in 1750, to Mme d'Épinay (*q.v.*), whose lover he became three years later. When Mme d'fipinay went to Geneva in 1757 on account of her health, difficulties arose as to who should accompany her; this was the immediate cause of Grimm's quarrel with Rousseau, who unjustly blackened his former friend's character in his *Confessions.* Yet Grimm retained the esteem and affection of Diderot, with whom he formed a lifelong, devoted friendship. It is difficult to estimate precisely what each man owed to the other, but it would seem that whereas Diderot had by far the richer mind, Grimm often stimulated him to activity, particularly in the dramatic field, and sometimes tempered his exuberance with methodical sobriety. He certainly shared most of Diderot's ideas and wrote one article, Du *Poème lyrique,* for the *Encyclopédie,* which he helped to edit and advertised abroad through his many correspondents and friends.

The number and importance of Grimm's connections indeed grew rapidly, for he promoted his career with great astuteness. He quickly became a person of note in the Parisian literary world. Two letters to the *Mercure de France* (1750 and 1751) on German literature made little impression; but in 1753, during the famous controversy over the merits of French and Italian music *(guerre des bouffons)*, he achieved a certain notoriety with his *Petit Prophète de Boehmischbroda* in which, like Rousseau and Diderot, he extolled Italian to the detriment of French composers.

In this same year Grimm decided to establish a private news service for foreign princes anxious to keep in touch with life in Paris. Every fortnight after May 15, 1753, usually through diplomatic channels, subscribers received a manuscript newsletter, normally composed by Grimm who was, however, frequently helped by Mme d'Épinay and Diderot who contributed, for instance, his famous *Salons* (1759–81). The venture was successful, attracting subscriptions from many minor European rulers as well as from Catherine the Great of Russia. But in March 1773, increasingly absorbed by diplomatic work, Grimm handed over his task to Jakob Heinrich Meister.

Frank because confidential, Grimm's letters constitute a social and literary document of outstanding importance. They chronicle events of all kinds, transmit social and literary gossip, record songs, epigrams and parodies and divertingly analyze and evaluate new publications in all spheres. The impartiality and sureness with which Grimm appraised contemporary French writers, even Rousseau and Voltaire, is increasingly appreciated. The *Correspondance litte'raire,* first published in 1812, has been described as the first great work of modern criticism.

Grimm's correspondence and his acknowledged tact served him well in the furtherance of his ambitions. He was appointed to a number of minor diplomatic posts and created successively a baron of the Holy Roman empire (1772) and Russian councilor of state (1777). He acted as Paris agent for some of his patrons, particularly for Catherine II, for whom he bought works of art and the libraries of Diderot and Voltaire. His activities brought him opportunities to travel extensively in Germany, England (1771), Italy (1776) and Russia (1773–74, 1776–77).

The position Grimm had thus built up was wrecked by the French Revolution. Horrified, faithful to the *ancien régime* and therefore suspect to the republic, which confiscated his property and ruined him financially, Grimm left France in 1792. In 1793, generously supported by Catherine II, he settled in Gotha where he died, impoverished and embittered, on Dec. 19, 1807.

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GRIMM, JACOB (LUDWIG CARL) (1785–1863) and **WILHELM (CARL)** (1786–1859), together were the collectors and editors of Grimms' *Fairy Tales* and were generally known as *THE BROTHERS* GRIMM; Jacob Grimm, the grammarian, was the formulator of "Grimm's law" *(see* below), and Wilhelm Grimm was the literary scholar. They were born little more than a year apart and spent their entire lives together in a happy community of interests. As children they were inseparable, at the university they studied and lived together, as mature scholars they worked together in the same room, and they were buried side by side in Berlin.

Lives.—Jacob was born on Jan 4, 1785, Wilhelm on Feb. 24, 1786. They attended the public school at Rassel and later studied at Marburg, where the lectures of Friedrich von Savigny awakened in both the love for antiquarian investigation which formed the real basis of all their later work. While still university students they laid plans for collaboration on medieval German literature, and in 1805 Jacob wrote irom Paris to Wilhelm that he hoped they would never again be separated. By a happy combination of good fortune and early recognition of their great talents they remained together and became the most distinguished brother-scholars of the German romantic period.

Following long periods of service in the Kassel library. the brothers moved in 1830 to Gottingen, where Jacob received the appointment of professor and librarian, Wilhelm that of under-librarian. Jacob lectured on legal antiquities, historical grammar, literary history, interpreted ancient Gcrmanic literature and commented on the *Germania* of Tacitus. The years at Gottingen were fruitful ones, despite the severe illness of Wilhelm; in 183j Wilhelm was named to a professorship and Jacob was given the title of *Hofrat* in recognition of their accomplishments. In 1837 however, the brothers being two of the seven professors who had signed a protest against the new king of Hanover's abrogation of the constitution, they were dismissed from their professorships and banished from the kingdom of Hanover. They returned to Rassel, but in 1841 went to Berlin. where they both received professorships and were elected members of the Academy of Sciences. They seldom lectured; but they worked assiduously together at the great dictionary of the German language. a task so large, even nhen first projected, as to make it impossible for the brothers to finish it themselves. The first volume was published in 1854; after the work had been apportioned among many other hands, the last volume was published, with some intermediate fascicles still to appear. just a century later, in 1954.

Wilhelm. never in robust health, died in Berlin on Dec. 16, 1859; Jacob. never ill. continued working until he died quite suddenly on Sept. 20, 1863.

Of the two. Jacob was the stronger, the more vigorous and the more strictly scientific; Wilhelm mas the weaker physically, the more sensitive and the more literary; Jacob became the great grammarian; Wilhelm gave literary form to the fairy tales.

Works.—The purely scientific side of Jacob's character developed slonly. Led by his careful study of Middle High German poetry to take up grammatical investigation, he apparently soon felt the need of a regular method of work in etymology, but he long grasped for scientific principles nithout finding them. He set himself against the use of logical concepts in the analysis of a language, and he called observation the soul of grammar; but his own almost exclusive interest in history. the variety of the evidence which he and his contemporaries collected and examined. and the necessarily slow evolution of a methodical procedure for dealing with very complex linguistic phenomena so controlled his talents as to make of him rather a careful collecter and arranger of data than a great intuitive expositor or inventive theoretician. Even the ordering of the correspondences among consonants in the Germanic and other Indo-European languages nhich bears his name had to wait 50 years for its final clear and simple treatment.

Jacob Grimm's *Deutsche Grammatik* (1819–22) was. moreover, the linguistic outcome of both brothers' previous philological nork. In 1811 Jacob published a work of purely literary character. *Über den altdeutschen Meistergesang* and Wilhelm brought out his volume of translations *Altdänische Heldenlieder, Balladen und Märchen übersetzt*. In 1812 the brothers jointly edited the two ancient fragments of the *Hildebrandslied* and the *Weissenbrunner Gebet*, and in 1812–1j they jointly brought out the first edition of the *Kinder-und Hausmärchen* (the *Fairy Tales*, of which one of many English translations was edited by Joseph Campbell in 1944) which have carried their name into every household of the civilized world. In 1816–18 an analysis of the oldest Germanic epic traditions appeared under the title *Deutsche Sagen*, and in 1815 one volume of an edition of the Poetic Eddas was published over both their names. This edition, however, was never completed; and Jacob, who had little taste for text-editing. about this time began to turn his mind to other things. Although he did occasionally bring out a new edition of an old text (*e.g., Reinhart Fuchs*, 1834), and although medieval literature and comparative mythology continued to interest him, more and more his activity became focused on grammar, lexicography and the history of the German language.

Grimm's Law.—Jacob had not at first intended to include languages other than German in his *Deutsche Grammatik;* but he soon found that Old High German postulated Gothic, that the later stages of German could not be understood without the help of the Low German dialects, including English, and that the evidence from the Scandinavian languages could likewise not be ignored. The first part of the *Grammar* appeared in 1819, a second revised edition in 1822. While the first edition gives only the inflections, in the second, phonology takes up no fewer than 600 pages, more than half of the whole work. The striking difference is evidence of the increasing interest in linguistic method which marked the early years of the 19th century. This advance must be credited mainly to the influence of Rasmus Rask (*q.v.*). To Rask belongs the credit for having first demonstrated the regularity of correspondence among sounds in genetically related languages, but the first full demonstration of the validity of this principle of regularity was made by Jacob Grimm in the long lists of correspondences of consonants in the Germanic and other Indo-European languages which he published in the second edition (1822) of his *Deutsche Grammatik*. It is the regularity in these correspondences which has come to be known as Grimm's law (*see* GERMANIC LANGUAGES). Thus, the initial sound of the inherited Indo-European word for "father" is represented in Latin writing by *p* and in English writing by f (Latin *pater;* English "father"). This correspondence is regular under conditions which can be clearly and certainly stated. Such regular correspondences for all consonants in all the Indo-European languages can now be given with similar certainty, only marginal problems remaining.

The question of who discovered what is known as Grimm's law is answerable only after much qualification. The correspondence of single consonants had been more or less clearly recognized by several of Jacob Grimm's predecessors; but the one who came nearest to the discovery of the complete law was the Swedish scholar J. Ihre who established a considerable number of *litterarum permutationes*, "changes of letters." Rask, in his essay on the origin of the Icelandic language, gives the same comparisons, with a few additions. As Grimm in the preface to his first edition expressly mentions this essay of Rask, there is every probability that it gave the first impulse to his own investigations. There is, however. a wide difference between the isolated oermutations of his predecessors and Grimm's comprehensive generalizations and massive assembling of evidence. The extension of the law to High German is also entirely Grimm's own. The importance of Grimm's generalization in the history of linguistics can hardly be overestimated, but much of the merit belongs to his predecessors. and some to his immediate successors; the completion of the solution, the demonstration of symmetry existent in complexity and the simple formulation which could finally be given to the discovery are, all taken together. a unique triumph and one large enough to be shared by many. Grimm's law proved that a simple, coherent and complete demonstration of order in the process of language was possible. Jacob Grimm and his contemporaries in the mid-19th century thus made the study of linguistic phenomena scientific.

The Fairy Tales.—The criticism and interpretation of the two brothers' fairy tales began early. Wilhelm himself in 1856 stated the brothers' theory that the Germanic folk tales were versions of Indo-European myths. Theodor Benfey, the Sanskritist, sought their origins in India. Joseph Bédier and others supported the view of polygenesis, the possibility of which had also been admitted by the Grimms. The Finnish school of folklorists attempted a strict historical and geographically limited approach—a procedure which may be said to have culminated in the unhistorical typological arrangement of Stith Thompson's *Motif-*

Index of Folklore Classification. A similarly unhistorical but otherivise totally different point of view is that of the psychoanalytic school of criticism which, following Freud's hypotheses, sees in fairy tales the dreams of the human race and thus interprets them as externalizings of unfulfilled wishes, of feelings of guilt and of profound anxieties deeply buried in the unconscious. Many essays expressing this view can be found in the pages of the periodical *Imago*. Still another judgment has been expressed by Albert Wesselski in his *Versuch einer Theorie des Märchens;* according to him the "people" never create; only storytellers, authors, create, and all collections of "folk stories," including the Grimms' fairy tales, come directly or indirectly from books.

Collaboration.— So harmonious was the collaboration of the brothers Grimm and so happy their life-long association that it is unjust to both to discriminate between them except only to show how perfectly their slight differences complemented each other. Wilhelm remained to the end of his life a literary scholar, historian and critic and, according to his brother, always loved the collections of fairy tales the most; while Jacob was occupied with grammatical problems and the history of the German language, Wilhelm continued his work on Germanic heroic legends and wrote beautifully, delightfully and learnedly about such matters as elves and children's games and customs. But these tasks for the last decade of R'ilhelm's life uere secondary or ancillary ones, the great work was the dictionary on which both brothers uorked always harmoniously together.

Jacob never married; Wilhelm was both a husband and a father. In a memorial address delivered in the Academy of Sciences in Berlin six months after his brother's death, Jacob said of himself that he in early youth had found an iron devotion to work which Wilhelm's weaker health denied him, but that Wilhelm's work was shot through with flashes of silver, as his own was not. Wilhelm, he also said. was fond of happy company, music and laughter, but of himself Jacob remarked that his joy arose from work itself.

The Grimm brothers' patriotism and love of historical investigation received full satisfaction in the study of the language, traditions, mythology, laws and literature of their countrymen and their nearest kindred. Both acted together for the sake of principle without bitterness and almost without complaint. Their work together was so harmonious that their genuine human kindness, which shows in their letters, made them both gently, modestly serene.

See the series of critical essays (entitled *Anmerkungen*) on the Grimms' iairy tales which were published by Johannes Bolte and Georg Polivka between 1913–31 A bibliography of the principal writings of both brothers and the principal critical works about them is given in Herman Gerstner's *Die Brüder Grimm* (1952) (My F.)

GRIMMELSHAUSEN, HANS JAKOB CHRISTOFFEL (JOHANN JAKOB CHRISTOPHER) **VON** (*c.* 1622–1676), German writer, author of *Simplicissimus*, the greatest German novel of the 17th century. The troubled times in which he lived, and which found expression in his work, are reflected in uncertainties about his birth, parentage and early life. Born probably at Gelnhausen, and certainly in Hesse, between 1610 and 1625, he lost his parents early, perhaps in the sack of Gelnhausen (1634), if one accepts the later date for his birth. Their circumstances are also uncertain; his father may have been a baker or an innkeeper, perhaps belonging to the unsuccessful branch of a noble family, but the "von" used by Grimmelshausen may have been only of his own bestowing. He certainly lived in Gelnhausen as a child. until swept up by the Hessian troops. His experiences with them can be inferred from his account of the adventures of "Simplicissimus" and from knowledge of the squalor, brutality and tragedy of the Thirty Years' War He may have entered the imperial army in 1635, but is first certainly identified in 1639 as secretary to Reinhard von Schauenburg, the commandant at Offenburg, on whose staff he served until May 1647. In 1648 he was with Johann von Elter, the commandant on the Inn, and soon after the war ended became steward of the Schauenburg estates. His marriage in 1649 may have been the occasion of his becoming a Roman Catholic: his parents and early education were certainly Lutheran. His stewardship was no sinecure in a divided family snd a despoiled countryside but he found time for writing, which he had begun in the army, and also opened an inn at Gaisbach near Oberkirch, probably to augment a meagre income. In about 1660 he entered the service of a Strasbourg physician and in 1668 became magistrate and tax collector at Renchen, a town belonging to the bishopric of Strasbourg. From 1674 onward his life mas again disturbed by invading armies. The district was occupied by the Lorrainers, the inhabitants fled and Grimmelshausen's household was broken up. He died at Renchen, perhaps after service on the imperial staff, Aug. 17, 1676.

His first published works, *Traumgesicht von dir und mir* (1658) and *Reisebeschreibung nach der obern Mondswelt* (1660) are mainly derivative: satiric in intent. yet lacking the singlemindedness of pure satire. In 1669 he published *Der abenteuerliche Simplicissimus, Teutsch, d.h. die Beschreibung des Lebens eines seltsamen Vaganten, genannt Melchior Sternfels von Fuchsheim,* in six books, of which the sixth was written first, with a later "key volume." It is the story of a "wild boy" brought into contact with life through experience of the Thirty Years' War. Modeled on the Spanish picaresque romances, it gives full rein to Grimmelshausen's power of narration, eye for realistic detail, creation of convincing minor characters, coarse humour and criticism of society. The religious allegory of the later part is sometimes obscure, and the Robinson Crusoe episodes of the last book lack coherence with the main plan, but it remains a masterpiece, as well as a valuable historical document for its vivid picture of 17th-century Germany. Its success was immediate, and led Grimmelshausen to write the so-called *Simplicianische Schriften*: *Die Erzbetrügerin und Landstörtzerin Courasche* (1669); *Der seltsame Springinsfeld* (1670); and *Das wunderbarliche Vogelnest* (1672) which he claimed as parts of the main work. He also wrote satires and "gallant" novels (*e.g., Dietwald und Amelinde,* 1670), but it is on *Simplicissimus* that his fame remains secure.

The leading modern edition of *Simplicissimus* is by J. H. Scholte (1938–39; 3rd ed. by K. Henniger, 1955), who also edited the *Simplicianische Schriften* (1923–43). There is an English translation (1912). A selection of Grimmelshausen's *Werke* was edited by H. H. Rorcherdt. 3 vol. (1921–22).

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GRIMSBY, formerly called GREAT GRIMSBY, a municipal, county and parliamentary borough of Lincolnshire, Eng., on the south bank of the Humber estuary, $35\frac{1}{2}$ mi. N.E. of Lincoln by road. Pop. (1961) 96,665. Area 8.5 sq.mi.

Grimsby was a Danish settlement and is mentioned in the Icelandic sagas. The name derives from Grim the fisherman. foster father of Havelok the Dane in the legend of that name. King John granted the first royal charter to the town in 1201, and Henry III granted a further charter in 1227. These grants were confirmed and extended by later sovereigns, the last charter being given by James II in 1688. An annual fair and weekly market are held under charter rights.

The parish church of St. James contains Norman, Early English and transitional work; it was extensively restored after suffering severe war damage in 1943. Grimsby has a bishop suffragan in the diocese of Lincoln.

Up to the end of the middle ages, Grimsby was an important seaport, but it declined as the old haven silted up. In s796 a statutory company was formed by a private act of parliament to improve the harbour, and the first dock was built in 1800. The modern development'of the town is due largely to its favourable situation as regards the North sea and other fishing grounds. The docks were rebuilt and modernized after 1846, and fishing smacks began trawling in 1856. The use of the steam trawler from the 1880s extended the area covered by the fishing fleet as far as Greenland and the White sea. At the same time the increase in the population of England! the construction of railways and the use of ice for preserving fish made possible for the first time a supply of fresh fish in bulk to all parts of the country. Approximately one-third of the fish landed in Great Britain passes through Grimsby docks. The trade greatly developed with the introduction of modern methods of curing and quick freezing, and there is a considerable export trade in frozen fish. A second fish dock was built in 1900 and a third (35 ac.) with slipways and coaling facilities was opened in 1934. The total dock area is 139 ac., 64 ac. of which are fish docks.

After World War II, Grimsby became a centre of the heavy chemical industry, and several large modern plants were erected. The town is one of the greatest single manufacturing centres of titanium oxide in the world. The commercial docks handle imports of timber, food wood pulp and raw materials for the chemical industry. Coal and general merchandise are exported. There are regular commercial services to the Scandinavian countries.

Immingham (*q.v.*) dock, 6 mi. N., is the deepwater port for Grimsby. Grimsby was a minesweeper base in World War II.

GRIMTHORPE, EDMUND BECKETT, 1ST BARON (1816-1905), English lawyer, horologist, Gothic revivalist and public controversialist, was born near Newark on May 12, 1816, the eldest son of Edmund Beckett Denison, later 4th baronet. Educated at Eton and Trinity college. Cambridge, he was called to the bar in 1841 and became queen's counsel in 1854. Between 1877 and 1900 he was chancellor and vicar-general of York, receiving a peerage in 1886. He rapidly acquired a large practice, achieving the leadership of the parliamentary bar by 1860—a position he owed more to vigorous self-assertiveness than to legal erudition. After 1880 he withdrew from legal work. An expert, inventive horologist, Beckett designed. despite bitter opposition the clock for the houses of parliament (Big Ben), installed in 1859. Clocks at Leeds town hall and at Worcester, Lincoln and St. Paul's cathedrals were also designed by him on new principles.

He was passionately interested in the revival of Gothic architecture, publishing *Lectures on Gothic Architecture* (1855), designing churches and secular buildings at Doncaster and elsewhere. His magnum opus was the "restoration" of St. Albans cathedral, where, having virtually bought the faculty in 1880, he raised the roof pitch recast the west front in a new style, redesigned the transept windows and vestries. His ruthlessness aroused a storm of protest and did much, as a negative exemplar, to provoke those better, sensitive conceptions of restoration since prevalent Nevertheless, his Gothic designs there and elsewhere have a coarse vitality typical of the man. Throughout his life, in parliament, in the *Times,* pamphlets and libel cases, he was a famous controversialist Among subjects of his virulent, dogmatic outbursts were architects, doctors, trade unions and ecclesiastical affairs. Though clever, versatile and dynamic, he was brutal, insensitive and wrongheaded Leaving more than £2,000,000, he died at St. Albans on April 29, 1905. (P. T. A.)

GRINDAL, EDMUND (1519?–1583), successively bishop of London, archbishop of York and archbishop of Canterbury, was the son of a farmer of Hensingham, Cumberland. He was educated at Magdalene and Christ's Colleges and then at Pembroke Hall, Cambridge, where he was elected fellow in 1538. He proceeded M.A. in 1541, was ordained deacon in 1544 and was proctor and Lady Margaret preacher in 1548–49. Probably through the influence of Ridley, who had been master of Pembroke Hall, Grindal was selected as one of the Protestant disputants during the visitation of 1549. When Ridley became bishop of London, he made Grindal one of his chaplains and gave him the precentorship of St. Paul's. He was soon promoted to be one of Edward VI.'s chaplains and prebendary of Westminster, and in Oct. 1552 was one of the six divines to whom the Forty-two articles were submitted for examination.

The death of Henry VIII frustrated Grindal's proposed elevation to the episcopal bench. He abandoned his preferments on Mary's accession and made his nay to Strasbourg. and then to Frankfurt, where he endeavoured to compose the disputes between the "Coxians" (*see* Cox, RICHARD), who regarded the 1552 Prayer Book as the perfection of reform, and the Knoxians, who wanted further simplification He returned to England in 1559, was appointed one of the committee to revise the liturgy, and one of the Protestant representatives at the Westminster conference. In July he was also elected Master of Pembroke Hall in succession to the recusant Dr. Thomas Young (1514–80) and Bishop of London in succession to Bonner.

Grindal himself was, however, inclined to be recalcitrant from different motives. He had qualms about vestments and other traces of "popery" as well as about the Erastianism of Elizabeth's ecclesiastical government. His Protestantism was robust enough; he did not mind recommending that a priest "might be put to some torment." But he was loath to execute judgments upon English Puritans; he had not that firm faith in the supreme importance of uniformity and autocracy which enabled Whitgift to persecute with a clear conscience nonconformists whose theology was indistinguishable from his own. As it was, his attempts to enforce the use of the surplice evoked angry protests, especially in 1565, when considerable numbers of the nonconformists were suspended; and Grindal of his own motion denounced Cartwright to the Council in 1570.

In 1570 Grindal was translated to the archbishopric of York, where Puritans were few and coercion would be required mainly for Roman Catholics. By Burghley's influence he was chosen to succeed Parker as archbishop of Canterbury in 1576. Burghley wished to conciliate the moderate Puritans and advised Grindal to mitigate the severity which had characterized Parker's treatment of the nonconformists. Grindal indeed attempted a reform of the ecclesiastical courts, but his metropolitical activity was cut short by a conflict with the arbitrary temper of the queen. Elizabeth required Grindal to suppress the "prophesyings" or meetings for discussion which had come into vogue among the Puritan clergy, and she even wanted him to discourage preaching; she would have no doctrine that was not inspired by her authority. Grindal remonstrated, claiming some voice for the church, and in June 1577 was suspended from his jurisdictional. though not his spiritual, functions for disobedience. He stood firm, and in Jan. 1578 Secretary Wilson informed Burghley that the queen wished to have the archbishop deprived. She was dissuaded from this extreme course, but Grindal's sequestration was continued in spite of a petition from convocation in 1581 for his reinstatement. Elizabeth then suggested that he should resign; this he declined to do, and after making an apology to the queen he was reinstated toward the end of 1582. While making preparations for his resignation, he died on July 6. 1583, and was buried in Croydon parish church. He left considerable benefactions to Pembroke Hall, Cambridge. Queen's college, Oxford. and Christ's college, Cambridge; he also endowed a free school at St. Bees, and left money for the poor of St. Bees, Canterbury, Lambeth and Croydon.

Strype's *Life* of *Grindal* is the principal authority; *see* also *Dict. Nat Biogr.* and, besides the authorities there cited, Gough's General Index to Parker Soc Publ ; Acts of the Privy Council, Cal of Hatfield manuscripts; Dixon's *Hist.* of *the Church* of *England;* Frere's volume in Stephens' and Hunts series; *Cambridge Mod Hist.,* vol. iii; Gee's *Elizabethan Clergy;* Birt's *Elizabethan Religious Settlement;* and Pierce's *Introduction to the Marprelate Tracts* (1908).

GRINDELWALD, a valley in the Bernese Oberland and one of the chief summer and winter tourist resorts in Switzerland. It is shut in on the south by the Wetterhorn, Mettenberg and Eiger, betneen which are two famous ice streams known as the Upper and Lower Grindelwald glaciers. On the north it is sheltered by the Faulhorn range while on the east the Great Scheidegg pass leads over to Meiringen; and on the southwest the Little Scheidegg and Wengernalp (railway across) divide it from Lauterbrunnen The main village is connected with Interlaken by a rack railway (13 mi) while the Jungfrau railway ascends from there to the highest Alpine railway station in Europe — Jungfraujoch 111,342 ft) The First, the longest chair lift in Europe. also starts from Grindelwald.

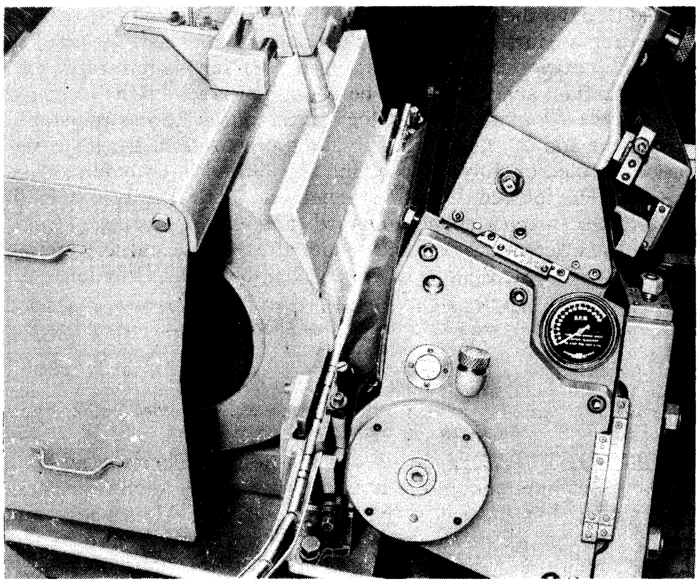
The valley possesses excellent pastures, as well as fruit trees, though little corn is grown. It is natered by the Black Liitschine, a tributary of the Aar. The parish church is 3,468 ft. above sea level. The population is practically all Protestant and German speaking.

The valley was originally inhabited by serfs of various great lords in summer for the sake of pasturage. A chapel in a cave was superseded about 1146 by a wooden church, replaced about 1180 by a stone church, which was pulled down in 1793 to make way for the present building. Gradually the Austin canons of Interlaken bought out all the other owners of the valley, but when that house was suppressed in 1528 by the town of Bern the inhabitants gained their freedom. (S. Ri.)

GRINDING MACHINE, a device using an abrasive wheel to produce a desired size, shape or surface finish on parts made of metal or other hard materials. The first cylindrical grinder was made in the 1860s in the United States by replacing the single-point tool of an engine lathe with a rotating abrasive wheel. At first the grinding wheel was made of natural sandstone, but later, for faster production and better control of quality, manufactured abrasives were formed into wheels by the ceramic process. By 1876 the universal cylindrical grinder had been developed to about its present state.

Many types of grinding machines have been developed for modern industry. They comprise a wide range of sizes and varieties, each designed to perform a particular type of work to best advantage. Polishing, buffing, lapping, honing and superfinishing are additional abrasive processes. each requiring a machine of special type. Some grinders use abrasive-faced belts instead of wheels.

Common Types of Grinders. — In cylindrical grinding of external surfaces. the work, with conically countersunk ends, is held rigidly on centres and rotated slowly, and the rapidly rotating wheel is fed against the work (for internal grinding, some form of chuck or clamp holds the work). When the surface to be ground is longer than the width of the wheel, the work is mounted on a cross slide and traversed slowly past the grinding wheel by hydraulic, mechanical or manual means. When the wheel face is as wide as the length of the surface being ground, the wheel may be fed in with no traversing movement; this is called plunge grinding. The wheel speed (usually about 6,000 ft. per minute), the wheel feed (about 0.001 in. per traverse), the work speed (50–100 ft. per minute), the table-traverse speed and the length of traverse are all independently adjustable to suit the machine and the type of work. The universal cylindrical grinder has a table mounted on a graduated base so that it may be swiveled for grinding tapered shapes.



BY COURTESY OF GRINDING MACHINE DIV., CINCINNATI MILLING MACHINE CO

WATER-PUMP SHAFTS BEING GROUND BY THE "THROUGH-FEED" METHOD ON A CENTRELESS GRINDING MACHINE

The plain cylindrical grinder has been modified to perform roll grinding on piston rods, turbine shafts and rolling-mill parts requiring great accuracy and superior finish. Other machines have been adapted for grinding the crank and main bearings of crankshafts: in these, the shaft is chucked so that its main journal bearings revolve in an orbit, while the crank pins being ground run concentrically. Camshaft-grinding machines are provided with master cams which cause a movement between the wheel and the cam being ground that evolves the desired contour of the cams. Other modifications are constructed for tool and cutter sharpening, drill pointing, saw and milling-cutter sharpening, etc.

The centreless grinding machine for external cylindrical or circular-section work consists of two abrasive wheels, each mounted on a horizontal axis with the wheel surfaces opposed to each other. An adjustable work-supporting blade is mounted between the two wheels. The smaller of the wheels, known as the regulating wheel, rotates slowly and acts as a brake to prevent the work from spinning as it is forced against the grinding wheel. For cylindrical shapes, the work is fed axially between the wheels. For formed work it is placed on the rest between the two wheels while the regulating wheel is fed forward.

Internal grinding machines have been developed for finishing holes to required sizes and surface conditions. These machines employ a small-diameter grinding wheel, rotating at high speed, which is traversed in and out of the hole as it is fed radially, to produce the correct diameter. Many grinding machines used for mass production have automatic measuring devices so that the grinding continues until the specified size is reached.

Several types of surface-grinding machines are available for grinding flat surfaces. One, with a reciprocating table carrying the work, moves under a straight wheel (which grinds on its periphery) mounted on a horizontal spindle or under a face-grinding wheel on a vertical or horizontal spindle. Other types have rotary tables employing a cup wheel on a vertical spindle or a straight wheel on a horizontal spindle. The rotary table supports the work in mechanical fixtures or on a magnetic chuck. There are also single- and double-opposed disk grinders in which the work is forced against the face of a single disk or fed between opposed disks to be ground to a desired thickness.

Special Grinding Machines. — Gear grinders finish gear teeth to an involute form. This is usually done after the gear teeth have been machined and hardened. One type of grinder uses a straight wheel formed to the desired tooth space. The wheel is traversed through the previously roughed-out tooth space as it is fed, at each stroke, to the depth that gives the desired tooth thickness. Another type of grinder uses a straight wheel with the faces dressed to straight bevel sides; the wheel simulates a tooth of a gear having a very large number of teeth. As the wheel traverses the rough tooth space it is fed gradually to a depth that gives the desired tooth thickness; and at the same time the wheel and gear are rolled back and forth together, just as one finished gear engages another.

Another gear grinder, using the generating process, employs a single large-diameter flat-face wheel with a thin edge tilted at an angle. The whole wheel is fed tangentially with its edge between two gear teeth as the gear is rolled, thus grinding one tooth face.

The thread grinder for finishing screw threads employs a wheel the face of which has the form of the thread space. The wheel is fed inward as it traverses back and forth along the axis of the screw, while the screw slowly rotates.

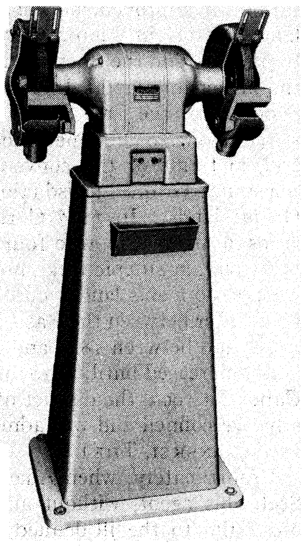
Finishing Operations. — The lapping or final finish of the teeth of spur, bevel or hypoid gears is done by running two gears together at crossed axes to provide a sliding action. An oil containing a fine abrasive is poured on the meshing gear teeth.

Polishing is done with an abrasive glued to the face of a flexible wheel, usually made of cotton or felt. Coarse or medium-size abrasive grain is used for fast metal removal with a resulting coarse finish, and fine grain for a good surface finish. Buffing follows finish polishing and involves a soft, pliable wheel with a very fine abrasive, such as tripoli powder mixed with grease, pressed against the wheel at intervals. This process produces a high lustre.

Honing involves the use of small honing stones supported in an adjustable head which is rotated slowly as it is reciprocated in, for example, the bore of a cylinder. The stones are forced radially against the cylinder wall so that a small amount of metal is removed. The bore is thus given a fine finish and accurate size. Superfinishing, quite similar to honing, uses fine honing stones supported flexibly and forced gently against slowly moving work, such as cylindrical bearings. This is done after grinding to give a smooth, accurate surface.

Grinding-Wheel Abrasives. — Abrasives for metal removal may be natural or manufactured. Natural abrasives such as sandstone (quartz), emery and corundum were used for centuries but have been largely replaced by manufactured abrasives, which are more uniform in composition and performance Diamonds are used for making up solid wheels and honing stones and as a powder for lapping very hard material.

The manufactured abrasives are of two principal compositions: silicon carbide is manufactured in an electric furnace, at about 4,000° F., from a mixture of a silica sand, petroleum coke, salt and sawdust; aluminum oxide is produced in an arc-type electric furnace by the fusion of the mineral bauxite mixed with ground coke and iron filings. Several hardnesses are available, each adapted to a specific class of uork. These abrasives are crushed and sorted into grains of various mesh size. A wheel of desired shape and size is produced by baking the grains, mixed uith a bonding agent.



BY COURTESY OF BLACK AND DECKER MANUFACTURING CO.

FLOOR-STAND GRINDER

The size, shape and bore diameter of the wheel, the abrasive type. grain size, bonding agent and structure are all part of the wheel specifications for each job. Wheels of silicon carbide are used generally to grind materials of low tensile strength (cast iron. brass, aluminum); aluminum oxide wheels are used for high strength materials, such as steel of all types. Grinding wheels must rotate at high speeds, and it is therefore important that they run true and are dynamically balanced and free of cracks. Adequate guards should be provided to minimize damage in the event of wheel breakage, and the operator should wear safety glasses.

(O. W. B)

GRINGORE (GRINGOIRE), **PIERRE** (*c.* 1475–*c* 1538), French poet, dramatist and satirist, was born in Normandy, perhaps at Thury-Harcourt (Calvados). His name, Gringore, found in acrostics in his poems, is the Norman equivalent of central French Gringoire, the latter form being already found in records of payments made to him at the court of Lorraine (*see* below). Fairly well educated by medieval standards, he enjoyed great popularity, particularly as an actor-manager and playwright between 1506 and 1512, in Paris where he helped to produce a play for the entry of Archduke Philip of Austria in 1501 and had other similar commissions, including the mimed *Sotie des Chroniqueurs* for the entry of Mary Tudor (1514). His first extant nork, *Le Chasteau de Labour* (1499; Eng. trans by Alexander Barclay, 1506; ed by A. W. Pollard, 1905), is an allegorical poem in which a despondent young husband learns how to overcome adversity by diligence. But Gringore is best known as a writer of satirical plays for the *Confrérie des Enfants Sans Souci* or *Sots,* uith their Prince and *Mère Sotte* the most famous guild of comic actors in France at the time. As *Mère Sotte* (a title which he kept until his death) he wielded great authority and enjoyed the favour of Louis XII, who "loved truth, even against himself" and employed Gringore and his fellow *Sots* as the mouthpiece of his antipapal policy. Gringore served Louis well, satirizing the Venetians and Saiss as well as condemning the temporal pretensions of Pope Julius II. He first attacked Julius II in his poem *La Chasse du cerf des cerfs* (1510), parodying the papal title of *Servus servorum Dei (le serf des serfs de Dieu)*; then on Shrove Tuesday. 1511 (old style; 1512, new style), when the dispute with the Pope was at its bitterest, he staged a trilogy (*sotie, moralité* and farce), *Le Jeu du Prince des Sots et Mère Sotte,* the Pope being *L'Homme obstiné* of the morality. but Holy Church, scathingly exposed in the *sotie,* being after all only *notre Mère Sotte*

Gringore's strikingly different *Vie Monseigneur Sainct Loys par personnaiges* (1514?), a piously conceived mystery play about Louis IX, sometimes considered his masterpiece, was written for the Paris guild of masons and carpenters. With Francis I's accession (151j), restrictions were imposed on playwriting, and royal favour passed to the Italian players. so Gringore moved to Lorraine in 1j18, to be herald to the duke with the title of Vaudémont, but also to continue to write and revise plays and to organize court festivities. In 1518, too, he married Catherine Roger (his poem *La Complaincte de Trop Tard Marié* may be earlier in date). His *Blazon des hérétiques* (1524), a tedious enumeration of heretics doun to Luther, whom he attacks, was dedicated to the duke. The exact date. place and manner of his death are unknown.

Gringore is best as a polemist and imitator: he is often laboured but he can be vigorous and witty, and his sound dramatic sense made him much sought after as a reviser of plays. His motto, *Tout par Raison, Raison par Tout, Par tout Raison,* framing *Mère Sotte* on the title page of several works, characterizes the love of order and good sense, rather than any corrective purpose, in his writing; and he was a good Catholic despite his difficulties with the Sorbonne over translations in his *Heztres de Notre-Dame* (1525). His other works include satirical poems and other satires such as *Les Folles Entreprises* (1505), *L'Entreprise de Venise* (1509), *Les Abus du Monde* (1jog), *L'Espoir de Paix* (1509?), *La Coqueluche* (1510), *L'Obstination des Suysses* (1512–13?); religious verse such as La *Quenouille spirituelle* (1524?) and *Chants Royaux* (1527); and collections of tales, *Les Fantasies de Mere Sotte* (1j16) and *Les Menus Propos et le Testament de Lucifer* (1521).

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(F. J. WE.)

GRINIUS, KAZYS (1866–1950), Lithuanian statesman, prime minister and president of the republic during the period of liberal democracy, a key figure of the Lithuanian Peasant party, was born on Dec 17, 1866, near Marijampole He studied medicine in Moscow and then, from 1893, practised as a doctor in several Lithuanian towns. Before World War I his house at Marijampole was a gathering place of Lithuanian democrats. For his patriotic activity he was persecuted by the tsarist Russian government. A member of the Lithuanian constituent assembly he formed a cabinet on June 19, 1920, which on July 12, 1920, signed a peace treaty nith the U S.S.R He resigned on Feb. 1, 1922. On June 7, 1926, Grinius was elected president of Lithuania and served until the military *coup d'ttat* in favour of a Nationalist government on Dec. 17, 1926. He then resumed his medical and social work. He escaped the second Soviet occupation by fleeing to Germany in 1944 and went to the United States in 1947. He died in Chicago on June 4, 1950. (MA. G.)

GRINNELL, a city of east central Iowa. U S , 50 mi. E of Des Moines, the seat of Grinnell college A co-educational school, Grinnell was founded in 1846 by pioneer settlers in Iowa who were Congregationalists and graduates of Yale college and by the "Iowa band" of graduates of Andover (Mass.) Theological seminary who went west in 1843 as educational missionaries The college was opened at Davenport in 1848 as Iowa college and in 1859 moved to Grinnell, where it absorbed Grinnell university (founded 185j). Known popularly as Grinnell college the school did not officially change its name until 1909. The city was settled in 1854 and was named after one of its founders. Josiah Bushnell Grinnell (1821–91), a Congregational clergyman, abolitionist, congressman and railway promoter Grinnell was incorporated as a town in 1865 and as a city in 1882 It adopted the council-manager form of government in 1955 Manufactures include sporting goods, gloves, chemical fertilizers and shoes. For comparative population figures *see* table in IOWA: *Population.*

GRIPENBERG, BERTEL JOHAN SEBASTIAN, BARON (1878–1947), one of the most outstanding of the Finnish poets who wrote in Swedish, was born on Sept. 10, 1878, in St. Petersburg, the son of a senator. He studied law at Helsinki university, became a free-lance writer and spent the last years of his life on his estate at Saaksmaki in southwest Finland. Gripenberg's first collection, Dikter (1903), attracted attention for its richness of colour and sensualism. This and other early collections, of which the most important are Gullergrinden (1905) and Svarta sonetter (1908), show his proud individualism, love of beauty and skilful handling of the sonnet form in particular. He gradually found in the landscape of central Finland a solace for the feelings of loneliness and anger so apparent in Svarta sonetter. The collections Drivsno (1909), Aftnar i Tavastland (1911), *Skuggspel* (1912) and *Spillror* (1917) include more tranquil contemplative poetry, often dwelling on the idea of death. Later collections contain some fine patriotic poems, *e.g.,* on the events of the 1918 war of independence, but in some Gripenberg degenerates into theatrical attitudes and empty pathos. In his last collections, Vid gransen (1930), Livets eko (1932) and Sista *ronden* (1941), the tone is again calmer and more sombre.

He also published some prose works, including his memoirs, Det var de tiderna (1943), and translated into Swedish the "Ballad of Reading Gaol" by Oscar Wilde, whose influence is apparent in his own works. He died in Sweden at the Savsjo sanatorium on May 6, 1947.

See M. Bjorkenheim, B. *Gripenbergs ungdomsdiktning* (1950); J. Louhija, *Symbolit ja kielikuvat B.* Gripenbergin tuotnnnossa (1959).
(K. L. K L)

GRIQUALAND EAST AND GRIQUALAND WEST are historical divisions of the Cape of Good Hope province in the Republic of South Africa. Geographically they are widely separate: historically they are linked hy the fact that in 1861 Adam Kok III (1835–76) of Griqualand West sold his land rights in what is now the Orange Free State. He trekked thence with about 3 000 Griquas across the Drakensberg and settled south of Natal and east of Basutoland in the no man's land, now called Griqualand East, between the Cape, Natal and Pondoland.

Griqualand West lies north of the Orange river and stretches from the Cape plateau eastward across the junction of the Vaal and the Harts rivers, with Kimberley almost on its eastern frontier. Its foundation dates from 1803, when nandering groups of Hottentots and Bastaards (offspring of mixed marriages) under Barend Barends were induced by the missionaries William Anderson and Kramer to settle at Klaarwater (modern Griquatown). They were joined by Koranna and Bechuana. and by 1823 the settlement numbered about 4,000 who called themselves collectively the Criqua people.

By the 1830s there were three Griqua communities with some claim to rank as states. The oldest. at Griquatown, had elected as captain Andries Waterboer. of part Bushman, part Hottentot extraction. He rescued the Kuruman mission station from attack by the Mantatees in 1823 and the following year gave shelter to Moshesh of Basutoland. North and northeast of Waterboer's Iands lay Campbell, another mission station, where the Griquas were ruled by Cornelis Kok. Southeast of both, Adam Kok's group had settled round the London Missionary Society mission centre at Philippolis.

In Dec. 1834 Sir Benjamin D'Urban signed a treaty with Waterboer recognizing his territorial rights as far east as Ramah, and sent a British resident to Griquatonn. By 1835, when the great trek was launched by the Afrikaners. it was Adam Kok, farther to the east, who found himself in the path of the trekkers. In 1843 he concluded a treaty with Sir George Napier (governor of the Cape. 1838–44). Previously (in 1838) Adam Kok had concluded a treaty fixing the frontier as between himself and Cornelis Kok on the west, and he now thought that the Napier treaty nould cover his eastern line facing the Boers. An attempt to exercise the duties imposed by Britain in terms of the Cape of Good Hope Punishment act led to a clash with the Boers at Zwartkopjes (May 1845) In 1845 Sir Peregrine Maitland revised the Napier treaty. Adam Kok's lands were divided theoretically into an inalienable area south of the Riet river, and a leasable area north of that river. In 1848 Sir Harry Smith (1848–52) converted those Boer farms in the leasable area into freeholds in return for cash compensation to Adam Kok. and stipulated that the Griquas pay compensation for improvement when leases terminated in the inalienable land. Notoriously improvident, the Griquas rarely had the money to pay this. and the Boers either usurped or bought freehold even in the inalienable land. In 1854, when Britain recognized the independence of the Free State, no security for Griqua lands was insisted upon; so the quiet and quasi-legal expropriation continued, and, in terms of the convention of Bloemfontein (1854), Free State, not Griqua, jurisdiction extended to European farmers in Griqua lands. In 1857 Cornelis Kok bequeathed the Campbell lands to Adam Kok. who four years later sold his lands to the Free State and. in an epic trek. moved eastward to settle in Griqualand East. in no man's land, where the British hoped the Griquas would be a buffer between the Basuto and the Pondo. Adam Kok died in 1876; and between 1878 and 1879 the control of European magistrates increased until. in 1879, Griqualand East was annexed to the Cape. In 1903, the district of East Griqualand was established as a native council and was admitted into the Transkeian Territories (see TRANSKEI, THE).

Unfortunately, when Adam Kok's lands mere sold to the Free State. his agent, without authorization. included the very dubious claim to the ill-defined Campbell lands. which the Griquas said should have reverted to Waterboer. Thus the Free State and Waterboer were rival claimants of territory which had strategic importance because it lay across the missionary road to the north. The road was vital to traders and, after the discovery of the Tati gold fields, sectors of the road were claimed by the Transvaal. Because of this the road was the focus of dispute among Britain, which protected the missionaries; Waterboer and the Free State, which claimed the Campbell lands; and Marthinius W. Pretorius of the Transvaal, whose westward claim to territory swung right across the road. (See PRETORIUS.) The Keate award, published in 1871, determined against the Transvaal frontier claim and defined the north and west limits of Griqualand West.

Meanwhile, confusion was increased by the discovery of diamonds; first in the Klipdrift area between the Vaal and the Harts rivers. and then in dry diggings far to the south and on the fringe of the eastern boundary of Campbell territory claimed by Waterboer. At Klipdrift the diggers had established a republic under the presidency of a former sailor, Stafford Parker. There. and in the dry diggings of what is now Kimberley, each nf the interested powers—Britain. the Orange Free State and the Transvaal—claimed control they dared not exert without the risk of war, while the diggers appealed to each in turn as seemed opportune. When in 1870 Waterboer and Pretorius and J. H. Brand failed to make an agreement. Waterboer offered his land, about which there was no dispute, together with his disputed Campbell claims, to Britain. In 1871, following the Keate award (*see* SOUTH AFRICA, UNION OF; TRANSVAAL), Sir Henry Barkly annexed the full Waterboer claim as Griqualand West. Legally the decision was premature, as was revealed when a land court was set up to settle matters of title, and Andries Stockenstrom, as judge, ruled that Waterboer's sovereignty had not extended to the Campbell lands, though he did not establish the converse—that Free State sovereignty had so extended. Two factors must rank as extenuating circumstances. First, control was urgently needed to stop acceleration of the gun traffic, and the Langalibalele crisis *(see* NATAL) demonstrated this. Second, had the earl of Carnarvon's federation scheme matured (see CARNARVON, HENRY HOWARD MOLYNEUX HERBERT), Griqualand would have been one unit in a new state. In 1876 Britain paid £90,000 as a final settlement of Free State claims. Even so, the annexation crisis of 1871 exercised a profound and adverse effect on Afrikaner sentiment.

Though in 1871 the Cape had passed a permissive annexation bill, Griqualand West remained under the British crown until 1880. Order was restored and maintained first by Sir Richard Southey and then by Sir Owen Lanyon, both scrupulous and able administrators. Land was surveyed and the Griquas were settled. some on farms, some in rural villages. Unrestricted freehold, im-providence and drink led to systematic expropriation. By 1903, as landowners, the Griquas were almost extinct. (W. A. ML.)

GRIS, JUAN (real name JOSÉ VICTORIANO GONZÁLEZ) (1887–1927), major Spanish Cubist painter closely associated with Georges Braque and Pablo Picasso, was born in Madrid on March 23, 1887, and was given a scientific education before being allowed to follow his inclination and study art. In 1906 Gris moved to Paris, where he made drawings (in an art *nouveau* style) for papers such as Le Charivari and Le *Témoin.* He settled in Montmartre in the Bateau-Lavoir, an artists' dwelling where his compatriot Picasso also lived. During his vital prentice years, Gris was thus closely in touch with the gradual evolution of Cubism. His first paintings in an analytical manner (including a "Portrait of Picasso") were exhibited at the Salon des Indépendants and Section d'Or in 1912. In 1913–14 he arrived at a personal and mature version of synthetic Cubism in which the use of *papier collé* was all-important. Gris envisaged the basis of every painting as "a sort of flat coloured architecture." He was, however, equally aware that "the essence of painting is the expression of certain relationships between the painter and the outside world"; pictures "with no representational purpose" were for him "incomplete technical exercises." He created synthetically an image of reality out of purely pictorial elements, and his greatness results from his having been able to temper intellectual and mathematical calculation with intuition and sensibility. Gris's version of Cubism was more severe and classical, less spontaneous and instinctive, than that of Braque and Picasso; at the same time he was not the victim of a system or theory. Between 1921 and 1927, Gris transformed his synthetic Cubist idiom so that his style became increasingly free, bold and lyrical; formal rhymes abound, curves prevail over angles, the colours are lighter and softer and objects assume more volume. In 1925, his health began to fail and Gris died at Boulogne-sur-Seine on May 11, 1927.

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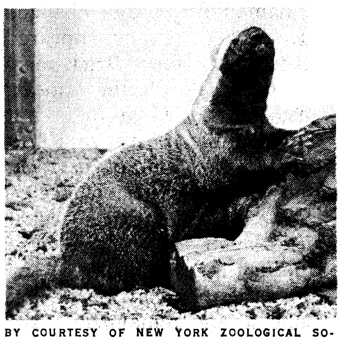
GRISAILLE is a kind of decorative painting done in a monochrome of grays, usually handled in severe or bold modeling in the manner of bas-reliefs. In French it is used as a general term to describe any painting technique that employs a completely developed monotone underpainting, in shades of gray or sometimes in brown, over which transparent or translucent oil colours are laid. It distinguishes between such a twofold method of colouring and the direct or alla *prima* method of putting down the final colours directly, but it does not include the type of painting in which transparent colours or glazes are applied over a multicoloured underpainting. Monochrome or single-toned paintings, or those in which two or three tones are used without regard for actual or realistic colour, intended as finished works in themselves are called *camaieu.* Among glass painters the term grisaille has still another meaning: it is the name of a gray vitreous colour or pigment used in the art of colouring glass for stained glass (*q.v.*). Neither the term grisaille nor the two technical procedures which it denotes are very widely used. Nevertheless monochrome decorations and monochrome underpainting methods are significant in the development of western art, and they have been practised to some extent in every period from Greek times to the present. See also OIL PAINTING, TECHNIQUE OF. (RH. M.)

GRISI, CARLOTTA (1819–1899) was the Italian ballerina who created the title role in Giselle in 1841. Born in Visinada, Italy, June 28. 1819, she studied at the ballet school of La Scala, in Milan. Dancing with Jules Perrot in Naples in 1834, she became his pupil and later his wife.

Following brilliant successes in Vienna and London, she was engaged at the Paris Opéra in 1841. She inspired the profound devotion of Théophile Gautier (*q.v.*), author of Giselle, who also wrote La *Péri* for her. She danced in Perrot's Pas de Quatre in London (1845), appeared in Russia, and at the age of 35 retired to Geneva, Switz., where she died, May 20, 1899. (LN. ME.)

GRISI, GIULIA (1811–1869), Italian opera singer, was born in Milan on July 28, 1811. Giulia was trained for a musical career, and made her stage debut in 1828 in Rossini's *Zelmira.* Later at Milan she was the first Adalgisa in Bellini's Norma, in which Pasta took the title part. Grisi appeared in Paris in 1832, as Semiramide in Rossini's opera, and had a great success. She played at the Théâtre Italien from 1832 to 1849, while in the summers from 1834 onward she appeared in London. Her voice was a brilliant dramatic soprano, and her established position as a prima donna continued for 30 years. Bellini wrote I *Puritani* for performance in 1835 by the great quartet of singers, Grisi, Rubini, Tamburini and Lablache, and the tradition of their peerless singing was long remembered in London and Paris. Later Giovanni Mario (*q.v.*) took the place of Rubini, and for them Donizetti wrote Don Pasquale. In 1854 Grisi toured with Mario in America. She died in Berlin on Nov. 29, 1869.

GRISON, a weasellike mammal (Grison vittata) found in Central and South America. It is about two feet long with an eight-inch tail. The small ears are broad. Grisons, skilled burrowers, climbers and swimmers, prefer to feed on flesh but will eat berries, nuts, etc. The lower parts are blackish, the back bluish-gray.



BY COURTESY OF NEW YORK ZOOLOGICAL SOCIETY
GRISON (GRISON VITTATA), NATIVE IN CENTRAL AND SOUTH AMERICA

A smaller species (*G. furax*) lives in southern Brazil. The least grison (*Lyncodon patagonicus*) occurs in Argentina; it is brown with a whitish crown, blackish nape and gray back. The tayra (*Eira bar*bara), about the size of an otter, with a long tail and ears, has been confused with the grison. *See* CARNIVORA. (J. E. HL.)

GRISONS: see GRAUBÜNDEN.

GRISWOLD, RUFUS WILMOT (1815–1857), U.S. editor who as literary executor edited the writings of Edgar Allan Poe (1850), was born in Benson, Vt., on Feb. 15, 1815. He was a Baptist clergyman for a time, then became a journalist in New York city, and succeeded Poe as literary editor of Graham's Magazine (Philadelphia). He died in New York city on Aug. 27, 1857.

See Honor McCusker, "The Correspondence of R. W. Griswold" More Books, vol. xvi, xviii (1941, 1943), continued by Zoltan Haraszti, Boston Public Library Quarterly, vol. i, ii (1949, 1950); Killis Campbell, "The Poe-Griswold Controversy," Modern Language Association Publications, vol. xxxiv, pp. 436–464 (1919); Joy Bayless, *Rufus Wilmot* Griswold, Poe's Literary Executor (1943).

GRIVET, an African guenon (*q.v.*), *Cercopithecus aethiops,* allied to the green monkey. The typical grivet lives in the Sudan and Ethiopia; related forms are found throughout the savanna country of Africa. The chin, whiskers, a band across the forehead and the underparts are white, the head and back olive green. (J. E. HL.)

GRIZZLY BEAR (*Ursus* horribilis) and its close relatives include some of the largest bears. The coat colour is brownish to buffy; the hairs are usually pale-tipped, producing a frosted, grizzled effect. A large animal may be nine feet long and weigh 1,000 lb. and can easily kill and carry a cow. The height of these bears at the shoulders produces a humped appearance. Because of their great bulk and long, straight claws, they seldom climb, even as cubs.

Formerly they occurred over western North America from northern Alaska to Durango, Mex., especially in open country. Because of their aversion to man, the disappearance of suitable food and relentless hunting they are almost extinct in the United States and Mexico and much reduced in numbers elsewhere. They are omnivorous, feeding on big game, rodents, fish, berries and occasionally even grass. Food is often cached in shallow holes and covered with brush or litter. The grizzly digs readily in search of rodents, often leaving a hillside thoroughly plowed. The home range of a grizzly may comprise several hundred square miles. A methodical animal, it prefers well-developed trails, each passing animal treading in the footsteps of its predecessor until the trail is deeply rutted. Despite their great bulk, grizzlies are surprisingly agile and when pressed run with a light gallop as fast as 30 m p h. When fleeing or charging, they can crash through brushy thickets or deep, matted grass with seeming ease. They are unpredictable. often sullen and ill-tempered and exceedingly dangerous when they feel themselves threatened. *See* also BEAR; CARNIVORA. (K. R. KN.)

GROCK (stage name of CHARLES ADRIEN WETTACH) (1880–1959), the clown whose blunders with piano and violin became proverbial, was born at Moulin de Loveresse, near Reconvilier, Switz., on Jan. 10, 1880. His father, a watchmaker, was an amateur acrobat, and his son grew up with such a love of the sawdust ring that he was allowed to spend each summer with a circus, where he performed first as a tumbler and then as a violinist, pianist and xylophonist. When he was 19 he clowned in a café. but the draw of the circus proved irresistible, though it brought him a wandering life of hardship from Hamburg to Bucharest. He then became the partner of a clown named Brick, and changed his name to Grock on Oct. 7, 1903. Together they appeared in France, North Africa and South America. When Brick married, Grock joined the celebrated Antonnet. At Berlin, appearing on a stage instead of in an arena, they failed at first; but by mastering the stage technique they obtained, through C. B. Cochran, an engagement at the Palace theatre, London, in 1911. Two years later Grock, with an anonymous partner, perfected those adventures of a simpleton among musical instruments that made audiences in many European cities laugh—at his wonder as to where the strings had gone when he held his fiddle the wrong side up, and at his labours to sit nearer the piano by pushing it toward the stool. In 1924 he left England and remained on the continent until his farewell at Hamburg in 1954. He died at Imperia, It., on July 14, 1959.

Grock wrote several books, among which is his autobiography, *Die Memoiren des Koenigs der Clowns* (1956), translated by Basil Creighton as *Grock, King of Clowns* (1957). (M. W. D.)

GROCYN, WILLIAM (1446?–1519), English scholar, was born at Colerne, Wiltshire. He was a scholar and fellow of New college, Oxford, reader in divinity in Magdalen college, and in 1485 became prebendary of Lincoln cathedral. About 1488 Grocyn left England for Italy, and before his return in 1491 he had visited Florence, Rome and Padua, and studied Greek and Latin under Demetrius Chalchondyles and Politian. As lecturer in Exeter college he found an opportunity of indoctrinating his countrymen in the new Greek learning

Erasmus says in one of his letters that Grocyn taught Greek at Oxford before going to Italy. He seems to have lived in Oxford until 1499, but when his friend Colet became dean of St. Paul's in 1504 he was settled in London. He was chosen by his friend to deliver lectures in St. Paul's. He also counted Linacre, William Lily, William Latimer and More among his friends, and Erasmus writing in 1514 says that he was supported by Grocyn in London, and calls him "the friend and preceptor of us all." He held several preferments, including the wardenship of All Hallows college at Maidstone, Kent. He died in 1519, and was buried in the collegiate church at Maidstone.

An interesting account of Grocyn written by Professor Burrows appeared in the Oxford Historical society's *Collectanea* (1890).

GRODNO, one of the former Lithuanian governments of western Russia, the northern part of which was the object of a dispute between Poland and Lithuania after World War I.

The government of the Polish republic occupied practically the whole area and created an administrative province of Bialystok.

Grodno's area under Russian rule was 14,926 sq.mi. and its population was somewhat under two million, mainly White Russians (54%), with large Jewish (17.4%) and Polish (10%) elements, also Lithuanians and Germans. Prior to 1795, when it was annexed by Russia, it had been Polish for centuries.

Grodno is called, by the Lithuanians, Gardinas. Immediately after the revolution of 1917 there was much shuffling of provinces and territories; for some years the districts and areas bordering on Russia were in *a* state of flux; by a system of gradual assimilation some of the territories were absorbed with the soviet union—others were simply annexed.

During the early part of World War II Grodno (that is, the northern part of the Polish province of Bialystok) was occupied by Soviet troops and, by the German-Russian partition agreement of Sept. 28, 1939, was allotted to the U.S.S.R. The small portion that had remained a part of Lithuania was also annexed to the Soviet Union when that nation absorbed the Baltic states in 1940.

After Germany attacked the U.S.S.R. Grodno came under German control and was held from 1941 until 1945.

Except for some hills (not exceeding 92j ft.) in the north, Grodno is a uniform plain, and is drained chiefly by the Bug, Niemen, Narev and Bobr, all navigable. There are also several canals, the most important being the Augustowo and Oginsky. Granites and gneisses crop out along the Bug, Cretaceous, and especially Tertiary, deposits elsewhere. The soil is mostly sandy, and in the district of Grodno and along the rivers is often drift sand. Forests, principally of Coniferae, cover more than one-fourth of the area. Among them are some of vast extent, *e.g.*, those of Grodno (410 sq.mi.) and Bialowieza (376 sq.mi.), embracing wide areas of marshy ground. In the last-mentioned forest the wild ox survived, having been jealously preserved since 1803. Peat bogs, sometimes as much as four to seven feet thick, cover extensive districts. Agriculture is the predominant industry, and over 2,250,000 ac. are arable. The principal crops are potatoes, rye, oats, wheat, flax, hemp and some tobacco. Horses, cattle and sheep are bred in fairly large numbers. There is, however, a certain amount of manufacturing industry, especially in woolens, distilling and tobacco. There are also factories which produce silk, shoddy and leather.

GRODNO (GARDINAS), town, formerly in Poland, in the Belorussian S.S.R., U.S.S.R., on the Niemen, 160 mi. N.E. of Warsaw. Population in (1959) was 72,000. It has two old castles and two churches. Tobacco factories and distilleries are important; machinery, soap and candles are also made. Once part of the principality of Lithuania, Grodno was frequently ravaged by the Teutonic Knights. After the union with Poland in 1569, it became one of the two meeting places of the Polish-Lithuanian diet. The second partition of Poland was signed at Grodno during the year 1792. In World War II Grodno was occupied by the U.S.S.R. from 1939 to 1941, when it was taken by German troops. It was again ceded to the U.S.S.R. in 1945.

GROEMER, WILHELM (1867–1939), German general, was born on Nov. 22, 1867, at Ludwigsburg, Wiirttemberg. In 1912 he was attached to the railway section of the general staff, and was its chief during the mobilization of 1914. From May 27, 1916 to Aug. 1917 he was departmental head of the War Office. He went to the eastern front as divisional commander and leader of an army corps in Aug. 1917, and in 1918 was chief of staff of the army group under the command of Linsingen and afterwards of Eichhorn. In Nov. 1918 he succeeded Ludendorff as quartermaster-general, but retired as a protest against the signature of the Treaty of Versailles. After the revolution he joined the Democratic Party. He was minister of communications (June 1920–Aug. 1923) and combated the proposals for the reversion of the state railways to private ownership. He wrote *Der Weltkrieg und seine Probleme* (1920). He was minister of defence, 1928–1932, and of the interior, 1931–32.

GROEN VAN PRINSTERER, GUILLAUME (1801–1876), Dutch politician and historian, was born at Voorburg, near The Hague, on Aug. 21,1801. He studied at Leyden university, and acted (1829–33) as secretary to King William I. of Holland. He became the leader of the so-called anti-revolutionary party, both in the second chamber, of which he was for many years a member, and outside. In Groen the doctrines of Guizot and Stahl found an eloquent exponent. They permeate his controversial and political writings and historical studies, of which his *Handbook* of *Dutch History* (in Dutch) and *Maurice et Barnevelt* (in French, 1875, a criticism of Motley's *Life of Van Olden-Barnevelt)* are the principal. Groen was violently opposed to Thorbecke, whose principles he denounced as ungodly and revolutionary. He died at The Hague on May 19, 1876. He is best known as the editor of the

Archives et correspondance de la maison d'Orange (12 vols., 1835–45), a great work of patient erudition.

See Bos, *Groen van Prinsterer en zijn tijd* (2 vols., 1886–91).

GROIN, in architecture, the edges formed at the intersections of two vaults at an angle to each other. If the vaults intersect at right angles and are of the same height and radius, these intersections will all lie on a vertical plane at 45° to the planes of the two vaults. If, however, one vault is lower than the other. or the curvatures are different, winding and distorted curves will result. Both the Roman and Renaissance constructors of vaults frequently regularized the rib shapes and slightly warped the surfaces of the vaults until they met at this regularized groin line. Thus in the coved, penetrated ceilings of the 16th century. where an elliptical vault was intersected by smaller vaults, the groins mould often be given simple segmental curves, meeting at a point in the centre of each penetration, and the smaller vaults forming the penetrations given a surface almost conical in order to meet this line. The term Welsh groin is often applied to the groin resulting from such an intersection of a smaller cross vault with a higher main vault. In the medieval period, when ribbed vaulting became common, the ribs under the groins (groin ribs or diagonal ribs), being built first, were usually on curves lying in a simple plane. The web. or filling in of small stones between the ribs, could be warped or twisted at will, so as to start correctly from the wall or cross ribs of different sizes and yet meet over the groin rib. *See* ARCH AND VAULT.

GROLIER, JEAN, VICOMTE D'AGUISY (1479–1565), French bibliophile, was born at Lyons, was the friend of Budé, the patron of Aldus, and was called the Maccenas of men of letters by his contemporaries. Of his great library of 3,000 volumes, dispersed in 1675, some 350 are known to be in existence. They are richly bound and bear their onner's *ex libris* "Grolerii Lugdunensis, et Amicorum." Grolier made the acquaintance of Aldus while he was French ambassador in Italy (1510–35).

See Leroux de Lincy, *Recherches sur Jean* ***Grolier*** (1866).

GROMATICI or **AGRIMENSORES,** the name for land-surveyors amongst the Romans, from Lat. *groma* or *gruma, a* surveyor's measuring appliance. The art of surveying was probably at first in the hands of the augurs, who from early times had made use of sighting instruments for marking out the rectangular consecrated space *templum* containing the *tabernaculum* in which the augur observed the omens given by birds. The first professional surveyor mentioned is L. Decidius Saxa, who was employed by Anthony in the measurement of camps (Cicero, *Philippics,* xi. 12, xiv. 10). The subsequent increase in the number of military colonies, the settlement of Italian peasants in the provinces, the general survey of the empire under Augustus, the separation of private from State domains, led to the formation of a recognized professional class of highly-paid surveyors, some of whom were even honoured with the title *clarissimus.* Their duties required not only geometrical but also legal knowledge, as their decisions were considered authoritative in matters relating to the distribution of lands. This led to the institution of special training schools and the growth of a special literature, chiefly between the 1st and 6th centuries A.D. The earliest of the gromatic writers was Frontinus (*q.v.*), whose *De agrorum qualitate,* written from A.D. 81–96, dealt more with the legal aspect of the art. Extracts of it are preserved in the commentary of Aggenus Urbicus, a Christian schoolmaster. Under Trajan a certain Balbus wrote a manual of geometry for land surveyors *(Expositio et ratio omnium formarum et mensurarum*). Also, under Trajan, Hyginus makes a definite reference to the use of the groma for laying out agricultural holdings. Later was Siculus Flaccus (de *condicionibus agrorum,* extant), while the most curious treatise on the subject, written in barbarous Latin and entitled *Casae litterarum,* is the work of a certain Innocentius (4th–5th century). The *Gromatici veteres* contains extracts from official registers (probably 5th century) of land surveys, lists and descriptions of boundary stones, and extracts from the Theodosian Codex. According to Mommsen, the collection had its origin during the 5th century in the office of a diocesan governor of Rome, who had a number of surveyors under him. The *agrimensores* have been known by various names, e.g., *decempedator* (with reference to the instrument used); *finitor, mensor castrorum* in republican times; *togati Augustorum* as imperial civil officials; *professor, auctor* as professional instructors.

GRONINGEN, most northerly province of the Netherlands, bounded south by Drente, west by Friesland and the Lauwers Zee, north and north-east by the North Sea and the mouth of the Ems with the Dollart, and south-east by Germany. German troops occupied the province in 1940. It includes the islands of Boschplaat and Rottumeroog, belonging to the group of Frisian islands (*q.v.*). Area, 867 sq.mi.; pop. (1957 est.) 467,712. The sandy tongue of the Hondsrug extends from the Drente plateau almost to the capital. West, north and north-east of this the province is flat and consists of sea-clay or sand and clay mixed, except where patches of low and high fen occur on the Frisian borders. Low fen predominates to the east of the capital. The south-east of the province is of high fen resting on diluvial sand largely reclaimed. The morass on the German border was long considered as the natural protection of the eastern frontier, and with the view of preserving its impassable condition neither agriculture nor cattle-rearing was permitted until 1824, and it was only in 1868 that the work of reclamation began. The gradual extension of the seaward boundaries ot the province owing to the process of littoral deposits may be traced by a triple line of sea-dikes marking the successive stages in this advance. The rivers of Groningen descending from the Drente plateau meet at the capital, whence they are continued by the Reitdiep to the Lauwers Zee (being discharged through a lock), and by the Ems canal (1876) to Delfzyl. The south-eastern corner of the province is traversed by the Westerwolde Aa, which discharges into the Dollart. The railways belong to the northern section of the State railways, and afford communication with Germany via Winschoten. Agriculture is the main industry and the proportion of landowners is a very large one. The ancient custom called the *beklem-recht,* or lease-right, doubtless accounts for this. By this custom a tenant-farmer is able to bequeath his farm, as he holds his lease in perpetuity.

The chief agricultural products are barley, oats, wheat, and in the north-east flax is also grown, and exported to South Holland and Belgium. On the higher clay grounds cattle-rearing and horse-breeding are also practised, together with butter and cheese making. Potatoes are cultivated. Coast fisheries are considerable. Groningen (*q.v.*) is the only large town. Delfzyl, formerly an important fortress for the protection of the ancient sluices on the river Delf, has benefited by the construction of the Ems (Eems) ship-canal connecting it with Groningen, and has a harbour, ordinarily importing wood. Appingedam and Winschoten are very old towns with cattle and horse markets.

GRONMGEN, a commune of the Netherlands, capital of the province of the same name, at the confluence of the two canalized rivers the Drentsche Aa and the Hunse (which are continued to the Lauwers Zee as the Reit Diep), 16 mi. N. of Assen and 33 mi. E. of Leeuwarden by rail. Pop. (1957 est.) 142,859 mun.

History.—The town of Groningen belonged originally to the *pagus,* or *gouw,* of Triantha (Drente), the countship of which was bestowed by the emperor Henry II. on the bishop and chapter of Utrecht in 1024. In 1040 Henry III. gave the church of Utrecht the royal domain of Groningen, and in the deed of gift the "villa Cruoninga" is mentioned. At first the bishops were too strong for the townsmen, and down to the 15th century an episcopal prefect, or burgrave, had his seat in the city, his authority extending over the neighbouring districts known as the Gorecht. Gradually, however, the burghers, aided by the neighbouring Frisians, succeeded in freeing themselves from the episcopal yoke. The city was walled in 1255; before 1284 it had become a member of the Hanseatic league; and by the end of the 14th century it was practically a powerful independent republic, which exercised an effective control over the Frisian Ommelande between the Ems and the Lauwers Zee. In 1440 Bishop Dirk II. finally sold to the city the rights of the see of Utrecht over the Gorecht.

The medieval constitution of Groningen, unlike that of Utrecht, was aristocratic. Merchant gild there was none; and the craft gilds were without direct influence on the city government, which held them in subjection. Membership of the governing council, which selected from its own body the four *rationales* or burgomasters, was confined to men of approved "wisdom," and wisdom was measured in terms of money. This Raad of wealthy burghers gradually monopolized all power. The bishop's bailiff (*schout*), with his nominated assessors (*scabini*), continued to exercise jurisdiction, but members of the *Raad* sat on the bench with him, and an appeal lay from his court to the *Raad* itself. The council was supreme and in 1439 it decreed that no one might trade in all the district between the Ems and the Lauwers Zee except burghers, and those who had purchased the *burwal* (right of residence in the city) and the freedom of the gilds. In 1536 the city passed into the hands of Charles V., and in the great wars of the 16th century suffered all the miseries of siege and military occupation. From 1581 onwards, Groningen, still held by the Spaniards, was constantly at war with the "Ommelanden" which had declared against the king of Spain. In 1672 the town was besieged by the bishop of Münster, but it was successfully defended, and in 1698 its fortifications were improved under Coehoorn's direction. The French Republicans were in control from Feb. 1795 until 1814. The fortifications of the city were destroyed in 1874. German troops occupied Groningen during the invasion of May 1940.

Buildings, et~. — Theancient part of the town is still surrounded by the former moat, and in the centre lies a group of open places. The chief church is the Martini-kerk, dating from 1477, and an organ constructed by the famous scholar and musician Rudolph Agricolo, who was born near Groningen in 1443. The Aa church dates from 1465, but was founded in 1253. The provincial museum of antiquities contains interesting Germanic antiquities, as well as medieval and modern collections of porcelain, pictures, etc. The old Ommelandcrhuis was built in 1509.

The university of Groningen, founded in 1614, has among its auxiliary establishments an observatory and a library which contains a copy of Erasmus' New Testament with marginal annotations by Luther. Groningen is the centre from which several important canals radiate. Hence steamers ply in all directions, and there is a regular service to Emden and the islands of Borkum and Schiermonnikoog. Groningen is the most important town in the north of Holland, with brick houses of the 16th and 17th centuries still standing. As capital of the province, and because of its natural position, Groningen ordinarily maintains a considerable trade, chiefly in oilseed, grain, wood, turf and cattle. The chief industries are flax spinning, sugar refining, book printing, and it also manufactures beer, tobacco, cotton and woollen stuffs, furniture and pianos; besides which there are numerous goldsmiths and silversmiths.

GROOTE, GERHARD (GEERT GROOT or GROETE; Lat. GERARDUS MAGNUS) (1340–1384), founder of the Brethren of the Common Life (*q.v.*) and also (through his disciple Florentius Radewyn) of the Windesheim Congregation of Canons Regular, was the father of the devotio *moderna,* the influential spiritual movement of the 15th century. Born of a wealthy family at Deventer, Neth., he was well educated (arts, canon and civil law, medicine. theology) at Aachen, Cologne, Paris and Prague. Influenced by a Carthusian friend, he abandoned the worldly life he was leading, renounced his two benefices (Utrecht and Aachen) and many possessions, gave over most of his home to devout women (first beginning of the Sisters of Common Life) and on the advice of Jan van Ruysbroeck (*q.v.*) went to a Carthusian monastery (c. 1375). Desiring apostolic activity, he left after two years, was ordained deacon (never a priest) and began zealously preaching the gospel in the diocese of Utrecht. His preaching was immensely fruitful, but he made enemies by rebuking lax priests and religious. They persuaded the bishop to retract his permission to preach. Groote obeyed but appealed to the pope. Before the response came, he died on Aug. 20, 1384. By preaching Groote gathered many disciples who became the nucleus of the Brethren of the Common Life, and from them was formed, at Groote's direction but after his death. the Windesheim congregation. Through these two groups he had his greatest influence, especially in spirituality. His spirituality was affective, practical, moderate and methodical. Some claim that Groote wrote The Imitation *of* Christ (*q.v.*).

See A. Hyma, ***Brethren of the Common Life*** (1950), with a biography of Groote, a history of the Brethren of the Common Life and the Windesheim congregation and a fine bibliography. (T. G. O'C.)

GROPIUS, WALTER (1883–), German-American architect, internationally famous for his leadership in modern architecture, was born May 18, 1883, in Berlin. After a brilliant early start, continued struggles against the German ruling taste made his life and career difficult. From 1903 to 1907 he studied at the institutes of technology in Berlin and Munich. He was Peter Behrens' chief assistant in Berlin from 1907 to 1910. In 1910 he set up his own architectural practice. In 1911 he built the Fagus works at Alfeld, Germany. through which, as Mies van der Rohe put it, Gropius "became with one stroke one of the leading architects of Europe." Today it is preserved as a national monument.

At the Werkbund exhibition at Cologne (1914), great architectural excitement was aroused by Gropius' model factory connected to an administration building, with its transparent staircase and glass-walled offices and roof terrace. Among his other exhibits were: the Paris exhibition's "Salon des Artistes Decorateurs" (1930) and the Pennsylvania Pavilion for the New York World's fair (1939). His famous Bauhaus at Dessau (1925–26) revealed the potentialities of new forms and spaces in a large building complex composed of two schools and a students' dormitory. The glass curtain wall, drawn around the corners of the main building, dominated the scene. The Impington Village college, Cambridge, England (1936), was designed to provide for the education of both children and adults. His most important work in the United States is the Harvard graduate center (1949–50).

Gropius' faith in teamwork is rooted in his qualities as a teacher. That the Bauhaus at Weimar and Dessau (1919–28) could stand up against its adversaries is a tribute to his talent for inspiring associates to cooperate in the service of an ideal. This emphasis on teamwork was largely responsible for his great influence as Chairman of Harvard's graduate school of design from 1937–52. In all his activities he sought to bridge the gulf between artistic form and industrial production. From 1934 to 1937 Gropius was a voluntary exile in London until he was summoned to Harvard. Beginning in 1946, as founder and member of The Architects' Collaborative, hc associated himself successfully with young American architects engaged in extensive building activity, including the American embassy in Athens (1957). The many honours accorded him include degrees from the Institute of Technology in Hanover (1929), and Harvard university (1953), the Grand Prix d'Architecture at São Paulo (1954), the Gold medal of the Royal Institute of British Architects (1956), the Goethe prize from the University of Hamburg (1957) and the Gold medal of the American Institute of Architects (1959).

See H. Bayer, W. Gropius, and I. Gropius, ***Bauhaus, 1919–1928*** (1952) ; and S. Giedion, ***Walter Gropius, Team and Teamwork*** (1954). (S. GN.)

GROS, ANTOINE JEAN, BARON (1771–1835), French (history) painter especially known for his pictures of Napoleon's campaigns, was born in Paris on March 16, 1771, the son of a miniature painter who gave him his first lessons in painting and drawing. Toward the end of 1785 he entered the studio of J. L. David; while revering him as a teacher, he was equally impressed by the works of Rubens, whose influence can be seen in his brilliant colouring and crowded compositions. In 1793, with David's help, Gros went to Italy, made his way to Genoa, and there met Joséphine de Beauhamais and through her his hero Napoleon. In 1796 he followed the French army to Arcole, and was present when Napoleon planted the flag on the bridge and commemorated the incident in his first major work, "Napoleon sur le Pont d'Arcole" (Louvre, Paris). Napoleon gave him the formal rank of *inspecteur* aux revues, which enabled him to accompany the army on its campaigns, and he also served on the commission to select works of art from Italy for the Louvre.

The Salon of 1804 saw the second of Gros's masterpieces, "Les Pestiférés de Jaffa" (Louvre), which shows Napoleon not only visiting the leper hospital but touching the sores in the way that former kings of France touched for the plague. This was followed two years later by "La Bataille d'Aboukir" (Versailles), of which the hero is Murat, and in 1808 by "La Bataille d'Eylau" (Louvre), in which Napoleon on the battlefield almost has the attributes of sanctity. Although he continued to paint large compositions containing passages of fine painting ("Départ de Louis XVIII," 1815. Versailles), Gros never repeated the great climaxes of Jaffa or Eylau. The decoration of the dome of Ste. Geneviève (1811), is a cold and disconnected work. After the fall of Napoleon, Gros's finest pictures were portraits, many of which are masterpieces; *e.g.*, "Jeune Fille au Collier de Jais" (Musée Magnin, Dijon), "Mme. Récamier âgée" (Zagreb).

Constantly worried by David's criticism of his work, Gros made an effort to paint in a more academic classical manner, in the ceiling of the Egyptian room of the Louvre in 1824. But it was too late; his brilliant crowded compositions of some 20 years earlier had already sown the seeds of the Romantic reaction to classicism. Eugene Delacroix and Théodore Géricault would not be possible without Gros. A sense of failure exacerbated his already strong tendency toward melancholia and on June 26, 1835, he was found drowned in the Seine.

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GROSBEAK, a name indefinitely applied to many thick-billed birds. It is one of the names of the hawfinch (*q.v.*) but is generally used in combination. The pine grosbeak (Pinicola enucleator) is a finch (*q.v.*) inhabiting the coniferous woods of the new and old worlds, moving southward in large flocks with the approach of winter. In structure and habits it resembles a bullfinch, but is larger; in plumage it is much like a crossbill (*q.v.*). It has many smaller allies. The bright red cardinal or Virginia nightingale (Richmondena *cardinalis*), one of the grosbeak group, inhabits the eastern, central and southwestern U.S. Many other American birds are called grosbeaks, of which the best known are the rose-breasted grosbeak (Pheuticus ludovicianus); black-headed grosbeak (P. melanocephalus); eastern blue grosbeak (*Guiraca* coerulea); and the eastern evening grosbeak (*Hesperiphona* vespertina). For "sociable grosbeak" see WEAVERBIRD.

GROSE, FRANCIS (*c.* 1730–1791), English antiquary, was born at Greenford, Middlesex. Grose early showed an interest in heraldry and antiquities, and his father procured him a position in the Heralds' college. In 1763, being then Richmond Herald, he sold his tabard, and shortly afterwards became adjutant and paymaster of the Hampshire militia. The fortune left him by his father being squandered, he began to turn to account his excellent education and his powers as a draughtsman. In 1757 he had been elected fellow of the Society of Antiquaries. In 1773 he began to publish his Antiquities of England and Wales, completed in 1787. In 1789 he set out on an antiquarian tour through Scotland, and in the course of this journey met Burns, who composed in his honour the famous song beginning "Ken ye aught o' Captain Grose," and in that other poem, still more famous, "Hear, land o' cakes, and brither Scots," warned all Scotsmen of this "chield among them taking notes." He died in Dublin on June 12, 1791.

Grose was a sort of antiquarian Falstaff—at least he possessed in a striking degree the knight's physical peculiarities; but he was a man of true honour and charity, a valuable friend, an inimitable boon companion. His humour, his varied knowledge and his good nature all contributed to make him a favourite in society.

Grose's works include The Antiquities of England and Wales (6 vols., 1773–87); Advice to the *Officers* of the British Army (1782), a satire in the manner of Swift's Directions to Servants; A Guide to Health, Beauty, Riches and Honour (1783), a collection of advertisements of the period, with characteristic satiric preface; A Classical Dictionary of the Vulgar Tongue (1785); A Treatise on Ancient *Armour* and Weapons (1785–89); Darrell's History of Dover (1786); Military *Antiquities* (2 vols., 1786–88); A Provincial Glossary (1787); Rules for *Drawing* Caricatures (1788); The Antiquities of Scotland (2 vols., 1789–91); Antiquities of Ireland (2 vols., 1791), edited and partly written by Ledwich. The *Grumbler*, 16 humorous essays, appeared in 1791 after his death; and in 1793 *The* Olio, a collection of essays, jests and bits of poetry, highly characteristic of Grose was printed.

A capital full-length portrait of Grose by N. Dance is in the first volume of the Antiquities of Englund *and* Wales, and another is among Kay's Portraits. A versified sketch of him appeared in the Gentleman's Magazine, lxi. 660. See Gentleman's Magazine, lxi. 498, 582; Noble's *Hist.* of the College of Arms, p. 434; Notes and Queries, passim.

GROSSETESTE, ROBERT (*c.* 1175–1253), bishop of Lincoln, and one of the greatest of mediaeval statesmen and philosophers, was born of humble parents at Stradbrook, Suffolk. About 1197, he graduated at Oxford where he had become proficient in law, medicine and the natural sciences. Some ten years later he took his divinity degree, and soon after this event, as the outstanding teacher at Oxford, he was appointed Master of the Oxford Schools, a status which was first termed "Chancellor" in the Legatine Ordinance of 1214. In 1229 when the Franciscans established their first school at Oxford, Grosseteste was secured as their reader in theology. According to Roger Bacon, who was a severe critic, Grosseteste was pre-eminent among his contemporaries for his knowledge of the natural sciences and of mathematics. Between 1214 and 1231 Grosseteste held in succession the archdeaconries of Chester, Northampton and Leicester. In 1232, he resigned all his preferments except one prebend at Lincoln. But he retained the office of chancellor, and in 1235 accepted the bishopric of Lincoln, an appointment which he held until his death on Oct. g, 1253.

Grosseteste's scheme to reform morals and clerical discipline throughout his vast diocese, brought him into conflict with more than one privileged corporation, in particular with his own chapter, and it was only in 1245 that by a personal visit to the papal court at Lyons, he secured a favourable verdict. His zeal for reform led him to advance, on behalf of the courts-Christian, pretensions which it was impossible that the secular power should admit. He twice incurred a well-merited rebuke from Henry III. upon this subject; although it was left for Edward I. to settle the question of principle in favour of the state. The devotion of Grosseteste to the hierarchical theories of his age is attested by his correspondence with his chapter and the king. Against the former he upheld the prerogative of the bishops; against the latter he asserted that it was impossible for a bishop to disregard the commands of the Holy See. Where the liberties of the national church came into conflict with the pretensions of Rome he stood by his countrymen. Of royal exactions he was impatient.

It was, however, soon made clear that the king and pope were in alliance to crush the independence of the English clergy; and from 1250 onwards Grosseteste openly criticized the new financial expedients to which Innocent IV. had been driven by his desperate conflict with the Empire. While visiting Innocent in 1250, the bishop laid before the pope and cardinals a written memorial in which he ascribed all the evils of the Church to the malignant influence of the Curia. It produced no eifect, although the cardinals felt that Grosseteste was too influential to be punished for his audacity. In 1251 he protested against a papal mandate enjoining the English clergy to pay Henry III. one-tenth of their revenues for a crusade, and in 1253 against a command to provide in his own diocese for a papal nephew.

In literary and speculative activities, Grosseteste found some release from his ecclesiastical and political cares. He was familiar with the Neo-Platonic materials introduced into the West by the Arabians, with their scientific treatises and with the newly translated works of Aristotle. He himself contributed to the revival of learning by his commentaries on Aristotle, and by his Greek-Latin translations of the Ethics, of the works of the pseudo-Dionysius and of the De Fide Orth. of the Damascene; hence Grosseteste, rather than Albert the Great, must be credited with having introduced Aristotle into the West. The peculiar originality of his mind is further manifested by his profound interest in science, by his exaltation of mathematics, by his enthusiasm for the study of languages, by his treatises on husbandry and politics, by his poetical compositions and by his concern for music and ecclesiastical architecture. His philosophy, which represents the first attempt to reconcile the doctrines of Augustine and of Aristotle, is full of interest, especially in its denial of the eternity of the world, and in its doctrines of light as the origin of corporeity, of the stars as composed of the four elements, of the active intellect in man, of angelology and of the divine knowledge of singulars.

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GROSSETO, a town and episcopal see of Toscana (Tuscany), capital of the province of Grosseto, Italy, 90 mi. S.S.E. of Pisa by rail. Population (1951) 24,640. It is 38 ft. above sea level. Fortifications constructed by Francis I (1574–87) and Ferdinand I (1587–1609) form a hexagonal enciente with projecting bastions, with two gates only. The small cathedral begun in 1190 and rebuilt in 1294, is of red and white marble, in the Italian Gothic style. The citadel was built in 1311 by the Sienese. Grosseto is on the main line from Pisa to Rome.

The town dates from the middle ages. In 1138 the episcopal see was transferred thither from Rusellae. In 1224, with the rest of the Maremma, of which it is the capital, it came under the dominion of Siena. By the peace of 1559, however, it passed to Cosimo I of Tuscany. In 1745 malaria had reduced the population to 648, though in 1224 it had 3,000 men who bore arms. Leopold I renewed drainage operations, and by 1836 the populatiop had risen to 2,392. Grosseto was bombed by Allied planes in World War II.

GROSSMITH, GEORGE (1847–1912), English comedian, noted for his roles in Gilbert and Sullivan productions, and for his authorship, with his brother, WALTER WEEDON GROSSMITH (1852–1919), of *The Diary of a Nobody* (1894), was born in London on Dec. 9, 1847. After several years of journalistic work he started about 1870 as a public entertainer, with songs and recitations. In 1877 he began a long connection with the Gilbert and Sullivan operas at the Opera Comique, London, in *The Sorcerer.* He appeared regularly thereafter at that theatre and from 1881 at the new Savoy Theatre, London. His capacity for "patter songs," and his humorous acting, dancing and singing marked his creations of the chief characters in the Gilbert and Sullivan operas as the expression of a highly original individuality. In 1889 he left the Savoy and again set up as an entertainer, visiting all the major cities of Great Britain and the United States. He died at Folkestone, Eng., March 1, 1912. His two sons, LAURENCE (1877–1944) and GEORGE Grossmith (1874–193j), were both actors.

See S. Naylor, *Gaiety and George Grossmith* (1913).

GROSVENOR, GILBERT HOVEY (1875–), U.S. geographer, writer and longtime editor of the *National Geographic Magazine,* was born in Constantinople, Turkey. Oct. 28, 1875. He was graduated from Amherst college, Amherst, Mass., and in 1899 became director and president of the National Geographic society, and, in 1900, editor of the *National Geographic.* Under his directorship the society membership grew from 900 to over 1,900,000. He resigned as editor in 1954 and became board chairman.

During Grosvenor's administration the society sent out numerous expeditions to the north and south poles, into the stratosphere, to the ocean depths, and conducted a myriad of other investigations. In addition to his articles in the *National Geographic Magazine* he wrote a history of the society, chapters on exploration for the Smithsonian institute report and Adm. R. E Peary's *The North Pole.* He was long a leader in the conservation and protection of wildlife.

GROS VENTRES, a name (Fr. "big bellies") applied to two distinct North American Indian groups:

1. The Hidatsa or Minitari, also known as the Gros Ventres of the Missouri. A Siouan-speaking tribe, linguistically related to the Crow and closely connected historically with the Mandan, they have been settled since the mid-19th century on Fort Berthold reservation, N.D. (*see* HIDATSA; MANDAN).

2. The Atsina, sometimes called the Gros Ventres of the Prairie (or Plains). An offshoot of the Algonkian-speaking Arapaho tribe, from which they may have separated as early as 1700, they were living in what is now northern Montana and adjacent regions of Canada in late historic times, and were culturally similar to other Plains tribes. Together with the Assiniboin, they were settled on Fort Belknap reservation, Mont., where the combined population totaled about 2,000 in 1950. (*See* also ARAPAHO; PLAINS INDIANS.)

The term Gros Ventres has been interpreted as a French-Canadian misunderstanding of Indian gestures designating the two tribes—possibly indicating hunger or greediness in the case of the Atsina and a pattern of body tattooing in the case of the Hidatsa.

See F. W. Hodge (ed.), *Handbook of American Indians North of Mexico,* part 1 (reprinted, 1959) ; A. L. Kroeber, *Ethnology of the Gros Ventre,* Anthropological Papers of the American Museum of Natural History, vol. i, part 4 (1908).

GROTE, GEORGE (1794–1871), English historian of Greece, was born on Nov. 17, 1794, at Clay Hill, near Beckenham, Kent, of a well-known family of bankers originating from Bremen. He was sent to the Sevenoaks grammar school and afterward to Charterhouse, but at the age of 16 he entered the bank in which his father was a partner.

Grote spent all his spare time in the study of classics, history, metaphysics and political economy, and in learning German, French and Italian. He became an intimate friend of Charles Hay Cameron, who strengthened him in his regard for philosophy, and George W. Norman. It was through the latter that Grote met Harriet Lewin, whom he married in 1820.

In 1817 Grote came under the influence of David Ricardo, and through him of James Mill and Jeremy Bentham. His first published work, the *Statement of the Question of Parliamentary Reform* (1821), was a reply to Sir James Mackintosh's article in the *Edinburgh Review* advocating popular representation, vote by ballot and short parliaments. In April 1822 he published in the *Morning Chronicle* a letter against Canning's attack on Lord John Russell, and edited, or rather re-wrote, some papers of Bentham, which he published as *Analysis of the Influence of Natural Religion on the Temporal Happiness of Mankind, by Philip Beauchamp* (1822). The book was published in the name of Richard Carlile, then in gaol at Dorchester. From 1826 to 1830 he worked with J. S. Mill and Henry Brougham in the organization of the new "university" in Gower street. He was a member of the council which organized the faculties and the curriculum of University college, London; but in 1830, owing to a difference with Mill as to an appointment to one of the philosophical chairs, he resigned his position. In 1849 he was re-elected to the council, in 1860 he became treasurer, and on the death of Brougham (1868) president. He became a member of the senate in 1850 and was vice-chancellor in 1862. He presented to the college the *Marmor Homericunt,* and finally bequeathed the reversion of £6,000 for the endowment of a chair of philosophy of mind and logic. He succeeded his friend Henry Hallam as a trustee of the British Museum in 1859, and took part in the reorganization of the departments of antiquities and natural science

At his father's death, in 1830, he became manager of the bank and took a leading position among the city Radicals In 1831 he published his *Essentials* of *Parliamentary Reform* (an elaboration of his previous *Statement),* and in Dec. 1832 entered parliament as one of the members for the City of London. He sat in the House of Commons until 1841, representing the Benthamite school of "philosophic radicalism." During these years of active public life his interest in Greek history and philosophy increased, and after a trip to Italy in 1842 he devoted himself to literature. In 1846 the first two volumes of the *History of Greece* appeared, and the remaining ten between 1847 and 1856. In 1847 he visited Switzerland to study a condition of things in some sense analogous to that of the ancient Greek States. This visit resulted in the publication in *The Spectator* of seven weekly letters, later collected in book form. *Plato and the Other Companions of Sokrates* (3 vols) appeared in 186j, but the work on Aristotle he was not destined to complete.. He had only finished the *Organon* (2nd ed.. 1880) when he died on June 18, 1871; he was buried in Westminster abbey. It is on his *History of Greece* that Grote's reputation mainly rests. It contains information collected from all sources, simply arranged and expressed in direct, forcible language.

BIBLIOGRAPHY.—The *History of Greece* passed through five editions, the fifth (10 vol., 1888) being final. It mas published in "Everyman's Library" (1907) and in a condensed form in the same year by J. M. Mitchell and M. O B. Caspari. Grote's *Minor Works* were published by Alexander Bain (1873). *See* Mrs. Grote, *Personal Life of George Grote* (1873), and article in *Dict. Nat. Biog. by G.* Croom Robertson.

GROTEFEND, GEORG FRIEDRICH (1775–1853), German epigraphist, who was instrumental in the decipherment of ancient Persian cuneiform script, was born at Münden in Hanover on June 9. 1775. He studied at Gottingen, became conrector of the Frankfurt *Gymnasium* and then director of the *Gymnasium* at Hanover. He published some important works on the Umbrian and Oscan dialects, on the coins of Bactria and other subjects. But it was in the east rather than in the west that Grotefend did his greatest work. The cuneiform inscriptions of Persia had for some time been attracting attention in Europe; exact copies of them had been published by the elder Niebuhr, who lost his eyesight over the work; and Grotefend's friend, O. G. Tychsen of Rostock, believed that he had ascertained the characters in the column. now known to be Persian, to be alphabetic.

At this point Grotefend took the matter up. His first discovery was communicated to the Royal Society of Gottingen in 1800 and reviewed by Tychsen two years afterward. In 1815 he gave an account of it in Arnold Heeren's great work on ancient history, and in 1837 published his *Neue Beiträge zur Erläuterung der persepolitanischen Keilschrift.* Three years later appeared his *Neue Beiträge zur Erläuterung der babylonischen Keilschrift.* His discovery may be summed up as follows: (1) that the Persian inscriptions contain three different forms of cuneiform nriting, so that the decipherment of the one would give the key to the decipherment of the others; (2) that the characters of the Persian column are alphabetic and not syllabic; (3) that they must be read from left to right; (4) that the alphabet consists of 40 letters, including signs for long and short vowels; and (j) that the Persepolitan inscriptions are written in Zend (which, however, is not the case). and must be ascribed to the age of the Achaemenid princes. The process whereby Grotefend arrived at these conclusions illustrated his persevering genius *(see* CUNEIFORM: *Decipherment).* He died Dec. 15, 1853.

GROTIUS, HUGO (HUIGH DE GROOT) (1583–1645), Dutch jurist and statesman, philologist, poet, theologian and historian, a "man of all-embracing learning" (R. Fruin) whose writings mere of fundamental importance in the formulation of international law, was born at Delft on April 10. 1583. His father a friend of men such as Simon Stevin and Justus Lipsius (*qq.v.*), had been burgomaster of Delft and curator of Leiden university and took a keen interest in his son's career. Grotius was a precocious but normal boy and became a student at Leiden in the faculty of letters at the age of 11. There his professor Junius imbued him with an undogmatic but profound religious outlook; and the great Joseph Scaliger was his preferred scientific mentor. At the age of 15 Grotius edited Martianus Capella's encyclopaedia and accompanied the leading statesman J, van Oldenbarnevelt (*q.v.*) on his embassy to Henry IV of France. Grotius was welcomed by the king of France as the "miracle of Holland." In a remarkable poem Grotius depicted the complicated international situation of the period and on his way back to Holland took the degree of doctor of law at Orleans. He became distinguished as an advocate in The Hague, moved in government circles and in 1601 was appointed historiographer of the States of Holland. His literary work at this time included the writing of two dramas in Latin and the editing of the literary remains of Xratus of Soli.

In 1604 the Dutch East India company. in order to justify the action of one of its admirals in seizing a Portuguese vessel, asked Grotius to write on the lawfulness of the capture of merchant ships. In his treatise *De iure praedae* ("On the Law of Prize and Booty"; published only in 1868) Grotius began by describing the law of mankind in general. The law of nature deriving from God's will contains four primary precepts: neither state nor individual may attack another state or individual; neither state nor individual may appropriate what belongs to another state or individual; neither state nor individual may disregard treaties or contracts; and neither state nor individual may commit a crime. These four precepts must be upheld by judges and, if there are no judges, by the states or individuals themselves in the form of a war or of private litigation. It follows from these precepts that because Portugal deprived the Dutch of the right to sail to the East Indies for commercial purposes, and as there was no judge, the East India company was entitled to capture Portuguese merchantmen in order to compensate itself for its losses, This is, in a nutshell, the content of Grotius' concise treatise, characterized by Jules Basdevant, a judge of the International Court of Justice. as "a triumph of juridical argument." Grotius thus maintains that the ocean is free to all nations, and one chapter of the *De iure praedae* was published in 1609 as the *Mare liberum.*

In his famous work *De iure belli ac pacis* ("On the Law of War and Peace"; 1625) Grotius describes (in the second book) the whole law of mankind, private, penal and constitutional as well as international. exactly based on the four precepts of the *De iure praedae.* In the case of nonobservance, any rule of that law may be upheld, if there is no judge, by mar or by individual action. The third book explains the rules of warfare. In the *De iure praedae* Grotius had already pointed out that the harsh rules of the law of warfare ought to be mitigated by equity. This statement is developed in the famous *temperamenta* ("moderations") of the third book, as well as in an analogous way at the end of the second book. The introductory first book contains general observations on law and wars and private litigation. The *De iure belli ac pacis* in fact constitures the second edition of the general part of the *De iure praedae,* as C. van Vollenhoven pointed out in the preface of its 1919 edition. In later years the *De iure belli ac pacis* was erroneously considered to be a book on international law and on a great number of things that have, in fact, nothing to do with international law. Van Vollenhoven showed that the book describes the whole law of mankind, of which international law is only a part. Giambattista Vico in 1719 rightly styled Grotius *generis humani iurisconsultus* ("the jurist of the human race"). Indeed, in the 20th century. international law has largely developed on the lines judged by Grotius to be positive lam.

In 1607 Grotius became *advocaat fiscaal* (attorney general) of the province of Holland and in the following year he married Maria van Reigersberch, the daughter of the burgomaster of Veere; she remained his courageous helpmeet until the end of his life. In 1612 he began his practical attempts to bring about the reunion of the Christian churches. He hoped that King James I would take the lead and to that end started a correspondence with Isaac Casaubon, the king's adviser in theological matters. In 1613 there was a great demand for Grotius' services from the town of Rotterdam, the high court of justice. the states-general and the States of Holland, who wished to keep him in their service. Oldenbarnevelt decided that Rotterdam should have him after he had first gone to London, where the states-general desired him to be the spokesman of an embassy whose purpose was the adjustment of difficulties between the two East India companies. The London conference 1%-asfollowed in 1615 by another at The Hague. As a pensionary of Rotterdam. Grotius now began his political career. He was one of the representatives of that town in the States of Holland and in that capacity he represented these states, together with Oldenbarnevelt, in the states-general, the government of the Republic of the United Provinces. When Oldenbarnevelt's health began to fail it was generally understood that Grotius would become his successor.

After the conclusion of a 12 years' truce with Spain (1609) the republic had been torn by a religious dispute. In its origin a theological difference about predestination between two Leiden professors. Jacobus Arminius and Franciscus Gomarus, it evolved into a quarrel between church and state and ended as a conflict between the provinces of Holland and Utrecht on the one hand and the orthodox Calvinist majority in the states-general supported by the head of the army, Prince Maurice, on the other *(see*

ARMINIANISM; DORT, SYNOD OF). While upholding the authority of the state over the church, the States of Holland tried to restore ecclesiastical peace. At last the schism in the republic ended in a show of force by Prince Maurice. Grotius had been the spokesman of the States of Holland, had drafted their peace resolutions and defended the policy of the states in his *Ordinum pietas,* although he did not always agree with Oldenbarnevelt. A short time before the final episode he proposed a skillfully drafted compromise solution of the problem at issue, but without success. Oldenbarnevelt and Grotius were arrested on Aug. 29, 1618. The latter was sentenced to life imprisonment (May 18, 1619) and taken to the castle of Loevestein. Through the resourcefulness of his wife Maria, however, he managed to escape from prison hidden in a chest. Grotius then made his way to Paris, where he mas well received as a statesman in exile by old friends and by the king, Louis XIII, who granted him a pension. Its irregular payment was attributed by Grotius to the fact that he was not prepared to become a Roman Catholic and accept a high position. Nor would he accept a position in commerce. which would probably do harm to Dutch interests and about which rumours reached Amsterdam.

Grotius continued to produce an extraordinary quantity of scientific and literary work in prison and exile. This included the *De veritate religionis Christianae* ("On the Truth of the Christian Religion"), *Annotations on the New and the Old Testament,* an *Introduction to the Jurisprudence of Holland,* an *Apology* on behalf of the States of Holland, the *De iure belli ac pacis* and a translation of Euripides' *Phoenissae* with an introduction on the subject of classical tragedy.

In 1631 Grotius made an attempt to return to his native country, but, after hot debates in the States of Holland and notwithstanding the intervention of his old friend Prince Frederick Henry of Orange, he was obliged to become an exile once more and went to Hamburg. An attempt was made to use his abilities outside his country by appointing him governor-general in the East Indies, but he refused. Until that time Grotius had also rejected overtures from foreign countries, which he considered incompatible with his Dutch nationality. However, when the Swedish chancellor, Oxenstierna, approached him in 1634 he accepted service under Sweden as ambassador to France, Sweden being at that time ally of the republic. The example of Joseph in the Old Testament who, as minister of Egypt, nevertheless served his Jewish people taught him that he was right to accept. In his drama *Sophompaneas* Grotius showed his gratitude to his mentor.

His hope that he would be in a position to promote the restoration of a general peace was not fulfilled; his task consisted mainly in insisting that France should give sufficient assistance to Sweden during the Thirty Years' War. It must be borne in mind that the great diplomatic centre of the two allies was neither Stockholm nor Paris but Hamburg, where permanent embassies mere installed. Grotius' letters to Oxenstierna are of great historic interest. When France's statesman Cardinal Richelieu met Grotius for the first time in 1625 in order to be informed about the political situation in the republic after the death of Prince Maurice, he pointed out that in matters of state the weakest must always be in the wrong. Grotius answered that God and time would show the truth, whereby Richelieu at once understood that he could not handle the Swedish ambassador as he used to do. It was a disappointment to Grotius when in 1643 he was not invited to become a member of the Swedish peace embassy. He equally deplored the fact that his persistent efforts to promote the reunion of the Christian churches were misinterpreted in Holland. In his testament of March 27, 1645, he prayed God "to unite the Christians in one church under a holy reformation." When France recalled its ambassador at Stockholm, Sweden recalled Grotius. He was then received in Sweden with great honour, but he refused to settle there as Queen Christina suggested. On his way back to Holland he died at Rostock on Aug. 28, 1645.

Grotius' varied interests included philology, poetry, theology and history. His Latin is splendid but often difficult, especially in his poetry; and his Latin translations of Greek poets are notable. His first drama, *Adamus Exul* (1601), has been called the greatest dramatic representation of the subject.

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GROTTAFERRATA, a village of Italy, province of Roma, 13 mi. S.E. from Rome by electric tramway, and $2\frac{1}{2}$ mi. S. of Frascati. 1,080 ft. above sea level, in the Alban hills. The name (in its Latin form. Crypta Ferrata, *i.e.,* "the crypt with an iron grille") probably comes from an older building, perhaps an oratory, perhaps originally an ancient tomb, which served as the foundation for the campanile. Pop. (1957 est.) 7,659 (commune). The Greek monastery of Basilians founded by St. Nilus in 1002 under the emperor Otho III occupies the site of a large Roman ville. It was fortified (end 15th century) by Giuliano Cardinal della Rovere (afterward Pope Julius II), whose arms may be seen about it.

The church with its fine campanile belongs to the 12th century, and the original portal. with a mosaic over it, is still preserved, as is also the mosaic of the apse. The chapel of St. Nilus contains frescoes by Domenico Zampieri (Domenichino) of 1610, illustrating the life of the saint. The abbot's palace has a fine Renaissance portico, and contains local antiquities. An omophorion of the 11th or 12th century. with scenes from the Gospel in needlework. and a chalice of the 15th century with enamels are among its treasures. The library contains valuable manuscripts, among them one from the hand of St. Nilus (965); and a paleographical school, for the copying of manuscripts in the ancient style, is maintained.

See T. Ashby in *Papers of the British School at Rome,* v, 228 ff. (1910); F. Tomassetti, *Campagna Romana,* iv, 279 ff. (1926). (T. A.)

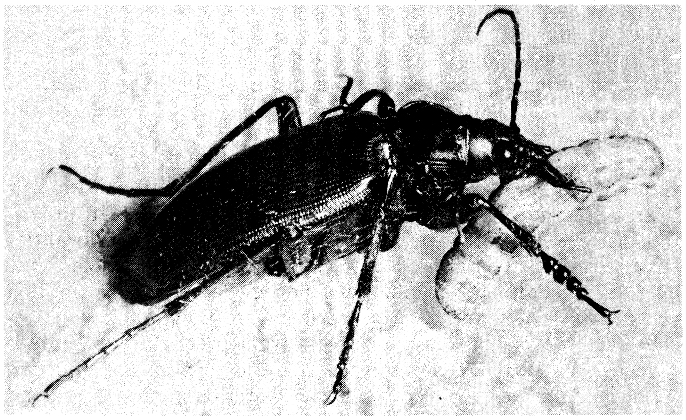
GROUCHY, EMMANUEL, MARQUIS DE (1766–1847), marshal of France, was born in Paris on Oct. 23, 1766, and entered the army. He served in La Vendée (1793), in the army of Ireland (1796–97) and in the campaign against the Russians and Austrians, being taken prisoner at Novi. On his release he returned to France and from 1801 was employed by Napoleon in important military and political positions. At the Restoration he mas deprived of the post of colonel general of *chasseurs à cheval* and retired. He joined Napoleon on his return from Elba and was made marshal and peer of France. In the Waterloo campaign he was appointed to command the right wing to pursue the Prussians (*see* WATERLOO CAMPAIGN, 1815). After the great disaster, Grouchy gathered up the wrecks of Napoleon's army and retired to Paris, where he resigned his command to Marshal Davout. He was court-martialed for his partial failure at Waterloo and exiled in America, till amnestied in 1821. On his return to France he was reinstated as general. In 1830 Louis Philippe gave him back the marshal's baton and restored him to the chamber of peers. He died at St. Etienne on May 29, 1847.

His publications include: *Observations sur* la *rélation de la campagne* *de 1815 par le général de Gourgaud* (1818) ; *Réfutation de quelques articles des memoires de M. le Duc de Rovigo* (1829) and other defenses of his military policy.

See his *Memoires,* ed. by Marquis de Grouchy (1873–74); Gen. Marquis de Grouchy, *Le Général Grouchy en Irlande* (1866); Le *Maréchal Grouclzy du 16 au 18 juin, 1815* (1864) ; *Appel à l'histoire sur les faits de l'aile droite de l'armée française; Sévère Justice sur les faits . . . du 28 juin au 3 juillet 1815* (1866).

GROUND BASS, in music, a form of bass which is repeated again and again unaltered, while the music above is constantly varied. The chaconne (*q.v.*) and the passacaglia are familiar forms of which this device constitutes an essential feature. (See VARIATIONS.)

GROUND BEETLE, any beetle of the family Carabidae of the order Coleoptera, comprising more than 25,000 species and forming the largest and most typical family of the suborder Adephaga. In many Carabidae the hind wings are reduced or ab-



ROSS E HUTCHINS

GROUND BEETLE FEEDING ON A CUTWORM

sent. and the elytra (modified fore wings) fused together along the suture, the hind legs being adapted for rapid movement. They are world-wide in their distribution, being represented in the arctic regions and on almost all of the oceanic islands. and can be traced back in fossil history to Lower Jurassic times (160,000,000 years ago). See BEETLE.

GROUND HOG: see WOODCHUCK.

GROUND-HOG DAY (Feb. 2). According to popular tradition in the United States, the ground hog or woodchuck comes out of his hole on this day after a long winter sleep to look for his shadow. If he sees 'it. he regards it as an omen of six more weeks of bad weather. and returns to his hole for that period. If the day is cloudy, and hence shadowless. he takes it as a sign of coming spring, and is content to stay above ground. The tradition, sometimes including the bear or badger, stems from similar beliefs associated with Candlemas (*q.v.*) (also Feb. 2) in England; according to an old English song: "If Candlemas be fair and bright. Come. Winter. have another flight: If Candlemas bring clouds and rain. Go. Winter, and come not again." (A. McQ.)

GROUND ICE, ice formed at the bottoms of streams while the temperature of the water is above the freezing point. It is also known as anchor ice and bottom ice. Radiation of heat from the stream bottom probably is the prime cause of the formation of ground ice. It is formed only under a clear sky, never in cloudy weather: it is most readily formed on dark rocks. never under any covering such as a bridge and rarely under surface ice. On a cold clear night the rocks on the bottom may radiate heat rapidly, cooling below the freezing point and resulting in the formation of loosely grown spongy masses of anchor or ground ice. On the next bright sunny day heat from the sun may detach them and they will rise to the surface with considerable force. Probably a thin film of stationary water rests upon the boulders and sand over which a stream flows, and this, becoming frozen; forms the foundation for the anchor ice and produces a surface upon which descending frazil ice (a canadian term for surface ice formed in spicules and carried downward in water agitated by winds or rapids) can lodge. The ice which rises to the surface has a spongy texture and frequently carries gravel with it. Ground ice often forms dams across narrow portions of rivers where the floating masses are caught.

GROUNDNUT (*Apios* tuberosa), a North American plant of the pea family (Leguminosae, *q.v.*), called also Indian potato, native to moist low grounds from New Brunswick, Canada, to Minnesota, U.S., and southward to Florida and Texas. It is a twining perennial, climbing to a height of several feet, with leaves composed of five to seven ovate leaflets, and bearing in late summer showy clusters of rather large, fragrant, chocolate-brown flowers. From the root are produced strings of starchy edible tubers, one to two inches long, with a somewhat nutty flavour. These tubers were used for food by the Delawares, Iroquois and other American Indians. Asa Gray (*q.v.*) observed that, except for the prior cultivation of the potato, the groundnut might have been developed into a food plant of high economic value. In Great Britain the name groundnut is given to the fruit of *Arachis hypogaea,* commonly known as peanut (*q.v.*) in the United States.

GROUND RENT. The accepted meaning of ground rent is the rent at which land is let for the purpose of improvement by building, *i.e.,* a rent charged in respect of the land only and not in respect of the buildings to be placed thereon. It thus conveys the idea of something less than a rack rent (see RENT); and accordingly, if a vendor described property as property for which he paid a "ground rent." without any further explanation of the term, a purchaser would not be obliged to accept the property if it turned out to be held at a rack rent. But while a rack rent is generally higher in amount than a ground rent, the latter is usually better secured, as it carries with it the reversionary interest in buildings and improvements put on the ground *after* the date at which the ground rent was fixed, and accordingly ground rents have been held a good investment.

A devise of "ground rent" carries not only the rent but the reversion. Where a tenant is compelled, in order to protect himself in the enjoyment of the land in respect of which his rent is payable, to pay ground rent to a superior landlord (who is of course in a position to distrain on him for itj. he is considered as having been authorized by his immediate landlord to apply his rent, due or accruing due, in this manner, and the payment of the ground rent will be held to be payment of the rent itself nr part of it A lodger should make any payment of this character under the Law of Distress Amendment Act 1908 (s. 3; and see RENT) Ground rents are apportionable.

In Scots law. the term "ground rent" is sometimes used in the above sense in relation to the rent stipulated for on building leases. but it has no technical significance. Owing to the limited nature of leasehold rights builders and other improvers of land in Scotland have generally insisted upon acquiring the right of property in the land taken by them in return for an annual payment economically equivalent to a ground rent. but legally distinct from rent. Where the land in question is not subject to prohibition against subinfeudation this has generally been done by a subfeu, the reddcndo or feu duty of which is the economic equivalent of ground rent. Where subinfeudation is prohibited the procedure in modern times has been by way of Contract of *Ground* Annual, a complex conveyancing device whereby the builder becomes proprietor. of and under the former feudal superior, in return for a payment to the fortner vassal of a ground annual economically equivalent, alone or in conjunction with an existing feu duty to a ground rent. "Ground rents" in the English sense do not seem to be in general use in the United States, but they obtain in Pennsylvania They are rent services and not rent charges—the statute Quza *Emptores* never having been in force in Pennsylvania. Ground rents are also found in Maryland and to a lesser extent in Ohio. A ground rent being a freehold estate, created hy deed and perpetual in duration, no presumption could, at common law, arise from lapse of time. that it had been released. But now. by statute (Act of April 27, 18jj, s. 7), a presumption of reiease or extinguishment is created where no payment, claim or demand has been made for the rent, nor any declaration or acknowledgment of its existence made or given by the owner of the premises subject to it, for

21 years. (A. W. R.; J. WA.; X.)

GROUNDSEL, Senecio *vulgaris,* an annual, glabrous, or more or less woolly plant of the family Compositae (*q.v.*), having a branched succulent stem 6 to 15 in. in height, pinnatifid irregularly and coarsely toothed leaves, and small cylindrical heads of yellow tubular florets enveloped in an involucre of numerous narrow bracts; the ribbed fruit bears a soft, feathery, hoary tuft of hairs (*pappus*). The plant is indigenous to Europe, whence it has been introduced into all temperate climates. It is often a troublesome weed, flowering throughout the year, and propagating itself rapidly by means of its light feathery fruits; it is used as a food for cage birds. The groundsel bush, Baccharis halimifolia, a native of the North American sea coast from Massachusetts southward to Florida and Texas, is a shrub of the same family attaining 6 ft. to 12 ft. in height, and having angular branches, obovate, somewhat scurfy leaves, and flowers larger than but similar to those of common groundsel. The long white pappus of the female plant makes it a conspicuous object in autumn. The groundsel bush is sparingly cultivated for ornament. See RAGWORT; SENECIO.

GROUND SQUIRREL. any burrowing member of the squirrel family (Sciuridae), but more commonly applied to the spermophiles. genus Citellus, rodents characterized by having cheek pouches, short ears, long front claws and generally a short tail. They are omnivorous, feeding upon vegetation, seeds, insects, etc. Although chiefly North American, one, known as the suslik (*q.v.*), reaches eastern Europe and others occur in Asia. The arctic species (C. *parryi*) is about 12 in. long, the tail j in.; it is yellowish brown, speckled with gray. Rock squirrels (C. *variegatus* and allies) are about the same size, with a longer tail and larger ears. The mantled ground squirrel (C. lateralis) is often confused with chipmunks, having black and white lateral stripes. The 13-lined ground squirrel (C. *tridecemlineatus*), often called gopher (the true gopher, however: is of a different family), is pale buff, marked with brownish lines and whitish spots.

Among the other ground-dwelling sciurids are the marmots (including the American woodchuck), chipmunks, prairie dogs and the spiny squirrels (*qq.v.*). See also RODENT; GOPHER.

(J. E. HL.; X.)

GROUND WATER. Water beneath the land surface that feeds wells and springs is called ground water. It maintains the dry-weather flow of streams. and helps maintain the levels of lakes and ponds after overland runoff from rain and melting snow has ceased. In western Europe and in North America, the near east, the Mediterranean basin, and Asia, water from wells or springs furnishes a substantial part of the supply for domestic, livestock, industrial, and irrigation uses. Many large cities draw their water from wells or infiltration galleries tapping vast reservoirs of ground water. Refrigeration is used for many industrial processes as well as for personal convenience, and ground water is especially valued for its uniform temperature.

History. — The initial use of ground water is lost in antiquity. In the arid and semiarid lands of the east, the near east, and the Mediterranean basin, men learned to tap vast reservoirs of ground water by digging wells. commonly several feet in diameter, and by driving tunnels called kanats into the alluvial ians festooning mountain chains such as the Atlas and the Himalayas. Ranats at Andamish, Persia (modern Dizful. Iran), yielded as much as 3,400 U.S. gallons per minute (gpm) each. Nineveh was supplied by kanats, and in 626 B.C. the city of Hamadan fell when the Medes destroyed the kanats that supplied its water. Tehran and Afarrakech are among the many modern cities supplied by kanats.

Water was drawn from ancient dug wells by hand. rope and bucket or various ingenious devices. In a large well at Orvieto, Italy, spiral ramps cut into the rock walls enabled donkeys to bring up water. The amount of water that could be obtained by such methods. even where the water was near the surface, was small by modern standards.

The Chinese nith primitive methods invented the art of drilling wells to tap artesian water that would flow at the land surface. Some of these are reported to have been 5,000 feet deep and to have taken many years to drill. Apparently the first drilled nells in Europe were sunk in the province of Artois. France (from which the term "artesian" is derived), and in Modena, in northern Italy. early in the 12th century. They aroused both popular and scientific interest in flowing wells, and they supplied copious quantities of nater for various uses.

Since these early days the use of ground water has increased steadily. but expansion was most rapid after 1900 as a result of: (1) increasing demands resulting from expansion of irrigation (*q.v.*) and industry, and rising standards of living; (2) improvements in construction and finishing of wells; (3) improvement of pumps; and (4) reduction in cost of power from electricity, gas and oil.

Use of Ground Water. — Most farms, villages and small cities draw their water from wells or springs. Many large cities, such as Berlin, Houston and San Antonio, Tex.. and Memphis, Tenn., are supplied almost entirely from wells. Others, such as New York, London, and Chicago, draw a part of their water from wells. About a fifth of all the water used in the United States in 1955 or 45,000,000,000 gallons a day, was ground water. In Germany before World War II, according to Carl Kiihne, more than 75% of the water supply was from ground-water sources, not even including springs which also are ground water. In India millions of acres are irrigated with ground water. In Holland nearly all the domestic water supply is from wells.

In some areas, such as certain parts of Texas, Arizona, and California, and in many cities, such as London, the ground water is being withdrawn more rapidly than it is replenished. In others, too many wells have been sunk locally, though other localities have large untapped ground-water supplies. On the whole, however, large additional supplies can be developed by distributing wells more widely and locating them where they will induce recharge to the ground-water reservoir from precipitation or from streams. or will recover water otherwise lost from the reservoir. Artificial recharge by spreading surface water on permeable ground or injecting clear water into wells will permit increased pumping in many places. To be practical all such improvements must be based on scientifically acquired information on the water resources of each area.

Better legal control is needed in nearly all countries to assure proper well construction. prevent waste of water, provide equitable distribution of available supplies and prevent overdevelopment. In New Mexico and several other western states of the U.S. the ground water, like surface water, is considered public property and may be appropriated for beneficial use, subject to prior rights. Thus with adequate quantitative information as to recharge and storage and proper legal control, ground-water supplies can be made perennially secure.

Ground-Water Reservoirs. — The upper crust of the earth is composed of a wide variety of rocks which in most places are covered by a mantle of soil. Soil is porous, and most rocks also contain open spaces which range in size from minute pores to huge caverns. Most of these openings are small, but collectively they may form an appreciable proportion of the total volume of rock material. The porosity, or percentage of open space, ranges from a fraction of 1% in very dense rocks to more than 80% in some water-laid deposits. 4 porosity of less than 5% may be regarded as small, between 5% and 20% as medium, and more than 20% as large. The porosity, however, shows only how much water the rock will hold, not how much it will yield. Of greater importance to water yield are the size, shape, and interconnection of the openings, ior they determine the permeability of the rock, therefore the rate at which water can move through it. Rock materials that have large or moderately large, interconnected openings, such as well-sorted sand and gravel, many limestones and fractured lava rock have high permeability and transmit water freely. Fine silt and clay have high porosity but small openings and low permeability and water moves, through them slowly or not at all. Mixtures of coarse and fine materials, such as glacial boulder clay and unsorted alluvial deposits. have relatively low permeability as do most igneous and metamorphic rocks, indurated sandstone. limestone, and shale, except where they are fractured.

A permeable stratum that lies below the water table will yield water to wells and springs and is called a ground-water reservoir, or aquifer. Some unstratified rocks also are aquifers—for example, the neathered zones at the top of many metamorphic and granitic rocks. Strata that are relatively impermeable allow little water to pass and are called aquicludes

Aquifers are of many different shapes and sizes. Among the most productive are the great deposits of sand and gravel laid donn by streams floning from high mountain ranges, especially the Himalayas, Alps. Atlas. Rockies, and Sierra Nevada, and from the continental ice sheets of the glacial or Pleistocene epoch, especially in northern North America and Europe. These materials may yield several million gallons a day to a single well. Fine sands generally yield only small supplies. There are many productive sands of various geologic ages, but also many that have lost their permeability by deposition of cementing mineral matter between their grains; these latter yield only small amounts of water from joints or solution openings. Soft shales are generally unproductive, but harder shales may yield small supplies from joint cracks—often less than a gallon a minute.

Limestones range to both extremes Lncompacted young limestones and compacted limestones that have become cavernous through solution by percolating water may yield large supplies to wells and springs For example, the Fontaine de Vaucluse in France and Silver springs of Florida each has an average discharge of about 500.000.000 gallons a day, and a flowing well at San Antonio. Tex., when completed had an artesian flow of 24,000,000 gallons a day On the other hand wells in limestone that do not encounter large openings may yield little water—for example, some nells only a few hundred feet from the productive well at San Antonio.

Most igneous and metamorphic rocks are of low permeability. Wells sunk in them may be unproductive, but most yield 1 to 10 gpm. The nater comes from cracks and from porous weathered rock near the surface. Basaltic lava rock may be broken and cavernous. and very permeable. Such rocks in Idaho. California and Oregon give rise to springs comparable to those in limestone. They also yield large supplies to wells notably in the Haaaiian Islands

Movement of Subsurface Water.—The tno principal forces that control movement of water in rocks are gravity and molecular attraction. Gravity causes the water to percolate vertically from the suriace into the zone of saturation and thence laterally to springs. wells. and streams at lower elevations.

Molecular attraction is a force that acts between neighbouring molecules, but only through very short distances. It is manifested in adhesion of films of water to rock surfaces and in the cohesion that holds water together. In very fine grained materials the openings between particles may be so small that the force of molecular attraction is exerted across the entire space; as this forct is greater than that of gravity, water is held tightly in the pore spaces. In coarser grained materials the openings are wider than the film of water held by molecular attraction, and though a film of water clings to the walls of the pores, the remainder moves downward by gravity until it reaches the zone of saturation where all openings are filled with water under hydrostatic pressure. The capacity of a permeable material to retain water against the pull of gravity is called its specific retention and is the ratio of the volume of water held in the material to the total volume of the material. The amount of water that will drain from the material, expressed as a ratio, is the specific yield. This is an important concept because when the water level is lowered in an aquifer the specific yield determines the water-yielding capacity of the aquifer per unit area.

Ground Water and the Hydrologic Cycle.—The movement of water, beginning with evaporation from ocean surfaces: bodies of fresh water and vegetation, progressing to the atmosphere, to precipitation and to surface- and ground-water runoff back to the sea, is known as the hydrologic cycle. Though described here in simple terms, the cycle is extremely complex in detail. *(See* HYDROLOGY.) We are concerned here only with that part of the water which passes beneath the land surface. When precipitation falls on the dry earth it is absorbed immediately. However, if rain continues long enough, the soil will become filled with water to the field capacity and can hold no more. Only when the soil has reached field capacity, at least in its uppermost layer, does overland runoff begin; and only when it has reached field capacity throughout does substantial ground-water recharge begin. The critical point at which runoff begins depends on the geology and the nature of the soil. In sandy areas considerably more rainfall is absorbed than in silty or clayey areas. For example, on Long Island, N.Y.. the soils are predominantly sand and they will absorb enormous quantities of precipitation. In fact. the heaviest rainfalls on record have been absorbed with no overland runoff whatever. The sand hills area of Nebraska likewise has no surface drainage because the soil absorbs all rainfall. On the other hand. the Badlands of South Dakota, adjacent to the sand hills, have tight. fine-grained soils which absorb relatively little water. Even moderate rains are sufficient to overtax their capacity to absorb water. causing overland runoff which erodes deep gullies and carries off huge quantities of sediment.

Water that enters the soil may penetrate only a few feet below the surface and thus may remain available to the roots of plants, which draw it up through their vascular systems and transpire it back to the atmosphere. This is known as soil water and is not available for use as water supplies. The zone in which it occurs is the upper part of the zone of aeration. in which at least the larger pores contain air, and in which the water is held by molecular attraction against the force of gravity except during occasional periods of abundant precipitation. At such times, if water enters the soil in excess of field capacity and if the earth materials are sufficiently permeable, the excess moves downward through an intermediate belt. where it is below the reach of roots of plants. and thence into the capillary fringe. The fringe, immediately above and connected to the zone of saturation. consists of water held up by capillary force. The thickness of the fringe depends upon the size of the pores and generally is inversely proportional to the permeability of the rock materials. Passing through the capillary fringe. the water enters the zone of saturation. The top of that zone is the water table—the level at which the water is at atmospheric pressure. Ground water lies below this table; the material for a short distance above may be saturated but the water is under less than atmospheric pressure and will not flow into a well. The water table is absent in many places because impermeable rock occurs at the junction between the zone of aeration and the zone of saturation. In such places the water in the aquifer beneath the impermeable zone is under artesian pressure and mill rise above the aquifer. There are infinite variations of the simple conditions described above.

Chemical Quality **of** Ground Water.—Ground water contains dissolved mineral matter, which when present in excessive amounts profoundly affects its usefulness. The commonest constituents are chloride, sulfate, bicarbonate, sodium, calcium, magnesium and potassium. Manganese. iron, silicon, boron and many other elements are present in small but sometimes significant amounts. All these materials are dissolved from the soil and underlying rocks as the water moves through them. Many mineral deposits were derived from waters issuing from hot magmas deep in the earth. Others may have been formed originally in this way but were greatly enriched by solution and redeposition after erosion thinned or removed the overlying rock and exposed the deposits to the action of atmospheric water *(see* also GEOCHEMISTRY: *Geochemistry of the Hydrosphere).*

Ground water that is highly mineralized is unfit for drinking by man or beast, for irrigation, and for most industrial uses. Water containing excessive amounts of calcium and magnesium is hard and not suitable for laundry or boiler use. In some aquifers these elements are exchanged for sodium and potassium and the water becomes soft as it moves through the rock. Iron and manganese cause stains on clothing and fixtures. Too much boron or too high a proportion of sodium is undesirable for irrigation. Iodine in small amounts tends to prevent goiter. Fluorine inhibits tooth decay in children if present in concentrations not exceeding one part per million, but causes mottling of their tooth enamel if present in larger amounts. Many industrial processes have exacting requirements as to mineral quality which cannot be met by some ground waters without expensive treatment. On the other hand, ground water is highly desirable in many processes because of its nearly uniform temperature and chemical quality. Bacterial pollution of ground water is of surface origin and can be largely prevented by proper construction and location of wells, but highly cavernous aquifers may be unsafe.

Head and Movement of Ground Water. — The water from rain or snow that percolates downward to the zone of saturation causes the water table to rise, as is shown by rising water levels in wells and increased discharge of springs during wet weather. Once in the zone of saturation, the water moves toward some area where ground water is being discharged through wells or springs, by evaporation and transpiration, or through subaqueous outlets. Its course may be short or as much as several hundred miles long, and the time may be brief or many centuries. The rate of flow, except in cavernous formations, is almost invariably slow, commonly ranging from a few feet per day to a few feet per year. The flow is caused by differences in head between the areas of intake and the areas of discharge. The flow is laminar, or viscous, that is, without the turbulence that characterizes surface streams. Hence, the rate of flow varies directly with the hydraulic gradient. *See* PERMEABILITY (FLUID).

In stratified rocks, the ground water moves chiefly through the more permeable strata, following their dips and folds. The flow is likely to be complicated by various structural features such as unconformities, faults, and dikes. If water-bearing strata are overlain by strata having low permeability, artesian conditions may result.

When a well is pumped, the head in its vicinity is lowered and a hydraulic gradient toward the well from all directions is created. The cone of depression thus formed increases in size and depth as pumping continues. The lowering of the water level in the well (drawdown) is greater nith increased rate of pumping and also greater with low than with high permeability, because in both cases steeper hydraulic gradients are required. The cone of depression expands slowly under water-table conditions because the ground water must be drained out of the rock in which the cone is created. Drawdown progresses more rapidly under artesian conditions because the rock is not drained, and the water must be derived from compression of the strata and slight expansion of the water itself as the head is reduced.

Methods have been developed for computing from pumping tests the theoretical drawdonn caused by pumping at any point at any time in the future. These methods have great practical value in appraising the quantity of water that may be drawn from the aquifer, in determining the optimum spacing of wells, and in forecasting their future interference with other wells.

Along seacoasts, fresh ground water under either artesian or water-table conditions may be balanced against sea water which has an average specific gravity of 1.025. If the water level in an aquifer is one foot above sea level, the interface between the salt and fresh water will be approximately 40 ft. below sea level. If the head of the fresh water is raised by recharge, the interface will be correspondingly depressed. If the fresh-water head is lowered by pumping or drought, the interface will rise and sea water will move toward the wells. This is called the Ghyben-Herzberg principle, after its discoverers.

See also WELL; SPRINGS; WATER SUPPLY.

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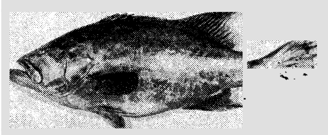
GROUPER, various medium-sized to gigantic sea basses (Serranidae) of warm shore waters. Some attain a weight of several hundred pounds and are the prized quarry of adventurous skin divers. The groupers are particularly numerous both in species and individuals in the West Indian fauna, and several are common in the southern United States. Most of the species are classified in the genera *Epinephelus* and *Mycteroperca.* Examples are the red grouper (*Epinephelus morio*), the Nassau grouper (*E. striatus*) and the rock hind (*E. adscensionis*) in the Atlantic, and the broomtailed grouper (*Mycteroperca xenarcha*) in the Pacific. The jewfish (*q.v.*), one of the largest groupers, inhabits Caribbean waters. (C. L. Hs.)



BY COURTESY OF CARL L. HUBBS

SPECIMEN OF BROOM-TAILED GROUPER (MYCTEROPERCA XENARCHA)

GROUP INSURANCE, a 20th-century development of the insurance business, represents a substantial portion of all private life and health insurance in the United States and other countries. The group technique was first applied to life insurance, but subsequently was adopted in the annuity field and among most forms of health insurance.

Group insurance is characterized by one master contract, issued by an insurance company, the insurer, to a policyholder, usually an employer, providing insurance for insureds, usually employees, and often for the benefit of fourth parties, the beneficiaries named by the insured employees. The employer normally receives a master policy from the insurance company, and each employee receives a certificate of insurance outlining the benefits of the plan. Depending on state regulatory rules, group insurance may be available to employee groups as small as ten. Even smaller groups are sometimes underwritten.

Another basic characteristic of group insurance is that, with few exceptions, it is issued without medical examination or other evidence of individual insurability, thus permitting all active employees to receive coverage under the group policy regardless of the state of their health.

Group insurance is essentially low-cost, wholesale protection. Mass distribution and mass administrative methods afford economies of operation not available in individual insurance. Further, most group life and health insurance is temporary or current-cost insurance, with the consequent elimination of the necessary reserve element found in level premium insurance. Since active employees typically make up the group, there is a constant flow into the group of younger persons and a flow out of the group of the older and infirm persons. A trend in the second half of the 20th century is to retain retired employees under the plan, thus necessitating the building of some reserve element.

Although the majority of all group insurance is provided through contracts issued to individual employer groups, it may also be issued to multiple employer groups, labour union groups, creditor-debtor groups and such miscellaneous groups as associations of public employees, fraternal society members, state police, savings account plan depositors, professional associations and the like.

Group life insurance is the most popular form of group insurance, representing one-third of all life insurance. A benefit schedule, normally related to earnings, determines the amount of death benefit for each employee. The employee may or may not contribute to the cost of the coverage. Often a disability provision provides for continuance of coverage in the event of total disability. Group permanent or group paid-up life insurance has a reserve element accumulated during the life of the contract.

Group annuities typically are issued to employers for the purpose of financing retirement benefits of employees. Group methods of marketing and administration afford cost advantages over the individual annuity plan.

Group health insurance represents the application of group principles and practices to a variety of health insurance coverages. Group disability income insurance provides cash benefits to replace lost earnings in the event of disability. Benefits may be paid for total or partial disability, and for temporary or permanent disability. Benefits may be provided for a stated number of weeks, until a certain age or for life. Coverage may be limited to disability from accident only, or from accident and sickness. Group medical expense insurance provides cash benefits or service benefits to meet hospital charges, surgical bills, doctor's bills, drug and X-ray charges and similar costs. A great variety of coverages are available from insurance companies and the Blue Cross and Blue Shield organizations. Broad blanket coverage of medical expenses is provided under "comprehensive medical expense" and "major medical" policies. Group travel accident contracts typically provide death, dismemberment and disability income benefits for accidents experienced while traveling. Group accidental death and dismemberment insurance providing additional benefits for accidental death and dismemberment normally is used as a supplemental coverage to group life insurance.

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GROUP MARRIAGE, the marriage of several men with several women. It has been found among various peoples who practise polyandry (*q.v.*)—in Tibet. India and Ceylon. In many of these cases it is said that if one of the brothers who have a wife in common brings a new wife. he shares, or has to share. her with his brothers. And that in the other cases, also. the group marriage has arisen as a combination of polygyny with polyandry may be inferred from the facts that both in Tibet and India polyandry is much more prevalent than group marriage; that the latter occurs there nowhere except side by side with polyandry; and that the occasional combination of polygyny with polyandry, when the circumstances permit it, is easy to explain, whereas no satisfactory reason has been given for the opinion held by some sociologists that polyandry has developed out of an earlier stage of group marriage.

While genuine group marriage has been found only side by side with polyandry, there are peoples—such as the Chukchee. the Herero in South-West Africa. the Masai and Akamba in East Africa, certain communities in New Guinea, and some Australian tribes — who have a kind of sex communism. in which several men have the right of access to several women, although none of the women is properly married to more than one of the men. Thus the *pirrauru* relation among the Central Australian Dieri and the *piraungaru* relation among their neighbours, the Urabunna, almost exclusively imply sexual licence. Yet these relations have been considered to give support to the hypothesis of ancient group marriage in Australia. according to which the men of one division or class had as wives the women of another division or class. Marriages of this sort no longer exist anywhere in Australia. No person becomes a *pirrauru* or *piraungaru* as a matter of course because of his or her status. An agreement must be made with the husband, the *pirrauru* may have to pay for it. and the relation may even be of short duration (in the case of a visitor); while the *piraungaru* requires the consent of the woman's elder brothers.

The existence of an early state of group marriage has been assumed from a variety of other customs. such as the lending or exchange of wives. the sexual intercourse to which a girl is subject before her marriage, the licence allowed at the performance of certain ceremonies when the ordinary rules of morality are more or less suspended, the levirate and the use of classificatory terms of relationship nhich group together under single designations many distinct degrees and kinds of relationship.

See also MARRIAGE.

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GROUPS. In the study of sets of mathematical objects such as numbers or transformations there are many cases of sets having the closure property that every pair of elements a and b of a set G may be combined to yield a unique result $a \times b$ in G. For sets of numbers the operation $a \times b$ may be either the sum $a + b$ or the product ab. For sets of transformations on the points of a geometric space $a \times b$ is usually the transformation obtained by applying the transformation b to the points which are the results of first applying the transformation a.

A set G having the closure property is said to form a group with respect to the operation $a \times b$ if every $a \times (b \times c) = (a \times b) \times c$ and if there exist solutions x and y in G of the equations $a \times x = b, y \times a = b$ for every a and b of G. Every group G has a unique identity element e such that $e \times a = a \times e = a$ for every a of G, and every element a of G has a unique inverse a^{-1} in G such that $a \times a^{-1} = a^{-1} \times a = e$.

A group G is called an abelian or a commutative group if $a \times b = b \times a$ for every a and b of G. The simplest abelian group is the cyclic group consisting of the powers a^k of a single element, powers being defined by $a^0 = e, a^{-k} = (a^{-1})^k, a^k = a^{k-1} \times a$ for every positive integer k.

If a subset H of a group G forms a group with respect to the same operation as that used in defining G then H is called a subgroup of G. Every element of a group generates a cyclic subgroup.

A group consisting of a finite number n of elements is called a finite group and the positive integer n is called its order. It can be shown that a subset H of a finite group G is a subgroup of G if and only if $h \times k$ is in H for every h and k of H. Moreover the order of a subgroup of a finite group C divides the order of G.

Examples of Groups. — The set of all ordinary integers forms an additive group; that is, a group under the operation of addition. This group is a subgroup of the additive group of all rational numbers, as well as of the additive group of all real numbers and the additive group of all complex numbers. The identity element of all these additive abelian groups is the number zero, and the additive inverse of any number a is $-a$. The additive nth power of any number a is na. This is the sum $a + a + \dots + a$ with n terms if n is positive, and if $-n = m > 0$ then na is the sum $m(-a)$.

The set of all nonzero complex numbers forms a multiplicative group; that is, a group with respect to the operation of multiplying complex numbers. It is customary to use the product notation ab instead of the more general notation $a \times b$ even in discussing abstract groups and the notation ab will be used in the remainder of this article.

The set of all rotations of axes in a plane forms an abelian group. Every rotation $r(A)$ depends upon an angle of rotation A and the product of two rotations is the result of applying them successively. Then $r(A)r(B) = r(A + B)$. This group has the finite cyclic subgroups of rotations through multiples of $1/n$ 360°, where n is a fixed positive integer.

The set of all rotations of axes in three-dimensional Euclidean space forms a noncommutative group. That this group is not commutative may be verified by taking a point on a co-ordinate axis and operating on it, in the two different possible orders. by a pair of rotations throuth 90° about two different co-ordinate axes.

The set of all n-rowed square matrices of nonzero determinant forms a noncommutative group with respect to matrix multiplication. (See MATRIX.)

Normal Divisors and Quotient Groups. — If H is a subgroup of a group G. and g is in G, the set Hg, consisting of all product; hg for h in H, is called the left coset of H and the set gH of all products gh the right coset of H defined by g. If the two sets gH and Hg are the same for every g of G then H is called a normal divisor of G. All subgroups of an abelian group are normal divisors. The product $Hg_1 \times Hg_2$ of tno cosets is then defined to be $H(g_1g_2)$ and it is a simple matter to shon that the set G_0 consisting of all cosets, forms a group. This group is called the quotient group of G relative to H and is usually designated by G/H.

The identity group **I**, consisting of the identity element of G alone. is a normal divisor of G. Also G is a normal divisor of G. When these trivial normal divisors are the only normal divisors of a group, the group is called a simple group.

A normal divisor H of G is called a maximal normal divisor of G if G/H is a simple group. A sequence of subgroups $G = G_0, G_1, \dots, G_r = I$, in which each G_i is a maximal normal divisor of its predecessor G_{i-1}, is called a composition series of G. Each composition series determines r simple quotient groups $G_0/G_1, G_1/G_2, \dots, G_{r-1}/G_r$. One of the most important theorems of group theory is that which states that if a group G also has a second composition series $H_0 = G, H_1, \dots, H_s = I$ then $s = r$ and the quotient groups $H_0/H_1, H_1/H_2, \dots, H_{r-1}/H_r$ are, when properly rearranged if necessary, mathematical equivalents of the quotient groups G_{i-1}/G_i. The result has immediate applications in the theory of the Galois group of an equation.

Permutation Groups.--Any rearrangement of the n integers $1, 2, \dots, n$ is called a permutation of these integers. The n

integers may be taken to represent any n ordered objects and the permutation is then a reordering of these objects. The two-rowed representation of a permutation P is

$$P = \begin{pmatrix} 1 & 2 & \dots & n \\ i_1 & i_2 & \dots & i_n \end{pmatrix},$$

where the second row is a rearrangement of the first row. For example, in case $n = 4$ the permutation

$$\begin{pmatrix} 1 & 2 & 3 & 4 \\ 2 & 1 & 4 & 3 \end{pmatrix}$$

states that 1 and 2 are to be interchanged, 3 and 4 are to be interchanged.

The result of applying two permutations successively is another permutation. The procedure of computing such products is illustrated in the example

$$P = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 3 & 1 & 4 & 2 \end{pmatrix}, \quad Q = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 4 & 3 & 1 & 2 \end{pmatrix}.$$

The columns of Q are first permuted so that the top row of Q becomes the second row of P, and P and Q are combined to form

$$\begin{pmatrix} 1 & 4 & 2 & 3 \\ 1 & 2 & 3 & 4 \\ 3 & 1 & 4 & 2 \end{pmatrix}.$$

Then the result of applying P and then Q is their product,

$$PQ = \begin{pmatrix} 1 & 2 & 3 & 4 \\ 1 & 4 & 2 & 3 \end{pmatrix}.$$

The set of all permutations on n letters is a group called the symmetric group on n letters. It is a finite group and n factorial is its order. Its subgroups are called permutation groups. All finite groups are mathematically equivalent to permutation groups and there is an immense literature on permutation groups.

Other Topics.—Since most number systems are additive abelian groups, the theory of groups has applications in all parts of higher algebra. It forms a most important part of topology and analysis, and geometry has actually been defined by the great mathematician Felix Klein as the study of the invariants of geometric configurations under groups of transformations. The notion of a group is one of the basic concepts in all mathematics.

Particular attention should be called to the theory of continuous groups and the theory of groups of linear transformations. The first of these topics was investigated extensively by Marius Sophus Lie and forms a fundamental part of the theory of continuous functions. It has applications in quantum mechanics. The second topic is connected with the problem of representing any finite group by a multiplicative group of linear transformations or their equivalent, a group of matrices. This topic is connected with the theory of representations, linear algebras by matrices. The study of the projective group of linear transformations is the basis of projective geometry. The unitary and complex groups of linear transformations are continuous groups and are, in general, simple groups. There are many groups which arise in problems of analysis, geometry and topology and many fruitful results are obtained by investigating the normal divisors of these groups. Thus. the notions of abstract group theory provide an important tool for the study of many topics of mathematics.

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GROUPS, CONTINUOUS. This subject comprises a fundamental branch of modern mathematics with applications to theoretical physics. The expression "continuous groups" has been employed since the 19th century for a variety of mathematical structures, some of which are not even groups (*q.v.*). Roughly speaking, the study arose from situations in which there is an infinite number of symmetries present. The set of symmetries is called "the group of transformations admitted by" the situation. In the early days of the theory, which was fathered largely by M. Sophus Lie, much of the research was devoted to applications to the theory of differential equations. As one might expect, the presence of symmetries serves to reduce many difficulties by drastically limiting possibilities. Toward the end of the 19th century, the work of E. Cartan shifted the course of investigation toward a deeper analysis, both algebraic and topological, of the continuous group itself. So fruitful were some of Cartan's ideas that they molded some of the basic notions of algebra and topology. The threefold structure of continuous groups—algebraic, topological and analytic—has attracted a variety of methods of attack, some of them marked by brilliant developments. The work of Lie and of Cartan had revealed many of the fundamental properties of continuous groups before the end of the 19th century. Rather than retrace their steps, this article will begin by introducing some 20th-century terms necessary for an adequate description of the basic ideas. The early developments in the relations between groups and differential equations will be presented later in the article.

Topological Groups.—A topological group G is a group G whose elements are the points of a *topological space (see* TOPOLOGY, GENERAL) for which the group operations are continuous. In greater detail, the elements of G satisfy the postulates for a *group:*

($G1$) There is *a* binary operation assigning to any two elements x and y in G an element in G denoted by xy and called the "group product" of x and y.

($G2$) There is an element e in G such that $ex = xe = x$ for all x in G; e is called the identity.

($G3$) For each element x in G, there is an element denoted by x^{-1} such that $x^{-1}x = e$; the element x^{-1} is called the inverse of x.

The condition that G is a topological space for which the group operations are continuous means that there is a notion of "nearness" among the various elements of G so that if x' is near x then x'^{-1} is near x^{-1} and if y' is near y then $x'y'$ is near xy.

The following are familiar examples of topological groups:

Example 1. G is the set of all real numbers with addition as the group product.

Example 2. G is the set of all complex numbers z with $|z| = 1$ and with multiplication as the group product.

Example 3. G is the set of all rigid motions in Euclidean space which keep some point O fixed. Here the group product is taken as *composition* of motions; that is, if T_2 and T_1 are in G, $T_2 \cdot T_1$ is the motion which takes any point p into $T_2(T_1(p))$.

Example 4. G is the group of all n . n matrices with complex coefficients and nonzero determinant, the group product being the usual matrix multiplication.

The groups in examples 1 and 2 above are abelian, that is $xy = yx$ for any two elements x and y. The groups in examples 2 and 3 above are compact, that is, any infinite sequence of elements $x_1, x_2, \dots, x_n, \dots$ contains a subsequence converging to an element of the group. The group in example 4 above is neither abelian nor compact, but it is *locally compact,* that is, each element has a compact neighbourhood. Each of the groups in the examples is locally Euclidean, that is, each point has a neighbourhood resembling topologically a solid ball in Euclidean space of dimensions 1, 1, 3 and n^2 respectively.

The theory of topological groups has developed in three principal directions: the theory of the algebraic structure, of the topological structure and of representations by transformation groups.

The algebraic structure of a topological group is especially accessible to investigation in case the group operations are analytic. In greater detail, in a topological space, one can define a continuous function as any real-valued function f with the property that $f(x')$ is close to $f(x)$ if x' is close to x. But one cannot speak of differentiable or analytic functions on a locally Euclidean topological space in a self-consistent fashion unless one is given a rule by which to pick out from the totality of continuous functions the differentiable and analytic functions. A locally Euclidean space with such a rule is called a differentiable or analytic manifold, as the case may be. For simplicity, this article deals with analytic manifolds.

An analytic co-ordinate system around a point p in an analytic manifold is a set of functions $(x_1, \ldots, x_k)$ defined near p with the property: a function f is analytic around p if and only if it is expressible as a convergent power series in $x_1, \ldots, x_k$ in some neighbourhood of the point p. In an analytic manifold M there is of course an analytic co-ordinate system around each point, but in general the co-ordinate system is not defined throughout the manifold.

If (x,, . . . , x_k) is an analytic co-ordinate system, the map Φ : $p \rightarrow (x_1(p), \ldots, x_k(p))$ is a map of a neighbourhood of p onto a neighbourhood in Euclidean k-space E^k and the map Φ is a topological equivalence or homeomorphism of some neighbourhood of p onto a solid ball in E^L.

A map ϕ (taking possibly many points into a single point) of a manifcld M into a manifold N is called an analytic map if for any analytic function f defined in a region of N, the composite function $f \circ \phi$ is analytic in M (recall $f \circ \phi(m) = f(\phi(m))$).

A ***Lie** group* G is a topological group of a special kind: the underlying space is an analytic manifold for which the group operations are analytic. That is, the map $(x,y) \rightarrow xy$ of the analytic manifold of ordered pairs G . G into G is an analytic map, and the map $x \rightarrow x^{-1}$ of G into G also is analytic.

Infinitesimal Transformations. — One of the basic notions in the theory of Lie groups is that of infinitesimal transformation. Let M be an analytic manifold and let m be a point of M. We wish first to speak of a tangent vector to M at m. In case M is a surface in Euclidean space, one regards, extrinsically, a tangent vector to a surface as a vector in the containing Euclidean space.

However, it is possible to make a mathematically satisfactory intrinsic definition of a tangent vector to a manifold (*i.e.,* without reference to a containing Euclidean space) by means of the following consideration: a tangent vector X is completely determined once one knons how functions vary along it. that is, the directional derivative of functions along X. Hence for all purposes we can equate the notion of tangent vector X with the operation of taking the directional derivative along X. In this pragmatic spirit one adopts the definition: a tangent vector X to a manifold M at a point m is an operator with assigns to each real-valued function f analytic around m a real number Xf, called the directional derivative of f along X, such that

$$\begin{aligned} X(f+g) &= Xf + Xg \\ X(fg) &= (Xf)g(m) + f(m)X(g) \\ X(af) &= aXf \end{aligned}$$

where j and g are analytic functions around p, and a is a constant. It is easily proved that the set of all tangent vectors at a point m of a k-dimensional manifold constitutes a linear or vector space whose dimension is k (over the field of real numbers). This linear space is called the tangent space to M at m and is denoted by M_m. A vector field on a manifold M is a rule which assigns to each point m of M an element of M_m. To illustrate, let $(x_1, \ldots, x_k)$ be an analytic co-ordinate system on a neighbourhood V of manifold M. We denote by $\frac{6}{\delta x_i}(m)$ the operator which assigns to the analytic function $f(x_1, \ldots, x_k)$ the value of $\frac{}{\delta x_i}$ at the point m. Then $\frac{6}{\delta x_i}(m)$ is a tangent vector to M at m, and $\frac{6}{\delta x_i}(m), \ldots, \frac{6}{\delta x_k}(m)$ form a base for the vector space M_m. We denote by $\frac{6}{\delta x_i}$ the vector field $p \rightarrow \frac{6}{\delta x_i}(p)$ on the neighbourhood V. The most general vector field on V has the form $\Sigma_i A_i \frac{\delta}{\delta x_i}$, where $A_1, \ldots, A_k$ are functions on V. An infinitesimal transformation on an (analytic) manifold is a vector field X such that for any analytic function f on M, the function $Xf : p \rightarrow X(p)f$ is analytic. An infinitesimal transformation on the neighbourhood V above is any vector field $X = \Sigma A_i \frac{6}{\delta x_i}$ such that the functions $A_1, \ldots, A_k$ are analytic. If $(y_1, \ldots, y_k)$ is a second co-ordinate system, then $\frac{Sj}{\delta x_i} = \Sigma_i \frac{\delta f}{\delta y_j}\frac{\delta y_j}{\delta x_i}$, so that

$$\frac{\delta}{\delta x_i} = \frac{\delta y_1}{\delta x_i}\frac{\delta}{\delta y_1} + \frac{\delta y_2}{\delta x_i}\frac{\delta}{\delta y_2} + \ldots + \frac{\delta y_k}{\delta x_i}\frac{\delta}{\delta y_k}$$

An infinitesimal transformation X can also be equated with the operationj $\rightarrow Xf$ taking any analytic function f into the analytic function Xf. Indeed, any operation X assigning to any analytic functionf an analytic function Xj such that

$$X(f+g) = Xf + Xg \tag{1}$$
$$X(fg) = Xf \cdot g + fXg \tag{2}$$
$$X(af) = aXf \tag{3}$$

for any analytic functions f and g, a being any constant, determines a unique infinitesimal transformation.

A map ϕ of an analytic manifold M into an analytic manifold N induces a map oi the tangent space M_m into the tangent space $N_{\phi(m)}$ called the differential of ϕ at M and denoted by $d\phi_m$, as follows: $d\phi_m(X)f = X(f\phi)$ for any function f analytic in M around the point m. For example, if ϕ is an analytic curve in N, that is an analytic map of the manifold of real numbers (t) into N, then $d\phi_t(\frac{d}{dt_t})$ is the tangent vector at the point $\phi(t)$ which assigns to any function f on N the value $\frac{d}{dt}f(\phi(t))$. $d\phi_t(\frac{d}{dt_t})$ is called the tangent to the curve ϕ at the point $\phi(t)$. In case ϕ is a map of an analytic manifold into the real numbers; *i.e.,* ϕ is a real-valued function on M, then for any tangent vector X in M_m, d$\phi(X)$ is a numerical factor of the tangent vector $\frac{d}{dt_{\phi(m)}}$; the numerical factor is also denoted by $d\phi(X)$. By this convention, $d\phi$ becomes a real-valued function of tangent vectors in case ϕ is an analytic (or differentiable) real-valued function on 34; this $d\phi$ coincides with the classical definition of differential.

Suppose now that X is an infinitesimal transformation on an analytic manifold M. Then by the fundamental existence and uniqueness theorem of ordinary differential equations, there passes through each point p of M a unique trajectory to X with initial point p; that is an analytic curve $\phi(p,t)$ in M with $\phi(p,o) = p$ and the tangent to the curve at any point q coinciding with the tangent vector $X(q)$; more explicitly, $\frac{d}{dt}f(\phi(p,t)) = Xf(\phi(p,t))$ for any t and for any function f analytic in M. We denote by "exp tX" the map $p \rightarrow \phi(p,t)$; for any point p, exp tX is defined for suitably small values of t (but not necessarily all). We can think thus of an infinitesimal transformation as the velocity field of a steady flow on a manifold, and exp tX is the displacement of points after t units of time.

In the special case that M is the set of real numbers and $X = \frac{6}{\delta x}$ – $\frac{d}{dx}, \frac{d}{dt}x(\exp tX(p)) = \frac{dx}{dx} = 1$ and exp $tX(p) = p + t$. If $X = x^2\frac{d}{dx}$, then exp $tX(p)$ is the trajectory to $\frac{dx}{dt} = x^2$, and exp $tX(p) = \frac{p}{1 - pt}$, which is not defined for $t = 1/p$. The term "infinitesimal transformation" owes its origin to the fact that for small values of the parameter t, the transformation exp tX consists of the displacement

$$(x_1, \ldots, x_k) \rightarrow (x_1 + tA_1, \ldots, x_k + tA_k)$$

up to infinitesimals of order t^2 if $X = \Sigma_i A_i \frac{6}{\delta x_i}$. If X is an infinitesimal transformation on a manifold then $f(\exp tX(p)) = \sum_{n=0}^{\infty}(n!)^{-1}t^n X^n f(p)$ whenever both sides are defined. This identity can be stated in a more familiar form when we adopt the following notational convention: if ϕ is a map of a space M into a space N, we denote by $\phi(f)$ the composite function $f\circ\phi$ where f is a function on N. Thus by definition, $f(\phi(m)) = (\phi(f))(m)$. By this convention we regard ϕ not only as a map of points of M into points of N, but also as the equivalent indicated map of functions on N into functions on M. Adhering to this convention, the identity above states

$$\exp tX = \sum_{0}^{\infty}(n!)^{-1}t^n X^n \tag{4}$$

as operators on analytic functions on M, whenever both sides can be applied.

It is clear from (4) that a point m is fixed under the transformations $\exp tX$ for all t if and only if the point m is a zero of X; *i.e.*, $X(m) = 0$ or $Xf(m) = 0$ for any analytic function f.

Local (Pseudo-) Groups of Transformations.— Let G be a topological group and M a topological space. Let $P(M)$ denote the set of all permutations of M; *i.e.*, all transformations of M onto M which have inverses. An operation of G on M is a rule T which assigns to each g in G an element $T(g)$ in $P(M)$ such that

(T1) $T(g_1g_2) = T(g_1)\circ T(g_2)$.

(T2) The element $T(g)(m)$ depends continuously on g and m.

If G is a Lie group and M is an analytic manifold, an operation is called analytic if the point $T(g)(m)$ depends analytically on g and m. An important variation on this idea is that of a local pseudo-group (sometimes called simply local group) operating on a manifold. Briefly, a local Lie group is a structure which resembles a neighbourhood of the identity in a Lie group; products are not always defined but, when they are, the group postulates are fulfilled. The celebrated first and second fundamental theorems of Lie describe the relation between local Lie groups on a manifold and infinitesimal transformations.

Let N and M be analytic manifolds and let T be a one-to-one map of N into $P(M)$ such that $T(n)(m)$ depends analytically on n and m. Assume that for some n_o in N, $T(n_o)$ is the identity transformation of M. One considers the map T_n which assigns to each tangent vector $X\epsilon N_n$ an infinitesimal transformation $T_n(X)$ by the following rule:

$$T_n(X)(m) = d\phi_n(X) \tag{5}$$

where $\phi : p \rightarrow (T(p)\cdot T(n)^{-1})(m)$ maps N into M and n into m. Roughly speaking, the infinitesimal transformation $T_n(X)$ describes how $T(p)$ differs from $T(n)$ as the point p moves away from the point n along a path whose tangent vector at n is X.

Lie's first *fundamental theorem* states that $T_n(\dot{N}_n)$ is independent of the point n if and only if N is a local Lie group and T is an analytic operation of N on M. If this is the case, the family of infinitesimal transformations $T_n(\dot{N}_n)$ is called the infinitesimal generator of the local Lie group of transformations $T(N)$.

It is readily verified that if X and Y are infinitesimal transformations on M, the operator XY − YX satisfies conditions (1), (2) and (3), and is thus an infinitesimal transformation. $XY - YX$ is denoted by $[X,Y]$ and is called the Poisson bracket of X and Y. If $(x_1, \ldots, x_k)$ is an analytic co-ordinate system on a neighbourhood v, then $X = \Sigma_i A_i \frac{\delta}{\delta x_i}$, $Y = \Sigma_i B_i \frac{\delta}{\delta x_i}$ and $[X,Y] = \Sigma_{ij}(A_j \frac{\delta B_i}{\delta x_j} - B_j \frac{\delta A_i}{\delta x_j})\frac{\delta}{\delta x_i}$.

Directly from definitions, it may be seen that

$$[X,Y] = -[Y,X] \text{ and } [[X,Y],Z] + [[Y,Z],X] + [[Z,X],Y] = 0$$

the latter being the Jacobi identity.

Suppose now that $\mathcal{J}$ is a set of infinitesimal transformations. $\mathcal{J}$ is called a Lie algebra of infinitesimal transformations if (1) $\mathcal{J}$ is a linear family, that is, $\mathcal{J}$ contains any linear combination of its elements with constant coefficients; and (2) $\mathcal{J}$ contains the Poisson brackets of any of its elements.

Lie's second *fundamental theorem* states that a family of infinitesimal transformations $\mathcal{J}$ is the infinitesimal generator of a finite dimensional local Lie group of transformations if and only if $\mathcal{J}$ is a finite dimensional (over the field of constants) Lie algebra of infinitesimal transformations. The corresponding local Lie group of transformations is the set of all transformations of the form

$$\exp t_1X_1 \cdot \exp t_2X_2 \cdot \ldots \cdot \exp t_rX_r \tag{6}$$

where $X_1, \ldots, X_r$ is a base for $\mathcal{J}$ and $t_1, \ldots, t_r$ are any set of real numbers which are suitably small. The elements of the corresponding local group can also be described as the set of all transformations

$$\exp X \quad X\epsilon\mathcal{J} \tag{7}$$

It may happen that the corresponding local group G is indeed a genuine group. In that case neither the elements of the form (6) nor (7) necessarily exhaust G; they merely cover a neighbourhood of the identity in G in general.

In case the family $\mathcal{J}$ of Lie's second fundamental theorem is infinite dimensional, there arises a so-called "infinite Lie pseudo-group." These pseudo-groups were studied extensively by Cartan, but basic questions about the nature of such structures were left unanswered. In the 1950s several independent investigations into some of these questions were initiated. In this article, however, the term Lie group is reserved for the finite dimensional case alone.

With the help of his second fundamental theorem, Lie was able to determine all the local groups of transformations depending on a finite number of parameters which operate on the line, plane and, in certain cases, on higher dimensional spaces. For example, it is relatively easy to show that the only finite dimensional Lie algebras of infinitesimal transformations on the line which have no common zeros have in suitable co-ordinates one of the following three bases (a) $\frac{d}{dx}$; (b) $\frac{d}{dx}, x\frac{d}{dx}$; or (c) $\frac{d}{dx}, x\frac{d}{dx}, x^2\frac{d}{dx}$.

These are the generators of the

(a) one-parameter translation group: $x \rightarrow x + t$;

(b) two-parameter affine group: $x \rightarrow ax + b$;

(c) three-parameter projective group: $x \rightarrow \frac{ax+b}{cx+d}$, $\det\begin{vmatrix} a & b \\ c & d \end{vmatrix} \neq 0$.

These three are thus up to equivalence the only finite dimensional local Lie groups operating transitively on the line.

The last example shows clearly that a local group of transformations of the line need not be a piece of a global group of transformations of the line. However, it is true that any local Lie group has a neighbourhood of its identity which is *in* abstracto isomorphic to a neighbourhood of the identity in some genuine (global) Lie group.

The Lie Algebra of a Lie Group.— Consider now a Lie group G. For each g in G, let $T(g)$ denote the "left translation" map $x \rightarrow gx$ of G onto G. Then T is an analytic operation of G on G. By Lie's first fundamental theorem, the group $T(G)$ has an infinitesimal generator, and by Lie's second fundamental theorem, the infinitesimal generator is a Lie algebra of infinitesimal transformations; this infinitesimal generator is denoted by $\dot{G}$ and is called the Lie algebra of G. It is readily proved that $\dot{G}$ consists of precisely those infinitesimal transformations on G which are left unchanged by the right translations $x \rightarrow xg$ of G into G. It follows at once that each infinitesimal translation in G is uniquely determined by its value at the origin. Thus as a linear space, $\dot{G}$ is equivalent to $\dot{G}_e$, the tangent space of G at the identity element e. If X is an element of G_e, and $\bar{X}$ is the element of $\dot{G}$ determined by X, then one defines $\exp X = \exp \bar{X}(e)$. Also, one defines $[X,Y]$ to be the value at e of $[\bar{X},\bar{Y}]$, where $\bar{X}$ and $\bar{Y}$ are the elements of $\dot{G}$ with $\bar{X}(e) = X$ and $\bar{Y}(e) = Y$. In the special case that G is the group $GL(n)$ of all inversible linear transformations of an n-dimensional linear space V_n over the real numbers, the tangent space to G at the identity element can be identified with the set of all linear transformations of V,. Then for any $X \epsilon \dot{G}_e$, exp X coincides with the classical exponential of the transformation X; *i.e.*, exp X $= \Sigma_i \frac{X^i}{i!}$. Moreover, for any X and Y in $\dot{G}_e$, $[X,Y] = XY -$ YX, where the multiplication on the right is the usual multiplication of linear transformations.

If we abstract from Ġ its algebraic structure alone, we see that it is an algebra with Poisson brackets as multiplication. This multiplication is nonassociative, but the structure of such algebras is capable of a virtually exhaustive description. On the other hand, there is a very close connection between the algebraic structure of a Lie group and the algebraic structure of its Lie algebra. Indeed, there is a one-to-pne correspondence between the subalgebras of the Lie algebra G and the connected Lie subgroups of G, the correspondence being, a connected Lie subgroup H corresponds to the subalgebra of Ġ that is determined by the tangent suhspace $\dot{H}_e$ to H at the identity. A connected Lie subgroup H is normal in G if and only if the corresponding subalgebra H is an ideal in G; that is, $[G,\dot{H}]$ is contained in H. To the commutator subgroup of G generated by the elements of the form $xyz^{-1}y^{-1}$, there corresponds the "derived" subalgebra which is generated by the elements $[X,Y]$ with X and Y in G. In particular, a connected Lie group G is abelian if and only if $[X,Y] = 0$ for all X and Y in Ġ.

The most elementary type of Lie algebra is one wherein the multiplication is trivial; *i.e.*, $[\mathcal{G},\mathcal{G}] = 0$. Such a Lie algebra is called abelian. Next in complexity is a Lie algebra wherein the product of some finite number of any elements is zero; *i.e.*, if setting $\mathcal{G}^{(\prime)} = \mathcal{G}$, $\mathcal{G}^{(n+1)} = [\mathcal{G}^{(n)}, \mathcal{G}^{(\prime)}]$, then $\mathcal{G}^{(n)} = 0$ for some n. Such a $\mathcal{G}$ is called nilpotent. One step more complex are Lie algebras G which have a decreasing sequence of ideals, $\mathcal{G} \supset \mathcal{G}_1 \supset \ldots \supset \mathcal{G}_n \ldots$ with the quotient algebra $\mathcal{G}_i/\mathcal{G}_{i+1}$ abelian and $\mathcal{G}_n = 0$ for some n; such a Lie algebra is called solvable. The maximum solvable ideal of a Lie algebra is called its radical. If $\mathcal{G}$ is a Lie algebra and $\mathcal{R}$ denotes its radical, then $\mathcal{G}/\mathcal{R}$ has no nonzero radical; such a Lie algebra is called semisimple. If a Lie algebra has no nonzero properly smaller ideal, it is called simple. The basic theorems describing the structure of Lie algebras over any field of characteristic zero areas follows:

1. Any Lie algebra is a semidirect sum of its radical and a semisimple subalgebra.
2. Any semisimple Lie algebra is a direct sum of simple Lie algebras.
3. Any simple Lie algebra over the field of complex numbers is one of the following type:

A,: the Lie algebra of the group of all complex-valued matrices of determinant 1;

B,: the Lie subalgebra of A_{2n+1} which annihilates the quadratic form $X_1^2 + X_2^2 + \ldots + X_{2n+1}^2$;

C,: the Lie subalgebra of A_{2n} which annihilates the alternating bilinear form

$$x_1y_{n+1} - y_1x_{n+1} + x_2y_{n+2} - y_2x_{n+2} + \ldots + x_ny_{2n} - y_nx_{2n}$$

D,: the Lie subalgebra of A_{2n} which annihilates the quadratic form $x_1^2 + \ldots + x_{2n}^2$

The five "exceptional" simple Lie algebras G_2, F_4, E_6, E_7, E_8 discovered by W. Killing and of dimensions 14, 52, 78, 133, 248 respectively.

This remarkable classification is achieved by a study of the so-called root diagram of the Lie algebra.

Although each Lie group has a unique Lie algebra, a Lie algebra in the abstract (*i.e.*, divorced from its presentation as the infinitesimal generator of a Lie group) may arise from inequivalent or nonisomorphic groups. For example, the one dimension abelian Lie algebra over the field of real numbers is the Lie algebra of both example $G1$ and example G2 above. The problem of determining the relation between the various connected Lie groups having abstractly isomorphic Lie algebras was solved by Otto Schreier. The situation is: to each abstract Lie algebra g (over the field of real numbers), there corresponds a unique (up to isomorphism) simply connected Lie group G; that is, a connected Lie group in which every closed curve can be deformed continuously to a point; any other Lie group G_1 whose Lie algebra is isomorphic to g is obtained from G by a homomorphism with a discrete kernel. Thus G_1 is evenly covered by G, and all connected Lie groups whose Lie algebras are isomorphic to G have the same simply connected covering group.

The spin representation of physics provides another example of this phenomenon.

It should be emphasized, however, that in a neighbourhood of the identity, any two Lie groups having isomorphic Lie algebras are isomorphic. This can be seen from the Baker-Campbell-Hausdorff formula

$$\exp X \exp Y = \exp (X + Y - \tfrac{1}{2}[X,Y] + \ldots) \qquad (8)$$

the dots denoting an infinite sum of terms built from X and Y with Poisson brackets.

By a process known as "complexification" it can be proved that the classification of complex simple Lie algebras also applies to compact Lie groups.

The Topological Structure of Lie **Groups.**—We have seen that to a given abstract Lie algebra there may correspond Lie groups which are not topologically equivalent. Therefore, one cannot expect that the abstract Lie algebra $\dot{G}$ of a Lie group G determines the topological structure of G completely. However, one of the greatest contributions of E. Cartan to mathematics was his demonstration that the Lie algebra G determines the important topological invariants called Betti numbers of the group G in the very important case that the Lie group G is compact and connected. Cartan's researches on this problem led him to invent his theory of exterior differential forms and to conjecture the celebrated De Rham theorems, which were proved by his student, G. de Rham.

Exterior Differential Calculus.—If V is a vector space, then, by the exterior algebra over V me mean an associative algebra $E(V)$ generated by the elements of I' together with a unit element 1 such that the product of p elements $x_1 \cdot x_2 \cdot \ldots \cdot x_p$ is not zero in $E(V)$ if and only if $x_1, \ldots, x$, are linearly independent in V. Since $x^2=0$ for any x in V, it follows that $x \cdot y = -y \cdot x$ for any x and y in V. If 1^{7*} denotes the dual space of linear functions on V, then $E(V^*)$ can be identified in a natural way nith the set of skew-symmetric multilinear functions on V, the multiplication being

$$\phi_p \cdot \psi_q(X_1, \ldots, X_{p+q}) =$$
$$(p+q)!^{-1}\sum_\sigma(-1)^{\epsilon(\sigma)}\phi_p(X_{\sigma(1)}, \ldots, X_{\sigma(p)})\psi_q(X_{\sigma(p+1)}, \ldots X_{\sigma(p+q)}) \quad (9)$$

where ϕ_p and ψ_q are respectively p- and q-linear, $X_1, \ldots, X_{p+q}$ are any p+q elements of V, $\epsilon(\sigma)$ denotes the parity of the permutation σ, and σ ranges over all the permutations of $1, \ldots, p+q$. The algebra $E(V^*)$ is called the Grassmann algebra of V. An exterior differential p-form on an analytic manifold M is a rule which assigns to each point m of M an element of degree p of the Grassmann algebra $E(\dot{M}_m{}^*)$, $\dot{M}_m$ being the tangent space to M at m. In the language of tensors, an exterior diflerential p-form is a covariant skew-symmetric tensor field of degree p. The novel operation introduced by Cartan is "exterior differentiation" of exterior differential forms. This operation assigns to any exterior differential p-form w a $p+1$-form dw such that

(D1) d is linear.
(D2) d applied to a function or zero form is the usual difierential.
(03) $d(w_1 \cdot w_2) = dw_1 \cdot w_2 + (-1)^p w_1 \cdot dw_2$ where p is the degree of w_1.
(04) $ddw = 0$ for any form w.

The geometric significance of exterior differentiations is seen in the generalized Green-Stokes theorem:

If S is a p-dimensional hypersurface bounding the $p+1$ dimensional solid region R, then

$$\int_S w = \int_R dw \qquad (10)$$

For example, if $w = Pdx + Qdy +$ Kdz, $dw = \left(\frac{\partial Q}{\partial x} - \frac{\partial P}{\partial y}\right)dxdy + \left(\frac{\partial P}{\partial y} - \frac{\partial Q}{\partial z}\right)dydz + \left(\frac{\partial P}{\partial z} - \frac{\partial R}{\partial x}\right)dzdx$; if $w = Rdxdy + Qdydx + Pdzdx$, then $dw = \left(\frac{\partial P}{\partial x} + \frac{\partial Q}{\mathrm{d}y} + \frac{\partial R}{\partial z}\right) dxdydz.$

Exterior differentiation has the fundamental property that it commutes with maps. That is, suppose ϕ is a map of a manifold M into a manifold N, and ω is an exterior differential p-form on N. Extending the notational convention adopted above, one denotes by ϕ (w) the p-form on M which is given by

$$\phi(\omega)(X_1, \ldots, X_p) = \omega(d\phi(X_1), \ldots, d\phi(Xp))$$

It follows from the properties $D1$ through $D4$ that for any analytic map ϕ,

$$\phi(d\omega) = d(\phi(\omega)) \tag{11}$$

In addition, since ϕ preserves the addition and multiplication of exterior forms, one can say that ϕ yields a differential algebra homomorphism.

An exterior differential form w is called closed if dw $= 0$; it is called exact if w $= du$. Since $d^2 = 0$, every exact form is closed. Conversely, if w is exact, then in any suitably small neighbourhood V there is a form u such that $du =$ w in V. But nevertheless a closed form need not be exact. The set of closed forms constitutes a vector space and the set of exact forms is a subspace. The quotient space of closed exterior p-forms by the exact p-forms is the p-dimensional Betti group, and the dimension of this space is the pth Betti number of M, denoted $\beta_p(M)$. Since locally, every closed form is exact, the number $\beta_p(M)$ must clearly depend on the global structure of M. Cartan showed that for a compact connected Lie group G, $\beta_p(G)$ is determined by the Lie algebra G.

This success of Cartan encouraged a closer study of the topological structure of Lie groups, in an attempt to determine for them the various finer topological invariants that were being introduced in topology.

The central position occupied by compact groups in topological questions concerning Lie groups was clearly established when it was discovered that any Lie group with a finite number of connected components is topologically a product of any of its maximal compact subgroups and a Euclidean space. Thereby the question of topological structure of Lie groups was reduced to the case of compact Lie groups, which are more amenable to topological treatment. The principal results on topological structure of compact groups are that the cohomology ring with real coefficients of a compact Lie group is isomorphic to the cohomology ring of a direct product of spheres; but a compact Lie group is not in general (even in the simply connected case) topologically equivalent to a direct product of spheres. This last result follows from a computation of the Steenrod reduced power operations in compact Lie groups that was carried out by A. Borel and J. P. Serre.

The torsion groups of nearly all compact Lie groups have also been determined. The compact Lie groups Su(n) and Sp(n) (the unitary unimodular group and symplectic group respectively) have no torsion; S pin (n), the two-sheeted covering group of the orthogonal group, has no torsion for $n \leq 6$. Su(n) ($n \geq 3$) and Spin (n) ($n \geq 7$) have 2-torsion and all their torsion coefficients are equal to 2.

Representation as Transformation **Groups.**—It is natural to compare general topological groups with special ones, and in particular much attention has been devoted to the study of homomorphisms of topological groups into groups of linear transformations or matrix groups. This study has achieved far-reaching results which throw fresh light on the classical Fourier transform and the theory of special functions. Only two results will be mentioned here.

1. The theorem of F. Peter and H. Weyl states that any compact Lie group is isomorphic to a subgroup of the unitary group.

2. The theorem of I. Ado states that any real Lie algebra is isomorphic to a Lie algebra of matrices. Thus any Lie group has a neighbourhood of its identity in which multiplication is isomorphic to multiplication in some matrix group.

Turning now to more general types of representations, there have been several investigations of the global relations between topological groups and the types of spaces in which they can operate as groups of continuous transformations, as well as special properties of the operations themselves. To indicate the scope of such investigations, we mention several results:

1. The only two-dimensional surfaces on which a Lie group can operate transitively (*i.e.*, carrying any point into any other point) are the plane, sphere, torus, projective plane, cylinder, Mobius band and Klein bottle.

2. A compact connected Lie group operating transitively and effectively (*i.e.*, so that each element other than the identity moves some point) on an even-dimensional sphere is simple; more generally if M is a manifold whose Euler-Poincaré characteristic $(= \Sigma(-1)^p\beta_p(M))$ is a prime number, then any compact connected Lie group operating on M is simple.

3. If a Lie group G operates transitively on a compact simply connected space M, then some compact subgroup of G operates transitively on M.

4. If a Lie group operates transitively on a space M having no "holes" (that is, all the homotopy groups are zero), then M is topologically Euclidean space.

5. If a compact Lie group G operates on a manifold M, then the operation is topologically equivalent to the operation of a group of rotations of some (higher dimensional) Euclidean space on a subspace that is topologically equivalent to M.

6. If a compact connected abelian Lie group operates on Euclidean space, then it must leave some point fixed, and the set of fixed points resemble a hyperplane topologically.

Hilbert's Fifth Problem.—Among the celebrated 23 problems for research that were proposed by David Hilbert in his address to the International Congress of Mathematicians of 1900 was the conjecture that any locally Euclidean topological group can be given the structure of an analytic manifold so as to become a Lie group. The first great inroad on this problem came with the discovery by A. Haar in 1932 that in any locally compact topological group one can introduce a measure and an integral which is invariant under all group translations x yx; that is, for any function f defined on a locally compact group G, the integral $\int_G f(x)dx$ satisfies, in addition to the usual rule of linearity, the condition

$$\int_G f(yx)dx = \int_G f(x)dx$$

In 1933 J. von Neumann was able to exploit Haar's integral by adapting the theory of integral equations on a Lie group that had been developed in 1927 by Peter and Weyl and thereafter succeeded in solving the Hilbert problem for compact groups. In 1934 L. Pontryagin was able to prove Hilbert's conjecture for abelian groups as a by-product of his theory of characters on locally compact abelian groups.

The final complete solution of Hilbert's fifth problem came in 1952 as a result of the work of A. Gleason, D. Montgomery and L. Zippin. Indeed, it was found that any locally compact topological group is a limit of Lie groups. This profound result affirmed the central position of Lie groups in the theory of continuous groups.

Algebraic Linear Groups.—An algebraic linear group is a subgroup of the group of all nonsingular n . n matrices $L(n)$ which is defined by the vanishing of polynomials in the matrix coefficients, that is a subgroup of $L(n)$ which is the intersection of $L(n)$ with an algebraic variety. If the underlying field is the field of real or complex numbers, then any algebraic linear group is a Lie group, but not conversely. On the other hand, most of the questions involving linear groups that arise in mathematics reduce to problems concerning groups which are algebraic. It is natural therefore to seek the special properties which characterize algebraic linear groups and their Lie algebras. This study was initiated by L. Maurer in the 19th century and resumed in mid-20th century by C. Chevalley and others.

The theory of algebraic linear groups has thrown fresh light on the relation between an arbitrary Lie group and the set of all its finite dimensional linear representations; this development was initiated by T. Tannaka in an effort to generalize Pontryagin's duality theory of characters, and was carried further by G. Hochschild and G. D. Mostow.

Chevalley's theory of algebraic groups was carried out for arbitrary ground field, even fields of prime characteristic p. This theory in characteristic p rested on very different considerations from the classical theory in characteristic zero but arrived at identical conclusions about the classification of simple groups. Moreover, Chevalley's work established a significant connection between finite simple groups and simple Lie groups.

Invariants of an Exterior Differential System.—The principal application of continuous groups to the solution of differential equations consists in forming first integrals of a system of differential equations from the infinitesimal generators of a group admitted by the system. The number of unknowns involved in the system is thereby reduced.

For simplicity of illustration, we consider only systems of the type

$$w_1 = \dots = w_n = 0 \tag{12}$$

where $w_1, \dots, w_n$ are independent differential 1-forms (*i.e.*, linear differential forms) on an $n+1$ dimensional manifold. The solutions of (12) are called integral curves, functions that are constant on solutions are called first integrals, and differential forms expressible in terms of first integrals and their differentials are called invariant forms. A first integral is thus an invariant 0-form. The system (12) is said to admit a transformation ϕ if ϕ carries solutions of (12) into solutions and to *admit the infinitesimal transformation* X if it admits the transformations $\exp tX$ for all small t.

The passage from groups of transformations admitted by (12) to first integrals of (12) is via invariant forms of (12). There are three simple principles for the formation of invariant forms out of given ones:

(A) If w is an invariant form, then dw is also invariant.

(B) If the system (12) admits the infinitesimal transformation X, and if w is an invariant iorm, then Xw is an invariant form.

(C) Under the hypotheses of (B), the form $\partial_X w$ is an invariant form, where, for any p-form w, $\partial_X w$ is the p − 1 form defined by $\partial_X w(X_1, \dots, X_{p-1}) = w(X, X_1, \dots, X_p)$.

Suppose the system (12) admits an n-dimensional Lie group of transformations G whose Lie algebra G has a base $X_1, \dots, X_n$ such that the determinant $w_i\,(X_j)$ is not zero.

We replace the forms $w_1, \dots, w_n$ by linear combinations $w_1', \dots, w_n'$ such that $w_i'(X_j) = \delta_{ij}$ – for $i,j = 1, \dots, n$. The linear forms $w_1', \dots, w_n'$ are invariant forms of (12) and are called the forms dual to $X_1, \dots, X_n$. If $(X_i,X_j) = \Sigma_s c_{ijs} X_s$, then $dw_s' = -\sum_{ij} c_{ijs} w_i' w_j'$. It follows that if G is solvable, then the equation (12) can be solved by n successive quadratures. This is an analogue of E. Galois's celebrated theorem on the solution of algebraic equations by radicals. For example, the equation

$$y\frac{d^2y}{dx^2} = F\left(\frac{dy}{dx}\right) \tag{13}$$

is invariant under the group G generated by translations along the x-axis and by uniform stretchings. The system (13) is put in form (12) by introducing the new variable y' and (13) then becomes

$$\begin{aligned} dy - y'dx &= 0 \\ ydy' - F(y)dx &= 0 \end{aligned} \tag{14}$$

The group G operates in (x,y,y')-space and its infinitesimal generators are $X_1 = \frac{\partial}{\partial x}, X_2 = x\frac{\partial}{\partial x} + y\frac{\partial}{\partial y}$ The dual forms are $w_1' = dx - \frac{x}{y}dy - \frac{y - xy'}{F(y')}dy'$ and $w_2' = \frac{dy}{y} - \frac{y'}{F(y')}dy$. Since $[X_1,X_2] = X_1$, we have

$$\begin{aligned} dw_2' &= 0 \\ dw_1' &= w_1'w_2' \end{aligned} \tag{15}$$

Thus w_2' is exact and gives by integration the first integral u_2 with $du_2 = w_2'$. On the surface $u_2 = C_1$, we have $w_1' = 0$ and thus $w_1' = 0$ can be integrated. The result of the two successive integrations are

$$\begin{aligned} y &= C_1 \exp \int \frac{y'dy'}{F(y')} \\ x &= C_1 \exp \left(\int \frac{1}{F(y')}\left(\exp \int \frac{y'dy'}{F(y')}\right)dy'\right) + C_2 \end{aligned} \tag{16}$$

The Poincare Invariant Integral and Cartan's Associated Form.—H. Poincaré has shown that for any Hamiltonian system

$$\frac{dp_i}{dt} = -\frac{\partial H}{\partial q_i} \tag{17}$$

$$\frac{dq_i}{dt} = \frac{\partial H}{\partial p_i} \quad i = 1, \dots, n$$

the form $w = \Sigma_i dp_i dq_i$ has the property that $\int_D w$ over any region in $(p_1, \dots, p_n, q_1, \dots, q_n t)$-space taken at a *simultaneous* time t is independent of t. A differential form with such a property is called a Poincaré integral invariant. If $F(x_1, \dots, x_k, t, dx_1, \dots, dx_k)$ is a Poincaré integral invariant of a system

$$\frac{dx_i}{dt} = A_i(x_1, \dots, x_k, t) \qquad i = 1, \dots, k \tag{18}$$

then $F(x_1, \dots, x_k, t, dx - A_1 dt, \dots, dx - A_k dt)$ is an invariant form of this system

$$\frac{dx_1}{A_1} = \frac{dx_2}{A_2} = \dots = \frac{dx_k}{A_k} \tag{19}$$

and it is called the associated Cartan form. The associated Cartan form of $\Sigma_i dp_i dq_i$ is thus $w' = \Sigma_i(dp_i + \frac{\partial H}{\partial q_i}dt)(dq_i - \frac{\partial H}{\partial p_i}dt) = \Sigma_i dp_i dq_i - dHdt$. This Cartan form is not only an invariant of the system

$$-\frac{dp_1}{\frac{\partial H}{\partial q_1}} = \dots = \frac{dq_n}{\frac{\partial H}{\partial p_n}} \tag{20}$$

but actually determines the system (20), namely, (20) is the first Pfaffian (or associated characteristic) system of w'. Any infinitesimal transformation admitted by the equations of motion leads to an invariant 1-form via the principle in (C) applied to w'. Quite frequently, such 1-forms are exact and by integration one gets first integrals. In this way one can derive the known first integrals of the n-body problem.

Poisson Parentheses and Contact Transformations.—A nondegenerate bilinear form B on a finite dimensional vector space V determines a one-to-one linear map B_1 of V onto its dual space of linear functions V^* by the rule $B_1(v)(w) = B(v,w)$. This map produces out of functions on V functions on V^*. In particular the function B produces the bilinear function B* in V^*

$$B^*(x,y) = B(B_1^{-1}(x), B_1^{-1}(y)) \tag{21}$$

for any elements x and y in V^*.

Now let M be a manifold (necessarily of even dimension) on which there is defined an exterior differential closed 2-form β which is nondegenerate at all points. If f and g are functions on M, set

$$(f,g) = \beta^*(df,dg) \tag{22}$$

The function (f,g) is called the Poisson parentheses of f and g with respect to β. In the neighbourhood of any point one can find co-ordinates $(p_1, \dots, p_n, q_1, \dots, q_n)$ such that $\beta = \Sigma_i dp_i dq_i$. A simple computation gives

$$(f,g) = \Sigma_i \frac{\partial f}{\partial p_i}\frac{\partial g}{\partial q_i} - \frac{\partial f}{\partial q_i}\frac{\partial g}{\partial p_i} \tag{23}$$

The function (f,g) is characterized by the identity

$$df \cdot dg \cdot \beta^{n-1} = (f,g)\beta^n \tag{24}$$

where the dot is exterior multiplication and $2n = \dim$ M. Transformations of a manifold of dimension $2n$ or $2n+1$ preserving an exterior 2-form β of maximum possible rank were called by Lie restricted nonhomogeneous contact transformations with respect to β. Lie studied more general nonhomogeneous contact transformations which preserve the equation $w = 0$ where w is a differential 1-form on 2n + 1 dimensional manifold such that $wdw^n \neq 0$; also, homogeneous contact transformations of a 2n-dimensional manifold preserving a 1-form w such that $dw^n = 0$. The best example of a one parameter group of restricted nonhomogeneous contact transformations is given by the movement of a wave front according to Huygens' principle.

Another important example is the motion of a conservative dynamical system in Hamiltonian form—the mathematical foreshadowing of quantum mechanics. If H is the Hamiltonian of a conservative dynamical system, then the infinitesimal transformation defined by equations (17) is the operator X_H, where X_g denotes the infinitesimal transformation defined by the operator

$$f \to (g,f) \tag{25}$$

parentheses being with respect to the Poincare integral invariant $\beta = \Sigma_i dp_i dq_i$. The most general (analytic) infinitesimal transformation of $(p_1, \ldots, p_n, q_1, \ldots, q_n)$-space which preserves β is of the form X_g with g an arbitrary analytic function. The Hamiltonian form (20) of the equations of motion is preserved by any contact transformation with respect to β, and the equations (20) admit the infinitesimal contact transformation X_g only if g is a first integral or if X_g preserves the associated Cartan form of β. Thus if g_1 and g_2 are first integrals of (20), then their Poisson parentheses is a first integral by the principle (B). Poisson parentheses are related to Poisson brackets by the identity

$$[X_f, X_g] = X_{(f,g)} \tag{26}$$

See also GROUPS; GROUPS, TRANSFORMATION; GROUPS AND ALGEBRAS, REPRESENTATIONS OF.

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(G. D. M.)

GROUPS, TRANSFORMATION. Transformation groups in geometry comprise a branch of theoretical mathematics that has received increasing attention in the 20th century and has close relations with important aspects of physics and with other phases of higher geometry.

Preliminary Definitions.—An abstract group (see GROUPS) is a system of elements in which a multiplication is defined satisfying certain simple rules (see below). A transformation group is always associated with a space of points and is an abstract group whose elements are one-one correspondences between the points; furthermore, the space has some kind of structure which is preserved by the correspondences. For example, the transformation group of principal interest in Euclidean geometry is the collection of congruences; these preserve distances between points and are called isometries. The correspondences, also called transformations, have this character: (1) to each point of space regarded as preimage they associate an image point; (2) each point is image of one and only one preimage. If T denotes a correspondence one writes $T(A) = A'$ to say that A' is image of A.

The set of all such transformations (and also certain subsets called subgroups) forms an abstract group; *i.e.*, an associative multiplication can be defined, there is an identity and each element has an inverse. Thus the *product* S . T of transformations S and T associates to A the image $A'' = S(T(A)) = S(A')$, nhere A' is $T(A)$. The inverse of T denoted by T^{-1} interchanges image and preimage: $T^{-1}(A') = A$ if and only if $T(A) = A'$. The identity, denoted by **I**, is defined by $I(A) = A$ for all A. If for two elements S and T, $S(A) = T(A)$ for all A, this means that $S = T$; in this sense $TT^{-1} = \mathrm{I} = T^{-1}T$, and for three elements R . ST = RS . T (associativity), as is easily verified.

S and T are said to commute, if ST = TS; if every pair commute, the group is called commutative.

Historical Survey.—High points in the development of this subject in the century (1830–1930) after the invention of group theory were as follows. (1) Discovery of Bolyai-Lobachevski plane geometry. This has distance-preserving transformations which give rise to "rigid motions" different from Euclidean motions. (2) Papers by B. Riemann and by H. L. F. von Helmholtz on the foundations of geometry; their investigations clarified the mathematical nature of space and motion and led to new geometries in all dimensions. (3) Studies by Arthur Cayley and by Felix Klein on the relation of metric geometries to subgroups of the projective group; the latter preserves collinearity (if A, B, C are on a line so are the images A', B', C') but distorts distance. (4) M. S. Lie's work on continuous transformation groups (now called Lie groups); here the group regarded as a spacelike structure (group manifold) plays a dominant role. (5) David Hilbert's axiomatization based on transformation groups of the two metric geometries on the plane. (6) Relativity theory with its emphasis on the principle of invariance—physical entities such as space-time intervals, forces, displacements, expressible in appropriate co-ordinate systems by some mathematical formalism. must keep their form after transformations of co-ordinates. In consequence the group of allowable transformations of co-ordinates reflects the nature of the physical world. This is the Lorentz group in relativity theory and the Newton-Galileo group in the older physics. (7) Studies by E. Cartan and H. Weyl on group manifolds whose structure is describable in local co-ordinate systems (Lie groups). (8) Studies by A. Haar, J. von Neumann and L. Pontryagin on the construction of co-ordinate systems in more general group manifolds.

General Concepts.—Let G denote a group acting on a space. The set of images of a point A under all elements of G is called the orbit of A, denoted by $G(A)$. Those elements S for which A is a fixed point, *i.e.*, $S(A) = A$, form a subgroup (possibly trivial; *i.e.*, consisting of the identity) called the stability group (also isotropy group) of A, denoted by G_A. G carries each point of $G(A)$ to every other point and is called transitive on the orbit. If G_A is the identity, G is simply transitive on $G(A)$; then each point can be associated to a unique element of G. In this case G and $G(A)$ have similar structure as spaces.

For example: (1) a line L can be reflected into itself across each point. The collection of these transformations and all their products forms a transitive group; each stability group has two elements. the identity and one reflection. G has a subgroup called the line-translation group, which is simply transitive on L. (2) the group of rotations of a circle is simply transitive on the circle, and is called a circle group.

Space is partitioned into distinct orbits each of which is a point in an abstract space called the orbit space. For example, if G is the group of rotations of the plane about a fixed origin, then all orbits (with one exception) are circles, and the orbit space is a half line whose end point corresponds to the one point left fixed by all elements of the group.

As this example shows, the stability groups associated with points on different orbits need not be similar. However, if A and B are on the same orbit, then G_A and G_B are actually conjugate groups; *i.e.*, there is an element T in G such that, for every element S in G_A, TST^{-1} is in G_B. It should be remarked for those familiar nith group theory that the orbit $G(A)$ is directly related to the coset space (either left or right) of G by G_A.

Euclidean Plane Geometry.—One of the simplest substantial illustrations of the foregoing is the Euclidean plane group. This can be defined on the basis of the first dozen or so propositions of Euclid's book i, as follows. Let ABC and A'B'C' be a pair of congruent triangles and let D be an arbitrary point in the plane. There is a unique point D' such that the distances AD, BD, CD equal AD', BD', CD' respectively. Thus the natural correspondence $T(A) = A'$, $T(B) = B'$, $T(C) = C'$ can be extended to a transformation of the entire plane: to each point D one simply associates the appropriate D'. The totality of all these transformations for all choices of a pair of congruent triangles constitutes the Euclidean group of isometries (distance-preserving transformations); let us call this G.

In the light of Euclid's fourth postulate (see L. W. Young, *Fundamental Concepts of Algebra and Geometry*, 1911, for a discussion of Euclid's geometry) that all right angles are equal, one sees that an ordered pair of perpendicular lines L_1, L_2 can be carried by an isometry into any other such pair. This corresponds to choosing reference axes in the plane, and is the first step in introducing rectangular co-ordinates.

It is instructive to see how other postulates of Euclid are related to properties of G and its subgroups. The third postulate, that to each pair of points A,B there is a circle with centre A passing through B, expresses the fact that stability groups G_A have circle orbits $G_A(B)$. The first and second postulates, covering the existence and uniqueness and extendibility of a line segment AB, express the fact that for each A,B there is in G a unique subgroup which is a line-translation group and for which A and B are on the same orbit.

The fifth and last, the "parallel" postulate, expresses the fact that for each of these line groups in G, the family of orbits is a system of parallel lines. The set of all elements on all of these line groups forms a commutative subgroup of G, called the translation group. It is the existence of this commutative, simply transitive subgroup which distinguishes Euclidean geometry from all other metric geometries and lends it a much simpler structure. This is also the group that. in applications to physics. gives rise to the "parallelogram law" of the addition of vectors.

Examples of Transformation Groups.— I. The affine group in the plane carries parallel lines to parallels but may distort shape (of triangles, for example) and size. To describe it, let x,y denote co-ordinates in the plane. Each transformation T is identified by six parameters (a,b,c,d,e,f) subject only to the condition (ad $-$ bc) not zero, to ensure that T^{-1} exists. T can be represented by

$$T: \begin{array}{l} \bar{x} = ax + by + e \\ \bar{y} = cx + dy + f \end{array}$$

Here x,y are co-ordinates of A; $\bar{x},\bar{y}$ are co-ordinates of A'; and $T(A) = A'$.

2. There is a corresponding affine group in n-dimensions whose elements depend on $n^2 + n$ parameters (also called co-ordinates).

3. The equiaffine plane group, with ad $-$ bc $= 1$, preserves area of triangles but alters shape.

4. If one regards T, above, as a substitution (transformation of co-ordinates) then one can find the Euclidean group as a subgroup of the affine by the requirement that the distance formula be left "invariant"; *i.e.,* $\sqrt{(\bar{x}_1 - \bar{x}_2)^2 + (\bar{y}_1 - \bar{y}_2)^2}$ goes over to $\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$.

5. The group of homeomorphisms of a metric space M is defined as follows. An infinite sequence of points A_0, A_1, A_2, A„ . . . , is called fundamental if the distances $A_0A_1, A_0A_2, A_0A_3, \ldots$, grow smaller approaching zero. A transformation T is called topological if T and T^{-1} preserve fundamental sequences; T is also called a homeomorphism. The totality of these T constitutes the group.

6. In every metric space one can define the group of isometries, but in general this group will be trivial; *i.e.,* reducing to the identity.

7. Two metrics on a space M are said to be topologically equivalent if every sequence which is fundamental in one metric is also fundamental in the other. Thus the Bolpai-Lobachevski and the Euclidean metrics on the plane are topologically equivalent. However, the two groups of isometries are very different.

A Theorem of **Hilbert.**—A topological transformation of the plane distorts linearity; nonetheless the images of all lines and circles under a fixed transformation of this kind form a system of point sets (called open curves and closed curves, respectively) which can be interpreted as the new lines and circles of an abstract geometry in the plane. This system satisfies all the postulates of Euclid's geometry.

In 1903 Hilbert proved a theorem equivalent to the following. Hypotheses. (1) we are given the plane and a metric which is only topologically equivalent to the Euclidean metric: (2) in this new metric the group of isometries G is transitive; (3) the orbits G_A(B) are infinite sets (*i.e.,* not finite). Conclusions: (1) it is possible to define straight lines, circles, angles, etc., in terms of the subgroups of G; and (2) one obtains either the Euclidean or the Bolyai-Lobachevski geometry and nothing else.

Modern Developments.— In the early 1950s, as the culmination of work by A. M. Gleason. K. Iwasawa, D Montgomery, H. Yamabe and others on topological grounds and that of H. Busemann, H. Freudenthal, J. Tits, H. C. Wang and others on the geometry of transformation groups, the theorm of Hilbert was extended and generalized in many ways. The following theorem is most quotable, and in its way definitive.

Hypotheses: M is an abstractly given metric space which is locally compact and connected and the group G of isometries has this property: if the distances between points A,B,C equal corresponding distances between A',B',C' then the two triples are congruent under some element of G.

Conclusions: M is a manifold on which one can define lines, angles and circles, giving rise to one of the four types of metric geometries, and G is the group appropriate to that geometry.

A remarkable feature of this theorem is the following: each type of geometry has a representative in each dimension n, from n = 2 upward, so that the theorem is about a fourfold infinity of geometries. To distinguish a particular one from among the others, it is merely necessary to choose the desired dimension and type.

See also GROUPS; GROUPS, CONTINUOUS; GROUPS AND ALGEBRAS, REPRESENTATIONS OF.

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(L. ZN)

GROUPS AND ALGEBRAS, REPRESENTATIONS OF.

Since their formal introduction in the early 19th century, groups have been one of the principal objects of mathematical attention. Their widespread and profound applications to such physical subjects as crystallography, quantum mechanics and hydrodynamics and to such other mathematical regimes as number theory, harmonic analysis and geometry have demonstrated their importance.

The main general technique for studying groups is the method of "group representation." Technically, a representation of a group is a homomorphism of it into another group. most commonly, into the group of invertible linear transformations (or matrices) on some linear space. Less technically, this method amounts to comparing the given group with better known examples of groups. Representation theory plays a significant part in all branches of mathematics in various ways; it also is important in theoretical physics, particularly in quantum theory.

To sketch briefly, a group is a set on which a multiplication satisfying certain specific properties is defined. Corresponding to each pair of elements a, b (in a given order) is another element (written ab) and this law of combination has the properties: (1) $a(bc) = (ab)c$; (2) there is an element e, called the group identity element, such that ae = ea = a; and (3) for each a there is an element a^{-1} called the inverse of a such that $aa^{-1} = a^{-1}a =$ e. If in addition ab = ba for each a and b, the group is said to be abelian (also commutative). A homomorphism is a mapping (function, correspondence) f of one group G into another group H such that $f(ab) = f(a)f(b)$ for each a and b in G; i e., f "preserves" multiplication. The positive and negative integers with their usual addition provide an example of an infinite abelian group (here, addition plays the role of group multiplicatian, 0 is the group identity and, for example, -5 is the group inverse to 5). The two integers 0 and 1 with the usual addition as group multiplication (except that 1 is to combine with 1 to give 0) provide an example of a finite abelian group. as does the set of two integers $+1$ and -1 with the usual multiplication of integers. The mapping of an integer into 0 if it is even and into 1 if it is odd provides an example of a homomorphism of the group of integers onto the first two-element group. The function which assigns 0 to $+1$ and 1 to -1 is an example of an isomorphism (*i.e.,* one-to-one homomorphism) of the second two-element group onto the first. Structurally (as far as group theoretical properties are concerned). the existence of this isomorphism indicates that both two-element groups are the same—they are different (isomorphic) representations of the same abstract group. so to speak.

The process of group representation may be likened to measuring some physical object aith a ruler. By comparing the object to be studied with the knoun object (the ruler), special information is obtained. Spreading the object out completely along the ruler might be thought of as an isomorphic representation; but such a procedure may not be possible. For example, a polyhedron would have to be studied by applying a series of partial measurements and combining them (corresponding to combining information from homomorphic representations). It would be hoped that sufficiently many measurements could be made to give detailed information—corresponding to the case of sufficiently many (a separating family of) representations so that each pair of distinct elements is carried into a pair of distinct elements by at least one of the representations. An instance of "combining" information is afforded by the simple fact that a group which has a separating family of representations in abelian groups is itself abelian (ab and ba are identified by all such representations). It would help little to make measurements with an unmarked straightedge; and in the same way, the representations would be expected to take place in groups with some discernible structure. On the other hand, if the ruler is too specialized, for example, circular, it is available for only a limited type of measurement; and, by analogy. the class of groups in which the representations take place should remain broad enough to have general application. The so-called linear groups, groups of invertible linear transformations on a linear vector space, are well suited to this task. Representations in such groups often are referred to as "linear" representations, or simply as representations if confusion is unlikely. In particular, representations by unitary operators on Hilbert spaces, called unitary representations, and representations by operators on finite-dimensional linear spaces, called finite-dimensional representations, have proved very useful.

In applying the technique of representations to the study of groups, the allied method of associating an algebra, the so-called group algebra, with the group has a key function. (An algebra is a linear space with a multiplication satisfying certain specific conditions; see ALGEBRAS [LINEAR]). For finite groups and the complex group algebra, this amounts to associating with the group sums of formal complex multiples of the group elements and multiplying two such sums by distributing products in the usual may, "commuting" numbers past group elements and multiplying group elements by means of the group multiplication.

A linear representation of the group can be extended to the group algebra by assigning to each sum of multiples of group elements the same sum of multiples of the operators (matrices) corresponding to those group elements under the given representation. This extension is a representation of the group algebra (a mapping into the algebra of operators on the "representation space" which preserves both products and sums). The analysis of the algebra representation is somewhat simpler than that of the group representation and yields much information about the group representation. The process of extension can be reversed. for the group elements are found in a natural way among those of the group algebra; *i.e.,* a representation of the group algebra gives rise to a representation of the group.

There are several ways of constructing new representations from one or more given representations. The first, restriction of a representation, starts with a representation f of a group G (or algebra) and a subspace V of the representation space which is mapped into itself by each of the representing operators (a so-called reducing or invariant subspace). The restricted representation assigns to each g in G, the operator $f_V(g)$ on V which is f(gj restricted (in its action) to V. If V is not 0 or the full space, the representation f is said to be reducible. If no such "proper" invariant subspace exists, the representation is said to be irreducible. (In the case of representations on Hilbert spaces, "subspace" is understood to mean "closed subspace.") Representations of finite groups enjoy the important property of complete reducibility. If V is a reducing subspace, there is a complementary space V' which is also invariant (V and V' have only 0 in common and each vector in the representation space is the sum of one from V and one from V').

The representation f is said to be the direct sum of f_V and $f_{V'}$. This description of direct sum from an internal viewpoint has an external counterpart. If f and f' are representations of G on spaces V and V', respectively, a representation f $\oplus$ f', called the direct sum of f and f', on the direct sum V $\oplus$ V' of V and V' (*i.e.,* the linear space of pairs of elements, one from V and one from V') is defined by assigning to each group element g the operator on $V \oplus$ V' which transforms a pair (v,v') into the pair $([f(g)](v),[f'(g)](v'))$. In the case of reducing complementary spaces V and V' for a representation f, it is an easy matter to see that $f_V \oplus f_{V'}$ is f when the full space is viewed as V $\oplus$ V'. In a similar manner, direct sums of more than two representations can be defined. For finite groups, the process of decomposition of a representation may be continued on each of the restricted representations until a full reduction into irreducible representations is effected (the representation is a direct sum of irreducible representations and such a decomposition is unique).

A more complicated procedure for constructing representations from families of representations, the tensor product, stems from the tensor product of linear spaces (the space of sums of multiples of formal products of basis elements one from each space in a given order—the dimension is the product of the dimensions of the individual spaces as contrasted with that of the direct sum which is the sum of the dimensions). If f and f' are representations of G on spaces V and V', respectively, then f $\otimes f'$, their tensor product, assigns to each g in G the operator $f(g) \otimes f'(g)$ which transforms one of the generating elements $v \otimes v'$ of the tensor product $V \otimes V'$ of V and V' into $[f(g)](v) \otimes [f'(g)](v')$. In particular, the square of a representation consists of tensoring it with itself (similarly for higher powers).

A problem of some importance and difficulty is that of describing the irreducible representations which appear in the decomposition of the higher powers of irreducible representations of specific groups (these higher powers are not themselves irreducible, in general). Of course, the basic problem of the theory is the description of the irreducible representations of specific groups, for these are the basic representations not only of the general theory but of the fundamental physical situation to which the theory applies. Speaking of the possible occurrence of a representation which is reducible in the description of a general scheme for quantum mechanics. H. Weyl, one of the founders of modern representation theory, wrote, "Nature could hardly be expected to indulge in such a superfluous luxury."

In dealing with representations of a given group, there is clearly no additional information to be obtained by passing from one representation to a second whose space can be identified with that of the first in such a way that the operators corresponding to each group element under both representations act in the same way on the spaces (relative to the identification). In this case, the representations are said to be equivalent. (Technically, if f and f' are the equivalent representations of G on spaces V and V', there is a linear isomorphism P of V onto V' such that $Pf(g)P^{-1} = f'(g)$ for each g in G.) When a representation f of a group is expressed as the direct sum of irreducible representations and precisely n of these are equivalent to a given irreducible representation f', then f' is said to "occur in f with multiplicity n." If the group G has m elements the set of complex-valued functions on G is a linear space of dimension m (addition and scalar multiplication performed pointwise). A natural representation of G on this space is available—to the function a assign the function a, whose value at g is $a(g^{-1}g')$, and let f(g) be the transformation of the function space so defined. Then f is a representation of G (called the "left regular" representation of G). In a similar manner, there is the "reflected" situation of the right regular representation of G. The crucial property of the regular representations is that each contains every irreducible representation of G in its direct sum decomposition (with multiplicity equal to the dimension of the representation space—as a consequence of the reflection situation of the right and left regular representations). The regular representation is an isomorphic one! from which one concludes that the group G has a separating family of irreducible representations. If f is a representation of the finite group G as operators on a Hilbert space, then the function which assigns to a pair of vectors x,y in the space the number $\sum_g (f(g)x, f(g)y)$ is again an inner product equivalent to the original one and relative to which each $f(g)$ is a unitary operator (orthogonal transformation, in the real case), so that each such representation of G is equivalent to a unitary representation of G. If f and f' are a pair of inequivalent (irreducible) unitary representations of G, then

$$\sum_g (f(g)x,y)(f'(g^{-1})x',y') = 0,$$

where x,y and x',y' are orthonormal pairs of vectors in their respective spaces (the same holds when $f' =$ f and x',y',x,y is an orthonormal set such that not both $x =$ x' and $y =$ y'); while $\sum_g |(f(g)x,y)|^2 =$ the number of elements in G (called the order of G) divided by the dimension of the representation. These are the so-called orthogonality relations. The sum of the diagonal entries of the matrix corresponding to an operator on and a basis for some finite-dimensional space is called the trace of the operator. It is independent of the basis chosen. If f is a representation of the finite group G on a finite-dimensional space, the function which assigns to each element of G the trace of its representing operator is called the character of f. A critical result of the theory states that two such representations are equivalent if and only if their characters are identical—the study of such representations is reduced to the study of the characters of G. The character of a direct sum of representations is the sum of their characters and that of a tensor product is their product. The character of the n-dimensional "identity" representation (mhich assigns the identity operator on n-dimensional space to each grnup element) has the constant function n as its character, and that of the regular representation is 0 at each group element except the identity where it takes the value equal to the order of the group (this is easily checked on the basis consisting of functions which are 1 at some group element and 0 at all others). The characters of the irreducible representations are precisely those characters k such that $\sum_g |k(g)|^2$ is the order of G.

Schur's lemma, which states that the only operators that commute with a unitary irreducible representation are the scalar multiples of the identity operator, is a key result in the development of representation theory. (Since each representation of a finite group is equivalent to a unitary representation, Schur's lemma covers all such representations.) Applying this fact to abelian groups, it follows that each irreducible unitary representation of such a group is 1-dimensional—each group element is mapped into a complex multiple (having absolute value 1) of the identity operator. The function on the group which assigns to each element its corresponding complex number is the character of the representation. There is, of course, no need to distinguish between the representation and its character, in this situation. The complex conjugate of such a character is again a character as is the product of two such characters. With this multiplication, the characters form a group—the character or dual group (to the original group). If G is an abelian group and G' its dual, then each g in G gives rise to a character of G' which assigns to an element of G' its value at g. The duality theorem for abelian groups states that the mapping of G just described is an isomorphism of G onto the character group of G' (roughly speaking, G is the dual group of its dual group). A function a on G may be viewed as the element $\sum_g a(g)\cdot g$ in the group algebra of G; and each character g' of G has the extension to this group algebra which assigns to $\sum a(g)g$ the number $\sum a(g)g'(g)$. Denoting this number by $a'(g')$, the transformation which maps a onto a' is an isomorphism of the group algebra of G onto the function algebra of G' (the linear space of functions on G' with pointwise multiplication). For finite abelian groups, this function mapping is the counterpart of the Fourier transform, so important in mathematical analysis (see FOURIER SERIES).

The "symmetric group on n letters," S_n, is the set of all one-one transformations of n objects (letters) onto itself (*i.e.*, the set of all permutations or arrangements of the n objects) with iteration of transformations (or arrangements) as the group multiplication. Thus S_2 can be viewed as the permutations of the numbers 1, 2: one permutation (the identity) leaving 1 and 2 fixed and the other interchanging 1 and 2 (the square of this last is the identity). It follows that S_2 has 2 elements; S_3 has $1\cdot 2\cdot 3$ (= 6) elements, and quite generally, S , has $1\cdot 2 \ldots n$ ($= n!$) elements. The natural combinatorial character of the symmetric groups results in their dominance of representation theory for finite groups—wherever physical quantities exhibit combinatorial symmetries (*e.g.*, in the quantum mechanics of a system of several "identical" electrons) the symmetric groups make their appearance. Group-theoretically, their importance is obvious from the fact that each finite group is isomorphic with a subgroup of some symmetric group. In fact, if G has n elements, the mapping that assigns to each element g of G the permutation of the n elements of G effected by (left) multiplying each by g is an isomorphism of G with a subgroup of S_n. From the general theory, one sees that the study of the representations of S , can be carried out by a detailed analysis of its group algebra and, in particular, of the regular representation. For arbitrary finite groups. the number of inequivalent irreducible representation is the linear dimension of the centre of the group algebra (those elements of the group algebra which commute mith all others); and this is seen to be the number of distinct conjugate classes of group elements. (Two group elements a and b are "conjugate" if there is some group element g such that a $= gbg^{-1}$. A conjugate class in a group is the set of conjugates of some fixed element.) For symmetric groups each conjugate class can be associated mith a certain symmetry pattern. Each permutation on n letters permutes various disjoint subsets of the letters cyclically among themselves (*i.e.*, placing the letters of one subset along the rim of a wheel at equal intervals and in the proper order. the permutation affects these letters as would a rotation of the wheel carrying one into the next). Two permutations are conjugate precisely when the subsets of one can be matched with those of the other so that matching subsets have the same number of elements. Thus there are as many inequivalent irreducible representations of S_n as there are ways of expressing n as a sum of nonnegative integers (independent of order). The subsets corresponding to a partition of n constitute a particular symmetry pattern. Relative to these, a generalized process of symmetrization and alternation is defined which gives rise to special elements of the group algebra, the so-called Young symmetrizers, in terms of which the irreducible representation corresponding to the pattern can be described. If a particular pattern has $m_1, m_2, \ldots, m_k$ elements in the respective subsets (listed in decreasing order of size), the dimension of the space of the corresponding irreducible representation is the quotient of $s(n!)$ by (n,!) $(n_2!) \ldots (n_k!)$, where s is the product of all the differences n, $- n_h$ with h less than j and n, = m, + k $- j$. Applied to S_5, for example, these results assert the existence of seven inequivalent irreducible representations corresponding to the partitions 5, 4 + 1, 3 + 2, 3 + 1 + 1, 2 + 2 + 1, 2 + 1 + 1 + 1 and 1 + 1 + 1 + 1 + 1, with dimensions 1, 4, 5, 6, 5, 4 and 1, respectively. It is no accident that the sums of the squares of these dimensions (120) is the order of S_5—it is a consequence of the fact that the regular representation takes place on 120-dimensional space and each irreducible representation occurs in it with multiplicity equal to its dimension.

The applications of the theory of group representations to mathematical analysis and to physics entail. for the most part, the description of the representations of infinite groups which have a topological structure related to their group structure—the so-called topological groups. (The topological structure is a mathematical formulation of the concepts of "nearness." The topological groups are those in which nearness is so defined that the product of an element and the inverse of another element is near to the group identity provided both elements are themselves near the identity.) The most important and the most intensively studied of these groups are the Lie groups. These are the topological groups in which the topology near each point is like that of n-dimensional Euclidean space for some fixed n. A more general class of topological groups, the locally compact groups, have received some attention. These include the discrete groups (those in which no group element is "infinitely near" the others—every group can be given such a topology), the Lie groups, and those which can be constructed from these two classes by certain group-theoretic processes. The various Euclidean spaces mith vector addition as group multiplication and the complex numbers of modulus 1 (the circle group) with the usual multiplication of complex numbers each with its usual notion of nearness are examples of abelian Lie groups. The invertible operators on n-dimensional Euclidean space, with nearness described in terms of nearness of the images of a specific vector and group multiplication the multiplication of operators, is an example of a nonabelian Lie group (the general linear group of dimension n).

The crucial property of locally compact groups is the existence of a measure on them, Haar measure (a notion of "volume" for subsets), which assigns the same number (measure) to a subset of the group and to the subset obtained from it by left multiplying each element of the subset by a fixed group element (each "left translate" of the set). Those groups with finite total measure constitute an especially important subclass, the compact groups. The circle group and the subgroup of the general linear group consisting of those operators which preserve the lengths of vectors, the orthogonal group (unitary group in the complex case), are examples of compact Lie groups. The finite groups are compact (discrete) groups.

Several different possibilities for group algebras and regular representations present themselves in the case of locally compact groups, each shedding some light on the representation theory of these groups. The set of finite sums of complex multiples of group elements is a direct generalization of the group algebra for a finite group, but it takes no account of the group topology. The integrable functions on the group with multiplication like that in the finite case (each function thought of as the sum of the products of each group element by the function value at that group element) except that integration replaces ordinary summation is an effective generalization which respects the group topology. (This group algebra is the L_1 group algebra and its multiplication is convolution multiplication of functions.) The space of square integrable functions on G (*i.e.*, $L_2(G)$) is a Hilbert space which is available for the various regular representations. Assign to each group element the operator which left translates an L_2 function by g^{-1} (as in the finite group case). This operator is unitary, and the algebra of finite sums of multiples of these operators is the (left) regular representation of the "finite" group algebra. "Convolving" an L_1 function with L_2 functions associates a bounded operator on $L_2(G)$ with the given L_1 function. This association is the (left) regular representation of the L_1 group algebra of G. The algebra of operators so obtained is not closed in the various relevant topologies on the set of bounded operators, and the various closures of this algebra are reasonable candidates for a group algebra (in particular, the uniform and the weak closures are of special interest). It is not to be expected that a general unitary representation of G can be "extended" to the L_1 group algebra (an essentially topological construct) without some further topological restriction. The unitary representations which appear in practice are the "strongly continuous" representations—those which represent elements near the group identity by unitary operators (strongly) near the identity operator (equivalently: "weakly continuous" and "measurable" unitary representations), and these representations are so extendible to the L_1 group algebra. They are often but not always extendible to the uniform closure of this group algebra (in its regular representation on $L_2(G)$); and the question of just when they can be so extended is related to some of the most delicate problems of mathematical analysis. They are rarely extendible to the weakly closed group algebra (*i.e.*, to the weak closure of the regular representation of the L_1 group algebra).

The most satisfactory aspects of this general theory are to be found in its application to the classes of compact groups and of abelian (locally compact) groups. The theory of representations developed for finite groups is valid for continuous representations of compact groups on Hilbert spaces, once summation over the finite group (divided by the group order) is replaced by integration with respect to Haar measure (normalized so that the group has measure 1). The equivalence of such representations with unitary ones, the character theory, direct sum decomposition into irreducible representations, the orthogonality relations and the existence of a separating family of (finite-dimensional) irreducible unitary representations are valid for compact groups. The critical new fact which must be established in the general case is the finite dimensionality of each irreducible representation. The duality theory for finite abelian groups carries over intact to the general case. The dual (character) group of a compact abelian group is discrete (and that of a discrete group is compact). In particular, the character group of the circle is the additive group of integers—the correspondence between (L_2) functions on the circle and those on the integers (described for finite abelian groups) is the Fourier series expansion of periodic functions. The additive group of real numbers (*i.e.*, 1-dimensional Euclidean space) is its own dual and the function mapping, in this case, is the important Fourier transform.

A foreshadowing of the complexities of the theory of representations for more general locally compact groups is afforded by the decomposition problem for reducible representations of abelian groups which are locally compact but not compact. Here a direct sum decomposition into irreducible representations (*i.e.*, characters) is not always possible as such. Rather, a direct integral decomposition, which bears the same relation to a direct sum decomposition as integration does to summation (ordinary addition), replaces the direct sum decomposition.

The representations of the 3-dimensional rotation group, R_3, supply an excellent and physically significant illustration of the theory for compact groups. The group R_3 consists of linear transformations of (real) 3-dimensional space which preserve the lengths of vectors and have determinant 1. The rotations preserve area on the unit sphere about the origin (best described in terms of 3-dimensional polar co-ordinates), so that each such rotation induces a unitary transformation on the Hilbert space of square integrable functions over the sphere. The resulting unitary representation decomposes into a direct sum of irreducible, finite-dimensional unitary representations. From a direct analytical study this representation can be shown to decompose into a direct sum of spaces of odd dimension, one for each odd number. This decomposition is effected by means of the spherical harmonic functions on 3-space and their associated surface harmonics on the sphere. The orthogonality relations for the surface harmonics establish the fact that this decomposition yields all the irreducible representations of R,.

For general locally compact groups it is still possible to establish the existence of a separating family of strongly continuous irreducible unitary representations, and it is still possible to decompose reducible representations into a direct integral of irreducible representations; but much of the value of this fact is lost in the observation that the decomposition can often be performed in many totally distinct ways (*i.e.*, so that no irreducible component of one decomposition is equivalent to any component of the others). These developments have given rise to the opinion that the appropriate process is not decomposition into irreducible representations but rather into factor representations. (A unitary representation is said to be a factor representation when the weak closure of the sums of multiples of the representing unitary operators has only multiples of the identity operator in its centre. Such an algebra of operators is said to be a factor.) The factors have been broadly classified into types depending on the nature of a dimension function on the projections in the factor (its discreteness or nondiscreteness, its finiteness or infiniteness). The so-called factors of type I are the most manageable type, from the point of view of group representations. These are the factors isomorphic with the algebra of all bounded operators on some Hilbert space. The (direct integral) decomposition of a group representation into factor representations is essentially unique. When the resulting factors are of type I the decomposition of the representation into irreducible components is also essentially unique. The problem of the types of factor representations a specific group has (the so-called type problem) is central to the general theory. In particular, establishing that specific class of groups have only type I representations is of vital importance to the general theory.

The detailed investigation of a Lie group and its representations proceeds via the study of its associated Lie algebra. If the Lie group with its associated topology is thought of as a surface in 3-dimensional space (or, more generally, a manifold in n-dimensional space) each vector in the tangent plane (space) at the group identity determines a unique vector at each group element by means of (left) translation by that group element. Relative to (*i.e.,* in the direction of) the invariant vector field so obtained, (differentiable) functions can be differentiated to give another function on the group. If two such vector fields are involved, differentiation is performed with respect to each successively in both orders, and the result of one is subtracted from that of the other, the mapping on functions obtained by this process is the same as that due to differentiation with respect to some third invariant vector field. This third vector field is said to be the Lie product or bracket of the other two. These vector fields, or—what amounts to the same thing since each is determined by a tangent vector at the group identity e—the tangent space at e, with the Lie product is the Lie algebra of the group (it is a nonassociative algebra). Since differentiation is a local process. depending only on the points near a point at which it takes place, the Lie algebra of a group is in reality a construct associated only with that portion of the group near the identity—the so-called local Lie group. Several Lie groups which are distinct "globally" may have the same local structure and hence the same Lie algebra (*e.g.,* the circle group and the group of real numbers both have the real line with the Lie product of each pair of elements 0 as their Lie algebra). The distinction between Lie groups which have the same Lie algebra is a (global) topological one. Loosely speaking they differ in the number and relation of the "holes" in them. A particular one of them "covers" the other; *i.e.,* maps homomorphically onto the other by a mapping which is an isomorphism near the identity. For example. the circle has a hole, the real line does not, and the real line may be "wrapped" homomorphically around the circle. In the family of Lie groups with a given Lie algebra there is one which covers all the others—the so-called universal covering group of the others (also called simply connected covering group—the one which has no holes). The group of reals is the universal covering group of the circle. The rotation groups in dimensions 3 and higher are not themselves simply connected, but have a twofold universal covering group (*i.e.,* each point in the rotation group is the image of precisely two points in this covering group). These are the "spinor groups" (Spin(n) for the n-dimensional rotation group R,).

The Lie algebra of a Lie group may be thought of as a linear approximation to the local Lie group in the same sense that a tangent plane to a surface is the best planar approximation in the neighbourhood of the point of tangency. The multiplicative nature of the local group is made linear (additive) by the transition to the Lie algebra in much the same way that the logarithm converts multiplicative numerical problems into additive ones. In fact, there is a generalized logarithmic mapping (which preserves differentiability) carrying the local Lie group onto a neighbourhood of the origin in the Lie algebra—or, technically more manageable, an exponential mapping of the entire Lie algebra into the group. By means of this mapping (local) questions about the group can be transferred to questions about the Lie algebra (which are more easily handled because of the added linearity). A (differentiable) homomorphism f of a Lie group G into another H induces a mapping of the functions on H into those on G and consequently of the differentiations with respect to invariant vector fields on G into those on H; *i.e.,* f gives rise to a mapping df of the Lie algebra h of H into the Lie algebra g of G. The mapping df is a homomorphism of g into h; *i* e., a linear mapping which preserves the Lie product. Conversely, a Lie algebra homomorphism stems from a homomorphism of the local Lie group which may or may not be extendible to the full group. It is always extendible if the first group is simply connected. Applied to finite-dimensional representations of G (*i.e*, a homomorphism of G into the n-dimensional general linear group) this process yields a representation of g; for the Lie algebra of the general linear group can be viewed as the set of all n-dimensional operators nith the Lie product of two operators A and B as AB — BA. The n-dimensional rotation group (and so Spin(n)) have the skew-symmetric operators of trace 0 (with the same Lie product) as its Lie algebra, r. The study of the representations of r uncovers the existence of a representation corresponding to one of the local group which cannot be extended to all of R,. The "spin" representation of Spin(n) can be effected in terms of a construct known as the Clifford algebra. In the physically important case of R,, Spin(3) can be identified as the group of 2-dimensional unitary operators with determinant 1 and also as the group of unit quaternions; the representation theory, in this case, is related to the physical phenomena associated with electron spin.

The deeper analysis of the representation theory for Lie groups whose finite-dimensional representations are completely reducible (the semisimple Lie groups) involves a profound analysis of the semisimple Lie algebras and the so-called theory of weights associated nith their representations. It has been established for such groups that their unitary representations on Hilbert spaces are of type I.

Historical Development.—The general representation theory for finite groups was developed by G. Frobenius, I. Schur and W. Burnside at the end of the 19th and the beginning of the 20th century. Nothing of the deeper theory of finite groups developed by such later workers as E. Artin and R. Brauer has been discussed here. The extension of the finite group theory to compact groups is due in part to Schur. who developed the representation theory of the rotation group in those terms. The general extension to compact groups of the completeness and orthogonality of the finite-dimensional irreducible unitary representations is known as the Peter-Weyl theorem (published in 1927). Lie groups are named after M. Sophus Lie, who discovered their fundamental properties in the last decades of the 19th century. A deeper analysis of their properties and, in particular, the classification of the semisimple groups was carried out by E. Cartan in the early part of the 20th century. The general finite-dimensional representation theory for semisimple Lie groups was developed principally by Weyl in the mid-1920s as were the connections between group theory and quantum mechanics. The general representation theory for topological groups started with the discovery by A. Haar in the early 1930s of an invariant measure on locally compact groups. The existence of a separating family of irreducible unitary representations for locally compact groups was established by I. Gelfand and D. Raikov in the early 1940s. The decomposition of unitary representations of locally compact groups into irreducible and factor unitary representations was carried out by F. Mautner at the end of the 1940s. This decomposition was based on the powerful theory of operator algebras developed by J. von Neumann in collaboration with F. Murray in the 1930s and early 1940s. In particular, the theory of factors is their creation. A general duality and function transform theory based on the Murray-Von Neumann operator algebras was developed by I. Segal in the early 1950s. G. Mackey created a forceful technique for the analysis of representations of groups with type I representations by generalizing the Frobenius theory of induced representations. The detailed analysis of the infinite-dimensional representations of the semisimple Lie groups is the work of Gelfand, M. Neumark and Harish Chandra (carried out in the late 1940s and throughout the 1950s). The fact that these groups have type I representations is a consequence of Harish Chandra's results. J. Dixmier established this same fact for the so-called nilpotent Lie groups. Examples of Lie groups with representations not of type I are known. See also FIELDS; GROUPS; GROUPS, CONTINUOUS; GROUPS, TRANSFORMATION; ALGEBRAS (LINEAR); MATRIX; TOPOLOGY. ALGEBRAIC.

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(R. V. K.)

GROUP THEATRE, New York, was founded in 1931 for the purpose of establishing a permanent company of stage craftsmen under a unified policy in the choice of plays and in production. The group preferred plays it considered relevant to the American social scene. The technique of acting employed emphasized personal as well as artistic truth—a technique derived from the so-called Stanislavski method.

(See STANISLAVSKI.)

The three director-founders of the organization were Harold Clurman (sole director after 1937), previously an actor, stage manager and playreader for the Theatre Guild; Cheryl Crawford, who had been the Theatre Guild's casting director; and Lee Strasberg, an actor and occasional director of amateur productions at a New York city settlement house.

The Group Theatre's first two productions, Paul Green's *The Hozcse* of *Connelly* and *1931*— by Claire and Paul Sifton, were produced under the auspices of the Theatre Guild. Subsequent productions, 25 in all, were presented independently and financed piecemeal, the latter condition being the cause for the final breakdown of the enterprise.

Though the first plays were critically acclaimed for the quality of their performances, financial success was not achieved until 1933 with the presentation of Sidney Kingsley's *Men in White*. Other outstanding plays produced by the Group Theatre were by Clifford Odets, a member of the actieg company from its inception — notably *Awake and Sing, Waiting for Lefty* and *Golden Boy*. *Johnny Johnson* by Paul Green, music by Kurt Weill, and *My Heart's in the Highlands* by William Saroyan were also presented.

The Group Theatre exercised a considerable influence on the American stage in three ways: (1) its acting and production methods became virtually standard after 1945; (2) its emphasis on social themes was characteristic of the period and helped foster new writing talent; and (3) its personnel came to occupy prominent places in the years following the Group's demise (1941). Harold Clurman, Elia Kazan and Robert Lewis were among the leading directors of the American theatre in the 1950s. Stella Adler (Studio). Sanford Meisner (Neighborhood Playhouse school) and Lee Strasberg (Actors' Studio) were outstanding teachers of acting.

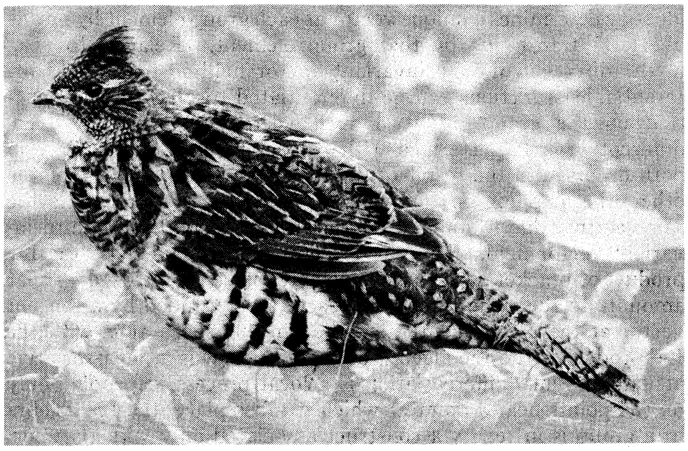
See H Clurman. *Fervent Years: the Story of the Group Theatre and the Thirties* (1945). (Hd. E. C.)

GROUSE, many well-known game birds belonging to the family Tetraonidae, plump-bodied, fowllike birds with strong, feathered legs and mottled plumage, lacking the brilliant colours of the pheasants but well adapted for concealment. They are of medium to moderately large size; fly swiftly for short distances; feed on or near the ground on seeds. berries and young plant shoots; and nest on the ground. usually laying six to ten or more eggs. They are confined to the northern hemisphere, six genera being found only in Sorth America, four only in the old world, and one—the ptarmigans (Lagopus)—circumpolar in distribution. The white-tailed ptarmigan (L. *leucurus*) is found in the mountains of western North America, while the willow ptarmigan (L. *lagopus*) and rock ptarmigan (L *mutus*) are circumpolar in range. The willow and the rock ptarmigan are remarkable for their seasonal changes in plumage; pure white in the winter blending with the snow, brown and black in the spring and more finely and more narrowly marked with brown and black in the summer, blending with the vegetation of their nesting grounds.

A very popular woodland game bird of North America is the ruffed grouse *(Bonasa umbellus)*, so named because it has a ruff of large feathers on the sides and back of the neck which are elevated somewhat in display. The cock's performance consists of posing rather stiffly erect and rapidly beating his wings to and fro to make a loud drumming sound. The bird has a favourite log from which it drums repeatedly in the spring and early summer. In the winter the scales on the toes grow out laterally forming a fringe nhich has been described as "snowshoes" and which may assist the birds in walking about in the snow.

The grouse of the British Isles is the red grouse (L. *scoticus)*, one of the four species of ptarmigan.

Two species of capercaillies *(Tetrao)*, two species of black grouse (*Lyrurus*) and two species of hazel hens *(Tetrastes)* occur in Europe and Asia. In North America there are tno species of prairie chickens or pinnated grouse (*Tympanuchus*), the sharp-tailed grouse (*Pedioecetes phasianellus*) and the large sage hen (*Centrocercus urophasianus*). The Canada spruce grouse (*Canachites canadensis*) is a less wary bird. as is its smaller relative. Franklin's grouse (*Canachites franklini*), also known as the fool hen. The sharp-winged grouse (*Falcipennis falcipennis*) of northeastern Asia is rather like the Canada spruce grouse. The sooty



WOODROW GOODPASTER FROM NATIONAL AUDUBON SOCIETY

RUFFED GROUSE (BONASA UMBELLUS), A POPULAR NORTH AMERICAN GAME BIRD

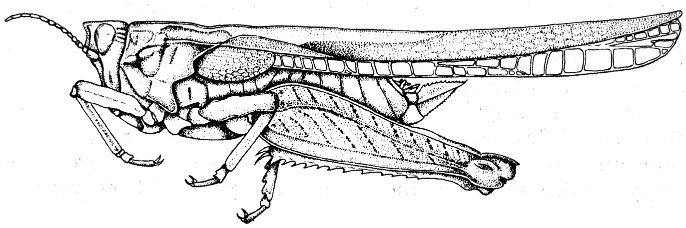
grouse (*Dendragapus obscurus*) is the blue grouse of hunters.

See Blackcock; Capercaillie; Heath Hen; Ptarmigan; Prairie Chicken or Prairie He?;.

(G. F. Ss.; Hr. Fn.)

GROUSE LOCUST, an insect of the orthopterous family Tetrigidae, related to the true grasshoppers or Acrididae *(see* Grasshopper). Grouse locusts are small (seldom over an inch long), commonly brown, gray or moss green and often blotched or lined with whitish. They are usually abundant on moist soil or among dead leaves along the edges of ponds. but are also found in dry places. Unlike the true grasshoppers their forewings are reduced to small pads or are absent, the folded membranous hind wings being protectively covered by a pointed prolongation of the thoracic shield. Many species are dimorphic—one form short, with reduced hind wings, the other long, with functional hind wings. Sound-producing and hearing organs are absent. The family is world-wide, but is best represented in the tropics, where are found bizarre forms with humped backs, spines or high crests. In North America 27 forms occur; in Europe there are about 10, and only 2 in Great Britain. The inheritance of form and coloration in species of the genus *Paratettix* has been much studied by geneticists. Although grouse locusts are vegetarians, they are not economically important pests.

See also Locust.



GROUSE LOCUST

Bibliography.—W. S. Blatchley, *Orthoptera of Northeastern America* (1920); *L.* Chopard, *Biologie des Orthopteres* **(1938)**; *R.* K. Sabours, "The Genetics of the Tettigidae," *Bibliogr. Genet.*, vol. j (1929).

(T. H. Hi.)

GROVE, FREDERICK PHILIP (1871?–1948**j**, outstanding Canadian novelist, was the first to write realistically about the pioneers of the Canadian west. Born in northeastern Europe of a Swedish father and Scottish mother, he spent much of his youth traveling in Europe with his mother. He was stranded in Toronto in 1892, while on a pleasure tour, by the sudden death and bankruptcy of his father. For the next 20 years he led the life of a hobo in the American and Canadian west. In 1912 he became a schoolteacher in Manitoba. where he lived until 1929. In that year he moved to Ontario, first to Ottawa and then to Simcoe. where he owned a farm and wrote his later novels. He died at Simcoe on Aug. 19. 1948. Soon after his arrival in Canada, Grove began to write his realistic novels of prairie life, but they remained in manuscript for a generation. It was not until 1922 that he found a publisher for his first book. *Over Prairie Trails,* a series of descriptive and narrative sketches. A similar book, *The Turn of the Year,* appeared in 1923. His first novel, *Settlers of the Marsh,* when it finally was published in 1925, caused a sensation by its frankness and realism. He subsequently published seven more novels, of which the best known are *A Search for America* (1927), *Our Daily Bread* (1928) and *The Yoke of Life* (1930); a book of essays, *It Needs to Be Said* (1929); and his autobiography. *In Search of Myself* (1946).

Grove's novels are somewhat stiff in style and clumsy in construction, but they live by virtue of the honesty of his vision. His pictures of prairie life (often bleak and sombre) bring out the rugged perseverance of the pioneers and have great documentary value.

See D. Pacey, *Frederick Philip Grove* (1945), *Creative Writing in Canada* (1952). (D. P.)

GROVE, SIR GEORGE (1820–1900), English writer on music, was born at Clapham on Aug. 13, 1820. In 1849 he became secretary to the Society of Arts. and in 1852 to the Crystal palace. In this capacity he threw all the weight of his influence into the task of promoting the best music of all schools in connection with the weekly and daily concerts at Sydenham, which had a long and honourable career under the direction of August Manns. Without Sir George Grove that eminent conductor would hardly have succeeded in doing what he did to encourage young composers and to educate the British public in music. Grove's analyses of the Beethoven symphonies, and the other works presented at the concerts, set the pattern of nhat such things should be; and it was as a result of these, and of the fact that he was editor of *Macmillan's Magazine* from 1868 to 1883, that the scheme of his famous *Dictionary of Music and Musicians,* published from 1878 to 1889 (2nd edition, edited by J. A. Fuller Maitland. 1904–07; 3rd ed., 1927 and 4th with supplement, 1940, both edited by H. C. Colles [1879–1943]), was conceived and executed. When the Royal College of Music was founded in 1882 he was appointed its first director, receiving knighthood. He died at Sydenham May 28, 1900

See C. L. Graves, *Life and Letters of Sir George Grove* (1904).

GROVE does not appear in any other Teutonic language, and the *New English Dictionary* can refer it to no Indo-European root; Skeat connects it with "grave," to cut, and makes the original meaning a glade cut through a wood, a small group of trees smaller than a wood. groning naturally or planted in particular shapes in a park, etc. Groves have been connected with religious worship from the earliest times. (*See* TREE CULTS.)

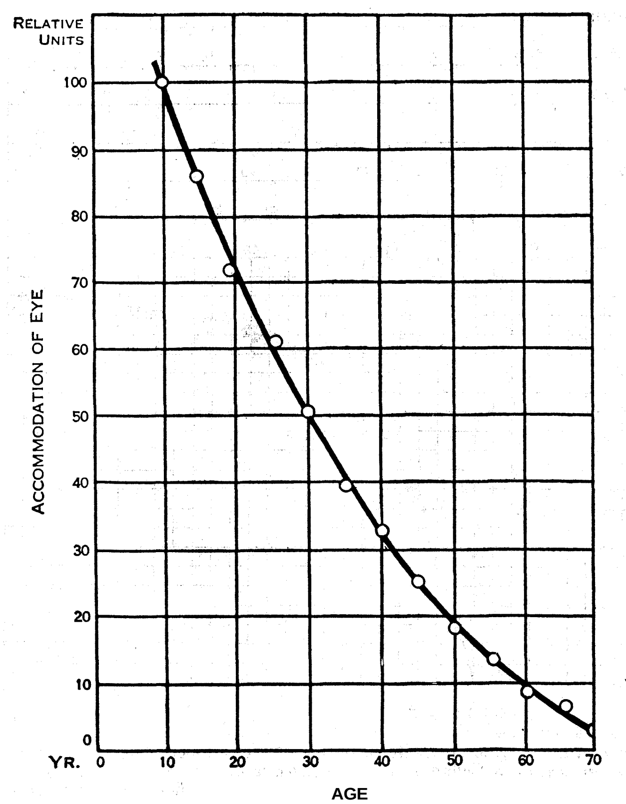
"Grove" mas used by the authors of the Authorized Version to translate two Hebrew words: (1) *'ēshel,* Gen. xxi. 33, 1 Sam. xxii, 6, rightly given in the Revised Version as "Tamarisk"; (2) *asherah* in many places in the Old Testament. The *asherah,* a wooden post erected at the Canaanitish places of worship, and by the altars of Yahweh, may have represented a tree.

GROWTH. Scope **and** Interrelations of the Growth Phenomenon. — There are many different yet closely interrelated categories of growth, including growth of individuals and growth of populations, growth of animals and growth of plants, growth of unicellular organisms and growth of multicellular organisms, growth by cell division into the same and into different kinds of cells and growth by cell enlargement.

The phenomenon of growth is basic and very complex; therefore, it is investigated by, and is of great interest to, many

Fig. 1. — (A) The rapid decline in range of accommodation of vision at age 10 years substantiates Minot's theory that the aging rate is most rapid in the earliest years. The lens continues growth but at a declining rate with consequent decline in the relative amount of young tissue with increasing age. (B) Duration of life is directly proportional to the length of time to reach mature sire; or inversely proportional to the speed of maturation (k in equation 2)

FROM BRODY, "BIOENERGETICS AND GROWTH" (REINHOLD PUBLISHING CORP., 1945)



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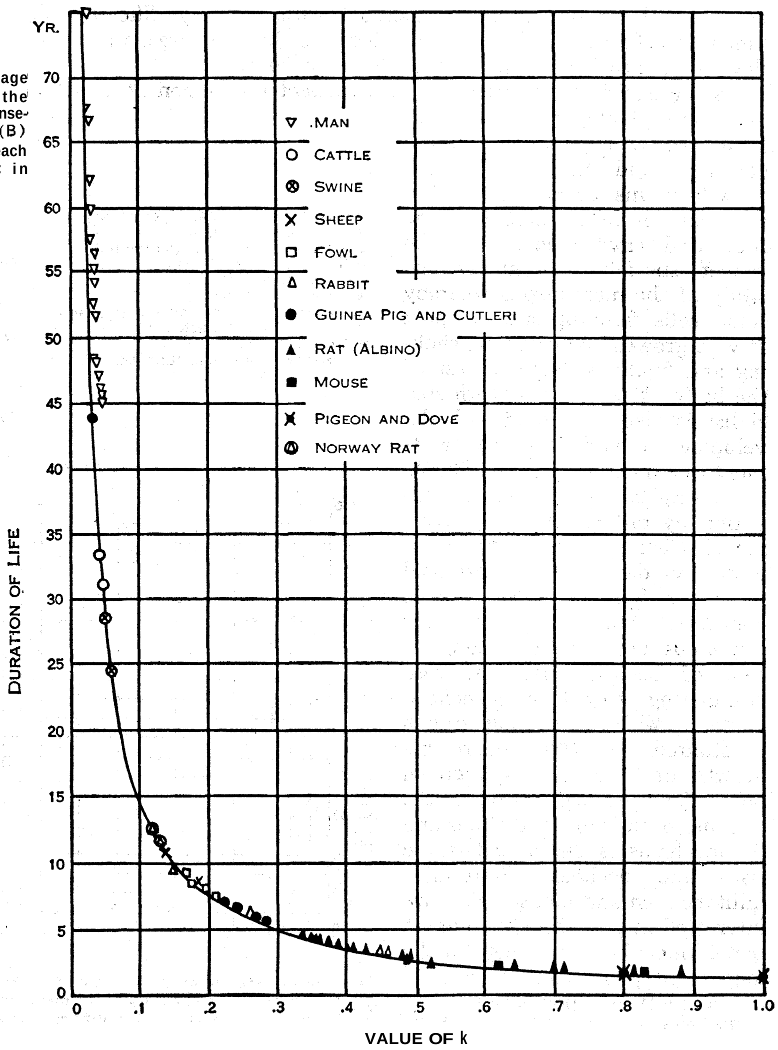

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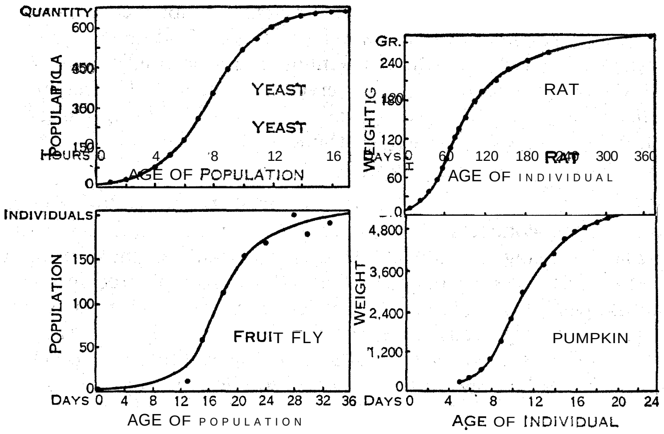

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Fig. 2. — The growth curves of individuals and populations (including human populations) are similar in design. indeed, they can be made to coincide for most of the curve. All growth curves consist of a segment of increasing slope in early growth and a segment of decreasing slope in late growth, joined together at puberty in animals, flowering in plants and "coming of age" in populations

specialists. For instance, embryologists specialize in the study of the embryonic period of growth, and investigate the mechanisms that make the embryo grow as it does, and how to modify it. Cytologists and histologists study the structure and function of individual cells in growth, how growth occurs by cell division, cell enlargement, differentiation and so on. hlorphologists are concerned with problems of organization, with the way different kinds of cells are produced, assembled into different organs and developed into bodies of different shape or form.

To the agriculturist, growth means efficient production of animals and plants to be used for food, shelter and work. To the educator and home economist, growth means promoting healthy development of children by good food and environment. To the cancer specialist, it means the study of the mechanisms whereby some cells flare up into a spurt of wild growth, overrunning, choking and finally killing the rest of the body. The cancer-growth specialist is also concerned with developing methods for the treatment of cancerous growth: Should it be surgical extirpation? Inactivation by radium or X-ray treatment? Changing the body chemistry by dietary and hormonal methods? The physician may be concerned with suppression of cancerous growths, with suppression of harmful bacteria, with stimulating growth of beneficial bacteria, with stimulating growth of stunted children or depressing growth of overfat or overgrown ones. The ecologist studies the rise and decline of populations and the mechanisms that actuate these rises and declines. Statesmen, military men and industrialists are interested in growth of the human population because they make long-range plans on the basis of predicted future population.

To the nutritionist, growth is a nutritional and metabolic process, and he analyzes foods and their fate and functions in the body, searches for unknown nutrients and investigates the influence of each nutrient individually and collectively on growth and metabolism. The endocrinologist likewise investigates the influence of hormones, individually and collectively, on metabolism and growth. The gerontologist views growth as the path to old age and to death, and death as the endpoint of all the antecedent events.

The student of reproduction and evolution views growth and maturation as preludes to reproduction, and reproduction as an evolutionary mechanism for replacing the aging and dying with new and possibly better individuals; for maintaining the social body young and crisp in spite of the aging and dying of its constituent members (*see* POPULATION ECOLOGY). Thus viewed, evolution is growth of the species (*see* EVOLUTION, ORGANIC) by a succession of growing, aging, reproducing, struggling, dying organisms, often overtaken by some catastrophe, analogous to the contemplated effects of atomic-bomb warfare.

The frequency of such evolutionary catastrophes to species is demonstrated by the fact that of the 8,000 species of mammals that have been known to exist, about 4,000 have become extinct, often at the peak of their evolutionary glory, such as the extinction of the sabre-toothed tiger after it developed the most perfect sabre teeth, the extinction of the mastodon and mammoth after they developed the largest body size. These evolutionary illustrations on how success in evolution may lead to eventual failure suggest the idea that an important characteristic of many biological processes, including growth, is that success tends to develop the seeds of failure. Everything, including growth, seems pregnant with its contrary. For instance, growth develops a condition which may first retard growth in accordance with the law of diminishing returns, then finally stops it.

Growth is a transformation of one form of energy and matter into another. Living things are by definition transformers of

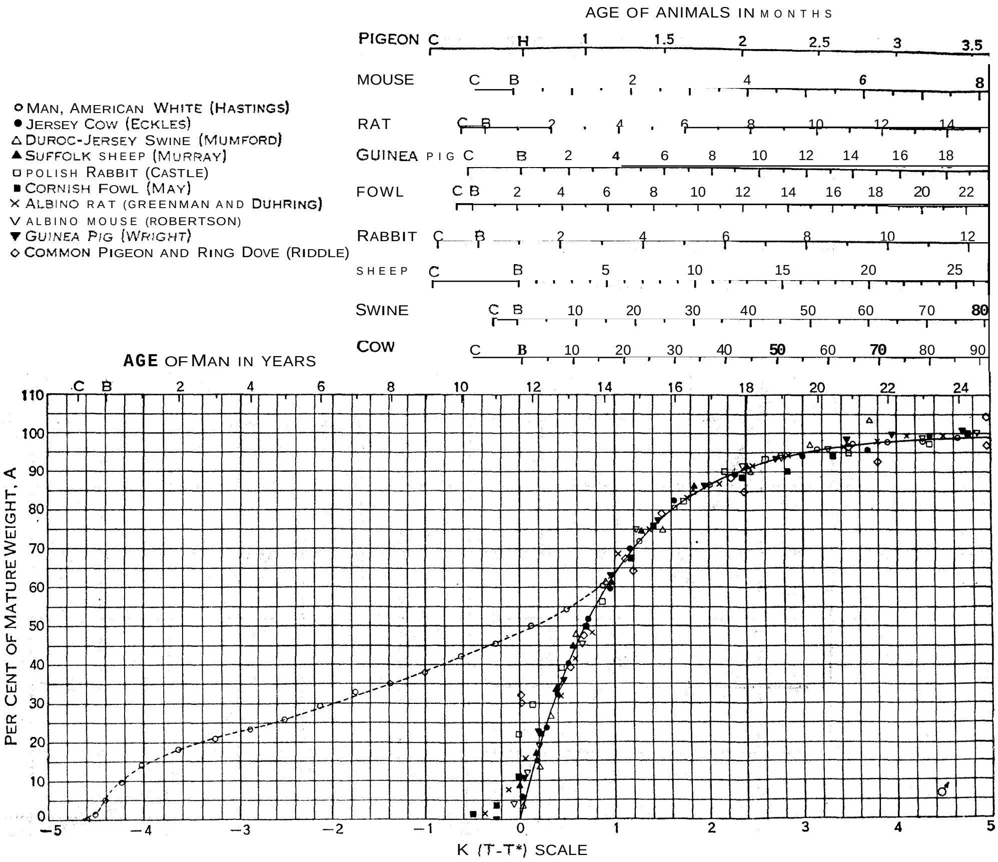

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Fig. 3. — With the exception of man, the growth curves of all species investigated are so much alike that they can be made to coincide. Man differs from other species in having a very long juvenile period (ages 3 to 13 years). In other species the termination of weaning almost coincides with sexual maturity, so they have little or no juvenile period

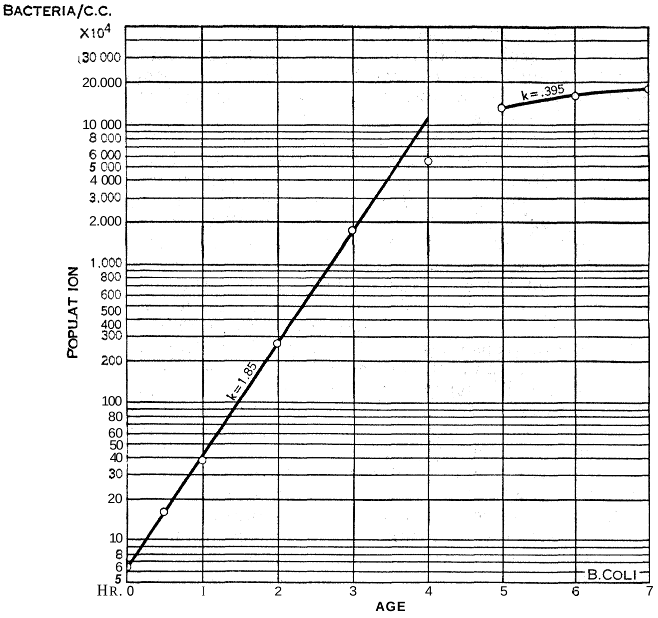

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Fig. 4.—The growth curve of a bacterial population plotted on arithlog paper. The data for 3 hours are distributed about a straight line, indicating that growth during this time is exponential, or in geometric progression, or at compound interest rate; at the instantaneous rate or 185% per hour, the population is doubled in size every 0.4 hour. The inflection in the curve at 4 hours coincides with food limitation

energy and matter. Green and related coloured plants appropriate energy from the sun and matter from the air and soil, transforming the energy and matter into the energy-matter of plant tissue (*see* PHOTOCHEMISTRY); animals appropriate the energy-matter synthesized by the plant (or feed on animals that consumed plants), The student of transformation of energy and matter in living things investigates the expenses associated with growth processes, and with the division of the energy expenses between the cost of maintenance of the formed organisms and the cost of work of growth—the work or energy cost of transforming the energy in the form of light to the energy in the form of plant tissue, and the work of transforming the food energy that the animal eats into the tissue energy of the animal body (*see* NUTRITION). In brief. he is concerned with the efficiency of the growth process.

Growth is most spectacular in early embryonic life; one contemplates with amazement how a minute protoplasmic disc, as on the yolk of a bird's egg develops, for example, into a respectable chick within 21 days, containing billions of cells grouped into many different organs ranging from deeply sensitive brain and nerve to inert feathers (see VERTEBRATE EMBRYOLOGY). A reproductive cell of similar microscopic size—about 1/10 of one millimetre (1/250 in.) in diameter—may develop into whale, mouse or man, depending on its constitution; an egg of a given species may develop normally, or sometimes into a helpless monster (*q.v.*), often depending on the diet supplied to the mother. The potentialities of the tiny reproductive cells (*see* REPRODUCTION) are relatively much greater than of the tiny atomic bomb which now grips the world in terrified fascination. Indeed, the potentialities of the bomb were developed by the potentialities of the human egg.

Growth and Aging.—Growth is not confined to early life; on the contrary, it lasts as long as life. Life is growth, constant renewal. R. Schoenheimer and associates, employing isotopes of hydrogen and nitrogen as tracers, demonstrated about 1940 that living tissue—protoplasm (*q.v.*)—is forever exchanging some of its "building stones," such as amino acids. and taking in others from the food. The breaking-down or giving-up phase of life is *catabolism;* the building-up phase is *anabolism;* the combination of the two is *metabolism.* In early life, anabolism (growth) is predominant; in late life anabolism is recessive; aging is decrease in anabolism. There is perpetual renewal of the body, but at an ever decreasing rate, so that the proportion of young tissue in it declines with increasing age. The metabolic, especially anabolic, decline with advancing age is associated with the tendency for a deteriorating hardening of the vital structures.

In 1889 C. S. Minot suggested that "retardation of growth is old age and its cessation is death." Decline in growth—in renewal of body cells—in anabolism, leads to aging, to growing old, probably because the body tissues are colloids; and, like other colloids, they undergo with increasing time progressive dehydration, reduction in chemical reactivity and elasticity, that is, they increase in hardness. The loss of elasticity is reflected on the body surface by the appearance and feel of the skin and by the inability oi the eye to accommodate itself to near or far vision, necessitating the use of "reading glasses" by age 40 in the farsighted. The loss of elasticity of the eye, with increasing age, has been measured irom the age of ten years onward as shown in fig. 1a. The loss oi elasticity within the body is reflected by hardening of the arteries and related vital tissues! with consequent increasing frequency of death from heart and kidney failure. The aging rate is, as a rule, directly proportional to the maturation rate; that is, the sooner the cells "cease" multiplying, the sooner they get old (fig. 1b). The masimal duration oi liie is about five times the period taken to reach iull body size. For instance, the maximal duration of human life is about 100 years, which is about five times the period taken to reach iull body weight and height. There are, of course, individual and species variations in this respect.

The nutritional relation between the rate of growth and the rate of aging, as measured by masimal longevity, was demonstrated by C. M. McCay and L. A. Maynard. They reported in 1941 that the maximum duration oi life in their rapidly maturing (richly-fed) male rats was 896 days and in their slowly maturing (underfed or starved) rats 1,02j days; in the rapidly maturing female rats 985 days and in the slowly maturing ones 1,320 days. These results do not imply that starvation of the young is desirable, because underfeeding also involves serious hazards; it does imply that the overieedine, leading to excessively rapid growth or fatness, is not desirable. Insurance companies are well aware of the lower expectation of life in overied adults. But, even in the young, excessive plumpness that mothers love so much in their children is not necessarily an indication of good nutrition.

Metamorphosis.—Growth continues from the time of conception

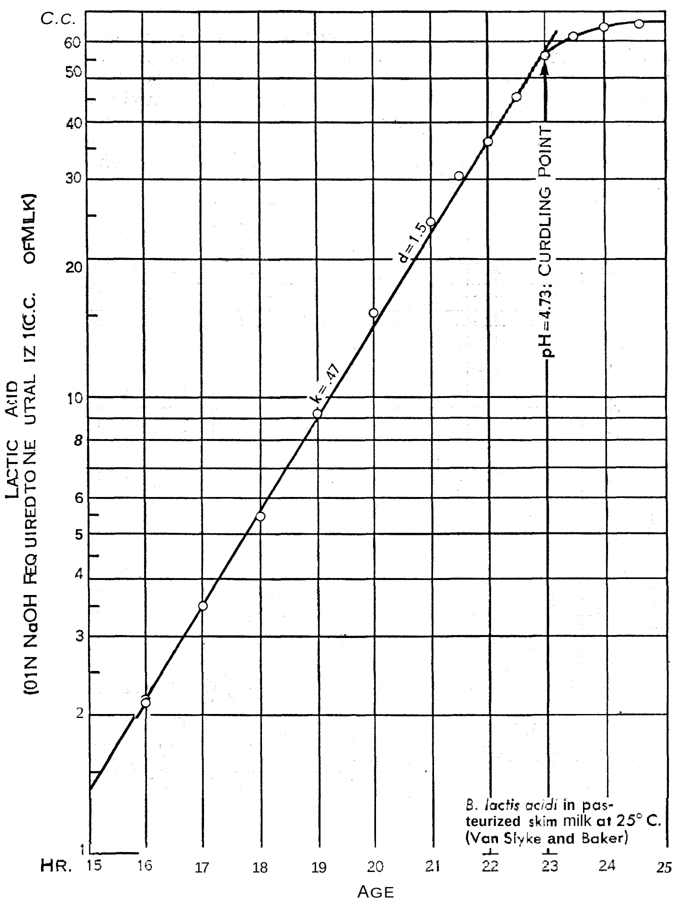

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Fig. 5.—Increase in lactic-acid level in milk associated with the growth of milk-souring bacteria. Up to 23 hours growth occurred exponentially at 47% per hour, doubling its size every 1.5 hours. At 23 hours the accumulated acid curdled the milk and stopped the exponential type of growth

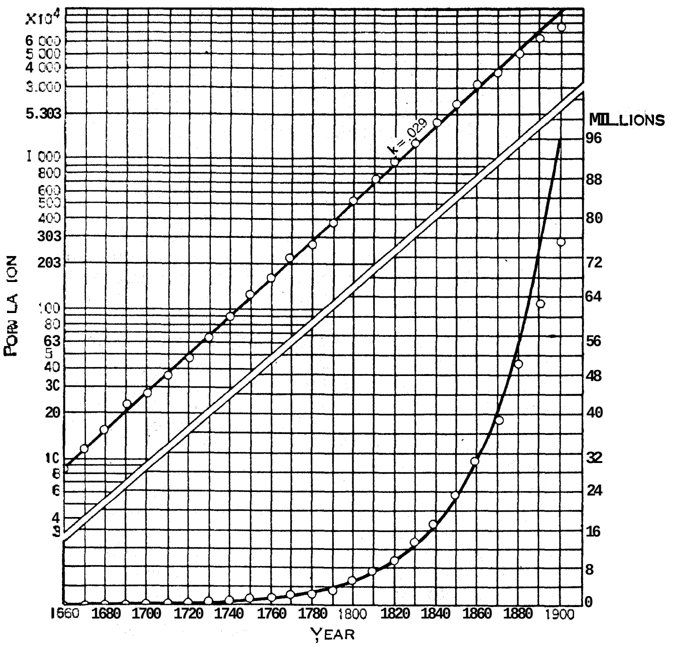

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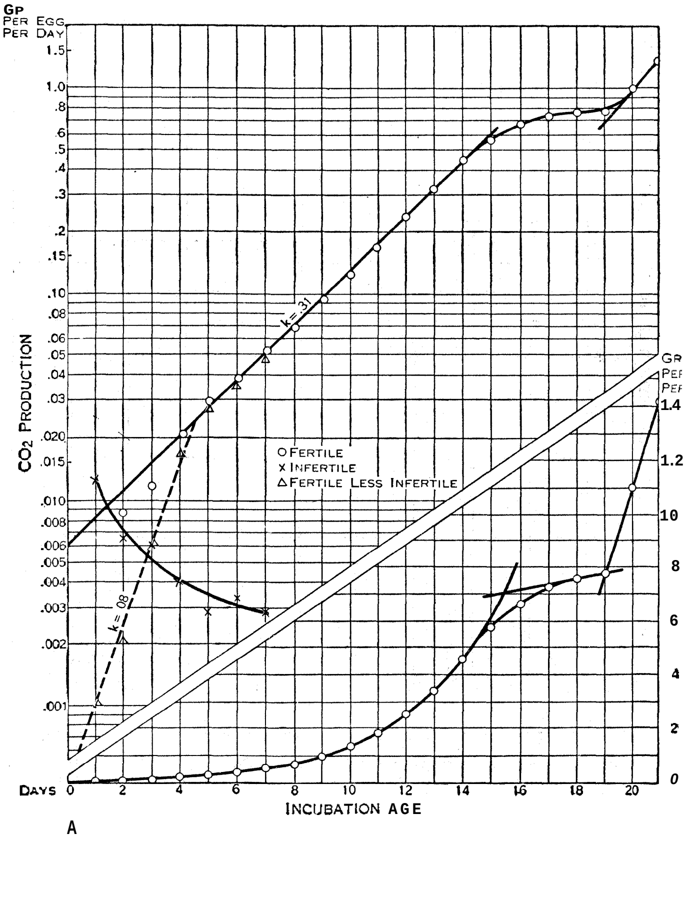
Fig. 6.—The growth curve of the human population in the North American colonies and in the United States. The distribution of the data about a straight line of slope 0.029 indicates that the human population increased in geometric progression between 1660 and 1880 at the instantaneous compound interest rate of 2.9% per year, or doubled every 24 years. By 1880 the data points began to fall off from the straight line. The population "came of age" in 1880, and its present growth rate is rapidly declining in accordance with the sigmoid shape in Fig. 2. (The population increase in the United States was 17,000,000 during 1920-30, and only 8,000,000 during 1930-40)

to death. But, within this general continuity, there are many discontinuities. Individual organisms, and frequently populations of organisms. pass through metamorphosis-like critical periods. For instance, birth, the emergence into the outside world is an obvious shock, a critical period which many fail to survive; puberty, the advent of the reproductive function with its associated personality changes, is another obviously critical period. Prenatal growth curves show breaks



which may reflect similarly critical periods (see figs. 7 and 8). But the most dramatic critical periods are observed among insects when, for instance, the grub is transformed into a butterfly; and in amphibians, when the tadpole is transiormed into a frog. Such changes are called *metamorphosis*. Growth is, then, a continuous process but containing many discontinuities.

Regeneration.— It is possible to introduce critical growth periods or induce special kinds of growth experimentally. For instance, on removing a tadpole's tail, a new tail will grow out, in every way similar to the one removed. This is called regeneration. Regeneration occurs even if the animal is not supplied with food, when the tail grows at the expense of the building materials in the other parts of the body. The healing of wounds and recovery from starvation are other examples of regeneration. Some parts of the body, such as the outer layers of skin and the blood cells, die continuously and are made good by regenerative processes. Similar regenerative processes probably occur in other parts of the body, as illustrated by the results of Schoenheimer already noted. Growth (and life in general) is like a stream with rapidly changing water but fairly stable patterns of banks and whirlpools.

Definitions.— Growth is biological synthesis of living tissue, or protoplasm. Growth may be by cell enlargement (such as growth of nerve and muscle fibres), but it is mostly by cell division. Development is growth co-ordinated toward the production of the complete organism. Growth of tissue *in* vitro, of cancer, of teratomata, is without directive significance outside of self-multiplication; growth of an embryo is directive, developmental in the production of an organism in accordance with a predetermined design. The cells in a healthy embryo do not merely increase in number as cancer cells do, but they differentiate into different kinds of cells (liver cells, brain cells, etc.) forming different organs (liver, brain, etc.), and such differentiation occurs in an orderly fashion so as to produce a normal harmonious adult. The successive cleavages of the mother cells into the different kinds of daughter cells is differentiation, and the grouping of the cells into organs is *morphogenesis* and *organogenesis*. (See also DEVELOPMENT, ANIMAL.)

Anticipatory and Organismic Aspects.— One distinguishing feature characterizing normal developmental growth is its "purposiveness," "anticipation" of future needs not only of the individual but also of the species. For instance, the production and expulsion of the polar bodies by the egg prior to fertilization occurs as if it anticipated and prepared itself especially for the reception of the sperm to form the zygote (the first body cell which carries hereditary determiners or genes of both parents). A related example is that the plan for the development of the reproductive system is laid out anticipatingly in very early life, long before it is called upon to function reproductively in the evolutionary interest of the species; another example is that the mammary gland is developed in anticipation of the possible birth of an infant long before the occurrence of the anticipated event which may never occur.

There is no physical explanation for this anticipatory, apparently purposive or teleological, behaviour in growth and development. One may perhaps view the living system in somewhat the same light as a physicist views an electromagnetic field. Just as the "field" in physics is conceived to be a physical (*i.e.,* electromagnetic) integrative process, so the growth field in biology may be considered to be an integrative biological process, binding many components into a harmonious whole to achieve or to maintain a certain desirable state. For instance, disturbing a tadpole by removing its tail leads to the replacement of the lost tail by an almost identical new one, thus restoring the disturbed "field." Many types of healing, *i.e.,* restoration of the integrity of the field, occur so rapidly that they are unnoticed. Growth of a whole

Fig. 7.— (A) Prenatal growth of the chick on arithlog paper (upper part) and on arithmetic paper (lower part) as measured by metabolism (CO_2 production). The two segments represent growth at 98% and 31% per day, and the breaks at 5 and 15 days represent metamorphosis-like critical period as indicated by Fig. 9. (B) The changes in modes of respiration at 5 and 15 days are associated with mortality peaks. At 5 days there is a change in ability to oxidize lactio acid and at 15 days a change in mode of respiration

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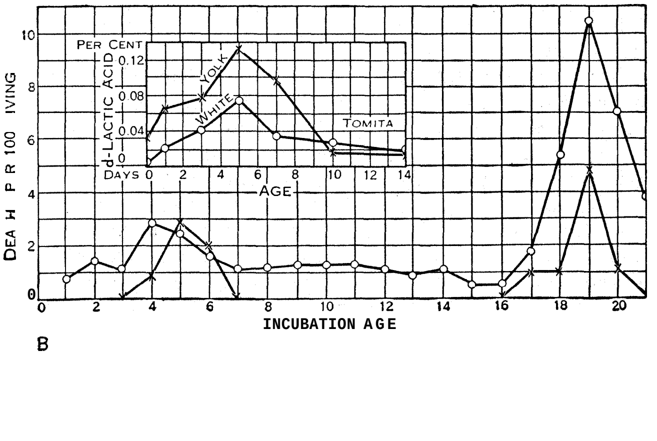

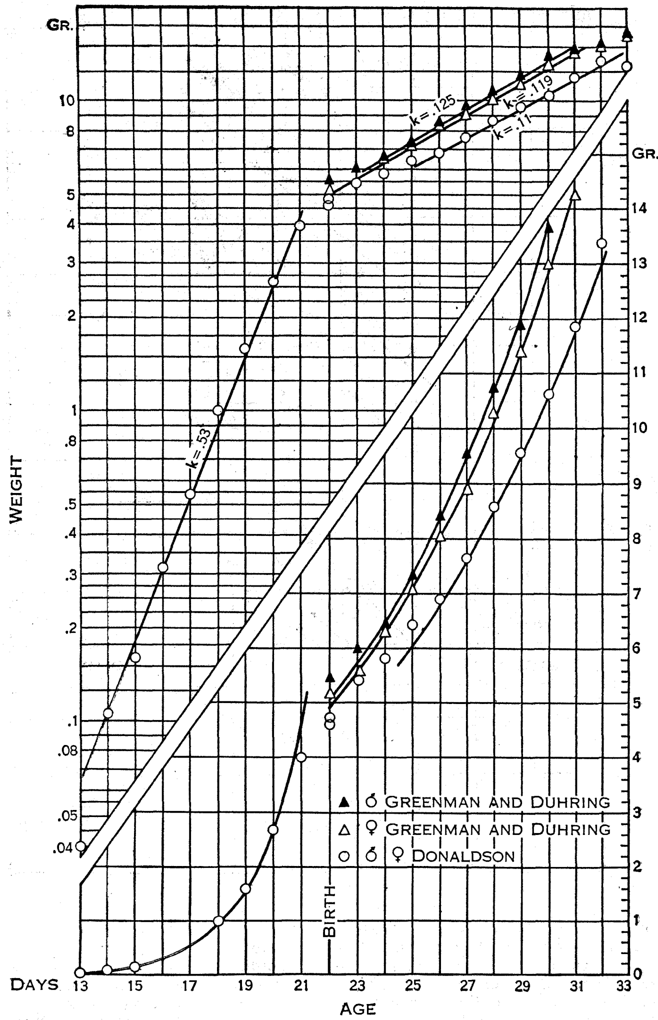

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Fig. 8.—Early growth of the rat plotted on arithlog paper (upper curves) and arithmetic paper (lower curves). From 13 days after conception to 21 days (birth) growth is in geometric progression at 53% per day. There is a break at birth followed by 10 days of growth in geometric progression at about 11% per day

organism, like the regeneration of a tadpole's tail, proceeds as if the "normal" condition were that represented by the mature state. One may then say that the growth process is controlled by a powerful biological organismal "field."

The Shape of the Age Curve of Growth and its Mathematical Representation.— Perhaps unexpected is the fact that, as shown in fig. 2, the general shape of the time curve oi growth in volume, weight or population number (see POPULATION ECOLOGY), is virtually identical for the growth of individual animals and plants, and of populations of animals or plants. On second thought, the similarity between growth curves of multicellular individuals and populations is not surprising since ultimately both are collections of reproducing individuals. Reproducing cells make up the body of gro ing individuals and these individuals, in turn, make up the body of growing populations.

Fig. 2 shows that the age curve of growth may be divided into two principal segments, the first of increasing slope, designated *self-accelerating phase;* the second of decreasing slope, designated *self-inhibiting phase.* The shape of the curve may accordingly be said to be moulded by two opposing iorces, *growth-accelerating* and *growth-retarding.*

The growth-accelerating force maniiests itself, in the early history of the individual or population prior to the development of growth-restricting iorces in the environment, by the tendency of the reproducing units to reproduce exponentially, that is, at a constant *percentage* rate in a *geometric progression, i.e.,* one reproducing unit, such as a bacterium, divides into two bacteria, 2 to 4, 4 to 8, 8 to 16, 16 to 32, etc. This may the population is doubled at constant time intervals, and the number of new units is always proportional to the number of reproducing units, to the growth already made. Money invested at compound interest is also doubled at constant time intervals. Early increase in the size of a body or a population is like that of capital invested at compound interest. The equation

$$S=Ae^{kt} \qquad (1)$$

represents the course of such growth, in which S is the size of the body or population at age or time *t*, and rook is the percentage growth rate, assuming that the compounding is done not annually or quarterly but every instant. Such instantaneous compounding is added up for a conventional unit of time such as hour, day, year, and *rook* is, then, the *instantaneous* compound interest rate of growth per finite time unit.

It is evident, however, that growth at compound interest—that is, in the sequence 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, etc.—can not last very long either in financial or biological processes. Sooner or later sufficiently powerful restrictive iorces must develop in the internal or external environment to prevent such exponential growth because of the sheer limitation of the universe for population growth; and ior individual growth because of clogging of the transportation systems for nutrients and wastes, through progressive decline in relative surface areas with increasing size, with accumulation of inert tissue and progressive dehydration and decline in permeability. Sooner or later growth must change its course from being proportional to the growth already made, or to capital already accumulated, to being proportional to growth yet to be made, or to the available space and other resources required for growth. Here the environmental limitations or growth-inhibiting forces exert the limiting repressive influence on growth rate. The precise factors limiting growth will be presently noted.

Now just as in early life, during the self-accelerating phase of growth, the percentage growth rate is directly proportional to the growth already made, so in late life, during the seli-inhibiting phase of growth, the percentage gronth rate is directly proportional to the growth yet ta be made to reach the mature size. The course of such growth is represented by the equation

$$S=A-e^{-kt} \qquad (2)$$

in which *S* is the size at age or time *t* and *rook* is the instantaneous percentage growth rate with respect to the growth yet to be made to reach mature size *A*.

The junction or "major inflection" between the seli-accelerating phase of growth represented by equation (1) and of the seli-inhibiting phase represented by equation (2) occurs during puberty in animals, flowering (or equivalent stage) in plants, and "coming of age" in populations. The whole curve, as shown in fig. 2, thus has a sigmoid or s-like shape. The junction between the segments of increasing and decreasing slope, called the *major inflection,* reflects the development of a limiting critical situation in the internal environment of multicellular organisms or in the external environment oi populations.

The fact that the major segments of the growth curve may be represented by the simple equations (1) and (2) above does not mean that growth is a simple process; just as a simple statement by an accountant of a manufacturing concern does not imply that the manufacturing process is simple.

Fig. 3 demonstrates the similarity of shape between the age curves of different animal species. The human age curve differs from the others in having a very long juvenile period, a long interval between weaning and puberty (approximately from 3 to 13 years); this period is absent in laboratory and iarm animals. In these animals, weaning merges into puberty without the intervention of the juvenile phase found in man. The uniquely long juvenile period in man is oi great interest to students of evolution and education because, as John Fiske remarked in 1883, "If there is any one thing in which the human race is signally distinguished from other mammals, it is the enormous duration of their infancy . . . a period of plasticity . . . a door through which the capacity for progress can enter . . . power to modify . . . inherited tendencies."

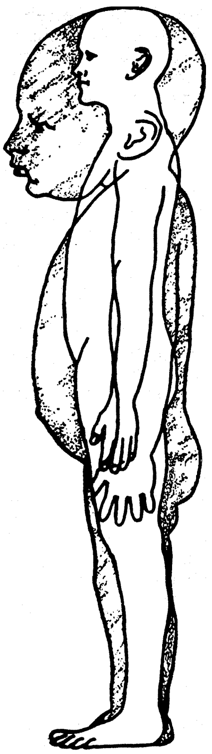
Curves of Early Growth of Populations and Multicellular Individuals.— Fig. 2 illustrates the general shape oi the entire growth curve as plotted on arithmetically divided paper. Fig. 4 shows early growth of a bacterial population as plotted on arithlog paper (horizontal axis is divided arithmetically, in the arithmetic progression 1, 2, 3, 4, etc., and the vertical axis is divided logarithmically, in the geometric progression 1, 2, 4, 8, 16, 32, etc.). Growth at compound interest (in geometric progression, according to equation 1) plots linearly about a straight line on arithlog paper. Fig. 4 shows that the early growth of a population of bacteria plots a straight line on arithlog paper. The slope of the line is 1.85, meaning that during the three hours in which growth proceeds in geometric progression, the population increases at the instantaneous rate of 185% per hour or that it was doubled every 0.4 hour. The break at 4 hours reflects the intrusion of a critical factor, which was a growth-limiting decline in the food supply, as demonstrated by adding food whereupon the preceding growth rate was resumed.

Milk-souring bacteria obtain their energy by transforming lactose (milk sugar) into lactic acid, and the rate of lactic acid accumulation is a good indication of the rate of growth of the bacterial population. Fig. 5 shows linear distribution of data for lactic acid accumulation for a period of 23 hours. The value of the slope (*k* in equation 1) is 0.47, meaning that during the 23 hours the lactic acid accumulated at the instantaneous compound interest rate of 47% per hour, or that the lactic acid level was doubled every 1.5 hours. The break in the curve at 23 hours indicates the development of a growth-inhibiting factor in the environment. On adding lime water to neutralize the accumulated lactic acid, the former growth rate was resumed, demonstrating that in this case the lactic acid was the growth-inhibiting factor.

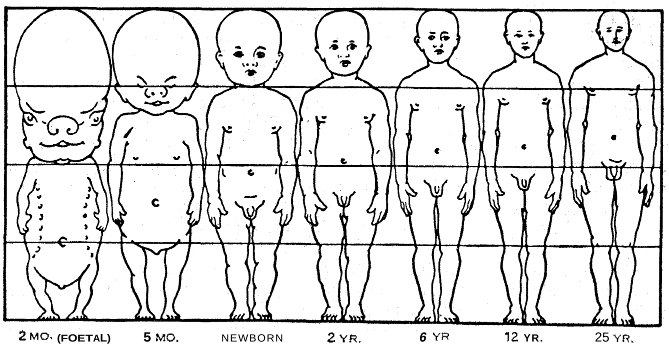
The reader may be surprised, perhaps shocked, to learn that, arithmetically speaking, human populations grow in accord with the same fashion, or "law" of growth, as bacterial populations. Fig. 6 shows that the human population, in what is now the United States, increased for a period of over two centuries, from 1660 to 1880, at the instantaneous constant percentage rate of 2.99% per year.

Whereas the bacterial population in fig. 4 was doubled every 0.4 hours, the human population was doubled every 24 years (fig. 6). Incidentally, about 1798 T. R. Malthus published a book which became famous for its pessimistic outlook for the future of man because of the discrepancy between the reproductive drive and capacity on one hand and the limited available land for food production on the other. Since the human population tends to be doubled every 25 years while the food supply tends to remain constant, eventual famine is inevitable. His statement about the doubling rate of population appears correct from fig. 6; but this holds only for the early history oi the population. Fig 6 shows the development of a deviaticn from the straight line by 1880.

This deviation about 1880 coincides with the end of the "free frontier land" era in the United States, with consequent gradual shiiting of the population from the farm (where wife and children are assets) to the city (where wife and children are liabilities) with consequent dampening of the child-bearing urge; it coincides with the increasing educational standards, with consequent delay in marriage; it coincides with the increasing wants for automobiles and other gadgets, with consequent delay in childbearing. Delay in childbearing means decline in population growth, not only by reducing the reproductive period but also because, as shown by R. Pearl in 1939, fertility in women declines following age about 20 pears. Since man is governed in his reproductive behaviour, as in other activities, by man-made psychological factors, such as traditions, more than by intrinsic biological drives, an explanation for one community may not hold for another. Nevertheless, in spite of the man-made fashions and sentiments in reproductive behaviour, the general shape of the curve of population growth of man is virtually identical with that of bacteria, or with any other species investigated.



What was said about the shape of early growth curves of populations holds for individual multicellular organisms because, after all, multicellular animals are, ultimately, a collection of reproductive individuals (cells), and the general growth curve of the body of individual multicellular animals may be fashioned by the same basic factors as of populations. There is, however, one exception: the curves of individual multicellular organisms show breaks (figs. 7 and 8) associated with metamorphosis as previously explained. The "break" in the growth curve of the chick (fig. 7a) at 15 days is undoubtedly associated with a change in the respiration function, which is then transferred from the chorioallantoic membrane to the lungs; the chick is metamorphosed irom an aquatic to a terrestrial mode of respiration. The break at 5 days also appears to be caused by some change in oxygen utilization because there is a lactic-acid peak at 5 days. Mortality peaks at 5 and 19 days (fig. 7b) substantiate the idea that these periods represent metamorphosis-like transitions.



FROM BRODY, "BIOENERGETICS AND GROWTH" (REINHOLD PUBLISHING CORP., 1945)

Fig. 9.—Change in form with increasing age. Note the relative size of head in infant and adult

Relative Growth of Part to Whole.—Figs. 9 and 10 show that the form of animals changes with increasing size, that different parts grow at different rates. For instance, the head matures first and the muscles last. The terms *allometry*, or *heterogony*, and *relative* growth have been recently coined to represent such change.

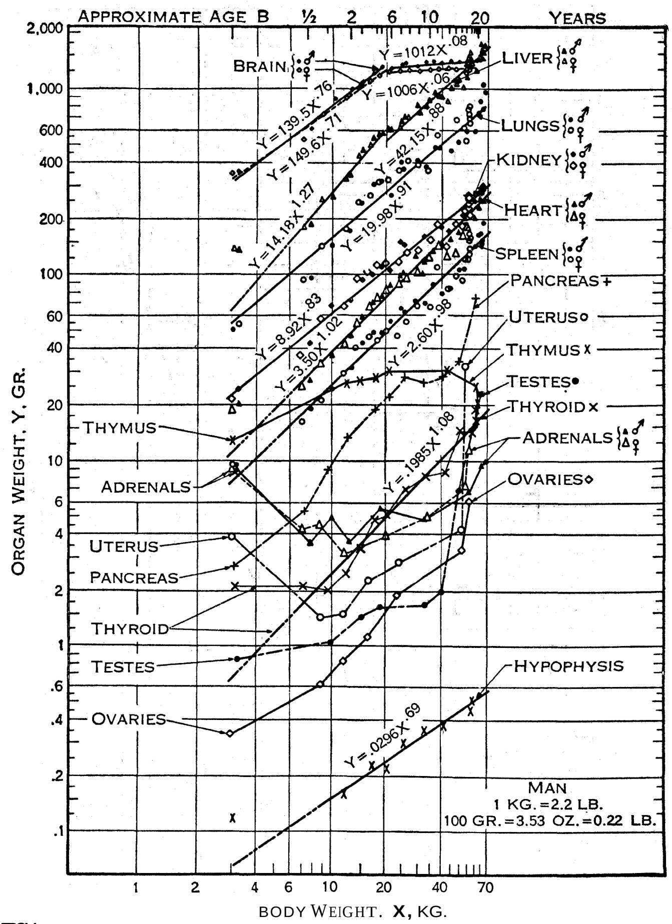


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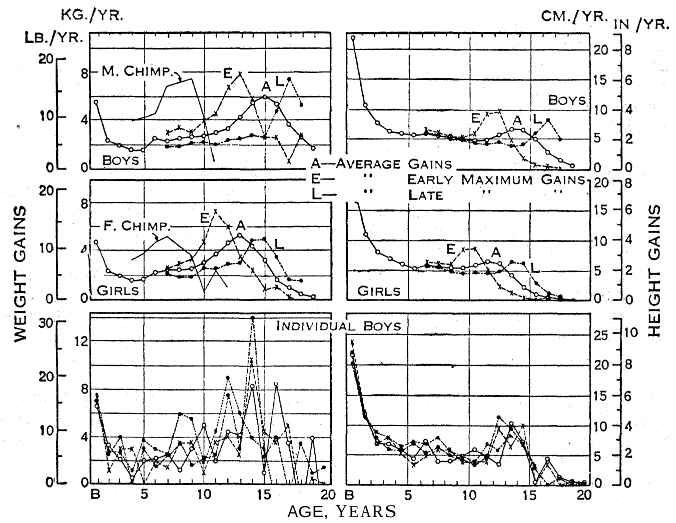
Fig. 10.—Relation of organ weight to body weight during growth in man; plotted on paper divided logarithmically according to equation (3) in the text. When the exponent is unity, the organs and total body grow at the same relative rates; when the exponent is less than unity, the organs grow at a lower rate; and if greater than unity, the organs grow at a higher rate than the whole body

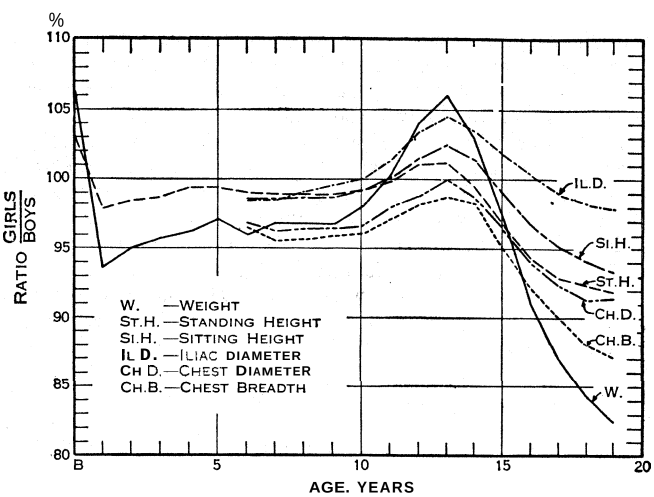
The relative-growth equation is the parabola

$$Y = aX^k \tag{3}$$



FROM BRODY, "BIOENERGETICS AND GROWTH" (REINHOLD PUBLISHING CORP., 1945)

Fig. 11.—Annual gains in weight and in height of children. The lower third represents individual boys; the centre third girls, "early maturing" (E), "late maturing" (L) and average (A) of all. "M. Chimp" represents gains in a male chimpanzee. The growth spurt at 12 to 13 years coincides with puberty and may. perhaps, be stimulated by the spurt in functional activity of the endocrine system



FROM BRODY, "BIOENERGETICS AND GROWTH" (REINHOLD PUBLISHING CORP., 1945)

Fig. 12.— There is a decided sex difference in growth during puberty as indicated by the ratio of growth of girls t~ boys, indicating differences in effects of sex hormones on growth

in which Y is the size of one part or function and X of another part or function, or of the whole body. The exponent k is the relative increase in part Y when the increase in the whole or in part X is 1. For instance, basal metabolism (heat production) Y, is related to body weight, X, by the equation $Y = 70.5X^{0.73}$, which indicates that an increase in body weight by 1% is associated with an increase of basal metabolism by 0.73%; or increasing body weight 100% increases basal metabolism 73%; and that the ratio of $Y/X^{0.73}$ is 70.5.

Change in form with increasing body size is a reaction to a developing instability. As a result, the organism changes geometrically (in form) so as to remain the same physiologically (in stability). For instance, the body weight increases with the cube of linear size while the strength of the supporting muscles increases with the square of linear size. Consequently, the body would become unstable unless growth of the supporting muscles is proportionately more rapid than of the body as a whole, and this actually occurs. The muscles become relatively larger while the visceral organs become proportionately smaller with increasing size; the value of the exponent k in equation (3) is, therefore, above unity for the supporting muscles and below unity for the visceral organs and the functions that they support such as metabolism (heat production), milk production, and so on. The value of the exponent k in equation (3) relating visceral organs, surface areas and function to body weight is near 0.7, indicating that increasing bcdy weight by 100% increases the size of such visceral organs as pituitary, kidney, etc., and such functions as basal metabolism and milk yield by about 70%.

Data on Growth.— It is not possible to cite the enormous body of data on growth of different species and races of animals and plants. But there may be space for the data on average growth of children shown in the table and in fig. 11. The data for 6 to 19 years are by F. K. Shuttleworth (1939) and birth to 5 years by B. T. Baldwin (1921). The growth spurt at puberty shown in fig. 11 and the sex difference in the spurt shown in fig. 12 suggests that sex hormones affect growth rate.

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Age years	Weight				*Height*			
	Boys		Girls		Boys		Girls	
	kg.	lb.	kg.	lb.	cm.	in.	cm.	in.
Birth	4.0	8.8	4.2	9.3	52.4	20 6	53.9	21.2
1	9.5	20.9	9.2	20.3	747	29.4	73.2	28.8
2	11.9	26.2	11.4	25.1	85.8	33.8	83.9	33.0
3	14.0	30.9	13.3	29.3	93.7	36.9	92.4	36.4
4	15.9	35.1	15 0	33.1	99 9	39.3	99.9	39.3
5	17.2	37.9	16.5	36.4	106.4	41.9	105.3	41.5
6	1 .	43.6	19 0	42 0	111.5	43.9	110.4	43.5
7	22.2	49.0	21.5	47.4	117.6	46.3	116.3	45.8
8	24.8	54.3	24 0	52.9	123.3	48.5	122.0	48.0
g	27.5	60.7	26.6	58.8	128.8	50.7	127 4	50.2
10	30.3	66 8	29 7	65.4	133 9	52.7	132.8	52.3
11	33.4	73.6	33.5	73 9	138.8	54.6	138.7	54.6
12	36.8	81.2	38 3	84.5	143.8	56.6	145.2	57.2
13	41.2	90.9	43.7	96.3	149.6	58.9	151.4	59.6
14	46.8		48.2	106.4	156.4	61.6	1 jj 6	61.2
15	52.9		51.5	113.6	163.1	64.2	157.8	62.1
16	58.4	128.6	53.2	117.4	168.3	66.3	158.8	62.5
17	62.2	137.1	54.2	119.5	171.3	67.5	159 3	62.7
18	64.9	143.1	54.7	120.7	173.0	68.1	159.6	62.8
19	66.7	146.9	55.0	121.3	173.8	68.4	159.6	62.9

GROYNE, a framed structure of timber or a low wall of masonry or concrete run out over a foreshore into the sea, in a direction approximately at right angles to the coast line, for the purpose of arresting the lateral travel of sand and shingle and thus raising the foreshore level as a barrier against the encroachment of the sea. On the coasts of Holland and Belgium low groynes constructed of fascine mattress-work and rubble stone are commonly employed. Groynes similar in form to those used on sea-shores, and also, in many cases, built up of rubble or fascine work, are employed for training the flow of rivers, protecting their banks from erosion, and deepening their channels. Such groynes are built out over the river banks and bed transversely to the flow of the current and are termed spur-groynes (*see* RIVER AND RIVER ENGINEERING). The word groyne appears to have been used originally to denote any wall run out transversely to the shore. In the United States of America the word is spelt *groin* both in architecture and as applied to seadefense works.

See also BREAKWATER. (N. G. G.)

GROZNY, a city of the Chechen-Ingush A.S.S.R., U.S.S.R., the capital of the former Grozny region of the Russian Soviet Federated Socialist Republic. It is on the Zunzha river in 43° 20' N., 45° 42' E., and is on the railway from Makachkala (Petrovsk) to Orjonikidze (Vladikavkaz).

Its population (1959) was 240,000. The naphtha area to the northwest of the town began to be exploited in 1893 and another area to the southeast in 1913. Grozny has a much higher percentage of natural oil fountains than the Baku region, especially in the new area. Its oil differs in quality from that of Baku, giving less kerosene and more paraffin. It has naphtha and paraffin refineries and electric sawmills.

A pipe line to Tuapse has been constructed to cheapen the cost of export, and another to Poti. The new plant erected in Grozny and in Tuapse has considerably increased production. Grozny and Makachkala are also connected by pipe, and there are refineries in Makachkala.

The administrative offices for the Grozny region were situated in Grozny, and a training college for teachers is also in the town.

GRUDZIADZ (Ger. GRAUDENZ), a town of Poland in Bydgoszcz, on the Vistula. Pop. (1960) 65,000. It possesses three Roman Catholic and two Protestant churches, and a synagogue. It was founded by the Teutonic knights in the 13th century, and came under the rule of Poland by the peace of Thorn in 1466. In 1772 it was seized by Prussia at the first partition of Poland, and was returned to Poland in 1918.

Germany again seized it in the first week of World War II. It was returned to Poland in 1945.

GRUIFORMES, an order of birds, the best-known members of which are the cranes (*q.v.*). (*See* also BIRD; BUSTARD; COOT; FINFOOT; GALLINULE; KAGU; LIMPKIN; MOOR HEN; RAIL; SERIEMA; SUN BITTERN; TRUMPETER.)

GRUMBACH, WILHELM VON (1503–1567), German adventurer, born on June 1, 1503, chiefly known through his connection with the so-called "Grumbach feuds" (*Grumbachsche Händel*), the last attempt of the German knights to destroy the power of the territorial princes. He was attached to the court of Casimir, prince of Bayreuth (d. 1527), and fought against the peasants during the rising in 1524 and 1525. About 1540 Grumbach became associated with Albert Alcibiades, prince of Bayreuth, whom he served both in peace and war. After the conclusion of the peace of Passau in 1552, Grumbach assisted Albert in his career of plunder in Franconia and was thus able to take some revenge upon his enemy, Melchior von Zobel, bishop of Wurzburg. Grumbach held his lands in fief from the bishops of Wurzburg. and had held office at the court of Conrad of Bibra, who was bishop from 1540 to 1544. Albert's career, however, was checked by his defeat at Sievershausen in July 1553 and his subsequent flight into France, and the bishop seized Grumbach's lands. The knight obtained an order of restitution from the imperial court of justice (*Reichskammergericht*), but he was unable to execute it; and in April 1558 some of his partisans seized and killed the bishop. Grumbach fled to France. Returning to Germany he pleaded his cause, unsuccessfully, before the diet at Augsburg in 1559. He had found a new patron in John Frederick, (*q.v.*) duke of Saxony, whose father, John Frederick, had been obliged to surrender the electoral dignity to the Albertine branch of his family. Grumbach suggested to the duke a general rising of the German knights as a means to the recovery of the electorate. Magical charms were employed against the duke's enemies, and communications from angels were invented which helped to stir up the zeal of the people. In 1563 Grumbach attacked Würzburg, seized and plundered the city and compelled the chapter and the bishop to restore his lands. He was consequently placed under the imperial ban, but John Frederick refused to withdraw his protection. Meanwhile Grumbach planned the assassination of the Saxon elector, Augustus; proclamations were issued calling for assistance; and alliances both without and within Germany were concluded. In Nov. 1566 John Frederick was placed under the ban, which had been renewed against Grumbach earlier in the year, and Augustus marched against Gotha. A mutiny led to the capitulation of the town. Grumbach was tortured, and executed at Gotha on April 18, 1567. John Frederick was imprisoned for life.

GRUMENTUM, an ancient town in Lucania, 33 mi S. of Potentia by direct road through Anxia. and 52 mi. by the Via Herculia. at the point of divergence of a road eastward to Heraclea. It seems to have been native Lucanian, not a Greek settlement. In 215 B.C. the Carthaginian general Hanno was defeated under its walls. and in 207 B.C. Hannibal made it his headquarters. In the Social War its strong fortress seems to have been held by both sides at different times. Its site is a ridge on the right bank of the Aciris (Xgri) about 1.960 ft. above sea level, ½ mi. below the modern Saponara, which lies much higher (2,533 ft.). Its ruins (all of the Roman period) include those of its enceinte in *opus reticulatum,* with scanty traces of a large amphitheatre (arena 205 by 197 ft.). the only one in Lucania. except that at Paestum.

GRUN, HANS: *see* BALDUNG, HANS.

GRUNDTVIG, NIKOLAI FREDERIK SEVERIN (1783–1872), Danish poet. statesman and divine, was born at the parsonage of Udby in Zealand on Sept. 8, 1783. At the close of his university life at Copenhagen he made Icelandic his special study, until in 1805 he took the position of tutor in a house on the island of Langeland. The next three years were spent in the study of Shakespeare, Schiller and Fichte. His cousin, the philosopher Henrik Steffens, had returned to Copenhagen in 1802 full of the teaching of Schelling, and his lectures and the early poetry of Öhlenschläger opened the eyes of Grundtvig to the new era in literature. His first work, *On the Songs in the Edda,* attracted no attention. Returning to Copenhagen in 1808 he achieved greater success with his *Northern Mythology,* and again in 1809–11 with a long epic poem, the *Decline of the Heroic Life in the North.*

The boldness of the theological views expressed in his first sermon in 1810 offended the ecclesiastical authorities, and he retired to a country parish as his father's assistant for a while. From 1812 to 1817 he published five or six works, of which the *Rhyme of Roskilde* is the most remarkable. From 1816 to 1819 he was editor of a polemical journal entitled *Dannevirke,* and in 1818 to 1822 appeared his Danish paraphrases (6 vols.) of Saxo Grammaticus and Snorri.

In 1825 he published a pamphlet, *The Church's Reply,* against H. N. Clausen, who was professor of theology in the university of Copenhagen. Grundtvig was publicly prosecuted and fined, and for seven years he was forbidden to preach, years which he spent in publishing a collection of his theological works, in paying two visits to England, and in studying Anglo-Saxon. In 1832 he obtained permission to preach again, and in 1839 he became priest of the church of Vartov hospital, Copenhagen, a post he continued to hold until his death. In 1837–41 he published *Songs for the Danish Church,* a rich collection of sacred poetry; in 1838 he brought out a selection of early Scandinavian verse; in 1840 he edited the Anglo-Saxon poem of the *Phoenix,* with a Danish translation. He visited England a third time in 1843. From 1844 until after the first German war Grundtvig took a prominent part in politics. In 1861 he received the titular rank of bishop.

The chief characteristic of his theology was the substitution of the authority of the "living word" for the apostolic commentaries! and he desired to see each congregation a practically independent community. His patriotism was almost a part of his religion, and he established popular schools where the national poetry and history should form an essential part of the instruction. His followers are known as Grundtvigians. He was married three times, the last time in his 76th year. He died on Sept. 2, 1872.

Grundtvig holds a unique position in the literature of his country; he has been styled the Danish Carlyle. He was above all things a man of action, not an artist; and the formless vehemence of his writings, which have had a great influence over his own countrymen, is hardly agreeable or intelligible to a foreigner. The best of his poetical works were published in a selection (7 vols., 1880–89) by his eldest son, Svend Hersleb Grundtvig (1824–83), who was an authority on Scandinavian antiquities, and made an admirable collection of old Danish poetry (*Danmarks gamle Folkeviser,* 1853–83, 5 vols.; completed in 1891 by A. Olrik).

His correspondence with Ingemann was edited by S. Grundtvig (1882); his correspondence with Christian Molbech by L. Schroder (1888); *see* also F. Winkel Horn, *Grundtvigs Liv og Gjerning* (1883); an article by F. Nielsen in Bricka's *Dansk Biografisk Lexikon;* and F. Gronning, *R.F.S. Gruntvig* (8 vol., 1907–14).

GRUNDY, SYDNEY (1848–1914), English dramatist, was born at Manchester on March 23, 1848, son of Alderman Grundy. He was educated at Owens college, Manchester, and was called to the bar in 1869, practising in Manchester until 1876. He became well known as an adapter of plays, his early successes being *The Snowball* (Strand theatre, 1879) from *Oscar, ou le mari qui trompe sa femme* by MM. Scribe and Duvergne, and *In Honour Bound* (1880) from Scribe's *Une Chaîne.* Among his most successful adaptations was the charming *Pair of Spectacles* (1890) from *Les Petits Oiseaux* of MM. Labiche and Delacour. Grundy died on July 4, 1914.

GRUNDY, MRS., an imaginary English character who typifies the control of the conventional "proprieties" of society over conduct, the tyrannical pressure of the opinion of neighbours on the acts of others. The name first appears in a play by Thomas Morton, *Speed the Plough* (produced in 1798), in which one of the characters, Dame Ashfield, continually refers to what her neighbour Mrs. Grundy will say as the criterion of respectability. Mrs. Grundy does not appear in the play, but is a mythical character similar to Mrs. Harris, Mrs. Gamp's friend, in Dickens' *Martin Chuzzlewit* (1844).

GRÜNEWALD, MATHIAS (*c.* 1460–1528), the painter so named by J. von Sandrart in his *Teutschen Academie* (1675), the creator of the pictures on the leaves of the great Isenheim altarpiece, one of the greatest artists of his time. was in fact called Mathis Gothardt Neithardt and was born in Würzburg about 1460.

He was probably a pupil in a studio on the middle Rhine. In 1485 he was resident in Aschaffenburg; all the work belonging to this period has been lost. In 1490, he moved away and disappeared from sight for a decade. In 1501 he settled in Seligenstadt and lived in this specially privileged little town on the Main river until 1520. In 1503 he painted the "Mocking of Christ" (Pinakothek. Munich) for the cathedral at Aschaffenburg, and about the same time a small "Crucifixion" (art museum. Basel). Both pictures already show his bold composition. expressive drawing and dramatic colouring. In 1509 he became court painter to the archbishop of Mainz, Ulrich von Gemmingen. who lived in Aschaffenburg. As artistic and technical adviser, Grünewald had to supervise the rebuilding of the castle; at the same time. he reached great heights as a painter. In 1510 the Frankfurt patrician Jakob Heller commissioned him to paint a two-leaved standing screen for the altar in the Dominican church. Two of the panels. painted gray on gray, depicting St. Lawrence and St. Cyriacus, have been preserved in Frankfurt (Städel); two others, with St. Elizabeth and St. Lucy, are in the museum at Donaueschingen.

Griinewald created his masterpiece in Isenheim, Upper Alsace, for the monastery church of St. Anthony upon commission by Abbot Guido Guersi. In 1505, the Strasbourg sculptor Niklaus Hagnower had delivered a carved screen for the high altar in the church, which had been expanded; now, Grunewald was commissioned to paint the pictures for four movable and two fixed wings. His subjects were taken from the mystical world of Antonine thought: Christ's early years; the Passion; and St. Anthony (the saint's temptation and his conversation with Paul the hermit). The altar, preserved in the museum in Colmar, was finished about 1515–16. Later, but before 1519, Grunewald painted an altarpiece for the Maria-Schnee chapel in the church of SS. Peter and Alexander in Aschaffenburg; its central picture (the Mother of God as guardian of the church) is now in Stuppach, Württemberg, and its right wing (the miraculous foundation of Sta. Maria Maggiore) is in the museum in Freiburg im Breisgau. In 1520. Grunewald delivered various altar pictures for the cathedral in Mainz, all of which were destroyed in the Thirty Years' War.

GIRAUDON

"VIRGIN AND CHILD" BY MATHIAS GRÜNEWALD. IN THE COLMAR MUSEUM. FRANCE

In the years following, commissioned by the young archbishop of Mainz, Cardinal Albrecht von Brandenburg, he painted the great panel with the meeting of St. Erasmus and St. Mauritius (Munich); for an unknown patron he painted an altarpiece for the city church in Tauberbischofsheim ("Carrying of the Cross" and "Crucifixion" in Karlsruhe; predella with the "Lamentation of Christ" in Aschaffenburg cathedral). Apparently Griinewald soon had differences with Albrecht von Brandenburg, and in 1526 there was an open breach between them over the painter's support of the Reformation. He was dismissed from court service and went to Halle, dying there in 1528.

Griinewald depicted the suffering Christ with cruel naturalism, yet was the master of a transfiguring colour and a transcendental light. His drawings (only about 40 survive, most of them in Berlin, others in Dresden, Erlangen, Karlsruhe, Oxford, Paris and Stockholm) also grow out of light.

Grunewald always approached form as if he felt the necessity to translate it into light. Above all, however, his pictures are all the result of an introspective gaze which expressed itself in the objectivity of its religious content. Thus he became a visionary interpreter, which was in his time accounted to be the highest artistic achievement.

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GRUNT, the name applied to perchlike marine fishes of the genus Haemulon, of which many kinds are abundant in the West Indies, north to Florida, probably by reason of the grunting sound they make when caught. Their mouths are large with a patch of red or orange in the corners.

Grunts are important food fish; some are brightly coloured, most are small, of pan-fish size. The name grunt or grunter is also sometimes used for the drum (*q.v.*) of a different family, the Sciaenidae. (J. T. N.)

GRUYERE (Ger. Greyerz), a district in the south-eastern portion of the Swiss canton of Fribourg, famed for its cattle and its cheese. It is composed of the middle reach (from Montbovon to beyond Bulle) of the Sarine or Saane valley, with its tributary glens of the Hongrin, the Jogne and the Trême. It forms an administrative district of the canton of Fribourg, its population being mainly French-speaking and Romanists. From Montbovon (11 m. by rail from Bulle) there are mountain railways leading S.W. past Les Avants to Montreux (14 m.), and E. up the Sarine valley to Saanen or Gessenay (14 m.), and by a tunnel to the Simme valley and Spiez on the Lake of Thun. The modern capital of the district is the small town of Bulle (Ger. Boll), with a 13th-century castle and 5,255 inhabitants in 1950. But the historical capital is the town of Gruyères, on a steep hill above the left bank of the Sarine, at a height of 2,713 ft. above sea-level and with an old castle. The town has 1,302 inhabitants. The castle was the seat of the counts of the Gruyère, first mentioned in 1073 The name is said to come from the word *gruyer,* meaning the officer of woods and forests, but the counts bore the canting arms of a crane (grue), which are seen all over the castle and the town. In 1555 the domains were sold to Bern and Fribourg. Bern took the upper Sarine valley, while Fribourg took the rest of the county, which it added to Bulle and Albeuve (taken in 1537 from the bishop of Lausanne), and to the lordship of Jaun in the Jaun or Jogne valley (bought in 1502–04 from its lords), in order to form the present administrative district of Gruyère.

GRYNAEUS, SIMON (1493–1541), German scholar and theologian, son of Jacob Gryner, a Swabian peasant, was born at Vehringen, and studied at Vienna. In 1524 he became professor of Greek at Heidelberg; from 1526 onwards he also held the chair of Latin. His religious views drove him from Heidelberg in 1529. After some years as professor of Greek at Basle, he reorganized the University of Tubingen, returning to Basle before 1536, when he assisted in drafting the so-called First Helvetic Confession. He represented the Swiss divines at the Worms Conference (1540) between Catholics and Protestants. He died of plague at Basle on Aug. 1, 1541. A brilliant scholar, a mediating theologian, and personally of lovable temperament, his influence was great and wisely exercised. Erasmus and Calvin were among his correspondents. His chief works were Latin versions of Plutarch, Aristotle and Chrysostom.

See Bayle, *Dictionnaire;* W. T. Streuber in Hauck's Realencyklopadie (1899); and for bibliography, Streuber, S. Grynaei *epistolae* (1847).

GRYPHIUS, ANDREAS (1616–1664), German lyric poet and dramatist, was born on Oct. 11, 1616, at Grossglogau, Silesia, where his father was a clergyman. The family name was Greif, latinized, according to the prevailing fashion, as Gryphius. Left early an orphan and driven from his native town by the troubles of the Thirty Years' War, he received his schooling in various places. In 1634 he became tutor to the sons of the jurist Georg von Schonborn (1559–1637), imperial count-palatine (*Pfalzgraf*), Schonborn, who recognized Gryphius's genius, crowned him *poëta laureatus,* gave him the diploma of master of philosophy, and bestowed on him a patent of nobility, though Gryphius never used the title. After Schonborn's death Gryphius went to Leiden, where he remained six years, both hearing and delivering lectures. Here he fell under the influence of the great Dutch dramatists, Pieter Cornelissen Hooft and Joost van den Vondel. After travelling in France, Italy and South Germany, Gryphius settled in 1647 at Fraustadt, where he began his dramatic work, and was syndic of Glogau from 1650 until his death on July 16, 1664.

Gryphius was a man of morbid disposition, and his melancholy temperament, fostered by the misfortunes of his childhood, is largely reflected in his lyrics, of which the most famous are the Kirchhofsgedanken (1656). His best works are his comedies, one of which, *Absurda Comica,* oder Herr Peter *Squentz* (1663), is based on the episode of Pyramus and Thisbe in The *Midsummer* Night's Dream Die geliebte Dornrose (1660). written in a Silesian dialect, is simple and graceful. and ranks high among the comparatively small number of German dramas of the 17th century. *Horribilicribrifax* (1663), founded on the Miles *gloriosus* of Plautus, is a rather laboured attack on pedantry. Besides these three comedies, Gryphius wrote five tragedies, modelled on Seneca and Vondel. They are *Carolus Stuardus* (1649), *Leo Armenius* (1646), *Katharina von Georgien* (1657), *Cardenio und Celinde* (1657), the only bourgeois tragedy earlier than Lessing, and *Papinianus* (1663). No German dramatic writer before him had risen to so high a level, nor had he worthy successors until about the middle of the 18th century.

A complete edition of Gryphius's dramas and lyric poetry was published by H. Palm in the Stuttgart Literarische Verein, 3 vol. (1878, 1882, 1884).

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GSTAAD (3,450 ft.), a health resort and centre for winter sports in the canton of Bern, Switzerland, on the upper Saane. It has a station on the railway Montreux-Bernese Oberland. It is the starting point of the route over the Col-de-Pillon to Diablerets. Gstaad belongs to the commune of Saanen, which had a total pop. (1960) of 5,649, mostly Protestant and German-speaking.

GUADALAJARA, a province of central Spain, formed in 1833 of districts from New Castile; bounded north by Segovia, Soria and Saragossa, east by Saragossa and Teruel, south by Cuenca and west by Madrid. Population (1960 est.) 200,982; area 4,707 sq.mi.; density per sq.mi. 42.7. . The province forms part of the uptilted northeastern edge of the Meseta, and consequently the high ground is in the north, while the southern section of the province slopes into the plateau basin of New Castile. The northern highlands reach about 7,000 ft. in places, as in La Cebollera (6,975 ft.) and Ocejon (6,744 ft.) in the Guadarrama mountains. The Sierra de Albarracin form an important group on the extreme southeast of the province. The ways through the northern mountains are few, the main pass being over the Sierra Ministra, which carries the railway from Madrid to Calatayud and the north. The southern section, composing part of the Tagus basin, is watered by its tributaries, the Tajuna, Henares, Jarama and Gallo. The climate of this area, as of Castile, is continental in type, marked by the severity of its winter cold and summer sun. The soil varies very much in quality from place to place, but is fertile in many regions, notably in the cornlands of Alcarria toward the south. Few of the cork and oak forests which formerly covered the mountains have escaped destruction, and the higher lands are mainly pasture for sheep and goats. Grain, olive oil, wine, saffron, silk and flax are produced, but agriculture naturally suffersin this difficult country. Common salt and silver are mined, while deposits of iron, lead and gold were worked by the Romans. The manufacture of coarse cloth and pottery are a typical feature of the towns and villages. The Madrid-Saragossa railway traverses the province for 70 mi., but the roads are naturally difficult. Guadalajara (*q.v.*) is the capital, and the only town of any considerable size. Molina de Aragon, a fortified town built at the foot of the Parameras de Molina (2,500–3,500 ft.), and on the right bank of the Gallo, is of some importance as an agricultural centre. Sigüenza, on the railway, is an episcopal city, with a fine Romanesque cathedral dating from the 11th century.

Guadalajara is probably the ancient Segontia, founded in 218 B.C., by refugees from Saguntum. The province was the scene of bitter fighting in the civil war of 1936–39, and government forces won a brilliant victory over a nationalist army driving south from Sigüenza. A large proportion of the nationalist force was made up of Italian volunteers.

GUADALAJARA, the second largest city of Mexico and the capital of the state of Jalisco, is 27j mi. W.N.W. of Mexico City. It is in the Antemarac valley, near the Río Grande de Santiago, at an elevation of 5.092 ft. Except for the rainy season, which extends from about July 1 to September 15, its climate is dry and mild. The city is connected by rail with Nogales on the Arizona border and Mexico City. All-weather highways connect it with those two cities as well as with cities on the central and Pan-American highways. An excellent highway leads to Lake Chapala, a popular resort 23 mi. from the city. Guadalajara is served by major national airlines which provide connections with all major cities of the republic and with the United States.

The city was founded in 1531 by Nuño de Guzmán. During the first decade of its existence its site was changed several times under pressure from the Indians. From its beginning the city was the centre for Indian slave hunting and remained so throughout much of the 16th century. Father Hidalgo y Costilla, who initiated the independence movement in Mexico. occupied the city late in 1810, and it was there that he decreed the abolition of slavery in Mexico. On Jan. 17, 1811, he suffered a disastrous defeat at Calderón bridge near the city. During the French intervention of the 1860s, Guadalajara was occupied by the invading forces. The city suffered from severe earthquakes on May 31, 1818, and March 11, 1875.

Guadalajara has experienced a significant population growth in the 20th century; the population increased from 179.600 in 1930 to 734,346 in 1960. After 1940 Guadalajara added to its traditional roles of political capital and commercial entrepbt for an extensive agricultural region (devoted primarily to corn growing and livestock raising) that of a major industrial producer. In the second half of the 20th century it ranked as one of the republic's important industrial centres; manufactures included textiles. shoes. chemicals, building materials, tobacco products and soft drinks. Handicraft industries. carried on in Guadalajara and the suburbs of San Pedro (commonly known as Tlaquepaque) and Tonolá, include glass blowing, leather tooling, pottery making, silver- and coppersmithing and weaving.

Industrial and commercial establishments are often quartered in ultramodern buildings, and modern residential suburbs have attracted members of the upper classes and the rapidly expanding middle classes from the older parts of the city. The city was made the seat of a bishopric in 1549, and the cathedral, built between 1571 and 1618, is richly decorated. Many of the city's more than 50 churches also date from the colonial period.

During the summer months, religious processions bear the image of the Virgin of Zapopan, the patroness of the city, to each of the churches; afterward there are secular festivals with elaborate moving fireworks displays (*castillos*). The governor's palace, begun in 1743, is generally considered to be one oi the finest examples of Spanish architecture in Mexico. Guadalajara has two universities—the University of Guadalajara dating from 1792 and the Autonomous University of Guadalajara founded in 1935. The Teatro Degollado is one of the largest and most ornate theatres in Latin America.

Guadalajara was the home of the painter José Clemente Orozco (1883–1949), and among his numerous murals in the governor's palace, the Autonomous university, and the Hospicio (orphanage) are to be found some of his finest works. The family home is a museum.

Mariachis (strolling orchestras) specializing in Mexican folk music, and found throughout most of the republic, originated in Guadalajara. (J. J. J.)

GUADALAJARA, the capital of the Spanish province of Guadalajara, on the left bank of the river Henares, and on the Madrid-Saragossa railway, 35 mi. E.N.E. of Madrid. Pop. (1960 est.) 15,730 (mun.). Guadalajara is a picturesque town, occupying a somewhat sterile plain, 2,100 ft. above the sea. Under Roman and Visigothic rule it was known as Arriaca or Caraca; its present name, which sometimes appears in mediaeval chronicles as Godelfare, represents the Wad-al-hajarah, or "Valley of Stones," of the Moors, who occupied the town from 714 until 1081, when it was captured by Alvar Yaiiez de Minaya, a comrade of the more famous Cid. The church of Santa Maria contains the image of the "Virgin of Battles," which accompanied Alphonso VI of Castile (1072–1109) on his campaigns against the Moors. The palace of the ducal house del-Infantado is in the Mudejar style, and the *panteón* or mausoleum of the Mendoza family, added between 1696 and 1720 to the 13th-century church of San Francisco, is remarkable for the rich sculpture of its tombs. Manufactures of soap, leather and woollen fabrics superseded the original cloth-weaving industry for which Guadalajara was famous.

In March 1937 a nationalist force was defeated near Guadalajara. See Spanish Lib. of Information, *Spain* (Jan. 1942).

GUADALQUIVIR (ancient *Baetis,* Moorish *Wadi al Kebir,* "the Great river"), a river of southern Spain. What is regarded as the main stream rises 4,475 ft. above sea level between the Sierra de Cazorla and Sierra del Pozo, in the province of Jaen. It does not become a large river until it is joined by the Guadiana Menor on the left, and the Guadalimar on the right. Below Coria it traverses the series of broad fens known as Las Marismas, the grestest area of swamp on the Iberian peninsula. Below Sanlúcar the river enters the Atlantic after a total course of 348 mi. It drains an area of 21,865 sq.mi. In the time of the Moors it was navigable up to Cordova, but because of the accumulation of silt in its lower reaches it is now only navigable up to Seville by vessels of 1,200 to 1,500 tons. Navigation was facilitated by a cut, known as the Corte de Tablada, and swing-open bridge.

GUADELOUPE, twin islands in the French West Indies, constituting most of the French overseas *département* of the same name, lying between Montserrat on the north and Dominica on the south, at 16° 20′ N. and 61° 50′ W. The two islands are separated by a narrow arm of the sea, the Rivière Salée (Salt river), 100 ft. by 400 ft. in breadth and navigable for small vessels, and by two bays, the Grand Cul de Sac Marin on the north and the Petit Cul de Sac Marin on the south. These islands have an area of 584 sq.mi.; the entire *département* is 687 sq.mi.

The western and larger island, Rasse-Terre, is a rugged mass of ridges, high peaks and lofty uplands. In the northwest, sharp spurs radiate in all directions from Grosse Montagne (2,297 ft.); near the middle of the west coast the twin heights of Les Mamelles (2,395 ft. and 2,359 ft.) rise sharply. Farther south is La Soufrière. This 4.869-ft. volcano erupted quite violently in 1797 and again in 1843, causing widespread destruction. but thermal springs and *solfataras* are now its only activity. Jagged Caraibe (2,290 ft.) is in the extreme south. These cloud-capped mountains and the high, sinuous ridge which links them are clothed in luxuriant vegetation. Grande-Terre, the eastern island, is smaller and low-lying, with a maximum elevation of 450 ft. It is irregular in shape, with a long peninsula, Châteaux Point, stretching from its south-eastern extremity. Its plain is mainly limestone and *maçonne du bon dieu,* a conglomerate of sand and broken shells much used in buildings. It has extensive sugar plantations. Basse-Terre has several streams, which flood suddenly in the rainy season, but Grande-Terre has few springs and depends principally on ponds and cisterns for its water supply.

Basse-Terre has old eruptive rocks covered by recent great volcanic cones, together with deposits derived from denudation of the older rocks. Grande-Terre has nearly horizontal limestones conformable upon a series of fine tuffs and ashes, the whole belonging probably to the Eocene and Oligocene. Occasional late Pliocene marl and limestone rest unconformably upon these older beds; and near the coast there are raised modern coral reefs.

The temperature has an extreme range of from 61° F. to 101° F.. but is usually fairly constant between 75° and 88°. Rainfall is heavy from July through November, with an average annual precipitation of 86 in. on the coast and much more in the interior. The trade winds blow throughout the year, and hurricanes are frequent. In 1825 a hurricane destroyed the town of Basse-Terre, and Grand Bourg on Marie Galante suffered similarly in 1865.

The soil is rich and fruitful. Sugar is by far the most important crop and, with its derivative rum, accounts for most of the exports. Ste.-Anne, Pointe-à-Pitre, Le Moule and Basse-Terre have sugar *usines.* Bananas are second in importance, but production after World War II was only about one-fifth of normal. A wide variety of other tropical agricultural products is grown, including vanilla, coffee, cacao, citrus fruits and an increasing amount of cotton. The forests of Basse-Terre are valuable, but because of their inaccessibility have not been exploited, Salt and sulfur are the only minerals extracted. Except for rum and liqueurs. manufactured products are intended for local consumption.

Under the French constitution of 1958, Guadeloupe is an integral part of the French community, along with its outlying islands, which include nearby La Désirade, Marie Galante and the Saintes group and more distant St. Bartholomew (130 mi. N.N.W.) and French St. Martin (142 mi. N.N.W.). The prefect (governor) and some other officials are appointed by the central government, but legislative power is in the hands of an elected assembly.

Pop. (1954) 229.120. It is largely Negro and negroid except in Les Saintes Islands, whose inhabitants are mainly of French stock. Basse-Terre (pop. 11,837) is the capital, but Pointe-à-Pitre (pop. 26,160) is the largest city and the commercial centre, handling 85% of the islands' trade. Le Moule (pop. 12,002), on the east coast of Grande-Terre. is important as a sugar port.

Internal communication is principally by a network of more than 800 mi. of roads. The only railways are used exclusively for hauling freight. Education is free in state schools.

History. — Guadeloupe was discovered in 1493 by Columbus, who named it from the monastery of S. Maria de Guadalupe at Estremadura in Spain. In 163j L'Olive and Duplessis took possession in the name of the French Company of the Islands of America, and L'Olive exterminated the Caribs with great cruelty. Four chartered companies were ruined in their attempts to colonize the island, and in 1674 it passed to the French crown and long remained a dependency of Martinique. After failures in 1666, 1691 and 1703, the British captured the island in 1759 and held it for four years. Guadeloupe was finally separated from Martinique in 1775, but it remained under the governor of the French Windward Islands.

In 1782 Rodney defeated the French near the island, and the British again took it in April 1794, but in the following summer they were driven out by Victor Hugues with the assistance of slaves freed for the purpose. In 1802 Bonaparte, then first consul, sent an expedition to the island in order to re-establish slavery, but, after a heroic defense, many of the Negroes preferred suicide to submission. In 1810 the British once more occupied the island, but, in spite of its cession to Sweden by the treaty of 1813 and a French invasion in 1814, they did not withdraw until 1816. In 1816–25 the code of laws peculiar to the island was introduced.

Municipal institutions were established in 1837, and slavery was finally abolished in 1848. Guadeloupe, with much of the West Indies and Florida, was devastated by a tropical hurricane in the middle of Sept. 1928. Plantations were wrecked and buildings destroyed in the towns. The French government recorded 660 deaths in the island.

Guadeloupe adhered (1940–45) to the Vichy government of France under the high commissionership of Adm. Georges Robert.

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GUADET, MARGUERITE ELIE (1758–1794), French revolutionist, was born at St. Emilion near Bordeaux on July 20, 1758, and became a lawyer. When the Revolution broke out, he had already gained a reputation as a leading advocate at Bordeaux. In 1790 he was made administrator of the Gironde and in 1791 president of the criminal tribunal. In that year he was elected to the legislative assembly as one of the group of deputies subsequently known as Girondins or Girondists.

As a supporter of the constitution of 1791, he joined the Jacobin club, and there and in the assembly became an eloquent advocate of all the measures directed against real or supposed traitors to the constitution. He bitterly attacked the ministers of Louis XVI and was largely instrumental in forcing the king to accept the Girondist ministry of March 15, 1792. An advocate of the policy of forcing the king into harmony with the Revolution, he remained a royalist, however. and with others even addressed a letter to the king soliciting a private interview. As president of the assembly, he vigorously opposed the insurrectionary commune of Paris on Aug. 10. As deputy to the convention (September) he voted for an appeal to the people at the trial of Louis XVI, and for the death sentence, but with a respite pending appeal. In March 1793 during the war in La Vendée he refused to cooperate with Danton, whom he held responsible for the September massacres. He was involved in the fall of the Girondists, and guillotined on July 17, 1794.

See J. Guadet, Les Girondins (1889) ; F. A. Aulard, Les Orateurs de *la législative* et de la convention, 2nd ed. (1906).

GUADIANA (anc. *Anas,* Moorish Wadi *Ana*), a river of Spain and Portugal. The Guadiana was long believed to rise in the lowland known as the Campo de Montiel, where a chain of small lakes, the Lagunas de Ruidera, are linked together by the Guadiana Alto or Upper Guadiana. This stream flows northwestward from the last lake and vanishes underground within 3 mi. of the river Zancara or Giguela. About 22 mi. S.W. of the point of disappearance, the Guadiana Alto was believed to re-emerge in the form of several large springs, which form numerous lakes near the Zancara and are known as the "eyes of the Guadiana" (*los* ojos de Guadiana). The stream which connects them with the Zancara is called the Guadiana Bajo or Lower Guadiana. It is now known that the Guadiana Alto has no such course, but flows underground to the Zancara itself, which is the true "Upper Guadiana." The Zancara rises near the source of the Jucar, in the east of the tableland of La Mancha; thence it flows westward, assuming the name of Guadiana near Ciudad Real, and reaching the Portuguese frontier 6 mi. S.W. of Badajoz. In piercing the Sierra Morena it forms a series of foaming rapids, and begins to be navigable only at Mertola, 42 mi. from its mouth. From the neighbourhood of Badajoz it forms the boundary between Spain and Portugal as far as a point near Monsaraz, where it passes into Portuguese territory, with a southerly direction. At Pomarão it again becomes a frontier stream and forms a broad estuary 25 mi. long. It enters the Gulf of Cadiz between the Portuguese town of Villa Real de Santo Antonio and the Spanish Ayamonte, after a total course of 509 mi. Its mouth is divided by sandbanks into many channels. The Guadiana drains an area of 23,455 sq.mi. Its principal tributaries are the Zujar, Jabalón, Matachel and Ardila from the left and the Bullaque, Ruecas, Botoa, Degebe and Cobres from the right.

GUADIX, a city of southern Spain, in the province of Granada; on the left bank of the river Guadix, a subtributary of the Guadiana Menor, and on the Madrid-Valdepeñas-Almería railway. Pop. (1950) 30,532 (mun.). Guadix occupies part of an elevated plateau among the northern foothills of the Sierra Nevada. Guadix el Viejo, 5 mi. N.W , nas the Roman Acci, and, according to tradition, the seat of the first Iberian bishopric, in the 2nd century. After 711 it rose to some importance as a Moorish fortress and trading station, and was renamed *Wad* Ash, "Water of Life." It was surrendered without a siege to the Spaniards, under Ferdinand and Isabella, in 1489. Guadix is surrounded by ancient walls, and was formerly dominated by a Moorish castle. It is an episcopal see of great antiquity. The cathedral was built in the 18th century on the site of a mosque. The city was once famous for its cutlery. It has some trade in wool, cotton, flax, corn and liqueurs. The warm mineral springs of Graena, much frequented during the summer, are 6 mi. west.

GUADUAS, a town of the department of Cundinamarca. Colombia, 53 mi. N.W. of Bogotá on the old road between that city and the Magdalena river port of Honda. Pop. (1951) 2.466. chiefly Indians or of mixed blood. It stands in a narrow and picturesque valley formed by spurs of the Eastern Cordillera, and on a small stream bearing the same name, which is that of the South American bamboo (guaduas), found in great abundance along its banks. Sugar cane and coffee are cultivated in the vicinity, and fruits of various kinds are produced in great abundance. The elevation of the town is 3,353 ft. above the sea, and it has a remarkably uniform temperature throughout the year.

Guaduas has a fine church facing upon its plaza, and an old monastery now used for secular purposes. Guaduas was founded in 1614.

GUAHIBAN, an independent linguistic stock of South American Indians. so called from the Guahibas, one of its most important tribes. The tribes composing this stock occupy or once occupied a large area in eastern Colombia, which extended from the Orinoco river westward between the Meta and Vichada rivers to the eastern slopes of the Andes. Some outlying tribes, houever, such as the Churoyas. Cofanes and Macas, were much farther south. extending as far as the upper Caqueta and Aguarico rivers. The Guahibas (Guaybas) and the closely affiliated Chiricoas are described as a purely nomadic hunting and fishing folk, going almost naked. They are wandering traders, thievish and adepts at cheating, and were likened by the early writers to gypsies. No adequate modern studies of these tribes appear to have been made.

See J. Rivero, *Historia* de *las Misiones* de *los* Llanos de Casanare, etc. (1736, new ed., 1883); J. Chaffanjon. *L'Orenoque* et *le* Caura (1889).

GUAIACOL, $CH_3.O.C_6H_4.OH$, the monomethyl ether of catechol and a constituent of beechwood tar.

GUAIACUM, a genus of trees belonging to the family Zygophyllaceae. the bean capers. The guaiacum or lignum vitae tree. G. *officinale,* is a native of the West Indies and the north coast of South America, where it attains a height of 20 ft. to 30 ft. G. sanctum grows in the Bahamas and Cuba, and at Key West in Florida. G. arboreum, the guaiacum tree of Colombia. is found in the valley of the Magdalena up to altitudes of 2,600 ft.. and reaches considerable dimensions. Guaiacum wood is of a yellow colour merging into green, and has an almost powdery fracture.

The lignum vitae of commerce, so named because of its high repute as a medicinal agent in past times, is procured from G. *officinale,* and in smaller amount from G. sanctum. It is exported in large logs or blocks, generally divested of bark. and presents in transverse section very slightly marked concentric rings of growth, and scarcely any traces of pith; with the aid of a magnifying glass the medullary rays are seen to be equidistant and very numerous. The outer wood is pale yellow and devoid of resin; the inner, which is by far the larger proportion, is dark greenish-brown, contains in its pores 26% of resin and has a specific gravity of 1.333, and therefore sinks in water. Ouing to the diagonal and oblique arrangement of the successive layers of its fibres, the wood cannot be split; and because of its hardness. density and durability it is much valued for the manufacture of rulers, mallets, etc.

Guaiacum resin is obtained from the wood as a natural exudation; by heating billets about three feet in length, bored to permit the outflow of the resin; or by boiling chips and raspings in water to which salt has been added to raise the boiling point. It occurs in rounded or oval tears, or in large brounish or greenish-brown masses. translucent at the edges; fuses at 8j° C.; is brittle, and has a vitreous fracture, and a slightly balsamic odour. increased by pulverization and by heat; and is at first tasteless when cheued, but produces subsequently a sense of heat in the throat. It is readily soluble in alcohol, ether, chloroform, creosote, oil of cloves and solutions of caustic alkalies; with glycerine it gives a clear solution, and with nitrous ether a bluish-green gelatinous mass. It is blued by various oxidizing agents; *e.g.,* ozone. The chief constituents are three distinct resins. guaiaconic acid (70%), guaiac acid, which is closely allied to benzoic acid, and guaiaretic acid Like all resins, these are insoluble in water. soluble in alkalies, but precipitated on neutralization of the alkaline solution.

Guaiacum wood was first introduced into Europe by the Spaniards in 1508 but the first edition of the London Pharmacopoeia in uhich the resin is mentioned is that of 1677. It was once popular as an alterative but is now little used medicinally. Guaiacum has been used as an antioxidant, especially in commercial lard. The active principle apparently is guaiaretic acid.

The tincture of guaiacum aas once used universally as a test for the presence of blood, or rather of hemoglobin, in urine or other secretions. but has been replaced by other tests.

GUALDO TADINO, a town and episcopal see of Umbria, It. (anc. Tadinum, on the Via Flaminia, 1 mi. to the W.), 1,755 ft. above sea level, province of Perugia, 22 mi. N. of Foligno by rail. Pop. (1951) 4,022. The cathedral has a good rose window, and the picture gallery contains 15th-century paintings by Umbrian artists. The town is still surrounded by walls. Art pottery is made there. In the plain below, near the ancient Tadinum, Narses defeated and slew Totila in 552.

GUALEGUAY, a town on the river of the same name in the province of Entre Rios, Argentina. 32 mi. above the confluence of the Gualeguay river with the Ibicuy branch of the Paraná, and about 120 mi. N.N.W. of Buenos Aires. The port of Gualeguay is

Puerto Ruíz, 5 mi. below, with which Gualeguay is connected by tramway. It is also on a branch railway. It is a stock-raising centre, its establishment dating from 1783. Pop. (1956 est.) 28,110. The town has tanneries and other factories.

GUALEGUAYCHÚ, a town and river port of the province of Entre Rios, Arg., on the river of the same name, 11 mi above its confluence with the Uruguay and about 130 mi. N.W. of Buenos Aires. The population according to 1956 estimate was 44.400 Gualeguaychti is the centre of an important cattle-raising country, and meat is chilled and beef extract manufactured in the town. There are also tanneries and shoe factories. Gualeguaychti is on a branch railway. (C. E. Mc)

GUAM, the largest and southernmost island of the Marianas, lies in the Pacific ocean at 13° 26' N. lat. and 144" 39' E long., about 5,100 mi. W. of San Francisco, 3,340 mi. W. of Honolulu and 1,500 mi. E. of Manila. Area 209 sq mi. The population was 59,498 according to the 1950 census. At the 1960 census, 66,910 persons were recorded in Guam, including military personnel. Agaña, the capital, had a population of 1,330 in 1950 arid 1,643 in 1960. Other important towns are Agaña Heights, Sinajana and Tamuning.

Physical Geography. — The island is sharply divided into a northern limestone plateau with a general elevation of about 500 ft. and an area of high, volcanic hills to the south. The plateau is covered with a thick growth of jungle; the volcanic hills support mainly sword grass. They rise over 1,000 ft. above sea level and their lower slopes to the east and, in part, to the west are covered with younger limestones, generally similar to those of the northern limestone plateau. The higher hills are found in the west central and southern parts of the island. Mt. Lamlam rises to an elevation of 1,334 ft.; Mt. Jumullong Manglo is 1,086 ft., Mt. Bolanos 1,220 ft. and Mt. Sasalaguan 1,109 ft.

Guam has a pleasant tropical climate. Temperatures range from 70° to go° F., being fairly even throughout the year. Average annual rainfall is about 95 in.. three-fourths of which falls during the wet season, generally starting in May or June and lasting through November. The climate is punctuated by destructive typhoons which occur at irregular intervals.

The People. — The native Guamanians, ethnically called Chamorros, are basically of Indonesian stock with a considerable admixture of Spanish, Filipino (Tagalog) and other strains. Their vernacular, called the Chamorro language. is not a Micronesian dialect but a distinct language with its own vocabulary and grammar. The word Chamorro is derived from Chamorri, or *Chanioli,* the ancient name for "chief." Pure-blooded Chamorros are no longer found on the island, but in every native family the Chamorro language is still the medium of communication. They are predominantly Roman Catholic.

At the end of World War II, the Guamanians were faced with the tremendous task of reconstructing the parts of their island which were levelled, of discovering and developing profitable home industries and of fulfilling Guam's potential position as an important new hub of Pacific activity. Agana, the seat of Guam's government and formerly a city of 12,000 inhabitants, was completely destroyed by bombardment.

Prior to World War II, the village was the social and economic unit, preserving conservatively the customs and traditions of 19th-century Europe. A family would work for a year, for example, in preparation for a costly wedding. The fiesta held in memory of a patron saint was the great social and religious event of the year in the village, for it was one of few occasions when people travelled from one village to another. Fiesta customs similar to those of earlier days continue to be followed in modern Guam. Changes in the social life and institutions of Guamanians, however, occur concurrently with the economic improvement of the people and their closer contacts with aestern civilization.

History. — Guam was discovered by Ferdinand Magellan in 1521. There mas no attempt to conquer the island until the latter part of the 17th century, when the Spaniards subdued it after considerable bloodshed. Guam remained a Spanish possession until 1898, when, in the course of the Spanish-American war, the U.S. warship "Charleston" steamed into the harbour of Apra and shelled the old fort. Guam was ceded to the United States and the other islands of the Marianas were sold by Spain to Germany in 1899.

After World War I, Japan which had occupied the German island possessions north of the equator, received the Marianas (except Guam) and the Caroline and Marshall groups. as a mandate under the League of Nations. Japan retained possession of the islands after she had quit the league in 1935.

The Japanese effected landings on Guam in the first days of World War II, and occupied the island by Dec. 12, 1941. Two and one-half years later U.S. marine and army forces returned to the Marianas, invading Guam on July 20, 1944; the island was again in U.S. hands by Aug. 9. Guam. turned into an air and naval base. was one of the major airfields for the squadrons of Superfortress bombers that attacked Japan in the last days of the war.

The U.S. department of the interior took over the administration of the island on Jan. 1, 1951, after 230 years of Spanish rule and 52 years of U.S. navy rule, interrupted only by the Japanese occupation. Guam served in the latter 1950s as the headquarters of the government of the Trust Territory of the Pacific Islands and of the U.S. air force's strategic air command in the Pacific.

Government. — Guam is an unincorporated territory of the United States and an organized sovereignty, governed under the Organic Act of Guam, passed by the U.S. congress and approved by the president on Aug. 1, 1950, and which took effect on Jan. 1, 1951. Although the Guamanians are citizens of the U.S., they cannot vote in national elections, nor do they have representation in the congress of the United States. The governor, who must be a civilian, is appointed by the president for a term of four years.

The second ranking member of the executive branch of the government is the secretary of Guam, who is likewise appointed by the president for a four-year term.

The legislature is a unicameral body with 21 members, popularly elected for four years. The legislature has the power to override the governor's veto by a two-thirds vote, but the governor may transmit the repassed bill to the president of the United States, who makes the final decision on legislation referred to him. The U.S. congress may vote to annul any act of the Guam legislature within one year of its passage.

The judiciary consists of the district court of Guam, whose judge is appointed by the president for four years. There is also an island court, police court and commissioners' court, whose judges are appointed by the governor to hold office at his discretion.

Each of the island's 15 municipalities is headed by a popularly elected native commissioner who serves for a four-year term. There is also a chief commissioner, appointed by the governor, who acts as liaison between the governor and the municipalities.

Finance. — All federal income taxes collected are remitted by the U.S. to the Guam government. Revenue and expenditures for the fiscal year ended June 30, 1955, were $10,190,000 and $9,873,-000 respectively. The value of imports in 1955 was $23,131,000 and of exports $4,597,000. Transshipments were valued at $2,-309,000.

Transportation. — Guam is served by scheduled and non-scheduled commercial air lines. The island is also a port of call for two major shipping lines: the American President line and the Pacific Far East line. The American President line's ships call at Guam on an average of one and one-half times a month. bringing cargo from both east and west coasts of the U.S., and the Pacific Far East line's ships call on an average of six times a month, carrying freight, including refrigerator cargo, and passengers from the west-coast ports of the United States. Both lines bring cargo to Guam from the orient. The American President line carries freight and a restricted number of passengers from Guam direct to the Philippines and Japan and back to Guam. while the Pacific Far East line carries freight and passengers from Guam to Japan, Korea and the mainland.

Guam is the home port of the Pacific Micronesian line, under contract to the Trust Territory of the Pacific Islands; the line carries cargo and passengers back and forth between those islands and Guam.

Agriculture and Industry.— The Chamorros live in villages from which they leave to cultivate their farms. Their traditional economy was. for the most part, still practised after World War II. However, modern agricultural methods were introduced by extension workers from the department of agriculture, and by the latter 1950s the economy of Guam had been expanded with increases in agricultural production and the establishment of new commercial and industrial enterprises. largely the result of the development of Guam as an important U.S. military base. The government aided economic development through the Guam Finance and Development agency, which made loans to farmers and businessmen.

By far the larger area of farmed land is near the coast in the southern, volcanic part of the island. On a representative farm, much like that of pre-World War II days, special attention is given to vegetables in areas near the new market among U.S. service personnel in the north. Three or four acres on a farm are generally cultivated, five or six times that amount being coconut forest, scrub. sword grass and wasteland. Corn, still the most important crop, is raised on one or two of the cultivated acres. Typically, a similar area is in pasture and an acre or so devoted to bananas, breadfruit. papayas, sweet potatoes, cassava, melons, pineapples and other vegetables.

Farmers raise a few scrub cattle for meat. oxen for draught animals and each generally has a carabao. Swine are native scrub stock, fed for the most part on swill, bananas and coconut pulp. Poultry are also predominantly native mongrel stock. Farm equipment usually includes a two-wheeled cart, a couple of machetes or bush knives and a *fosino* or scuffle hoe.

Fertilizers are little used. not even barnyard manure; it is not. in fact, readily available because livestock are rarely concentrated in one place. In accordance with long-established practice, new land is cleared by burning when the soil of cultivated areas becomes depleted.

Education.— There were 21 public elementary schools, a junior high school and a high school in the territory in the latter 1950s. The Territorial college was established in 1952, at Xgana.

(*See* also PACIFIC ISLANDS.)

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GUAN, a tropical American chickenlike bird related to the chachalacas and curassows (*q.v.*) and with them constituting the family Cracidae of the order Galliformes. They comprise a number of genera of \\-hich *Penelope* and Ortalis are the largest. Nearly all have a bare throat. from which. in many forms. hangs a wattle. Except for a few which extend to Central and North America and the Antilles, the guans are confined to the South American continent. Like their allies, the omnivorous guans are most often seen hopping and flying about in the treetops. Attempts to domesticate these birds generally have been unsuccessful.

The noisy chachalaca (Ortalis *vetula macalli*) reaches the lower Rio Grande valley of Texas.

GUANABACOA, a city in Havana province, Cuba, 3 mi. E. of Havana. It is situated in a hilly section and is essentially a residential suburb of the capital, though a number of industries have been established. It is connected to Havana by highway and railway around Havana bay and by the Regla ferry. Pop. (1953) 32,490. Guanabacoa (meaning "site of waters") was an old Indian town. Established by the Spanish in 1617, it became a summer place for fashionable families in the colonial period because of its medicinal springs. Interesting old buildings include churches, monasteries and administrative buildings. (D. R. D.)

GUANABARA, a state of Brazil bounded north by Rio de Janeiro state, east by Guanabara bay, south by the Atlantic and west by Sepetiba bay. Area 524 sq.mi.; pop. (1950) 2,377,451, of which nearly all live in Rio de Janeiro (*q.v.*), now the state capital. Three massifs dominate the topography, occupying a third of the area and reaching a height of 3,360 ft. Guanabara was created from the former federal district in 1960, when Brasilia (*q.v.*) succeeded Rio de Janeiro as the national capital. The state's first governor and legislature were elected on Oct. 3, 1960. (R. M. M.)

GUANACASTE, a province of Costa Rica located on the Pacific coast and bordering Nicaragua. Area 4,015 sq.mi.; pop. (1950) 88,190, (1958 est.) 125,520. Shortly after independence from Spain this area separated itself from Nicaragua and in 1825 officially became a province of Costa Rica. As a result: Guanacaste was the source of ill-feeling between the two nations during the 19th century. It was also the centre of much of the warfare between the Central Americans and William Walker (*q.v.*) in the 1850s. Guanacaste, bisected by the Inter-American highway, has impressive agricultural prospects. Occupying 20% of Costa Rica it is a frontier of flat grassland with dry forests in the north. The chief income is from cattle, which are driven to market in Alajuela. About one-half of the beef, corn and rice consumed by Costa Ricans comes from Guanacaste province. The largest towns are Nicoya and Liberia, the provincial capital. (T. L. K.)

GUANACO (HUANACA), the larger of the two wild representatives in South America of the camel tribe, the other being the vicuiia. The guanaco (Lama guanicoe) stands nearly 4 ft. at the shoulder, with gracefully curved neck and long slender legs, the hind pair each with a naked patch. The hair is long,and soft, of a fawn colour above and white beneath. Guanaco are found throughout the southern half of South America, from Peru to Cape Horn. They live in herds, usually of from 6 to 30, and are exceedingly timid and difficult of approach. Their cry is something between the belling of a deer and the neigh of a horse. The chief enemies of the guanaco are the Patagonian Indians and the puma, as it forms the principal food of both. Its flesh is palatable although wanting in fat, while its skin forms the chief clothing material of the Patagonians. Guanaco are easily domesticated. They take readily to the water. They regularly deposit their droppings on the same spot, a habit appreciated by the Peruvian Indians, who use these deposits for fuel. Guanaco also have favourite localities in which to die, as appears from the great heaps of their bones found in particular spots.

GUANAJUATO, an inland state of Mexico; area 11,805 sq.mi.; pop. (1950) 1,328,712.

It lies wholly within the limits of the great central plateau of Mexico, and has an average elevation of about 6,000 ft. The northern half of Guanajuato is mountainous, but its southern half is covered by fertile plains, called the *Bajío,* largely devoted to agriculture. It is drained by the Rio Lerma and its tributaries, the Rio Turbio and the Rio de la Laja. The climate is semitropical and healthful, and the summer rainfall, 20 to 30 in., is sufficient to ensure good results in agriculture and stock raising. Indian corn, beans, barley and wheat are grown.

The principal industry of the state is mining, the mineral wealth being enormous. Among its mineral products are silver, gold, tin, lead. mercury. copper and opals. Silver has been extracted since the early days of the Spanish conquest. Some of the more productive mining sites are the Veta Madre (mother lode), the San Bernabi. lode and the Rayas mines of Guanajuato, and the La Valenciana mine, the output of which is said to have been $226,000,000 between 1766 and 1826. Industries include flour mills, tanneries and leather factories, cotton and woolen mills distilleries,, foundries and potteries.

The first Spanish settlement in the state was San Miguel de Allende, 1542, a picturesque colonial town now an art and study centre. The capital, Guanajuato city (*q.v.*), also has great colonial charm. As the silver mines poured forth their wealth Mexican baroque architecture flowered in this area. Miguel Hidalgo y Costilla (*q.v.*) began the Mexican War for independence in the village of Dolores Hidalgo in 1810. That same year his forces took the capital and looted it. Later. the Spaniards executed Hidalgo and his three lieutenants and displayed their heads on the Alhóndiga de Granaditas in Guanajuato for a period of ten years. Other important cities of the state are Leon (*q.v.*) and Celaya. Álvaro Obregón decisively defeated Pancho Villa at Celaya in 1915. Until 1824 Guanajuato with Querétaro was administered as a Spanish intendancy. (J. A. Cw.)

GUANAJUATO, capital of Guanajuato state, Mexico, is 1; j mi. N.W. of Mexico city. Pop. (1950) 23,389. It is served by a branch of the Mexican National railway, which joins the main line at Silao, and a paved road branching 13 mi. N.E. from that city. Guanajuato's dry climate is considered healthful.

Guanajuato is situated at an elevation of 6,835 ft. in the Caiiada de Marfil at the junction of three ravines. The city stands essentially as a foremost example of a Spanish colonial centre, whose location and mineral riches determined its plan and historical role. It gives the appearance of being crowded. The narrow tortuous streets (some are built as steps) rise steeply up the hillsides. Balconies which overhang the narrow streets are a distinctive feature of the city. There are a few modern buildings.

During the late 1520s and early 1530s Spaniards overran the area which remained little more than a military frontier until silver was discovered. Guanajuato was founded in 1554 and became a city in 1741. The town, along with Zacatecas to the north and Potosi in Bolivia, became one of the three greatest silver mining centres of the 16th century. Its celebrated Veta Madre (mother lode) was described as the richest in the world. The mineral wealth of Guanajuato--over 1,800 mines were in operation at one time—was largely responsible for making Mexico city the most splendid jewel in Spain's New World empire. In Guanajuato itself fabulous wealth was most manifest in the elaborate and richly endowed churches notably La Valenciana and La Parroquia. The only post-Spanish building of significance is the Teatro Juárez, built during the Díaz regime. and an excellent example of both the romanticism and the ostentation which characterized the era.

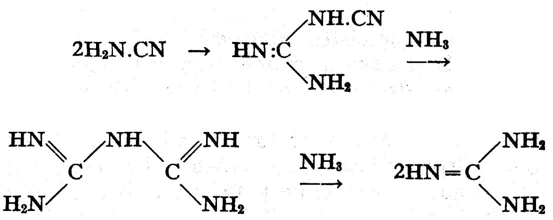
Guanajuato was the first major city to fall to the independence leader Hidalgo y Costillo in 1810. The plundering and destruction which accompanied the overrunning of the Alhóndiga de Granaditas (granary used as a fortress) were followed by subsequent struggles for control of the city which by 1822 had resulted in a greatly reduced output of the mines, through flooding, and the exodus of many wealthy families. Guanajuato entered a period of decline. which continued until the 1930s, when as a result of the increased tourist trade and federal support of mining and agriculture in the state, the city began a slow recovery which appeared to be continuing in the 1960s. It is the site of a national college. The Panteón, or public cemetery, has catacombs which contain mummies. (J. J. J.)

GUANCHES, the aboriginal inhabitants of the Canary islands. Now extinct as a distinct people, they were an offshoot of the Berbers of northern Africa, but were long isolated because of their lack of boats. The Carthaginians under Hanno found the archipelago uninhabited, but saw ruins of great buildings. This suggests that the Guanches were not the first inhabitants, and that this extreme westerly migration of Berbers took place between the time of which Pliny wrote and the conquest of northern Africa by the Arabs. The early Guanches lived in villages of stone houses and cultivated cereals and raised livestock. An hereditary class system distinguished nobles from commoners, and descent and inheritance of the chieftainship apparently was matrilineal. Studies of this extinct culture are of particular interest as suggesting the prototype of Berber culture before Arab influence was felt. Many of the Guanches fell in resisting the Spaniards in the late 15th century, many were sold as slaves and others conformed to the Roman Catholic faith and married Spaniards.

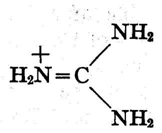
See also BERBERS.

See E. A Hooton, *Ancient Inhabitants of the Canary Islands,* Harvard African Studies, vol. 7 (1925); G. P. Murdock, *Africa,* chap. 15, with a bibliography (1959).

GUANIDINE is an organic compound of formula HN:C-$(NH_2)_2$. It was first prepared by Adolph Strecker in 1861 from guanine. which had been obtained from guano, and this is the origin of the name. The compound has been detected in small amounts in a variety of plant and animal products, but some of its derivatives are widely distributed and are of considerable importance, especially in the action of muscular tissue. It is closely related to urea. into which it is converted by hydrolysis. Guanidine is readily prepared from technical calcium cyanamide. This, when heated with water, gives dicyandiamide, which gives a good yield of guanidine when fused with an ammonium salt.



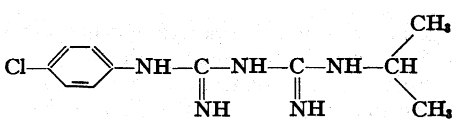
A variety of other syntheses are known, some of which (*e.g.*, the reduction of tetranitromethane and the action of ammonia on carbonyl chloride) give a simple indication of the constitution of the compound. Guanidine itself is a colourless crystalline solid that absorbs water and carbon dioxide from the air and is thus not easy to prepare pure, but the salts crystallize well, notably the carbonate and the nitrate. Guanidine as a base is much stronger than the majority of organic bases; its aqueous solutions have a conductivity approaching that of the alkali hydroxides and it forms stable salts even with acids as weak as boric and silicic acids. It behaves as a monacidic base only, and forms a cation — a positively charged ion — that can be written as



An X-ray crystal analysis of the iodide (W. Theilacker, 1935) shows, however, that, as might be expected, all three nitrogen atoms are identically linked in the ion and are symmetrically arranged in a plane around the carbon atom. This is caused by resonance between the three structures which can be written by allotting the positive charge to each of the three nitrogen atoms in turn. The resonance energy is the cause of the stability of the ion and hence of the strong basic character of the compound.

Uses.—Of the derivatives, nitroguanidine, obtained by the action of sulfuric acid on the nitrate, has been used to some extent as a constituent of explosives; its peculiarity is the low temperature produced in the explosion. Aminoguanidine and substituted aminoguanidine are intermediates in the synthesis of a variety of dyes and other heterocyclic compounds.

Two amino acid derivatives are of great physiological interest. Arginine, a guanidinyl-aminovaleric acid, $HN{:}C(NH_2).NH.$-$(CH_2)_3.CHNH_2.COOH$, is a constituent of proteins and particularly of protamines, but also plays an important part in nitrogen excretion in animals. With mammals this is largely excreted as urea, which is synthesized in the liver from ammonia and carbon dioxide by a series of reactions in which arginine is an intermediate. Creatine, methylguanidine-acetic acid, $HN{:}C(NH_2).NMe.CH_2.$-$COOH$, is present in large amounts in mammalian muscle, and its internal amide, creatinine, is excreted by mammals especially during growth. The contraction of muscle is known to derive its energy from the enzymatic hydrolysis of adenosine triphosphate and it is also known that one of the mechanisms whereby this substance is reformed in the muscle is by the action of creatine phosphate. The importance of the guanidine group in muscle is further shown by the fact that certain types of tetanus are associated with the occurrence of guanidine itself or of methylguanidine in the body, Other guanidine derivatives have proved to be of value as therapeutic agents. Synthalin (decamethylene-diguanidine) and related compounds have a specific effect in destroying trypanosomes; and sulfaguanidine, one of the least soluble of the sulfanilamide derivatives, is of great value in bacillary dysentery. Paludrine, the synthetic antimalarial, is a substituted biguanide (N_1-*p*.chlorophenyl-N_5-isopropyl-biguanide):



See also UREA. (T. W. J. T.)

GUANO the accumulated excrement and dead bodies of birds, bats or seals. Bird guano is mainly from fish-eating cormorants. pelicans. and gannets which populate some islands off the west coast of Peru. Lower California, and Africa up to 5,600,000 per square mile and consume 1.000 tons of fish daily. Exports from the Peruvian deposits began about 1810 and reached 50,000 tons in 1856. The government protects the seafowls and processes the guano uhich contains about 11% to 16% nitrogen, 8% to 12% phosphoric acid, and 2% to 3% potash in fertilizer terminology. Bat guano is found in caves throughout the world with significant deposits in Missouri (16,000 tons) and in a cave of the Grand Canyon (100,000 tons). Seal guano has accumulated to 230 ft. on the Lobos Islands off South America and to a lesser extent on the Island of Tortuga. Bat and seal guano are lower in fertilizing value than Peruvian guano. See also FERTILIZERS AND MANURES; PERU: *Economic* Conditions. (S. R. A.)

GUANTÁNAMO, a city in Oriente province, Cuba, about 40 mi. E. of Santiago de Cuba and about 60 mi. from the eastern end of the southern coast. Pop. (1953) 64.671. It is 10 mi. N. of Guantánamo bay, one of the largest and best sheltered bays in the world, having a narrow entrance into a harbour about 4 mi. wide and 12 mi. long. capable of accommodating large vessels. The bay is served by the ports of Caimanera and Boquerón uhich are linked by rail to Guantánamo.

The strategic importance of the bay close to the Winduard passage. which is between Cuba and Haiti and links the Atlantic to the Caribbean and Panama. was recognized by the United States during the Spanish-American War, when American marines landed at the bay. A large U S. naval base, including fortifications and airfields, was established by treaty in 1903.

The city is the centre of an agricultural region in which sugar cane and coffee are the main products. The chief industrial activities are coffee roasting, sugar milling, and the manufacture of chocolate. liqueurs and salt. Air traffic is active, owing to the difficulty of land cbmmunications in the mountainous eastern region of Cuba.

Guantanamo bay was named Cumberland bay in 1741 when an English force landed and attacked Santiago. The town was founded in 1819 and was called Santa Catalina del Saltadero del Guaso until 1843. French refugees from Haiti aided in the colonization of the area and many cultural characteristics. such as architecture, stem from their influence, as well as from a number of Catalan settlers. The old French-Creole atmosphere of earlier days has been changed somewhat by the activity and industry of the 20th century. (D. R. D)

GUAPORÉ (Spanish ITÉNEZ), a river of northeast Bolivia, which, with the Paraguay river. rises in the mountains of the state of Mato Grosso, Brazil. It flows to the northwest marking the frontier with Brazil until its confluence nith the Mamoré river (*q.v.*) several miles above the town of Guayaremerin. Proceeding north, the Amazon (q v.) may then be reached by way of the Madeira river (q *v.*), formed by the juncture of the Mamoré and Beni (*q.v.*) near the river port of Villa Bella, and the Madeira-Mamoré railroad via Pôrto Velho. The Guaporé is the largest affluent of the Mamoré. and is navigable along its course of about 1,000 mi. at any season of the year. The town of Mato Grosso, lying less than 100 mi. from the source of the Guaporé, may be reached by river craft. The Guaporé constitutes the border between the Brazilian state of Mato Grosso and the federal territory of Rondônia to the east, and the Bolivian departments of Santa Cruz and Beni to the nest. It flows through a forested region having a hot and humid climate which is almost uninhabited except for occasional settlements of Indians and mestizos along the banks. The Guaporé, in contrast with the brown silt-laden Mamoré. is a beautiful river with unusually clear water. For several miles below their juncture, the identity of the two streams can still be readily perceived.

The upper tributaries of the Guaporé, flowing largely from the slopes of the Serra dos Parecis, include the Branco, the Corumbiari, the Colorado. the São Miguel and the Cautario. Its affluents flowing from the south and southwest comprise the Paraguá, the Baures and the Itonamas. Ports of the Guaporé are Principe da Beira, which may be reached by air, Versalles, Pedras Negras and Santa Isabel. Historically, the region was witness to numerous frontier conflicts between the Spanish and Portuguese and the struggles of both with hostile Indians. Forte Principe de Beira, constructed near the confluence of the Guaporé and Mamoré in the late 18th century, is a reminder of this era. (J. L. TR)

GUARANA, the plant *Paullinia cupana* (or *P.* sorbilis) of the natural order Sapindaceae, indigenous to the north and west of Brazil. It has a smooth. erect stem; large, pinnate, alternate leaves with five oblong-oval leaflets; narrow panicles of short-stalked flowers; and ovoid fruit about as large as a grape and containing usually one seed shaped like a minute horse chestnut. Guarana, guarana bread or Brazilian cocoa is prepared from the seeds as follows. In October and November, when ripe, the seeds are sun-dried, to allow the ready removal by hand of the white aril; ground in a stone mortar or deep dish of hard sandstone; the powder, moistened with water, is made into a paste with a certain proportion of whole or broken seeds and worked up usually into rolls 5–8 in. in length, and 12–16 oz. in weight. After drying by heat, the guarana is packed between broad leaves in sacks or baskets. Thus prepared, it is of extreme hardness, has a brown hue, a bitter astringent taste and an odour faintly resembling that of roasted coffee. An inferior kind is manufactured by admixture of cocoa or cassava. Rasped or grated into sugar and water, guarana forms a popular beverage in South America.

Guarana owes its stimulant properties to its caffeine content, and its astringent action to tannin. In addition, guarana yields the glucoside saponin, with starch, gum, three volatile oils and an acrid green fixed oil.

GUARANIS, a group of South American Indian tribes, forming an important subdivision of the Tupian (*q.v.*) linguistic stock. At the time of the first arrival of Europeans, the Guarani tribes were spread over the region east of the Paraguay river in what is now Paraguay and the adjacent Argentine states of Corrientes and Misiones. and extended eastward along the upper Uruguay river some distance into the Brazilian states of Santa Caterina and Rio Grande do Sul. In the early portion of the 16th century, in part at least because of Spanish attacks, a considerable body left their homes and migrated westward to Bolivia, where, as the Chiriguanos and Guarayos, they settled in the Andean foothills and edge of the Chaco, expelling the older Chane and other Arawakan tribes.

The Guaranis, originally a very numerous people, were sedentary agriculturists, living in large palisaded villages of wood and thatch houses, and presented a strong contrast to the nomad hunting tribes to the west and south. The Guaranis became widely known as a result of the activities of the Jesuit missions—the Doctrinas de Guaranies—founded among them in the early years of the 17th century. The missions comprised in all about 30 settlements, where the Jesuits, in spite of attacks by slave raiders from the Portuguese territories (who in 1628–30 alone carried off 60,000 Indians) built up a community of great interest, which lasted until the expulsion of the order in 1768. In their primitive state the Guaranis often went entirely naked, and wore as their most characteristic ornament a long pendant labret in the lower lip. Although essentially agricultural, raising corn, manioc and sweet potatoes, they had a bad reputation for killing and eating prisoners taken in war. They appear to have had trade with the border regions of the Inca empire, from which they secured small quantities of gold ornaments and metal objects, which through them reached the Atlantic coast, where a few examples were found in the possession of the people by the earliest European explorers.

GUARANTEE. In law, a guarantee is a contract to answer for the payment of some debt, or the performance of some duty, in the event of the failure of another person who is primarily liable for such payment or performance. In order that there may be a contract of guarantee there must be a primary liability, present or future, of a principal debtor, and a promise made for valuable consideration by a third party (called the "surety" or "guarantor") to the creditor to discharge that liability if the principal debtor does not. The promise of the surety must be such that liability only arises in the event of the failure of the principal debtor to meet his obligations.

A contract of guarantee must be distinguished from a contract of indemnity. If A says to B, who is about to sell goods to C, "Let C have the goods; if he does not pay you, I will," this is an offer of a guarantee on the part of A But if A says to B, "Let C have the goods; I will see you paid," A's promise to pay is an original liability to indemnify B against any loss which he may incur in letting C have the goods, and not a promise to answer for C s debt. *(Birkmyr* v *Darnell,* 1704, I Sm. LC. 12th ed p 335) So "if a man says to another, 'If you mill at my request put your name to a bill of exchange, I will save you harmless', that is a contract of indemnity. It is not a responsibility for the debt of another. It amounts to a contract by one that, if the other will put himself in a certain situation, the first will indemnify him against the consequences" *(per* Pollock, C.B. in *Batson* v. King, 1859, 4 H. & N at p 740). The distinction is important, for a contract of guarantee is not enforceable unless it is evidenced by some note or memorandum in writing, whereas no written note or memorandum of the agreement is required in the case of a contract of indemnity.

The common law requisites of a contract of guarantee in no way differ from those essential to the formation of any other contract. That is to say, they comprise the mutual consent of the parties, competency to contract, and, unless the guarantee be under seal, valuable consideration. The consideration may consist of some advantage given to, or conferred on, the principal debtor by the creditor at the surety's request, *e.g.,* an advance of money to the principal debtor. Or it may take the form of a forbearance on the part of the creditor at the surety's request to sue the principal debtor. In some guarantees the consideration is given once for all, as where a third person guarantees that, in consideration of a lessor granting a lease, he will be answerable for the lessee paying the rent and performing the covenants; in other cases it is supplied from time to time, as where a guarantee is given to secure the balance of a running account at a banker's, or a balance of a running account for goods supplied. *(See* the judgment of Lush, L. J. in *Lloyd's* v. *Harper,* 1881,16 Ch. D .at pp. 319, 320).

The statutory requisites of a contract of guarantee are prescribed by s. 4 of the Statute of Frauds 1689 (29 Car. II. c. 3), which provides that "no action shall be brought whereby to charge the defendant upon any special promise to answer for the debt, default, or miscarriage of another person . . . unless the agreemrnt upon which such action shall be brought, or some memorandum or note thereof, shall be in writing and signed by the party to be charged therewith, or by some other person thereunto lawfully authorized." A promise to give a guarantee is as much within the statute as the guarantee itself. But a promise to procure another person to sign a guarantee for the debt of another is not within the statute. though the guarantee would be. The statute does not invalidate a verbal contract of guarantee, but only renders it unenforceable by action. It may, therefore, be available in support of a defence to an action, and money paid under it cannot be recovered.

To satisfy s. 4 of the Statute of Frauds, the agreement, or the note or memorandum thereof, must set out all the material terms of the guarantee; it must name or unmistakably identify the parties thereto, and must also state the liability guaranteed and the time during which the guarantee is to continue. It is not necessary that the agreement, or memorandum, should contain any statement of the consideration given to the surety in return for the guarantee (Mercantile Law Amendment Act 1856, s. 3). The agreement, or memorandum, must be signed by the surety or by some duly authorized agent on his behalf. In the case of a joint and several guarantee all the sureties must sign the agreement or memorandum, otherwise none will be liable thereunder (*National Provincial Bank of England* v. *Brackenbury,* 1906, 22 T.L.R. 797).

The promise of a *del credere* agent (*q.v.*) which binds him in consequence of the higher consideration he receives to make no sale on behalf of his principal except to persons who are solvent, and renders him liable for any loss that may result from the nonfulfilment of his promise. is not within the statute, and need not be in writing, for, though such promise may terminate in a liability to pay the debt of another, that is not the *immediate* object for which the consideration is given (*Coutourier* v. *Hastie,* 1852, 8 Exch. 40, j6).

4 contract of guarantee may be limited to a single transaction, or may cover a number of transactions extending over a period of time—as where a guarantee is given in respect of money to be advanced, or goods to be supplied, to the principal debtor—and remains a standing security until it is revoked either by act of the parties or by death of the surety. It is then called a continuing guarantee. A cause of action thereon arises in respect of each item of account (whether principal or interest) as soon as that item falls due and is unpaid, and, consequently, the Statute of Limitations begins to run in the guarantor's favour in respect of each item from that moment (*Parr's Banking Co. Ltd.* v. *Yates,* 1898, 2 Q. B. 460).

Liability of Surety.—Before the surety can be rendered liable on his guarantee, the principal debtor must have made default. When, however, this has occurred, the creditor, in the absence of express agreement to the contrary, may sue the surety, without even informing him of such default having taken place, or requiring him to pay, and before proceeding against the principal debtor or resorting to securities for the debt received from the latter. The surety's liability is limited to the amount which he has undertaken to pay on default of the principal debtor. This amount may be equal to the sum due from the principal debtor, or it may be less than such sum. If the guarantee is one which the surety has entered into jointly with others, he is still liable to pay the whole amount he has agreed to pay on the debtor's default, unless the guarantee otherwise expressly provides. His right of contribution against his co-sureties may be a partial indemnity, but cannot, in the absence of agreement binding the creditor, compel the creditor to proceed against the other sureties. Should the surety become bankrupt. either before or after default has been made by the principal debtor, the creditor will have to prove against his estate. This right of proof is regulated by s. 30 of the Bankruptcy Act 1914, which is most comprehensive in its terms.

Rights of Surety Against Principal Debtor.—The surety can recover, with interest, from the principal debtor all money properly paid when due on account of the guarantee, provided of course that the guarantee was made with the principal debtor's consent. In the event of the principal debtor's bankruptcy, the surety can, if the. creditor has not already proved in respect of the guaranteed debt, prove against the bankrupt's estate, not only in respect of payments made before the bankruptcy of the principal debtor, but also, it seems, in respect of the contingent liability to pay under the guarantee. The surety is also entitled to enforce against the debtor the rights which the creditor enjoyed with respect to the debt in question. Moreover, a surety has the right *before* payment to compel the principal debtor to relieve him from his liability by paying off the debt, if the debt is actually due and the surety admits liability. In such a case it is not necessary to prove that the creditor has refused to sue the principal debtor *(Ascherson* v. *Tredegar Dry Dock and Wharf Co. Ltd.,* 1909, 2 Ch. 401).

Rights of Surety Against the Creditor.—The surety, on payment of the debt, is entitled to the benefit of the securities in the hands of the creditor. whether he knew of them or not at the time of contracting; including all securities which the creditor may have acquired since the date of contracting; and where, by the default or laches of the creditor, such securities have been lost or rendered otherwise unavailable, the surety is discharged *pro tanto.* If the surety is surety for part of the debt only. his rights to the securities also are but partial (*Goodwin* v. *Gray,* 1874, 22 *W.R.* 312). On this subject the Mercantile Law Amendment Act 1856, s. 5, provides that "every person who, being surety for the debt of another, or being liable with another for any debt or duty, shall pay such debt or perform such duty, shall be entitled to have assigned to him, or to a trustee for him, every judgment, specialty, or other security which shall be held by the creditor in respect of such debt or duty, whether such judgment, specialty, or other security shall or shall not be deemed at law to have been satisfied by the payment of the debt or performance of the duty, and such person shall be entitled to stand in the place of the creditor, and to use all the remedies, and if need be, and upon a proper indemnity, to use the name of the creditor in any action or other proceeding, at law or in equity, in order to obtain from the principal debtor, as the case may be, indemnification for the advances made and loss sustained by the person who shall have so paid such debt or performed such duty; and such payment or performance so made by such surety shall not be pleadable in bar of any such action or other proceeding by him; provided always, that no co-surety, co-contractor, or co-debtor, shall be entitled to recover from any other co-surety, co-contractor, or co-debtor, by the means aforesaid, more than the just proportion to which, as between those parties themselves, such last-mentioned person shall be justly liable."

Right of Surety Against Co-sureties.—A surety on payment of the debt, or more than his proportion, is entitled to contribution from his co-sureties in respect of the excess. This right is not founded originally upon contract, but upon a principle of equity, though it is now established to be the foundation of an action. It exists whether the sureties are bound jointly, or jointly and severally, and whether they are bound by the same or different instruments. If the principal debtor makes default, all must contribute equally, if each is a surety to an equal amount, and if not equally, then proportionately to the amount for which each is a surety (*Ellesmere Brewery Co.* v. *Cooper and Others* 1896, *Q. B.* 75). In counting the number of sureties for this purpose, those unable to pay are not reckoned. Thus where four sureties are jointly and severally bound in a surety bond, and one of them pays the amount of the bond, but one of the remaining three sureties is insolvent, the right of contribution against the two other sureties is for thirds, not for fourths, of the sum paid (*per* Lord Esher, *M.R.*, *ibid.*, at p. 80). But a surety is not entitled to call upon his co-sureties for contribution until he has paid more than his proportion, either of the whole debt or of that part which remains unpaid, even though his co-sureties have not been required by the creditor to pay anything (*Ex parte Snowdon,* 1881, 17 Ch. D. 44). And so where the debt guaranteed is payable by instalments, a surety cannot call on his co-sureties to contribute until he has paid more than his proportion of the entire debt. The fact that he has paid more than his share of the instalments which have come due will not entitle him to contribution (*Stirling* v. *Burdett,* 1911, 2 Ch. 418).

A surety against whom judgment has been obtained by the principal creditor for the full amount of the debt can, before paying the amount, maintain an action against his co-sureties to compel them to contribute towards the common liability, and where the principal creditor is a party to the action, the surety may obtain an order directing the co-sureties to pay their proportions to the creditor (*Wolmershausen* v. *Gullick,* 1893, 2 Ch. 514).

The right of contribution is not the only right possessed by a surety against his co-sureties; he is also entitled to a share in every counter-security which his co-sureties may have obtained from the principal debtor, and such security must be brought into hotchpot, in order that the ultimate burden may be distributed between the sureties equally, even though the co-sureties consented to become sureties only upon the terms of having the security (*Steel* v. *Dixon,* 1881, 17 Ch. D. 825).

Discharge of Surety.—The surety will be discharged on any of the grounds which suffice to terminate contracts in general, and also on the following which are peculiar to contracts of guarantee. In the case of a guarantee for the fidelity of a servant, the non-disclosure by the employer to the surety of the fact that the servant had previously been guilty of dishonesty in his employment will avoid the contract although such non-disclosure was not fraudulent (*London General Omnibus Co. Ltd.* v. *Holloway,* 1912, 2 K.B. 72). On the other hand, in the case of a guarantee given to a banker to secure an overdraft, the mere non-disclosure by the banker to the surety of the fact that, at the time when he signed the bond, the customer was already indebted to the banker for the full amount of the credit and payment had been requested by the banker, will not avoid the contract, for the bank cannot reasonably be taken as affirming, by mere silence respecting earlier dealings, the financial ability of the customer whom the surety is asked to guarantee (*Hamilton* v. *Watson,* 1845, 12 Cl. & F. 109). Fraud subsequent to the execution of the guarantee (as where, for example, the creditor connives at the principal debtor's default) will certainly discharge the surety. Again, a material alteration made in the terms of the contract between the creditor and the principal debtor, without the assent of the surety, will discharge the surety, unless it is self-evident that the alteration cannot prejudice the surety; the surety himself being the judge as to the materiality of the alteration (*Holme* v. *Brunskill,* 1878, 3 Q.B.D. 495).

Giving time to the principal debtor without the surety's consent will discharge the surety, and for this reason, because the creditor by giving time deprives the surety of his right to pay off the debt which he has guaranteed and to sue the principal debtor (*Samuel* v. *Howarth,* 1817, 3 Mer. 272). But to produce this result there must be a binding contract to extend the time for payment, not merely by a forbearance of the creditor to enforce his rights, and the contract must be with the principal debtor. A contract with a stranger, or even with a co-surety, to give time to the principal debtor, will not prevent the surety discharging the debt and pursuing his remedy over against the principal debtor, and will not discharge the surety from liability (*Frazer* v. *Jordan,* 1858, *8 E.* & B. 303; *Clarke* v. *Birley,* 1889, 41 Ch. D. 422).

To the rule that time given to a principal debtor discharges a surety there is an important exception. A surety is not released by an agreement to give time to the debtor if the creditor expressly reserves his rights against the surety. The reasons why the reservation by the creditor of his rights against the surety does not release the latter are (i.) because it rebuts the implication that the surety was meant to be discharged, and (ii.) because it prevents the rights of the surety against the principal debtor being impaired, for the principal debtor, by consenting to the creditor reserving his rights, impliedly agrees that the surety shall have recourse against him, and he may, notwithstanding the agreement, pay the creditor and enforce his rights against the debtor (*Kearsley* v. *Cole,* 1847, 16 M. & W. 128, at p. 135). The rule also does not apply where time is given to the principal debtor after a judgment has been recovered by the creditor against both the principal debtor and the surety; the judgment creates a new liability in respect of which the judgment debtors are in the same position (*in re a Debtor,* 1913, *3* K.B. 11).

An absolute release of the principal debtor will discharge the surety. But a covenant not to sue the principal debtor, qualified by a reservation of rights against the surety, allows the surety to retain all his remedies against the principal debtor and will not discharge him from liability (*Price* v. *Baker and Another,* 1855, 24 L.J.Q.B. 130). A release by the creditor of one of two or more co-sureties will discharge all (*Evans* v. *Brembridge,* 1856, 25 *L.J.* Ch. 334). This is not so, however, if the sureties contract severally (*Ward* v. *National Bank of New Zealand,* 1883, *8* App. Cas. 755).

A surety is discharged if the creditor takes a new security from the principal debtor in lieu of the original one, or by his wilful neglect or default loses the securities which he holds, or deals with the securities in such a way as to deprive the surety of the means of recouping himself by them.

A guarantee, the consideration for which is given once for all (as where a third person guarantees that in consideration of the lessor granting a lease, he will be answerable for the lessee paying the rent), cannot be determined by the surety, and does not cease on his death (*Lloyd's* v. *Harper,* 1881, 16 Ch. D. 290). On the other hand, when the consideration for a guarantee is fragmentary, supplied from time to time, and therefore divisible (as where a guarantee is given to secure the balance of a running account at a banker's), the surety may at any time terminate the guarantee, and notice of death of the surety will put an end to his liability (*Coultlzart* v. *Clementson,* 1880, 5 Q.B.D. 42). But the death of one of the co-sureties under a joint and several continuing guarantee does not by itself determine the future liability of the surviving cosureties *(Beckett & Co. v. Addyman,* 1882, *9* Q.B.D. 783).

A continuing guarantee given either to a firm or to a third person in respect of the transactions of a firm is, in the absence of agreement to the contrary, revoked as to future transactions by any change in the constitution of the firm (Partnership act, 1890, s. 18).

A surety who has executed a guarantee on the faith that another person will also become a surety is wholly discharged from liability if that other person refuses to do so, or for any other reason does not join in the guarantee *(Evans v. Brembridge,* 1853, 25 L.J. Ch. 334).

A discharge in bankruptcy of the principal debtor, or the acceptance by his creditors of a composition or scheme, will not release from liability a person who was surety for his debts (Bankruptcy act 1914, s. 28, subs. 4; s. 16, subs. 20).

The statutes of limitation bar the right of action against a surety after 20 years if the guarantee was under seal; and in the case of other guarantees, after six years from the date of the accrual of the cause of action, that is to say from the date on which the creditor might have sued the surety. Where, by the express terms of the guarantee, the surety is only liable to pay after demand, time does not begin to run until after demand to pay has been made upon him.

See Sir S. A. T. Rowlatt, *Law of Principal and Surety,* 2nd ed. (1926); T. Hewitson, *Suretyship, its Origin and History* (1927).

(C. GA.)

THE UNITED STATES

There have been repeated efforts by U.S. courts and legal writers to distinguish a surety from a guarantor; the effortshave failed, since hardly two of them find the same line of distinction; hence, in the United States as in England the two terms became substantially synonymous. But in some U.S. states a statement of the consideration in the memorandum of a contract of guarantee became a requirement if the contract is to be enforceable. Furthermore, laches in the creditor's dealing with any security he may hold, to be sufficient in U.S. law to discharge the creditor's claim against the surety, must either involve affirmative action, or must consist in failing to take simple, standard, businesslike precautions: such as recording a mortgage, or so presenting a negotiable note as to keep the endorsers from being discharged. But mere failure to enforce the security before it depreciates in value will not in the United States be considered such laches, the judicial view being that the surety's remedy is to pay off the debt and then realize on the security himself. It is hard to see why the surety should be forced thus to strain his resources; it is equally hard to reconcile the harshness against the surety of this rule with the extreme leniency found in discharging him by reason merely of extension of time to the principal. The two lines of precedent grew up separately, and did not come into contact until both were set.

Two other divergences from the English law as stated above need notice: the periods of the statute of limitations differ among the U.S. states; and the fact that a surety stipulated that a cosurety be procured, or other condition be fulfilled, will not, commonly, discharge him as against a creditor who has relied upon surety's signature without notice of stipulation or condition.

Corporate Suretyship.—In the United States a great and growing part of suretyship business is in the hands of professional surety companies, which write surety bonds for a premium calculated on loss-expectancies, and which in cases involving any considerable risk take measures to assure themselves of indemnity in advance of loss. In the case of such "compensated sureties" the courts tend distinctly to tighten up the law in favour of the creditor, so that the older tendency to construe the contract narrowly, and employ every possible loophole to let the surety out, is limited to the cases out of which it originally grew: those of the friend or family member who has lent his credit, without compensation, in an individual case. Hence the bonds of surety companies are approaching, in law as in social function, policies of insurance.

They are perhaps of peculiar importance in the field of guaranteeing the fidelity of trusted employes or of public officers (where the check-up system of the bonding companies goes some distance toward anticipatory prevention of frauds) and in that of contracts for building and public works. It should be noted that these bonding companies are not, like most corporations, without charter power to enter into binding contracts of suretyship; also that the larger modern business corporations are commonly being given charter power to become surety at least for their own subsidiaries. Hence guaranteed bonds are becoming familiar in the market. To be distinguished from suretyship, in law though not in function, is the growing practice among bankers of accepting negotiable paper *(see* BILL OF EXCHANGE) on behalf of their customers for a commission; this is not in strictness suretyship, not only because the customer's obligation in all probability ceases when the banker's is given, but because, in any event, the customer's liability must be conditional on prior dishonour by the banker.

Bail Bonds.—A field of suretyship, finally, which deserves special mention because of the abuses encountered in practice, is that of the bail bonds given to secure the supposedly temporary release of persons charged with crime.

The bail is forfeited if the accused disappears; this is supposed to force the bondsman to keep a constant eye on the accused. But the practice of allowing professional bondsmen to sign bonds totalling far in excess of their available assets, together with the difficulty of getting suit prosecuted against such as are politically influential, made this phase of suretyship a serious hindrance to convictions.

See E. C. Arnold, *Outlines of Suretyship and Guaranty* (1927), *Missouri Crime Survey,* part v (1926). (K. N. L.)

GUARAUNAN: *see* WARRAU.

GUARDA, an episcopal city of Portugal on the Guarda-Abrantes and Lisbon-Vilar Formoso railways. Pop. (1950) 7,704. It is 3,370 ft. above sea level, at the northeastern extremity of the Serra da Estrêla, overlooking the fertile valley of the river Côa. It contains a ruined castle, a fine 16th-century cathedral and a sanatorium for tuberculars. Its industries comprise the manufacture of coarse cloth. In 1199 Guarda was founded, on the site of the Roman Lencia Oppidana, by Sancho I of Portugal, who intended it to be a "guard" against Moorish invasion. The administrative district of Guarda coincides with northeastern Beira; pop. (1940) 294,166, (1950) 307,667; area 2,122 sq.mi.

GUARDI, FRANCESCO (1712–1793), Venetian landscape and figure painter, and his brother NICOLÒ (1715–86), were trained under their elder brother, GIOVANNI ANTONIO (*q.v.*) (1699–1760). By 1731 the brothers are recorded as collaborating in a studio which specialized in supplying paintings together with copies of others' works. About 1738 an uncle presented a group of religious and decorative paintings produced in this studio to the church at Vigo d'Anaunia (Trentino) of which he was the parish priest. Works of like character are also known, notably altarpieces at Belvedere di Aquileia (*c.* 1746) and Cerete Basso (*c.* 1755), the celebrated "Story of Tobias" panels in the church of the Angelo Raffaele in Venice (before 1750), two large allegorical figures in the Ringling museum, Sarasota, and two secular paintings, the "Ridotto" and the "Parlatorio" in the Museo Correr (Cà Rezzonico). Very few works of this type are signed, but a number of figure paintings, still-lifes, etc., have been attributed to the Guardi studio, though the individual contributions of Francesco and Gianantonio are hotly disputed, it would seem there was fairly extensive collaboration between them. Nicolb's part remains completely obscure.

Francesco does not appear to have adopted the practice of view painting, on which his fame rests, before the mid-1750s or later. Perhaps he was impelled by the approaching death of Gianantonio and the relative absence of competition in this profitable field except from the aging and then unproductive Canaletto. It is possible, but not certain, that he actually worked with Canaletto at this period. His earliest views are almost always signed or initialed as though to draw attention to his new artistic aims and seem inspired by Canaletto's own works of 30 years before. Francesco certainly copied Canaletto's compositions, notably in the "Feste Dogali" painted from engravings after Canaletto drawings; he often based capricious landscape compositions (like his earlier subject paintings) on the works of other artists.

In 1782 he depicted the official celebrations in honour of the grand duke Paul's visit to Venice, basing at least one of the compositions on commonplace contemporary engravings. Later in the year he was commissioned by the republic to make similar records of Pius VI's visit. the contract specifically forbidding such copying. He enjoyed considerable favour with the English and other foreigners and his late election to the Academy (1784) was doubtless, like Canaletto's. due only to the low esteem which landscape painting then enjoyed. His works are not easily datable, though the costumes occasionally provide a clue; his later landscapes are generally more sparkling and lighter than his first view paintings. He was an exceedingly prolific artist whose scintillating and romantic impressions of the declining city are in marked contrast to Canaletto's limpid photographic records of its architecture.

See G. Fiocco, *Fvancesco Guardi* (1923) ; J. Byam Shaw, *The Drawings of Francesco Guardi* (1951) ; A. Morassi, *Conclusioni su Antonio e Francesco Guardi* (1951) ; V. Moschini, *Francesco Guardi* (English trans. with full bibliography, 1957). (F. J. B. W.)

GUARDI, GIOVANNI ANTONIO (GIANANTONIO) (1699–1760), Venetian painter of religious and figure subjects, was born in Vienna in May 1699, the son of a modest painter, Domenico Guardi. in whose studio at Venice he was trained. After his father's death in 1716 Gianantonio worked for a time under Pittoni before opening his own studio. Here, he and his two brothers Francesco (*q.v.*) and Nicolò, specialized in paintings of religious and genre subjects as well as copies of earlier masters: frequently of minimal significance. Only one painting signed by Gianantonio. a "Death of St. Joseph" (Berlin), survives. though a few signed drawings are known. With his brothers he probably worked on the decoration of the sacristy of the parish church at Vigo d'Anaunia in the Trentino (1735–38).

There is still much dispute about the precise part played by each of the three brothers in these and other works, such as the now famous paintings on the organ loft in the church of the Angelo Raffaele at Venice with the story of Tobias (before 1750) and the altarpieces in the parish churches at Belvedere di Xquileia and Cerete Basso (*c.* 17jj). Gianantonio Guardi died in 1760 at SS. Apostoli.

See F. de Maffei, *Gian Antonio Guardi, pittore di figure* (1951) ; C. Donselli, I *Pittori Veneti del Setteconto* (1957), with up-to-date bibliography. (F. J. B. W.)

GUARDIAN, one who guards or defends another, a protector. The Old French *guarden, garden,* modern *gardien,* from *guarder, garder,* is of Teutonic origin, from the base *war-,* to protect; compare the O. H. German *warten* and the English "ward"; thus "guardian" and "warden" are etymologically identical, as are "guard" and "ward." Compare the use of the correlatives "guardian" and "ward," *i.e.* a minor, or person incapable of managing his affairs, under the protection or in the custody of a guardian.

For the position of guardians of the poor *see* POOR LAW and for the legal relations between a guardian and his ward *see* CHILDREN: PROTECTIVE LAWS.

GUARDS AND HOUSEHOLD TROOPS. From antiquity heads of state have maintained special troops who served as personal bodyguards. Such was the function of the praetorian guard, founded in 27 B.C. by Augustus Caesar, and of the housecarls of the Anglo-Saxon kings. Steady expansion in numbers of such picked troops led to their employment as a *corps d'élite* in battle. This occurred with the "Immortals" of Xerxes and Philip II of Macedon's *hetairoi,* and later the Mamelukes of Egypt and the Turkish Janizaries. (*See* JANISSARIES; MAMELUKE; STRELITZ.)

Early Bodyguards. — In the Hundred Years' War a contingent of Scottish archers was recruited in 1418 as an elementary *gnrde du corps* for the French monarch. When Charles VII formed his *maison du roi* in 1440, this company took senior rank. The second company of the *garde du corps* was enrolled by Louis XI in 1479, the third by Louis XII in 1514 and the fourth by Francis I in 1jqj. Sir Walter Scott's *Quentin Durward* gives a picture of life in the corps as it was under Louis XI. Only marshals of France could be captains of the *garde du corps.* As minister of state to Louis XIII, Cardinal Richelieu recruited a personal bodyguard of musketeers. In 1671 came the establishment of the *maison militaire du roi,* of which the senior corps was the *gendarmes de sa majestie.* Then came the *chevaux légers* (given the standing of household troops by Henry III), the *première* and *seconde compagnie* de *mousquetaires* a *cheval,* who provided their own equipment and were trained as dragoons. Lastly, companies of gendarmes were titularly commanded by the queen, the dauphin and the royal dukes. The duties of the *gardes de* la *porte* and the *cent Suisses* were more those of a personal bodyguard.

In England, the king's bodyguard or the yeomen of the guard (*q.v.*), raised by Henry VII in 1485, was not called upon to take the field. But the present-day honourable corps of gentlemen-at-arms. instituted as "the nearest guard" or "king's speres" by Henry VIII in 1509. accompanied the king to France and was actively engaged at Guinegate (the battle of the Spurs) in 1513 and in the siege of Boulogne in 1544. The corps was sometimes known as the gentlemen-pensioners. It last appeared under arms at the time of the Chartist disturbances in 1848. Reconstituted on a purely military basis in 1862, only officers entitled to a war decoration were eligible for appointment. 'The establishment consists of a captain, lieutenant. standard-bearer, clerk of the cheque and adjutant. subofficer and 39 gentlemen-at-arms. The office of captain is a political appointment, the holder (always a peer) relinquishing his post on a change of government.

The English gentlemen-at-arms and the pope's Swiss guard, founded in 1505 and still garbed in the uniform designed by Michelangelo, are the two oldest bodyguards surviving; the pontiff's noble guard was not founded until 1801. In 1527, when the Austrians invaded Rome, the Swiss guard perished to a man in covering the flight of Clement VII from the Vatican.

Mounted Guards. — During England's Great Rebellion, Charles I's life guard consisted of four companies of Cavalier gentlemen. Parliament also established a body of life guards, which was reviewed by Oliver Cromwell in Tuttle fields in April 16j6.

During Charles II's exile about 80 expatriate Cavaliers, under Lord Gerrard, served as the king's life guard. With the Restoration in 1660 these faithful followers formed the "1st or his majesty's own troop of guards." The 2nd troop was mostly made up of men who had soldiered as the "duke of Tork's guards" in the Spanish service. On the death of Gen. George Monk in 16jo his "duke of Albemarle's troop" became the 2nd or queen's troop, the duke of York's troop becoming the 3rd. In 168j the 1st and 2nd troops were styled Life Guards of Horse. Two years later the blue-coated Royal Regiment of Horse, a parliamentary "New Model" regiment disembodied in 1660 and immediately re-enrolled. was elevated to the status of a household cavalry corps. In 1690, while on station in Ireland with some of William III's Dutch "Blue guards," the name of the "Oxford Blues" was bestowed on the British formation, after the earl of Oxford, its colonel. The 1st troop (1693–1788) and Scots troop (1702–88) of Horse Grenadier guards were absorbed when the household cavalry was reorganized to form the 1st and 2nd regiments of Life guards and the Royal Horseguards Blue, the latter title being officially changed to that of the Royal Horse guards (the "Blues") in 1819. In 1922 the 1st and 2nd Life guards were amalgamated.

The "Tins" (Life guards) and the "Blues" wear a scarlet and a deep blue tunic respectively, white metal helmets with white or (for the "Blues") red horsehair plumes, steel cuirasses, buckskin breeches and jack boots with spurs. Their bands are arrayed in richly laced coats and wear blue velvet "jockey" caps. Their senior noncommissioned officers are known as corporal majors and corporals of horse. Since the battle of Dettingen in 1743 they have participated in all major wars; particularly distinguishing themselves at Waterloo.

Foot Guards. — In 1656, during his exile in Holland, Charles II of England recruited a small bodyguard of foot, which was merged in the regiment of guards enrolled at the Restoration in 1660. On St. Valentine's day, 1661, on Tower hill: what had been the

Lord General's Regiment of Foot guards, formed by Oliver Cromwell in 1650, took up its arms as an "extraordinary guard" for the sovereign. Having marched from Coldstream, near Berwick-upon-Tweed, it acquired the title of the Coldstream guards; and its motto of *nulli secundus* sufficiently denotes its denial of precedence to the 1st guards. The latter acquired their title of Grenadier guards and their bearskin headdress—subsequently adopted by the rest of the guards brigade—by virtue of their defeat of Napoleon's grenadier guards at Waterloo. The Scots guards, at one time known as the Scots Fusilier guards, were raised in 1662, being a re-creation of Charles I's Scottish Foot guards of 1643 They were put on the same footing as the other two guards regiments with the Act of Union of 1707.

No further addition was made to the brigade until 1900, when Queen Victoria was pleased to command that the Irish guards be formed. in tribute to the fighting quality of the Irish regiments in the South African War. In 1915 the representational nature of the brigade was rounded off by the formation of the Welsh guards.

The guards brigade serves as a personal bodyguard to the sovereign and as a *corps d'élite* in the field. There has been no major conflict in which it has not taken full part; and it can expand into machine-gun companies, armoured formations and other specialized units as occasion may demand. The battalions regularly take their turn of garrison duty overseas.

The governor general's bodyguard in Canada is furnished by a guards formation organized, equipped and uniformed on similar lines to the British guards brigade. In India, up to 1947, the viceroy's bodyguard consisted of scarlet-coated native lancers with British and Indian officers.

The Royal Company of Archers, the British sovereign's bodyguard for Scotland, derives from the ancient archer guard of the kings of Scotland. It was constituted in its present form in 1676.

Bodies of Guards Containing Both Cavalry and Foot.— Frederick William of Brandenburg (1620–88) scoured Europe for giants to lure into his regiment of household guards. But Frederick the Great substituted an effective fighting force for what hitherto had been largely an ornamental bodyguard. The tradition was preserved by imperial Germany. whose white-clad. silver-helmeted *Kürassier* headed the heavy cavalry in 1870 and. in Field gray, were again in action in 1914, as were the Prussian foot-guard regiments.

The national guard of revolutionary France. composed of citizen-soldiery, was neither a bodyguard nor a *corps d'élite*, but a kind of militia. Napoleon created a small corps of "guides" to act as a personal escort throughout his Italian and Egyptian campaigns. A consular guard was instituted in 1799, and out of this grew the formidable body of troops, representative of all arms of the service and including the veteran "old guard," the "middle guard" and the "young guard," that made up the emperor's imperial guard. In 1813 this totaled 81.000 officers and men. Napoleon III sought to revive the glories of the imperial guard, adding the decorative *cent gardes* to his household troops. The *garde républicaine* was made responsible for ceremonial duties about the French president.

There are Swedish, Danish and Monagasque royal guards, and a presidential guard in Italy, which includes a unit of cuirassiers in white uniforms and gilt helmets crowned with horsehair. Before World War I the Balkan kingdoms invariably boasted highly decorative bodyguard formations, although Rumania's Iron Guard developed into a partisan association of extreme political views. The emperor of Ethiopia recruits a large imperial guard.

(R. C. H.)

GUÁRICO, a state in central Venezuela: bordered on the north by outliers of the central highlands and on the south by the Orinoco river and two of its tributaries, the Xpure and the Portuguesa. Pop. (1950) 164,523. Area 25,637 sq.mi. A typical llanos region, Guarico is primarily cattle country. Corn, cotton and tobacco are grown along the rivers; coffee, cacao and sugar cane are produced in the north. Some oil has been discovered, but production is limited. The state capital is San Juan de los Morros (pop. 1950 est. 13,764). Calabozo (*q.v.*), the old capital, and Valle de la Pascua are trading and agricultural centres. (L. WE.)

GUARIENTO, (d. between 1368 and 1370), Italian painter who was, under the influence of Giotto, the first Paduan artist to detach himself from the Byzantine tradition. He is mentioned in Paduan records as early as 1338, In 1365 he was invited by the Venetian authorities to paint a "Paradise." and some incidents of the war of Spoleto, in the great council hall of Venice. These works were greatly admired at the time, but disappeared under over paintings of later periods. In 1903 the fresco of "Paradise" was uncovered. transferred onto canvas and exhibited at the Doge's palace. Guariento's works in Padua have suffered much. In the church of the Eremitani are allegories of the Planets. and. in its choir, some small sacred histories in dead colour. such as an "Ecce Homo"; also, on the upper walls, the life of St Augustine, with some other subjects. A few fragments of other paintings by Guariento are still extant in Padua. In the gallery of Bassano is a "Crucifixion" by him.

GUARINI, GIOVANNI BATTISTA (1538–1612), Italian poet author of *Il Pastor fido,* a pastoral dramatic poem which became very popular throughout Europe and reflected and influenced the manners of the age. He was born at Ferrara, Dec. 10, 1538 six years before Tasso whose friend he became, and whose poetic achievement he rivaled, at least in contemporary esteem. He studied at Pisa and Padua. and, before he was 20. became professor of moral philosophy in his native city In 1567 he entered the service of Alfonso II, duke of Ferrara. Guarini aimed at state employment as the serious business of his life, and was sent on various embassies and missions by the duke. But he spent his time and money to little purpose, suffered from the spite and ill will of two successive secretaries to the duke, quarreled with his old friend Tasso and at the end of 14 years of service found himself half ruined, uith a large family and no prospects. When Tasso was condemned to S Anna. the duke promoted Guarini to the vacant post of court poet. He found the position uncongenial, and retired in 1582, to his ancestral farm. the Villa Guarina, where he wrote *Il Pastor fido* In 1585 he was at Turin whence Alfonso recalled him to Ferrara, and gave him the office of secretary of state. This reconciliation did not last long Guarini moved to Florence. then to Rome. and back again to Florence, to the court of Ferdinand de Medici, and finally took refuge in Ferrara. His last years were passed in study. lawsuits and polemical disputes with his critics. until his death at Venice, Oct. 7, 1612.

Il Pastor fido, published in 1590 and first performed at the carnival at Crema in 1595, is a pastoral tragicomedy. set in an Arcadia of idyllic urbanity. It is occasionally reminiscent of *Aminta,* Tasso's earlier work in the same *genre,* but lacks his lyrical simplicity. The brilliant polish of its diction is sometimes flaned by the contemporary faults of frigid conceits and forced antitheses, and by sententious maxims revealing the moralist rather than the poet. Yet it lives as an expression of late 16th-century Italian society. and of an attitude toward life at once pagan, sensual and refined. proper to an age of social decadence. Its fame was widespread and its influence great, and for nearly two centuries it was regarded as a code of gallantry and shared with *Aminta* a prominent position in European literature, becoming a guide to manners as well as their mirror. It was several times translated into English. most notably by Sir Richard Fanshawe (1647). Contemporaries criticized its departure from Aristotelian rules of dramatic structure, against which Guarini wrote an able defense, in *Compendio della poesia tragicomica.* He also wrote a comedy in prose, *L'Idropica,* miscellaneous *Rime,* and some polemical works.

BIBLIOGRAPHY.—Guarini's works were published in 4 vol. (1737–38) The best contemporary edition of *Il Pastor fido* was the 20th (1602); there is a modern critical edition, *Il Pastor Fido e Il Compendio della poesia tragicomica,* by G. Brognoligo (1914). *See* also V Rossi, *G B. Guarini ed il Pastor Fido (1886)*; G. Grillo, *Poets at the Court of Ferrara* (1943).

GUARINO (GUARINUS) DA VERONA (1370–1460), one of the Italian restorers of classical learning. was born in 1370 at Verona, and studied Greek at Constantinople, nhere for five years he was the pupil of Manuel Chrysoloras. On his return to Italy he brought back a number of Greek mss. He supported himself as a teacher of Greek: in 1436 he became, through the patronage of Lionel marquis of Este, professor of Greek at Ferrara; and in 1438 and following years he acted as interpreter for the Greeks at the councils of Ferrara and Florence. He died at Ferrara on Dec. 14, 1460.

His principal works are translations of Strabo and of some of the *Lives* of Plutarch, a compendium of the Greek grammar, of Chrysoloras, and commentaries on Persius, Juvenal, Martial, and on some of the writings of Aristotlc and Cicero. *See* Rosmini, *Vita e disciplina di Guarino* (1805–06); Sabbadini, *Cuarino Veronese* (1885); Sandys, *Hist. Class. Schol.* ii. (1908): *Epistolario de Guarino Veronese* (2 vols. and commentary) in *Miscellanea di Storia Veneta,* 8, 11, 14 (1915–19).

GUARNIERI or GUARNERIUS, a celebrated family of Italian violinmakers of the late 17th and early 18th centuries, the most famous of whom, "Giuseppe del Gesù," produced violins only surpassed by those of Antonio Stradivari.

ANDREA (*c.* 1626–1698), the first to work as a violinmaker, lived at Cremona, where, with Stradivari. he was a pupil of Nicolo Amati. His instruments are less highly finished than Amati's and have a fine orange varnish. His work is dated from the sign of "St. Theresa" in Cremona. Of his three sons PIETRO GIOVANNI (1655–1720), ("Peter of Mantua," where he lived, although born at Cremona), also worked *"sub* signo *Sanctae* Teresae." His violins are more original than his father's: the space between the soundholes is broader, the soundholes more rounded and perpendicular and the whole instrument more raised. His nephew, PIETRO (1695–1762), "Peter of Venice." copied his uncle closely at first, but his later, less well finished work shows Venetian influence.

Andrea's younger son. GIUSEPPE (1666–c. 1740) ("Josephi filius") was born and died at Cremona: and developed distinctive instruments, widening sharply from a narrow waist, with unusual souridholes and a brilliant varnish. His son was (BARTOLOMEO) GIUSEPPE (1698–1744), whose nickname "del Gesù" came from his use of the sacred monogram "I.H.S." (taken from the first three Greek letters of the name "Jesus": I, *Iota;* H, Eta; S, Sigma) on his labels.

Giuseppe was born at Cremona. Aug. 21. 1698, and died there, Oct. 17, 1744. Little is known of his life and the details of his birth and parentage were long disputed. His work owes more to the earlier Brescian makers,'Gasparo di Salb and Paolo Maggini, than to Xmati. Instead of sweetness of tone and symmetry of form, he aimed at a powerful sonority and the great variety of his instruments in size, shape and structure reflect his experimental approach. His violins are bold in outline. and often carelessly constructed. and it is clear from his materials that he was working for wandering fiddlers rather than for wealthy patrons. He chose his wood for its sonorous qualities. and many of his finest instruments are made from a particular piece of pine. as is shown by a stain or sapmark running parallel to the fingerboard on either side. His best work was done during 1730–35. The faulty construction of some of his later instruments gave rise to a legend that he spent some years in prison and was handicapped by lack of tools, and to the sale of many spurious "prison Josephs." It is more probable however that the faults are due to a shaky hand caused by heavy drinking.

Guarnieri's work was not fully appreciated until Nicolo Paganini (*q.v.*) chose a "Joseph" in preference to the more mellow Amati or Stradivarius. With Guarnieri the golden age of Italian instrument-making may be said to have ended.

See W. Hill *et al., Violin Makers of the Guarneri Family, 1626–1762* (London, 1931).

GUASTALLA, a town and episcopal see of Emilia-Romagna. Italy, province of Reggio, 18 mi. N. by rail of Reggio, on the south bank of the Po, 79 ft. above sea-level. It is also connected bv rail with Parma and Mantua (via Suzzara). Pop. (1951) 6,416. The cathedral dates from the 10th century. Guastalla was founded by the Lombards in the 7th century. In 1307 it was seized by Giberto da Correggio of Parma. In 1403 it passed to Guido Torello, cousin of Filippo Maria Visconti of Milan. In 1539 it was sold by the last female descendant of the Torelli to Ferrante Gonzaga. In 1621 it was made the seat of a duchy, but in 1748 it was added to the duchies of Parma and Piacenza.

GUATEMALA (REPÚBLICA DE GUATEMALA), the northernmost of the Central American republics, extending between the Caribbean sea on the northeast and the Pacific ocean in the south. Pop. (1950) 2,790,868. Area 42,042 sq.mi. The country has a coast line of about 70 mi. on the Caribbean (Gulf of Honduras) and 200 mi. on the Pacific.

Its boundaries on the north and west, which touch Mexico, were fixed by treaty, finally on May 8, 1899. which set the Suchiate river, from the Pacific inland, as the start of an irregular line which runs generally northwestward until it strikes the parallel of 17° 49' N., which it follows to the border of Belice (Belize) or British Honduras (*q.v*), to which Guatemala lays claim. The eastern border, with Belice, follows the meridian of 89° 20′ W. southward to the Sarstún (Sarstoon) river, which it follows eastward to the Gulf of Honduras on the Caribbean sea; this boundary was set by the treaty of July 9, 1893. The boundary with Honduras (*q.v.*) on the east was long in dispute but, by treaty in 1930, was submitted to the arbitration of the U.S., Chile and Costa Rica, and a final decision was rendered in 1933. The award was "essentially on the basis of status *quo* of operation," and made the Motagua river the frontier in most of the disputed area. The southeastern boundary with Honduras was never in serious dispute, and the southeastern line touching on El Salvador is accepted and marked, chiefly along natural lines.

This article is divided into the following sections:

I. Physical Geography
II. Geographic Regions
III. The People
IV. History
V. Population
VI. Administration and Social Conditions
VII. The Economy

Further aspects of Guatemala can be found in the article CENTRAL AMERICA and the short articles on the departments and more important cities.

I. PHYSICAL GEOGRAPHY

Geology and Surface Features.—Guatemala is located within the Central American-Antillean region of Charles Schuchert. This is a region of folded and faulted geologic structures running more or less fram west to east from Central America through the Greater Antilles to and beyond Puerto Rico. On the southwest, facing the Pacific coast of Central America from the Gulf of Fonseca to about latitude 20° N. in Mexico, there is much volcanic activity and the underlying west-east structures are buried under a deep accumulation of lava and ash.

The national territory of Guatemala includes four major surface divisions. These are: (1) the Pacific coastal lowland; (2) the highlands; (3) the valleys and ridges of central Guatemala; and (4) the plains of Petén, a part of the Yucatán peninsula.

The Pacific Coastal Lowland.—This is a southeastward continuation of the coastal lowland of Chiapas in Mexico. At the Mexico-Guatemala border it is about 25 mi. wide, and it continues for about 1 jo mi. across Guatemala into El Salvador. The coast is bordered by long sand bars and has few indentations. In back of the lagoons the land rises gradually toward the base of the mountains.

The Highlands.—These rise steeply from the inner edge of the coastal lowlands to elevations between 3,500 and 8,000 ft. Numerous cone-shaped volcanoes rise above this general level. The highest is Tajumulco (13,812 ft.), but there are at least six others nearby that are over 11,500 ft. Among the volcanic peaks there is a series of more or less isolated basins, deeply filled with volcanic ash In one such basin is the well-known and spectacularly beautiful Lake Atitlin.

The Valleys and Ridges of Central Guatemala.—These emerge from under the cover of volcanic material proceeding away from the Pacific coast. The buried structures of the Central American-Antillean region have been etched by the rivers draining toward the Caribbean into a series of more or less west-to-east deep valleys separated by steep, sharply crested ridges. Within the territory of Guatemala there are two major structural depressions. The northern one is occupied by the headwaters of the Chixoy river. The Usumacinta river, which forms the border between Mexico and northern Guatemala, has cut headward to capture the upper Chixoy and carry its waters northward. The lower part of the

BY COURTESY OF NATIONAL TOURIST BUREAU GUATEMALA CITY
ATITLÁN VOLCANO (11.565 FT) OVERLOOKING LAKE ATITLÁN (24 MI LONG). DEPARTMENT OF SOLOLÁ, GUATEMALA

structural valley in Guatemala is occupied by Lake Izabal and drains out through the Dulce river to the Gulf of Honduras.

The southern of the two structural valleys is occupied throughout its length by the Motagua river. The ridges that separate these deep structural depressions extend all the way to the Caribbean. Another but smaller, depression. parallel to the larger ones, is occupied by the Sarstun river, on the border between Guatemala and British Honduras.

The Plains of Petdn — These are a part of the peninsula of Yucatán and consist of a limestone tableland, honeycombed with sinks and underground channels with much of the water draining off through solution caverns.

Climate. — The pattern of climatic conditions, as in all mountainous lands, is quite complex. Along the Pacific coast and on the volcanic highlands there is a distinctive "monsoon" climate, with very heavy rainfall in summer (May to October) when the ninds are onshore from the south, and a very dry season in wmter (Sovember to April) when the prevailing wind is offshore from the north. On the Caribbean side however, rainfall is heavy throughout the year on east-facing slopes. There are dry pockets in the rain shadow of the mountains, such as, for example, the middle part of the Motagua valley. Temperature varies with altitude but is never cold. At sea level the average annual temperature is about 78° F.. nith very little difference between summer and winter. 'Ihe old concept of steaming jungles refers to the high humidity rather than high air temperature. At Guatemala City *(4,872* ft. above sea level) the average annual temperature is about 65°, ranging from an average of about 61° in December to about 69" in May just before the beginning of the rainy season. In the higher basins of western Guatemala, between 5,000 and 10,000 ft. above sea level. average temperatures are between 65° and 55°. There is seldom much variety in the day-to-day weather, although occasionally hurricanes reach the Caribbean coast of Guatemala in September or October.

Vegetation. — The vegetation cover of Guatemala exhibits two basic characteristics of mountain geography: a general zoning by altitude and an intricacy of detail that makes the vertical zoning in places difficult to identify. Along the wet coastal lowlands on the Caribbean and on the lower east-facing mountain slopes there is a heavy tropical rain forest which comes as close to exhibiting the popular idea of a jungle as any place in the tropics. Along the Pacific lowland and the lower slopes of the south-facing volcanic highlands there is very little rain and the vegetation cover is a tropical semideciduous forest with patches of tall-grass savanna. Some of the species of trees in the forest, like all the species in the rain forest on the Caribbean side, are evergreen. During the dry season some of the trees in the semideciduous forest shed their leaves which reappear when the rains come again. The colour of the forest changes from dark green in the rainy season to grayish in the dry season and that of the savannas from green to brown.

As one ascends the mountains, contrasts in vegetation appear in what Alexander von Humboldt described as "vertical zones." The lowland species of trees give way to evergreen forests of oak and cypress. Above 5,000 ft. the oak is mixed with Sorth American species of pine. However, the vegetation reflects the lack of rain wherever there are dry pockets in the mountain valleys. In the dry middle part of the Motagua valley the vegetation is xerophytic, with many species of cactus and other drought-resistant plants.

Above 10,000 ft. the pines become thinner and grow only in patches in sheltered places. The trees are then replaced by a cover of mountain tall grass, similar to the paramos of the northern Andes. In no part of Guatemala are the mountains high enough to rise above the mountain grasslands. At these latitudes (between 14° and 16° N. of the equator) the zone of permanent snow is between 14,000 and 15,000 ft., and none of the Guatemalan volcanoes reaches such an altitude.

Animal Life.—Apart from domesticated cattle, sheep, pigs and mules. deer, monkeys and peccaries are common, especially in the less settled areas. Jaguars, tapirs and pumas are rarer. Crocodiles are found in the Polochic river and manatees in Lake Izabal and elsewhere. The bird life of the country is remarkably rich—wild turkeys and ducks, doves and pheasants abound; one almost extinct parrot oi magnificent plumage. the quetzal (*Pharomachrus mocinno)*, has been chosen as the national emblem.

II. GEOGRAPHIC REGIONS

There are two major geographic divisions of Guatemala: the highlands and the lowlands. But because of human action each of these two divisions is subdivided-the highlands into tno parts, the lowlands into three.

The Highlands. — Including the volcanic region and the ridges and valleys of central Guatemala, these are the most densely populated sections of the country. The highlands are sharply marked off into two distinctive regions—one region occupied by Indians, the other by people of Spanish and Spanish-Indian ancestry.

The Indian region is that part of the highlands that stands more than 5,000 ft above sea level. It begins a short distance west of Guatemala City and includes the whole western part of the country. The Indians are descendants of the Mayas Although there are a few large commercial towns, such as Quezaltenango and Huehuetenango. there are also many smaller village communities with less than 500 inhabitants

In some areas the people live in towns and villages and go out daily to work their farms—a pattern of living well developed around Lake Atitlán In other areas the individual farmer lives on the land he is cultivating The land is sometimes held in common and cannot be sold, although it can be used by the farmer as long as he continues to live on it. The chief Indian crop is maize, which can be grown up to elevations of about 9.500 ft. It yields well and makes up the greater part of the Indian diet, along with beans, chili and other vegetables. The one crop above the upper limit of maize is the potato, which can be cultivated up to 10,500 ft. Still higher. there are a few Indian communities that are supported only by the pasture of sheep on the high grasslands. But even in the more productive wheat and maize-growing parts of the highlands, the Indian farms are too smali to provide adequate support for farm families.

The other part of the highlands was divided up long ago among the Spanish conquerors. Most of the properties are large, and in many cases only partly utilized. The largest area is used for the pasture of cattle. But the chief commercial crop, which ordinarily provides over 70% of Guatemala's exports, is coffee. This crop grows well at altitudes of between 1,000 and 5,000 ft. The chief coffee-growing section of the country is westward from Guatemala City to Lake Atitlán and down to the coast below Quezaltenango. To the east of the gap where the Chixoy river turns northward to form the Usumacinta river, there is another coffee-growing district centring on the town of Cobán. This area was developed by German planters, most of whom lost their properties by expropriation during World Wars I and II.

The two highland regions are connected by the Inter-American highway which is completed, except for several bridges, as far as the Mexican border.

The Lowlands. — These were never utilized by people of Spanish ancestry until after the development of the banana plantations by the United Fruit company. The first banana plantations were created in clearings carved out of the rain forest in the lower Motagua valley, and Puerto Barrios was built as a banana-shipping port. When disease hit the banana plantations on the Caribbean side in the 1920s and '30s, the company moved its operations to the Pacific lowland. The conipany also built a railroad to connect Guatemala City with Puerto Barrios and later from the capital to the Pacific port of San José. The line was extended along the Pacific base of the highlands to connect with the Mexican railroads. Another line reaches El Salvador. The banana plantations of the United Fruit company were in part expropriated by the government during the early 1950s; but when the government again became more friendly. the company began to rebuild its plantations in the late 1950s. (See *The* Economy, below.) The plantations on the lower Motagua continued to decline and new planting was extended along the rail line on the Pacific lowland.

The third part of the lowlands — more than a third of the total area of Guatemala — is in the plains of Petén. This is a very thinly populated area. There are few permanent settlements. Most of the inhabitants are engaged in the work of gathering and shipping chicle, the major ingredient in chewing gum. A maze of foot trails winds through the forest over which porters carry the chicle to collecting stations. Some is brought out by mules or canoes, some by small airplanes. Petén is isolated from the rest of the country by vast stretches of empty, forest-covered area. (P. E. J.)

III. THE PEOPLE

More than half of the population of Guatemala is Indian (*cf. Population,* below), and most of the remainder is composed of Ladinos, who are europeanized in culture and usually of mixed Spanish-Indian ancestry. The two groups are not always physically distinguishable, but are demarcated by speech — whether an Indian language or Spanish — by dress — whether native or western — and by community membership.

The Indian cultures of Guatemala are remarkable for the high degree of native custom retained. The modern Indians of Guatemala come, in general. from the Maya or the kindred Quiché strain. The Indian settlements are predominantly in the highlands (see *Geographic Regions,* above). It is estimated that about 18 different Indian languages are spoken in Guatemala. Costume and dialect vary from one village to another. although Quiché serves as a trade language to some extent. and Spanish is a second language learned by some of the Indians. Traditional arts and crafts pursued in the villages include pottery, basketry, hand-tooled leather articles and colourful textiles. The social life of the Indians is centred in markets and *fiestas.*

The Indians differ but slightly among themselves. being of dark copper skin, stocky build, with coarse, straight black hair, high cheekbones and low foreheads. Formerly the Indians. who are the chief labour supply for the large coffee plantations at harvest time, were treated in almost feudal fashion by the coffee planters. With the constitutions of 1945 and 1956, which guaranteed many basic liberties. and the enactment of the labour code of 1947, which abolished the so-called vagrancy laws. the situation of the Indians was considerably ameliorated, although some abuses undoubtedly were continued.

The cultural isolation of the Indians results in their underrepresentation in the national life: Ladino leadership in public affairs is predominant. However, since the tno groups, Indian and Ladino, are distinguished mainly by speech, dress and community membership, Spanish-speaking Indians can and sometimes do become "ladinoized," particularly in the cities.

RY CCLRTESY OF PAN AMERICAN WORLD AIRWAYS

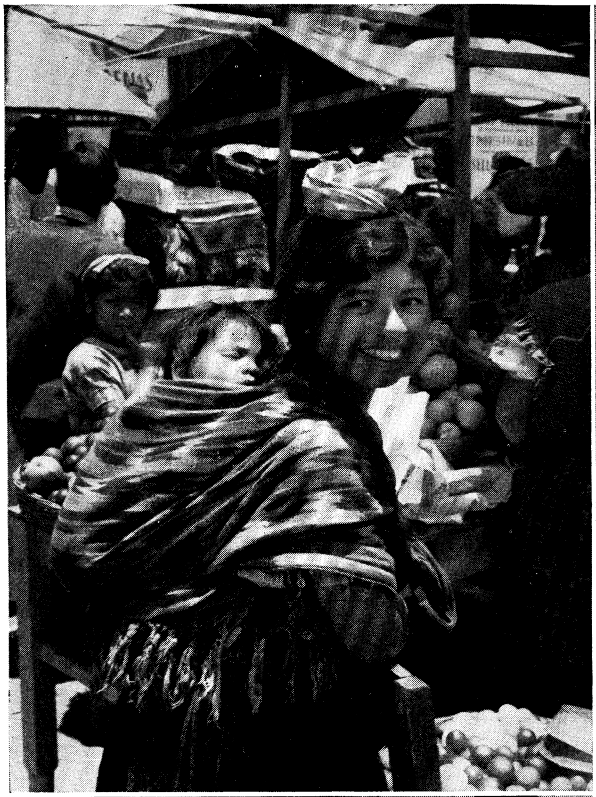
INDIAN WOMAN WEAVING ON A HAND LOOM. THE DESIGN OP THE FABRICS DIFFERS FROM VILLAGE TO VILLAGE ACCORDING TO TRADITIONAL PATTERNS

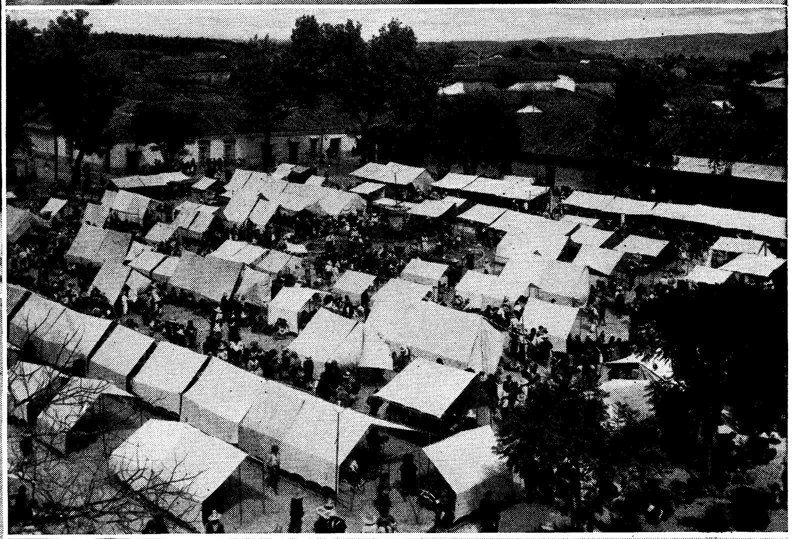
(*See* also **Indian, Latin-American; Central America:** ***Anthropology.***)

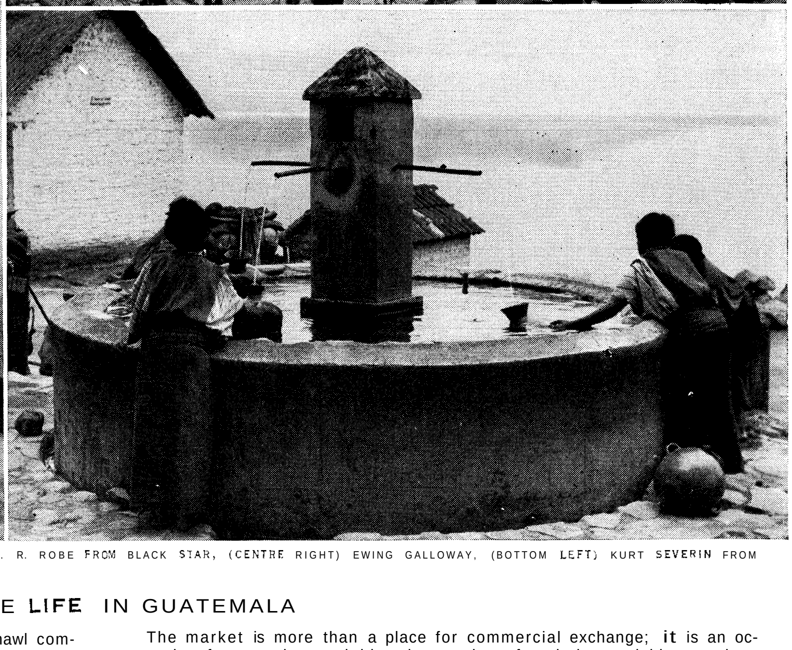
Religion. — The prevailing form of religion in Guatemala is Roman Catholic, the church claiming virtually 90% of the population as communicants. The archbishop of Guatemala is the primate of Central America and church influence is not inconsiderable. There are some Protestant missionaries and mission schools. The Indians are nominally Roman Catholic, but retain elements of native religions such as deities and ceremonies associated with soil fertility. Much of the white population is notably religious, and while there is sometimes a division on political lines, and the church has at times been accused of opposing the prevailing liberal government with serious consequences, the religious attitude of the people of the higher classes has not been greatly affected. (X.)

IV. HISTORY

Since the European conquest of the new world, Guatemala has been a colony of Spain (1524–1821), a part of the Mexican empire set up by Agustín de Iturbide (1822–23), a state in the Central American Federation (1823–47) and an independent republic (since 1847) Its history has been coloured by the fact that Europeans settled among Indians whom they dominated but whose culture has kept them a people apart.







PHOTOGRAPHS (TOP LEFT) HERBERT LANKS-PIX FROM PUBLIX, (TOP RIGHT) R. R. ROBE FROM BLACK STAR, (CENTRE RIGHT) EWING GALLOWAY, (BOTTOM LEFT) KURT SEVERIN FROM BLACK STAR, (BOTTOM RIGHT) DOROTHY HOSMER-PIX FROM PUBLIX

VILLAGE LIFE IN GUATEMALA

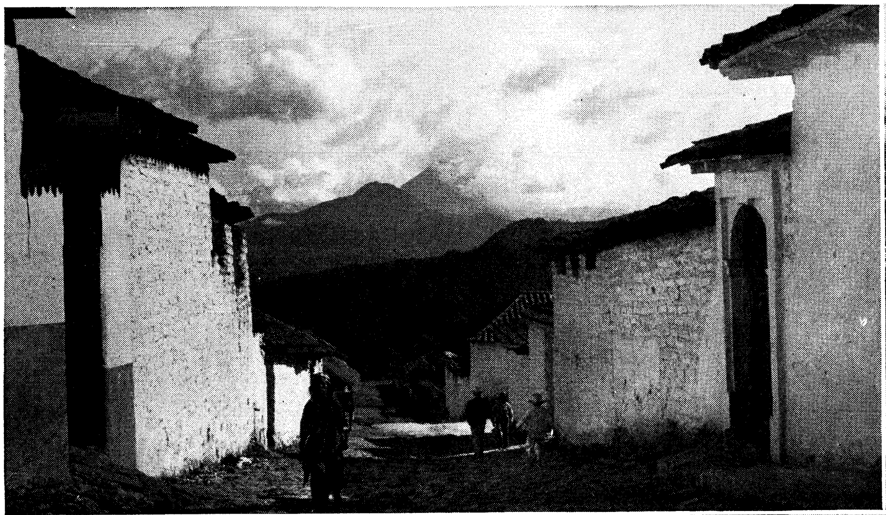
Top left: Young woman carrying a sleeping child in the extra shawl commonly worn as a wrap or head covering or for carrying things on journeys or trips to market. Native costumes have been retained more by the women while the men wear factory-made clothes in increasing number

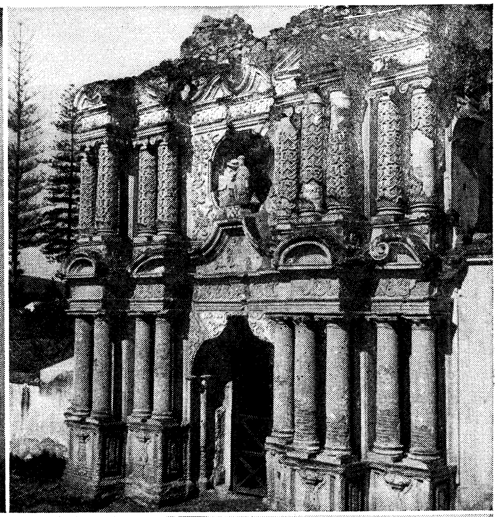
Top right: Religious procession during a fiesta on St. John's day at San Juan Sacatepéquez

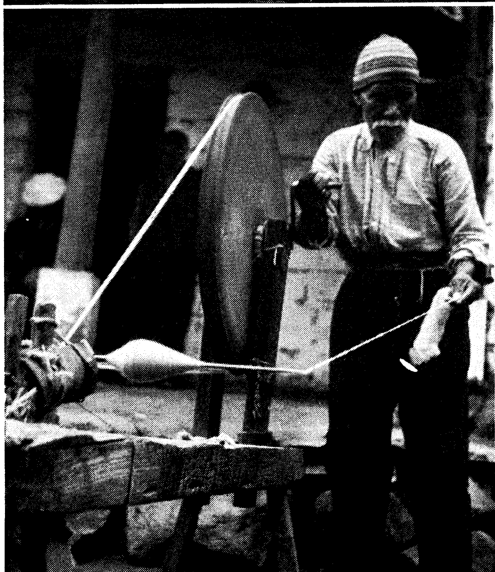
Centre *right:* Indian market day in the village square, Chichicastenango. The market is more than a place for commercial exchange; it is an occasion for travel to neighbouring markets for their specialties, and an important social occasion for visiting and travel

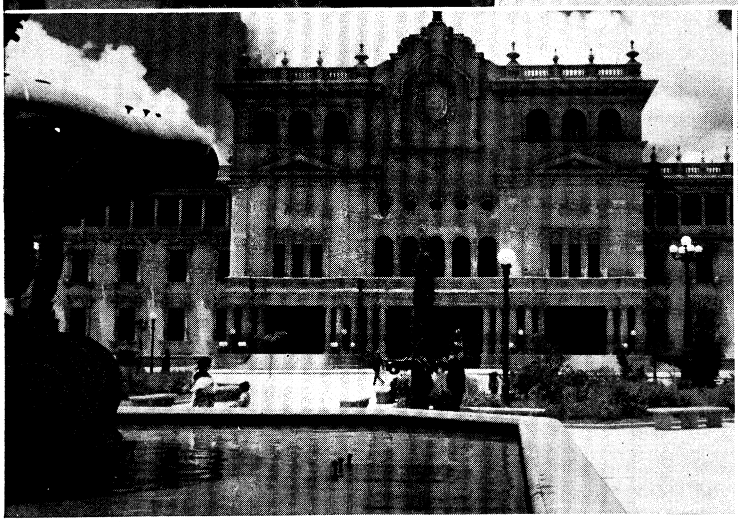
Bottom left: The marimba, an essential feature of merrymaking at the frequent village fiestas

Bottom right: Women of San Antonio Palopó at the pila or well which is also the viilage gossip corner









PHOTOGRAPHS (TOP LEFT, TOP RIGHT, BOTTOM RIGHT) DOROTHY HOSMER-PIX FROM PUBLIX, (CENTRE RIGHT, BOTTOM LEFT) HERBERT LANKS FROM BLACK STAR, (CENTRE LEFT) KIRKLAND-PIX FROM PUBLIX

ARCHITECTURE AND INDUSTRY IN GUATEMALA

Top left: Indian houses in the town of San Francisco el Alto, a highland town of 8,661 ft. elevation overlooking the valley of Samalá. In the background is the conical Santa Maria volcano

Top right: Ruins of the façade of Our Lady of El Carmen at Antigua, fourth capital of the Spaniards in Guatemala. Most of the Spanish art treasures of Antigua were removed to Guatemala City in modern times

Centre left: An old spinner and weaver of Momostenango, important wool centre in Guatemala

Centre right: Knitting mill in Quezaltenango, a modern city of dense population

Bottom left: The government palace, Guatemala City

Bottom right: Circular steps and modernized facade of the church of Santo Tomás, Chichicastenango. To the right of the doorway is a quemador where copal incense is burned to non-Christian gods. The Indians rest on the steps after a tiring market day

The territory which is now Guatemala was inhabited at the time of the European conquest by a sedentary, agricultural, highland people of Mayan stock organized in tribal societies headed by "kings" who frequently warred on each other. For reasons not definitely established, the brilliant Mayan culture, which once flourished in the tropical forests that bordered the central plateau on the north, had declined, and the magnificent cities, possibly as a result of drought and soil erosion, were deserted. Trade and conquests from the west had already brought the area under strong Mexican influences which were strengthened by the presence of Mexican Indian allies among the forces of the conquering Spaniards.

Guatemala was conquered (1524) by Pedro de Alvarado (*q.v.*), one of the principal officers of Hernán Cortés, who was sent from Mexico in command of a force of Spaniards and Indian allies to punish and subdue the rebellious natives of the south. The invaders defeated in sequence the warriors sent out by the chiefs of the disunited local tribes, reduced many Indians to vassalage and appropriated the more accessible lands. The conquest completed, Alvarado was appointed the first captain general of an area which included modern Central America and the adjacent portions of contemporary Mexico.

The origin of the name Guatemala is certainly Indian, but its derivation and meaning are undetermined. Some hold that the original form was Quauhtemallan (which indicates an Aztec rather than a Mayan origin), meaning "land of trees," and others hold its origin was Guhatezmalha, meaning "mountain of vomiting water," referring no doubt to the so-called volcano of water which destroyed Ciudad Vieja, the first permanent Spanish capital of the captaincy general.

Colonial Period. — The colony was organized in the typical Spanish pattern. The conquerors mere assigned lands and Indians to support them, the capital was eventually established at Antigua (*q.v.*) and Spanish officials, subject in some matters to the viceroy of Mexico but in local affairs independent, were appointed to administer the area. Public buildings, churches and monasteries were constructed, and a university was established under clerical control. The capital achieved a certain magnificence and the major towns acquired some aspects of Spanish culture, but the outlying areas were only lightly affected by Spanish domination. When Antigua was razed by an earthquake in 1773, the capital was moved by royal order to the site of modern Guatemala City (*q.v.*).

The colony developed no great degree of economic prosperity. The cultivation for export of agricultural staples, principally cacao and indigo, by Indian or Negro labour was the major economic activity, exclusive of production for subsistence. Commerce, however, was never extensive; a satisfactory port was never discovered, internal transportation was difficult and pirates harassed the coasts and preyed'on shipping.

Independence. — Successful termination of the war for independence in Mexico led to a declaration in Guatemala City of Central American independence from Spain on Sept. 15, 1821. Shortly thereafter, the former captaincy general, which included the modern republics of Guatemala, El Salvador, Honduras, Costa Rica, Nicaragua and Chiapas state (Mexico). joined the empire which Agustín de Iturbide. the successful general of the Mexican independence movement. proclaimed in that country. When Iturbide fell from power in 1823, Central America determined upon separate nationhood, and the Republic of the United States of Central America (Central American Federation) was formed with its capital in Guatemala City.

The federation had a brief and stormy life. Manuel José Arce, the first president. came into conflict with the Liberal state authorities in Guatemala and El Salvador, and was overthrown (1829) by a military force under Francisco Morazán, who was shortly elected to the presidency. Morazán's government, with the cooperation of friendly authorities in some of the states, attempted to carry through the Liberal program of reform, one feature of which was subordination of the church to the civil authorities. The rapid and drastic changes produced a reaction which, coupled with other divisive factors, threw the union into civil war, and by 1838 the federation had, for practical purposes, ceased to exist. The Guatemalan government functioned independently after 1839. Morazán was defeated decisively and exiled in 1840, and his attempt to regain power in 1842 ended in his execution.

The principal factor in the overthrow of Morazán was the backcountry uprising in Guatemala of which Rafael Carrera assumed leadership. This astute but illiterate rustic established himself as the military arbiter of the state (1838) and, from the executive's chair or from behind it, controlled policy until his death in 1865. The formality of elections was dispensed with in 1854 when the presidency was conferred upon him for life. He completely dominated the political life of Guatemala during the mid-19th century.

Carrera, with the support of the Conservatives, returned Guatemala to a regime similar to that which had prevailed during the colonial period. He restored the church to its position of privilege and power and catered to the aristocracy He followed a nationalistic policy and in March 1847 formally declared Guatemala an independent and sovereign nation. In 1859 he made a treaty with Great Britain defining the status and boundaries of British Honduras (Belice), the interpretation of which is still an issue between the two governments.

In 1871 a revolution headed by Miguel Garcia Granados and Justo Rufino Barrios overthrew Gen. Vicente Cerna. Carrera's Conservative successor in office, and inaugurated a period of "Liberal" ascendancy that extended almost unbroken to 1944. After a brief period in the presidency, Garcia Granados ceded to Barrios (1873), nho became known as the "Reformer" because of the sweeping changes he introduced.

With the approval of the assembly Barrios broke the power of the local aristocracy; brought the church under civil control and confiscated its properties; instituted lay education; promulgated a new constitution (1876); fostered the construction of improved rneans of communication including roads. railways and telegraph lines; encouraged development by private initiative of the resources of the country; and opened the country to foreign capital. He stimulated the cultivation of coffee to replace the declining trade in cochineal, and enacted legislation designed to assure producers of a ready supply of labour. He was an ardent exponent of the idea of Central American union and, when persuasion failed to produce the ends he desired. he invaded El Salvador and lost his life at the battle of Chalchuapa (1885) in an attempt to accomplish them by force.

After the death of Barrios, Manuel Lisandro Barillas occupied the presidency and was succeeded by José María Reina Barrios, nephew of the Reformer, who was elected in 1892 and assassinated in 1898. Manuel Estrada Cabrera became provisional president. regularized his status by an election and by repeated re-elections (1904, 1910, 1916) maintained himself in power until leaders of the opposition Unionist party. nith the co-operation of some former adherents of the dictator, forced him from office by the novel expedient of having the assembly declare him inssne (1920).

During his long tenure in power, Estrada Cabrera fostered economic development and progress along the lines established by Barrios. He encouraged improvements in agriculture. continued to build roads, supported railroad construction and had the satisfaction of seeing the railroad to the Atlantic completed. Health conditions were improved and education stimulated, especially in practical fields. His political policies were less admirable. He persecuted political opponents, disregarded individual rights and liberties, muzzled the press and summarily disposed of his enemies.

After the fall of Estrada Cabrera, the presidency was held by Carlos Herrera, Gen. José M. Oreilana, Lázaro Chacón, Baudilio Palma, Gen. Manuel Orellana and José María Reina Andrade, for periods ranging from a fen days to nearly a full six-year term. In 1931 Jorge Ubico mas elected president and began the fourth of the extended dictatorships that covered a century of Guatemalan history.

Contemporary **Period.**—Ubico stressed economic development and, in particular, improvement and diversification of agriculture and the construction of roads. He balanced the national budget and transformed a deficit into a surplus. In part his financial achievement was due to economies, in part to the efficiency and honesty of his administration. Although his vagrancy law (1934) made workers, especially Indians, liable to periods of forced labour at critical seasons. Ubico's paternalistic policies toward the natives established him as their patron. During his motorcycle tours of the country, or in his office, he listened to their complaints and dispensed immediate "justice." Their reverence for him was expressed in their custom of addressing him as Tata, "father." This relationship deluded Ubico into stating that Guatemala no longer had an Indian problem.

Education, which had received considerable emphasis under preceding Liberal regimes, was of but slight interest to Ubico. He closed several of the few institutions of secondary level outside the capital, allowed teachers' salaries to remain at levels incompatible with decency and, as a final disparagement, militarized the schools and required teachers and students to march in his parades and festivals.

Ubico's administration dramatized the degree to which Liberal thought had lost its idealism and was concerned principally with material progress. The new socioeconomic groups that had been brought into existence by such innovations as lay education, mechanized transportation and industrial development found no stimulation and no hope in the dreary materialism and military repression which had come to characterize Liberal regimes.

These latent sources of opposition were solidified and focused by the increasing disregard which the dictator showed for individual rights and liberties. The familiar trappings of military dictatorship became increasingly evident, and the reorganized national police came to be regarded as an espionage force. Protests were answered by sterner restrictions and even by violence. The discontent was increased by the economic dislocation incident to World War II, and by the unfavourable contrast between the idealistic pronouncements of Allied war leaders and conditions in Guatemala. Guatemala declared war on Japan Dec. 8, 1941, and on Germany and Italy Dec. 11, 1941.

In June 1944 a general strike forced Ubico to resign. Labour was allowed to organize, political parties were formed and a presidential electoral campaign was begun in which Juan José Arévalo soon emerged as the most popular candidate. When Gen. Federico Ponce Vaides, head of the interim government, gave indications that he intended to maintain himself in power, he was ousted on Oct. 20, 1944, by a popular uprising headed by students and teachers, workers and younger elements of the military. A revolutionary junta presided over the drafting of a new constitution, the electoral campaign and, in March 1945, the inauguration of Arévalo, the successful candidate.

The Arévalo administration consolidated the social revolution of which the October uprising had been an expression. A favourable labour code was enacted and a social security system was inaugurated which promised progressive extension of benefits. Under this fostering legislation urban labour increased in strength, and organization of agricultural workers began. Public-school education was expanded and improved. teachers' salaries were increased and the university was granted autonomy. These measures were tangible evidence of the intent of the administration to place the instruments of culture within reach of the masses.

In many respects Arévalo manifested the nationalism inherent in the revolution of October. He pressed the Belice issue with Great Britain, subjected foreign enterprises to regulation that he conceived to be in the national interest and attempted to guarantee to Guatemalan labourers a larger share of the benefits produced by their toil and improved status in comparison with foreign employees of foreign corporations operating in the country. The policies followed by Arévalo consolidated the revolutionary elements of 1944 into a politically effective group prepared to support any government of like orientation. Thus the revolution and the Arévalo regime accomplished the transfer of political power in Guatemala from the military to a popular group of which organized labour was the most important single element.

This development Guatemalan Communists turned to their peculiar advantage. Lack of leadership from the rank and file allowed Communists to organize the labour movement and use it for their own ends. Arévalo was not friendly to their activities, but his nationalistic bent gave them opportunity to establish themselves as his most enthusiastic and reliable backers on issues for which he badly needed support. In this fashion they won for themselves a degree of toleration which permitted them to operate.

The most likely candidates to succeed Arévalo were Francisco Arana and Jacobo Arbenz Guzmán, but Arana was removed from contention by assassination. Arbenz Guzmán became the official candidate, was elected, with Communist support, over Gen. Miguel Ydigoras Fuentes, and assumed office in March 1951. Arbenz Guzmán made agrarian reform the central project of his administration. With strong Communist support, the assembly passed a measure providing for the expropriation of unused portions of landholdings in excess of a specified acreage, and the distribution of the land, title to which remained with the government, among landless peasants. Most sober observers admitted that land reform was necessary, but many criticized specific details of the Arbenz Guzmán law and the fact that administration officials made it less an instrument for achieving reform than a weapon against the interests and the classes they wished to destroy.

The growth of Communist influence in Guatemala became the most controversial issue of the Arbenz Guzmán regime. The president's toleration allowed the party to operate openly. and individual Communists to hold key posts in government, official agencies and organized labour. In the minds of many individuals, the crucial issue was not social reform but Communist domination of Guatemala. Internal opposition to the trend was eventually stifled by increasingly terroristic means, but exiles and foreign recruits headed by Col. Carlos Castillo Armas planned outside the country to overthrow the government. When the blow fell, military officers informed Arbenz Guzmán that the army would not fight in his defense and forced him to resign (June, 1954).

Castillo Armas emerged from a military junta as provisional president in September and a plebiscite subsequently regularized his status. His attempts to extirpate Communist influence, moderate the extreme social reforms inaugurated by his predecessors and restore the confidence of foreign investment capital were cut short when he was assassinated in the presidential palace by one of his guards, July 26, 1957. After two temporary governments and an election which was nullified by the assembly, Ydígoras Fuentes (National Democratic Reconciliation party) was declared elected to the presidency and took office March 2, 1958.

V. POPULATION

The population of Guatemala has increased, according to census figures, from 2,004,900 in 1921 to 2,790,868 (1,410,775 males; 1,380,093 females) in 1950, or 66.4 inhabitants to the square mile. The official 1957 estimate placed the figure at 3,453,264. Population is concentrated in the highlands paralleling the Pacific, but clusters occur in the lowlands on either side and particularly on the Pacific slope. About 25% of the population is urban, the rest

Table I.—Population of Guatemala by Departments, Census of 1950

Department	Area (sq.mi.)	Population	Capital city	Population
Alta Verapaz	3,354	189,812*	Cobán	7,911
Baja Verapaz	1,206	66,313†	Salami	2,760
Chimaltenango	764	121,480‡	Chimaltenango	6,138
Chiquimula	917	112,841†	Chiquimula	8,840
El Petén	13,843	15,880	Flores	1,596
El Progreso	742	47,872	El Progreso	2,427
El Quiche	3,235	174,911‡	Santa Cruz del Quiché	4,211
Escuintla	1,693	123,759	Escuintla	9,760
Guatemala	821	438,913	Guatemala	284,276
Huehuetenango	2,857	200,101‡	Huehuetenango	6,187
Izabal	3,489	55,032	Puerto Barrios	15,155
Jalapa	796	75,190†	Jalapa	6,610
Jutiapa	1,243	138,925	Jutiapa	5,162
Quezaltenango	753	184,213†	Quezaltenango	27,672
Retalhuleu	717	66,861†	Retalhuleu	9,304
Sacatepéquez	179	60,124†	Antigua Guatemala	10,996
San Marcos	1,464	232,591‡	San Marcos	4,694
Santa Rosa	1,141	109,836	Cuilapa	2,746
Sololá	410	82,921*	Sololá	3,311
Suchitepéquez	969	124,403†	Mazatenango	11,067
Totonicapán	410	99,354*	Totonicapán	6,405
Zacapa	1,039	69,536	Zacapa	8,260
Total	42,042	2,790,868		

*More than 93% Indian. $More than 70% Indian. †More than 50% Indian.

is rural.

On the basis of cultural traits (not ancestry). inhabitants are classified locally as Indian (54%) and Ladino (see The People, above). Less than 5% of the population is white, and about 5% is Negro or mixed Negro and Indian (such as the "Black Caribs" of the Caribbean coast). Indigenous highland communities, particularly those in isolated locations, tenaciously maintain their traditional tribal customs and language and their distinctive village dress and mode of life. These characteristics keep Indian groups apart from European (Ladino) culture. as well as from each other. This division of the population into two distinct culture groups has consistently been a basic national problem. (W. J. G.)

VI. ADMINISTRATION AND SOCIAL CONDITIONS

Constitution and Government. — The constitution of Guatemala which became effective on March 1. 1956, was preceded by those of 1851, 1876, 1879 and 1945. The government is divided into three equal branches, executive, legislative and judicial.

Executive power is vested in the president, who is elected for a term of 6 years by popular vote and is ineligible for re-election for 12 years after leaving office. The president must be a native Guatemalan over 35 years of age. He appoints and presides over the council of ministers or cabinet whose members are responsible to him, although congress may under certain conditions bring about the dismissal of one or more of them. They have the right to participate in congressional debates and are obliged to appear and answer questions put to them by members of congress.

Legislative power is delegated to the congress, which is unicameral and composed of one deputy for each 50,000 inhabitants or fraction thereof in excess of 25,000, each department having the right to elect at least one deputy. Deputies are elected by popular direct suffrage for a term of four years, with half the congress being elected every two years. A nine-member permanent committee composed of eight members elected by congress and the president of congress acts during recesses. Deputies must be native Guatemalans over 21 years of age and may be re-elected.

The judicial power is exercised by the judges of the tribunals of the republic. The judges of the supreme court of justice and of the court of appeals, which may be composed of one or more chambers. are elected by congress for terms of four years and may be re-elected. Judges of first instance and lower judges are appointed and removed by the supreme court.

Guatemala is divided for administrative purposes into 22 departments, each headed by a governor appointed by the president. The departments in turn are divided into municipalities which are controlled by popularly elected municipal corporations

The constitution contains broad guarantees of rights to citizens, including life, liberty, equality and security of person. honour and property, freedom of movement in or out of the country. freedom of religion, the right of association and peaceful assembly and freedom of speech, but outlaws the Communist party. Detailed social guarantees are established for labour, public employees, the family and culture. Certain guarantees may be suspended by the president in agreement with the council of ministers, subject to ratification by congress.

All males over 18 years of age may vote but only those women over 18 who can read and write Spanish may vote. Male illiterates may hold municipal but not national office. Voting is compulsory for literate males and optional for women and illiterates.

Living Conditions. — The Guatemalan cost-of-living index showed a steady rise in the 1950s (1953 = 100, 1958 = 109) although living standards were low. The gross national product remained about U.S. $170–$180 per person. Approximately 1,000,000 Guatemalans were gainfully employed. During the revolutionary period from 1944 to 1954, the Guatemalan government placed heavy emphasis on labour reforms. A labour code adopted in 1947, designed to stimulate the growth of trade unions, provided for collective bargaining, settlement of labour disputes in labour courts and compulsory arbitration of disputes involving public services. Amendments in 1948 required severance pay and permitted farm workers to join unions, regardless of the size of the enterprise in which they worked. Despite these and other similar measures, only about 5,000 Guatemalan workers remained members of internationally affiliated labour unions in the mid-1950s.

Welfare Services. — Guatemala's social security coverage was also expanded during the period 1944–54. Laws passed in 1946 provided cash and medical benefits for both occupational and nonoccupational injuries, insurance being compulsory for employers of five or more persons. Benefits are financed by employer, employee and government contributions. Severe problems characterize health and sanitation conditions in Guatemala. In the late 1950s, the infant mortality rate averaged about 100 per 1,000 births; there were about 6,000 persons per physician, and 30,000 people per dentist; and fewer than three hospital beds existed for every 1,000 Guatemalans. As a result of its strained relations with the United States, particularly during the administration of Arbenz Guzmán, Guatemala curtailed its participation in bilateral technical assistance programs designed to cope with these health and sanitation problems, although the country continued its contracts for the multiiateral programs of the United Nations. After the revolution of 1954, Guatemala resumed interest in the bilateral programs.

Education. — Education is in theory free. secular and compulsory. According to the 1950 census 72.2% of persons seven years old and over were illiterate. Some progress has been made in combating illiteracy by extending the school system but there are handicaps such as the language barrier (with non-Spanish-speaking Indians).

The University of San Carlos of Guatemala (originally founded in Antigua, Jan. 31, 1676. as the University of San Carlos de Borromeo) was re-established May 2, 1918, with seven faculties and schools. The 1956 constitution provided that the university receive no less than 2% of the annual national budget. The National library and government archives contain more than 83,000 volumes.

Defense.—Military service is legally compulsory between the ages of 18 and 50 but not observed. The size of the armed forces is limited by agreement with the other Central American nations. There is a small air force. The president is chief of the armed forces. (G. I. B.)

VII. THE ECONOMY

Agriculture. — The economy of Guatemala is basically dependent upon agriculture. The country is exceptionally well suited both in soils and climate to a diversified agricultural development. In the late 1950s about 3,500,000 ac. were devoted to field and tree crops and 1,500,000 ac. to pasture, Maize and beans. the leading crops for domestic use, are grown everywhere. Other crops mainly for home consumption are rice, wheat, sugar cane, tobacco, potatoes, fruits and vegetables.

Coffee, the chief export crop, is grown between 1 000 and 5,000 ft. above sea level. There are about 12,000 producers. but 80% of the crop comes from 1.500 larger coffeefarms. Production consists largely of the Arabica and Bourbon types. Bananas, the second export crop, are grown on large plantations in the region of Tiquisate on the Pacific coast and in the valley of the Motagua river on the Atlantic coast. The United Fruit company, by far the largest producer, handles almost all banana exports. Export crops of lesser importance include essential oils (mainly citronella and lemon grass), cotton, abaci, chicle. and cacao.

Annual production of coffee in the late 1950s was about 1,800,000 quintals (1 quintal = 101.43 Ib.) with exports averaging 1 300,000 quintals. Banana exports, reduced sharply by plant disease, labour disputes and hurricanes, mere about 3,000,000 quintals yearly in the late 1950s.

In the late 1950s the livestock population numbered well over 1,000,000 cattle; about 750,000 sheep; more than 400,000 pigs; 250,000 horses, mules and asses; and 80,000 goats.

An extensive land-reform program was authorized by an agrarian reform law of June 17, 1952, which gave the government power to expropriate uncultivated lands on large estates and on the *fincas nacionales* ("national farms'). estates taken over from German nationals during World War II. Owners were to be compensated by government bonds and the lands leased in small holdings of about 25 ac. Expropriations were halted after the change of government under a statute of July 27, 1954, and the 1952 legislation was replaced by a new agrarian law in 1956 under which the program of providing small holdings was resumed at a reduced rate.

A substantial portion of the extensive holdings of the United Fruit company on the Pacific coast had been expropriated under the 1952 law but these holdings were returned to the company by the government of Castillo Armas. By an agreement signed Dec. 27, 1954, the United Fruit company was to return to the government about 17j sq.mi. of land along the southern coast and to pay a 30% tax on profits. Under a revised contract signed Dec. 11, 1956, the company was also obligated to invest at least $5 000,000 within five years to bring an additional 5,500 ac. under cultivation.

Mining. — Major known mineral resources include gold, silver, lead, zinc. copper, chromium and sulfur. The leading mining area is near Cobán where lead and zinc are produced. Lead is also produced near San Miguel Acatán in the department of Huehuetenango. By the late 1950s around 11,000 tons of lead concentrate and 16,000 tons of zinc concentrate were being produced annually. Petroleum deposits may exist in northeastern Guatemala, particularly in the Petén, Alta Verapaz and Izabal. A new petroleum code in 1955 was followed by applications by 29 international and local companies for exploration permits, chiefly in the Petén.

Forest Resources.--Nearly two-thirds of the country is forested. including about 15,000,000 ac. of hardwood and 3,000,000 ac. of softwoods, but forest resources remain relatively unexploited because of their inaccessibility. The Petén is particularly rich in mahogany and dyewoods. Production of chicle. Guatemala's most important forest derivative, dropped sharply after World War II because of destructive harvesting practices and the competition of synthetic substitutes and natural latex from chilte trees. Nevertheless, exports of chicle showed some recovery by the late 1950s.

Industries. — Manufacturing occupies a comparatively minor place in the national economy. Production is chiefly for the domestic market and enterprises tend to be small. Products include textiles, alcoholic beverages, soft drinks, food products, cement, shoes, soap, candles, cigarettes, furniture and Indian handicrafts. Production of brown sugar (*panela*) and molasses is significant on the southern coast. The first tire factory in Central America was opened. with U.S. capital, in 19j8.

Industrial expansion is hampered by the lack of power which is relatively expensive, since coal and oil must be imported. There is, however, a large potential supply of hydroelectric power, nith suitable installation sites, on the rivers running to the Pacific and the Caribbean.

Foreign Trade. — The U.S. is Guatemala's best customer, followed by the German Federal Republic, Mexico and the United Kingdom. Coffee is the most important export product and usually accounts for more than 75% of the total value of all exports. Bananas, whose share in the late 1930s amounted to nearly 30%, represented less than 10% in the 1950s. Some diversification of exports took place during and after World War II and Guatemala became for a time the world's leading producer of essential oils.

Table 11.—Foreign Trade of Guatemala (in $000)

Item	1947	1950	1953	955	1956	1957
Imports	$57,319	$71,222	$79,538	$104,318	$137,700	$159,900
Exports	52,033	67,605	88,922	98,699	116,291	108,796

In the 1950s cotton, a crop new to Guatemala, enjoyed a mild boom.

The U.S. usually takes about 75% annually of the exports and supplies about 80% of the imports. The latter include machinery, motor vehicles, petroleum, textiles, flour, chemicals and iron and steel manufactures.

Finance. — The monetary unit is the quetzal, at par with the U.S. dollar. The 1958–59 budget estimates balanced revenue and expenditure at $113,100,000. In 1957–58 revenue totaled $124,630,300; expenditure $123,192,900. The national debt was officially reported to be $48,237,400 on March 31, 1958, of which $9,917,500 mas external. National income was estimated at $559,200.000 in 1957.

Communications. — Railway service in Guatemala is provided by the International Railways of Central America, a company controlled by the United Fruit company, its principal user. The main line runs from Puerto Barrios on the Caribbean to Guatemala City, nith branch lines into El Salvador, to San José on the Pacific and to Ayutla, a point for connection with the National Railways of Mexico. United Fruit company operates two private banana railways; 6jz mi. out of a total of 720 are operated by the International railways. There are about 5,000 mi. of highways and roads, mostly unpaved with the exception of the highway from Guatemala City to San José and sections of the Pan American, Pacific Coast and Atlantic (Guatemala City-Puerto Barrios) highways. Puerto Barrios (*q.v.*) on the Atlantic is the most important port and three ports of lesser significance are Santo Tomás on the Caribbean, and San José and Champerico on the Pacific coast.

Air transport service is supplied by three international lines—Pan American Airways, Transportes Aereo Centro-Americanos (Taca) and Royal Dutch Airlines (KLM)—and by a government-owned line (Aviateca) which provides the principal domestic service.

Most of the domestic telecommunications facilities, including telephone, telegraph and radio, are owned by the government. They provide contact between the principal points in the country, but equipment and service are inadequate and good local telephone networks are almost nonexistent except in the capital. International cable services connect with the government telegraph lines.

(G. E. Bl.)

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GUATEMALA, a department in central Guatemala. Area 821 sq mi. Pop. (1950) 438.913. A volcanic highland region, it extends northward to the Motagua river. In the southern part, in the midst of volcanoes, is Lake Amatitlán, a popular resort area with picturesque Indian villages on its shores and also the chief coffee-growing region of Guatemala. Other crops include maize, beans and sugar cane. There is much land in pasture for beef cattle.

Guatemala City (q *v.)* is both the departmental and the national capital and is connected by paved highway and railroad to the lake district. Roads and railroads provide communications with Mexico to the west and El Salvador to the east, and also with the Pacific port of San José and the Caribbean ports of Puerto Barrios and Santo Tombs. (P E. J.)

GUATEMALA CITY is the largest city in Central America (pop., 1950, 284,276), the political and social capital, the cultural centre and the economic heart of Guatemala. It is also the capital of Guatemala department. The city is situated in an intermountain valley at an elevation of slightly less than 5.000 ft , and enjoys the temperate climate and invigoratingly fresh atmosphere characteristic of high altitudes in the tropics

Guatemala City was founded (1776) to replace Antigua (q v.), ruined by an earthquake in 1773, as the capital of the captaincy general of Guatemala. After independence from Spain was declared (1821), it served successively as the capital of the province of Central America under the Mexican empire of Agustin de Iturhide (1822–23), the Central American Federation (1823–33), the state and, finally, the independent republic of Guatemala. The tradition of government from Guatemala caused distrust of the city in other areas of Central America that was a factor in the demise of the federation and the failure of subsequent attempts to revive it.

The modern city was largely rebuilt after the disastrous earthquakes of 1917–18. The characteristic appearance created by low, massive structures has been somewhat modified by the erection of steel and concrete multistoried hotels and office and apartment buildings of modern design. Elegant residential districts have grown up on the borders of the old city, particularly toward the south in the direction of La Aurora airport, and low-cost housing units have been constructed in various parts of the urban area. Most streets are well paved and well lighted, and their cleanliness has become proverbial.

In addition to the government offices and services concentrated there, Guatemala City employs nearly half of the capital invested in the country, accommodates more than half of the industrial establishments and accounts for a like proportion of the industrial production of the republic. It is the focus of transport, both local and international, by highway, railroad and air, and is the commercial and banking metropolis of the country.

The cultural role of the city is equally dominating. It is the seat of the principal faculties of the University of San Carlos; the major institutions for artistic, commercial, vocational and military education; the Society of Geography and History; and several of the important museums and related institutions of the country. Most performances by the national orchestra and the national ballet company and those of foreign artists on tour are given in the capital.

Public buildings of note include the National palace. the post office, police headquarters, the National Archives and the National Library. Among the major religious structures are the cathedral and the churches of San Francisco, Santo Domingo and La Merced. Other points of interest include the remarkable relief map of the country in Minerva park (constructed in 1905 by Francisco Vela), the archaeological and historical museums, the colonial aqueduct, the central market and the Olympic city.

In the environs of Guatemala City are the villages of Chinautla, famous for hand-formed pottery, and Mixco, which supplies the capital with fruits and vegetables. Nearby are the Indian towns of San Pedro and San Juan Sacatepéquez. (W. J. G.)

GUAVA, in Spanish *guayaba,* is the name applied to the fruits of numerous trees and shrubs of the genus *Psidium* (family Myrtaceae), all of which are natives of tropical America. Horticulturally the two important species are the so-called common guava, P. *guajava,* and the cattley or strawberry guava, P. *cattleianum,* which occurs in two forms, one with maroon-red fruits and the other with bright yellow ones. The latter is sometimes listed botanically as P. *lucidum.*

The common guava is a large shrub or small tree with quadrangular branchlets, oval to oblong leaves about three inches in length and white four-petaled flowers an inch broad. The fruits are round to pear shaped, sometimes as much as three inches in diameter though usually less; the flesh, which is white to salmon red in colour. contains numerous small. hard seeds — more abundant in primitive forms of the fruit than in the modern improved varieties. The musky, at times pungent, odour of the sneet flesh is characteristic and not always appreciated.

While useful in many ways, guavas are pre-eminently suited for the preparation of jellies, jams and preserves, highly popular in many tropical countries and exported from a few, notably Cuba. Fresh guavas are rich in vitamin C; they are eaten out of hand or may be sliced and served with sugar and cream as a dessert.

The common guava resists little frost. hence is not cultivated in many parts of California but is successfully grown throughout southern Florida; in several tropical regions it grows so abundantly in a half-wild state as to become a pest.

Propagation of the plant is usually by seeds, but the fine varieties which have been developed in Florida, California and a few other parts of the world must be perpetuated by some vegetative means. Because of its hard, dry wood and thin bark, propagation by cuttings and by conventional methods of grafting are not practical, but veneer grafting, using as rootstocks young plants in vigorous growth, and covering the grafts with strips of polyethylene plastic, gives excellent results. A method known as modified Forkert budding has been recommended in Hawaii.

The cattley or strawberry guava is considerably more frost resistant and is popular in many subtropical regions. It is a large shrub, attractive for its thick, glossy-green oval leaves and its white flowers. The fruits are round, occasionally as much as two inches in diameter, and contain numerous hard seeds like those of the common guava. The flavour of the soft whitish flesh has been likened to that of the strawberry, hence one of the common names. This species is frequently planted in gardens throughout southern California and several other subtropical regions; nowhere has it attained commercial importance.

Other guavas which are used to a limited extent in parts of tropical America include the cis of Costa Rica (P. *friedrichsthalianum*) and the guisaro (P. molle), both of which yield highly acid, not very pungent. fruits. (W. Po.)

GUAYAMA, a town and municipality on the southeastern Caribbean coast of Puerto Rico. Town pop. (1960) 19,152; municipality pop. (1960) 33,685. The town is located on a broad and fertile plain about j mi. from the coast. Extensive irrigation facilities have made the area around Guayama rich in sugar production. Five large *centrales* or sugar factories grind the cane which directly or indirectly supplies the livelihood for about 85% of the population in the area. The sugar is shipped from tno small ports, Arroyo and Puerto Jobos. Guayama is connected by highways to the west with Salinas and Ponce, to the east with Humacao, and with Cayey to the north by the scenic Spanish-built military highway.

The central plaza of Guayama, dominated by San Antonio church and adorned by carefully pruned trees, is one of the most beautiful on the island. Textiles, optical products and soft drinks are manufactured. In the mountains to the north of Guayama are important hydroelectric plants which service the southeastern section of Puerto Rico. The town was founded in 1736 as San Antonio de Padua de Guayama. (T. G. Ms)

GUAYAQUIL, chief port and largest city of Ecuador, capital of the province of Guayas (*q.v.*), located on the west bank of the Guayas river (*q.v.*) about 45 mi. upstream from the Gulf of Guayaquil. Pop. (1950) 258.966; (1955 est) 304,571. The main part of the city is on high ground at the foot of a hill which has two humps called Cerro Santa Ana and Cerro Santa Carmen, about 30 ft. above sea level, and stands above the highest floods of the river although the lower town is at times inundated.

The climate of Guayaquil is equatorial but temperatures are never extreme: the average of the warmest month (April) is 80.4° F., and for the coldest month (July), 75.4°. Rainfall is heavy from January to May, but there is little rain during the rest of the year. Violent storms and heavy uinds are unknown. but the humidity is high, especially in the rainy season. The average annual rainfall is 38 8 in.

A settlement was established near modern Guayaquil in 1535 by Sebastibn de Benalcazar. This site, at the mouth of the Babahoyo river, was subject to flooding and disease. The location was moved, and finally in 1538 Francisco de Orellana established the town in its present location. naming it Santiago de Guayaquil to honour both the saint on nhose day it was founded and the Indian chief Quaya and his wife Quila. The city has survived attacks by buccaneers, fires. earthquakes and pestilence. For many years Guayaquil, uhich is slightly more than 2° south of the equator, was regarded as a plague spot. In the 20th century notable engineering and hygienic achievements were accomplished by the government in co-operation with the Rockefeller foundation, and after 1920 health hazards were reduced to a minimum. In 1822 Guayaquil was the scene of the conference that took place between Simón Bolivar and José de San Martín, after which Bolivar emerged as sole leader of the South American liberation movement.

Traditionally the products of the Guayas lonland are brought to Guayaquil by river boat. Even in the dry season, shallow-draft steamboats are able to ascend the Guayas river for about 80 mi. to Babahoyo and to navigate the Daule river for about 40 mi A branch of the Inter-American highway descends from the highlands to Durán on the left bank of the Guayas river opposite Guayaquil. This is also the western terminal of the Guayaquil-

Quito railway (288 mi.). Passengers and goods cross the river in ferries. An all-weather highway runs from Guayaquil to Quevedo and thence up into the highlands at Latacunga, connecting there with the Inter-American highway; another highway connects Guayaquil with Salinas to the west. In the early 1960s a new highway was being built from Quevedo more directly to Quito by way of Santo Domingo de los Colorados. Guayaquil is served by both international and domestic airlines.

The port of Guayaquil can accommodate ships of up to 22-ft. draft. Larger ships, however, anchor about 40 mi. below Guayaquil at Puná Island and are met there by lighters and ferries. A new port on the Salado estuary, about 10 mi. S.W. of Guayaquil, was being built. Most of the exports and imports of Ecuador pass through the port. The decline in the importance of cacao. however, means that no longer is Guayaquil filled with the odour of the drying cacao kernels, which once were spread on the streets in the dry season and gave the city a distinctive aroma.

Guayaquil has numerous industrial plants, producing leather goods, alcohol, soap, candles, textiles, beer and cement. There are sugar refineries. iron foundries, machine shops, tanneries and sawmills. It has one of Ecuador's two leading universities, founded 1867, and among its older buildings are some notable examples of colonial architecture. Since the earthquake of 1942 much of the city has been rebuilt. (P. E. J.)

GUAYAS, a coastal province of Ecuador, bounded west by the Pacific ocean, north by Manabí, Pichincha and Los Rios. east by Los Rios, Cañar and Azuay and south by El Oro. Area 8,208 sq mi. Pop. (1950) 582,144. The provincial capital is Guayaquil (*q.v.*). The greater part of the province is a lowland surrounding the Gulf of Guayaquil. It is rainy and covered with tropical forest in the north, and becomes drier toward the south.

The flood plains of the Guayas river (*q.v.*) system and along the Guayas itself below Guayaquil, including the swampy Puná Island at the mouth of the river, are inundated each year during the rainy season from December to May. Above the flood plains, plantations produce cacao, bananas, rice, cotton, coffee and fruit. Much of the land, including the flood plains, is used for the pasture of beef cattle.

At the end of the Santa Elena peninsula. 7j mi. W. of Guayaquil. is Ecuador's only oil field. At the town of Salinas, in the midst of the oil field, there are salt-extracting works and a rapidly growing seaside resort. Salinas enjoys an arid climate, with blue skies and comfortable ocean winds, and sandy beaches.

The Galápagos Islands (q *v.*), which form a separate territory of Ecuador. are administered from Guayas province. (P. E. J)

GUAYAS RIVER, a river in the coastal region of Ecuador. Its tributaries rise on the western slopes of the Western Cordillera and descend to drain the wet lowland, upstream from Guayaquil. Chief among these are the Daule, the Vinces. the Chimbo (Yaguachi in its lower course) and the Babahoyo. These tributaries join to form the Guayas which carries all this water about 37 mi. to the Gulf of Guayaquil.

The whole length to the end of the longest tributary is about zoo mi. Steamers drawing 22 ft. can ascend even in the dry season to Guayaquil (*q.v.*), where the river is 2 mi. wide, and smaller river steamers can reach Babahoyo. In the rainy season small steamers can navigate to Zapotal, go mi. S.W. of Quito. The river enters the Gulf of Guayaquil through an estuary on either side of Puna Island. (P. E. J.)

GUAYCURUAN, an independent linguistic stock of South American Indians, so called from the Guaycurus, its best known tribe. The tribes of this stock lived in the Argentine Chaco in the region west of the Paraná and Paraguay rivers, from a little above Santa Fé nearly to the mouth of the Pilcomayo and extending westward north of the Salado river, nearly to the foothills of the Andes. After the early period of Spanish settlement, the Guaycuruan tribes expanded eastward some distance across the Paraná below Corrientes and, farther north, penetrated into southern Mato Grosso in Brazil. The Toba are the best known tribe of the stock today, the Abipones (*q.v.*), made famous by the missionary Dobrizhoffer in the 18th century, being extinct.

See D. G. Brinton, "The Linguistic Cartography of the Chaco Region," *Proc. Amer. Phil. Soc.,* vol. xxxvii; L. Kersten, "Die Indianerstämme des Gran Chaco," etc., *Internat. Archiv. für Ethnographic,* vol. xvii, pp. 1–75.

GUAYMI, an Indian tribe who inhabit the mountains of western Panamá between the Chiriqui volcano and the Belén river, and linguistically allied to the Chibcha of South America. During the Spanish colonial epoch they were dominated by missionaries, but later reverted to their natural living conditions.

The ancestors of the Guaymi are regarded as the makers of gold images and ceramics found in ancient graves throughout western Panamá.

See H Pittier, "Little-Known Parts of Panama," *National Geographic Magazine,* vol. xxiii, no. 7 (1912).

GUAYULE (*Parthenium argentaturn),* a rubber-bearing desert shrub of the Compositae (*q.v.*) family, native to the north central plateau of Mexico and the Texas Big Bend area. Prehistoric Indians are believed to have obtained the rubber by chewing the bark. The modern method is to macerate the shrub mechanically. Rubber mas extracted in Mexico from wild plants during the first half of the 20th century, and vigorous efforts were made to cultivate guayule in southwestern United States during World War II. Commercial production of guayule rubber ceased soon after the end of the war, but research plantings were continued in Spain, Turkey and the United States.

See Alton I. Moyle, *Bibliography and Collected Abstracts on Rubber Producing Plants (Other Than Species of Hevea),* Texas Agricultural Experiment Station *Circular* 99 (Nov 1942) ; K. W. Taylor, "Guayule—An American Source of Rubber," *Econ. Bot.,* 5:255 (1951). (L G. P.)

GUBBIO, a town and episcopal see of Umbria, Italy (anc. IGUVIUM [*q.v.*]; med. EUGUBIUM), province of Perugia. 23 mi. N.S.E. from Perugia by road; by rail 13 mi. N.W. of Fossato di Vico (on the line between Foligno and Ancona) and 70 mi. E.S.E. of Arezzo. Pop. (1951) 8,7j6. Gubbio is at the foot and on the steep slopes of Monte Calvo, 1,568 to 1,735 ft. above sea level, at the entrance to the gorge which ascends to Scheggia, probably on the site of the ancient Umbrian town. The Palazzo dei Consoli, on the north side of the Piazza della Signoria, is a huge two-storied Gothic edifice with a tower (1332–46). It contains the famous *Tabulae Iguvinae,* and a collection of paintings of the Umbrian school, of furniture and of majolica. Being on the slope, palace and piazza are raised on arched substructures. On the south side of the piazza is the Palazzo Podestà. begun in 1349.

Above the Piazza della Signoria, at the highest point of the tonn, is the Palazzo Ducale, erected by the dukes of Urbino in 1474–80; the Palazzo Beni is lower donn. The Palazzo Accoramboni is a Renaissance structure, with a fine entrance arch.

Opposite the Palazzo Ducale is the 12th-century cathedral of SS. Mariano e Jacopo. The interior contains some good pictures by Umbrian artists. a fine episcopal throne in carved wood and a fine Flemish cope given by Pope Marcellus II (1555) in the sacristy. The town is full of specimens of medieval architecture. On May 1j three colossal wooden pedestals. each over 30 ft high, and crowned by statues of SS. Ubaldo, Antonio and Giorgio. are carried through the town, and then, in a wild race, up to the church of S Ubaldo on the mountainside (2,690 ft.). (*See* H M. Bower. *The Elevation and Procession of the Ceri at Gubbio,* 1897.)

After its reconstruction nith the help of Narses (*see* IGUVIUM) the town remained subject to the exarchs of Ravenna. and, after the destruction of the Lombard kingdom in 774, formed part of the donation of Charlemagne to the pope. In the 11th century struggles it was generally on the Ghibelline side. In 1151 it repelled an attack of several neighbouring cities, and formed from this time a republic governed by consuls. In 11jj it was besieged by the emperor Frederick I, but saved by the intervention of its bishop. S Ubaldo. and was granted privileges by the emperor. In 1203 it had its first podesta. In 1387, after various political changes. it came under the dukes of Urbino until, in 1624, the whole duchy was ceded to the pope

Gubbio was the birthplace of Oderisio, a famous miniature painter (1240–99), mentioned by Dante as the honour of his native town. In the 14th and 15th centuries a branch of the Umbrian school of painting flourished here, the most famous masters of which were Guido Palmerucci (1280–1345) and several members of the Nelli family, particularly Ottaviano (d. 1444), whose best work is the "Madonna del Belvedere" in S Maria Nuova at Gubbio (1404). Another work by him is the group of frescoes including a large "Last Judgment," and scenes from the life of St. Augustine, in the church of S. Agostino.

Gubbio occupies a far more important place in the history of majolica. In a decree of 1438 a *vasarius vasorum pictorum* is mentioned, who probably was not the first of his trade. The art was brought to perfection by Giorgio Andreoli, generally known as Maestro Giorgio *(see* POTTERY AND PORCELAIN).

See A. Colasanti, Gubbio (Bergamo, 1905); L. McCracken, *Gubbio* (1905).

GUBEN (now WILHELM-PIECK-STADT), a town of Cottbus *Bezirk,* Ger.. at the confluence of the Lubis with the Neisse. 28 mi. S.S.E. of Frankfurt-on-Oder. Pop. (1959 est.) 22,479. Guben, of Wendish origin, is mentioned in 1207 and received civic rights in 1235. It was surrounded by walls in 1311, about which time it came into the possession of the margrave of Brandenburg, from whom it passed to Bohemia in 1368. In 1635 it passed to the elector of Saxony, and in 1815 it was united to Prussia. After 1945 part of the city on the right bank of the river passed to Poland; it is called Gubin; population in 1950 was 4,329. The principal industries are the spinning and weaving of wool, dyeing and the manufacture of pottery ware, hats, cloth, paper and machinery.

GUCHKOV, ALEXANDER (1862–1936), Russian politician, was born in Moscow. He studied at the universities of Moscow and Berlin. He helped to found the Russian "Octobrist" party. In 1910 Guchkov was elected president of the Duma, but as Stolypin became more reactionary, the Octobrisrs lost their *raison d'être,* and Guchkov eventually resigned the presidentship of the Duma. During World War I he was in charge of the Red Cross organization on the German front. When the March Revolution of 1917 broke out Guchkov became minister of war, but resigned on May j. Later, he took refuge in Paris.

GUDBRANDSDAL, a geographic and cultural district of south central Norway, comprising the valley of the Laagen R. from Lake Mjosen to its source in Lake Lesjeskogen, together with tributary valleys and the vast stretches of the encircling fjells. Though the fjells (including the famed Dovre-fjell) are barren and rugged and the mountains are covered with eternal snow, the narrow valley and its slopes, where arable, are richly fertile. The crude forest economy of the 17th and 18th centuries has disappeared, but the region still produces much timber. Lillehammer, at the southern end, is a thriving town; other communities are small. The district offers excellent fishing and hunting, especially for fowl. A railway and motor road through the valley connect Oslo with Trondheim, and from Dombas both rail and road lead to Andalsnes. Like the other valleys of the country, Gudbrandsdal has developed its own culture and dialect but has long possessed a deeply national sentiment.

GUDERIAN, HEINZ (1888–1954), German army officer, an outstanding tank expert in World War II, was born at Kulm (Polish Chelmno) on June 17, 1888, the son of an army officer. After serving as a staff officer in World War I, he vigorously advocated development of armoured forces. In 1935 he attracted Hitler's attention and was promoted rapidly. Designated chief of mobile troops in Nov. 1935, he proved the soundness of his tank warfare theories in the Polish campaign (1939) and in the conquest of France (1940). Following his unsuccessful drive on Moscow in Oct. 1941, he was temporarily out of favour with Hitler, but in March 1943 he became inspector general of Panzer troops with authority to establish priorities in the production of armoured vehicles as well as to direct their employment. After the attempted assassination of Hitler on July 20. 1944, Guderian became acting chief of staff, a position he held until March 28, 1945.

Guderian was a highly competent officer of the Prussian school who accepted Hitler's leadership as a matter of duty. Of special interest among his several books are *Achtung! Panzer!* ("Attention, Tanks," 1937) and *Erinnerungen eines Soldatcn* (1951), published in English as *Panzer Leader* (1952). Guderian died in West Germany on May 14, 1954. (P. N. T.)

GUDGEON *(Gobio gobio,* sometimes called *G. fluviatilis*), a cyprinid fish inhabiting Europe and northern Asia. It rarely exceeds a length of eight inches; it has a barbel at each corner of the mouth, and a row of blackish spots along the side of the body; it frequents sandy or gravelly shallows. Other species of *Gobio* inhabit-China and Japan.

GUEBRIANT, JEAN BAPTISTE BUDES, COMTE DE (1602–1643), marshall of France, was born near St. Brieuc on Sept. 2, 1602, of an old Breton family. In the Thirty Years' War he commanded (1638–39) the French contingent in the army of Bernard of Saxe-Weimar. Upon the death of Bernard he received the command of his army, and tried, in conjunction with J. Baner (1596–1641), the Swedish general, a bold attack upon Regensburg (1640). His victories of Wolfenbüttel (1641) and Kempen (1642) won for him the marshal's baton. He was mortally wounded at Rottweil on Nov. 17, 1643.

GUELDER-ROSE, so called from Guelderland, its assumed source, is commonly called snowball or snowball bush in the United States. It is *Viburnum opulus sterile,* a sterile-flowered variety of the cranberry tree (V. *opulus*) which is native throughout temperate Eurasia. The guelder-rose is much cultivated for its showy, spring-flowering, ball-like clusters of white, sterile flowers; but. lacking fruit, it does not have the showy autumnal colour of the red drupes of the cranberry tree. In England the term guelder-rose is more often applied to the cranberry tree *(V. opulus)* which is there also called rose elder. An American form of it, sometimes known as V. *americanum,* contains in its bark several fatty acids of which an aqueous solution was once thought to be effective in uterine cramps, hence its common name of cramp bark. *See* VIBURNUM. (N. TR.)

GUELPH, a city and the seat of Wellington county southeastern Ontario. Canada, is 28 mi. N W. of Hamilton and 45 mi. W. of Toronto. On the Canadian National and Canadian Pacific railways, it is in one of the more densely populated areas of Canada —within 13 mi. of the cities of Kitchener and Galt and the towns of Fergus, Elora, Acton, Hespeler and Preston. Founded by the Scottish writer John Galt in 1827 at a power site on the Speed river. a tributary of the Grand, the settleinent was named after the British royal family, Guelph was incorporated as a village in 1851, a town in 1856 and a city in 1879. The Ontario Agricultural college and the Ontario Veterinary college helped mske Guelph an important centre for research and training in scientific agriculture. Among products manufactured are electrical apparatus. hardware, stoves, flour, biscuits, pharmaceutical supplies, leather goods and textiles. Pop. (1961) 39,336. (G. FN.)

GUELPHS AND GHIBELLINES, originally the names of two German parties formed in the 12th century around the families to which respectively belonged the dukes of Saxony and Bavaria and the lords of Hohenstaufen. The rivalry between these two families determined much of the history of Germany in the 12th century, and the names in question were employed at an early date in Italy, where the Ghibellines formed the party of the emperor Frederick I and the Guelphs formed the party opposed to him. In the next century the terms acquired a wider sense; the Ghibellines still formed the imperialist party, but the term Guelph lost all trace of its original association with dynastic rivalries in Germany and became applied to the supporters of the papacy in its struggle against the empire. Long after this struggle had become a matter of history these names survived in Italian civic politics, often denoting factions whose origin had no real connection with the rivalry of empire and papacy in an earlier age. Of the terms themselves, Guelph represents the old German personal name *Hwelp,* originally perhaps a nickname (it corresponds to the English word "whelp"), but borne by many persons of rank, notably Welf, duke of Bavaria in the 11th century. Ghibelline is a form of the place name Waiblingen, an ancient possession of the lords Hohenstaufen and not far from the castle of that name.

GUENEVERE, the wife of King Arthur. Geoffrey of Monmouth, who calls her Guanhumara, makes her a Roman lady, but the general tradition is that she was of Cornish birth and daughter to King Leodegrance. Wace, who, while translating Geoffrey, evidently knew and used popular tradition, combines these two, asserting that she was of Roman parentage on the mother's side but cousin to Cador of Cornwall, by whom she was brought up. The tradition relating to Guenevere is decidedly confused: the Welsh *Triads* know no fewer than three Gwenhwyfars. Giraldus Cambrensis, relating the discovery of the royal tombs at Glastonbury, states that the body found was that of Arthur's second wife. The prose *Merlin* gives Guenevere a bastard half-sister of the same name, who strongly resembles her, and the prose *Lancelot* relates how this lady, trading on the likeness, persuades Arthur that she is the true Guenevere, and the queen the bastard supplanter. This episode of the false Guenevere is very perplexing. The relations with early Irish tradition, where the name appears as Findabhair (Guenevere) add another element to the confusion.

To the majority of English readers Guenevere is best known in connection with her liaison with Lancelot, a story which forms no part of the early Arthurian tradition. The Lancelot-Guenevere romance took form and shape in the latter part of the 12th century, amid the artificial atmosphere encouraged by such patronesses of literature as Eleanor of Aquitaine and her daughter Marie, Comtesse de Champagne (for whom Chretien de Troyes wrote his *Chevalier de la Charrette,* where Lancelot first appears as Guenevere's lover), and reflects the low social morality of a time when love between husband and wife was declared impossible. The tradition of Guenevere's infidelity is, however. of much earlier date, and probably formed part of the genuine Arthurian tradition. The stories vary; sometimes she is the unwilling victim of an abduction, sometimes she figures in a guilty flight with her lover. The *Vita Gildae* relates how she was carried off by Melwas, king of Aestiva Regis (Somerset), to Glastonbury, whither Arthur, at the head of an army, pursued the ravisher. A fragment of a Welsh poem seems to confirm this tradition, which certainly lies at the root of the story of her abduction by Meleagant, told by Malory. In the *Lanzelet* of Ulrich von Zatzikhoven the abductor is Falerin, a magician. The story in these forms represents an other-world abduction. A curious fragment of Welsh dialogue, printed by Sir John Rhys, appears to represent Kay as the abductor. In the chronicles, and the romances based upon them, the abductor is Mordred. and the queen is no unwilling victim. On the final defeat of her lover she retires to a convent, where she takes the veil and is no more heard of.

Layamon says that she was reported to have drowned herself, and that her memory and that of Mordred were hateful in every land. so that none would offer prayer for their souls.

The truth seems to be that we are dealing here with a mixture of mythic elements and pseudo-historic tradition. The story of Guenevere's abduction belongs to the former, that of her betrayal of her husband, with a near relative, and consequent flight, to the latter.

See Sir *J. Rhps, Studies on the Arthurian Legend* (1891); *J.* L. Weston, *The Legend of Sir Lancelot* (1901); *R.* S. Loomis, *Celtic Myth and Arthurian Romance* (1928). (J. L. W.)

GUENON, any of the long-tailed African monkeys (*Cercopithecus)* with hair many-banded, dark and light. They are more slender than the macaques, but like them have cheek pouches. (J. E. HL.)

GUÉRANGER, PROSPER LOUIS PASCAL (1805–1875), French Benedictine monk, restorer of Benedictine monachism in France and pioneer in the modern liturgical revival, was born on April 4, 1805. Reacting while still a theological student against the lingering Gallicanism (*q.v.*) of his day. he was ordained priest in 1827. Although strongly sympathizing with the views of Hugues Felicité Robert de Lamennais (*q.v.*), he never identified himself intimately with the views of that erratic genius. His studies in Christian antiquity and the history of Christian institutions led to a strong feeling for the Roman liturgy and to the beginning of a campaign for the abolition of the various local liturgies then flourishing in France. It was not long before the idea of restoring Benedictine monachism. extinct in France as a result of the Revolution and the legislation of the Napoleonic era, took hold of him. In Dec. 1832 he acquired the monastic buildings and lands of Solesmes, an 11th-century foundation. In spite of numerous difficulties. within five years Solesmes was confirmed as an abbey by the Holy See with Guéranger as first abbot and head of the Benedictine Congregation of France. A great advance had been made. and in spite of recurring administrative problems, studies long interrupted could now be resumed.

In 1840 appeared the first volume of Guéranger's *Institutions liturgiques*, an ambitious project never carried to completion, but of extraordinary effectiveness in restoring the Roman liturgy in dioceses in which it had been supplanted by unauthorized compositions of the 17th and 18th centuries. The second volume appeared in 1841, the third ten years later. The historical sections of the work must be pronounced defective, at times seriously so, but the second volume is still important for the history of the liturgy in France in the 17th century and in the two centuries following. When the three volumes were re-edited after the author's death, a fourth was added (1885) containing several controversial letters, written in reply to criticisms uhich the work had evoked. Of quite a difierent character — that is, strictly devotional — is another work which began to appear in the same year as the *Institutions*, the *Année liturgique*, of which nine volumes — from Advent through Paschaltide — were published in the author's lifetime. Six volumes, the work of Dom Lucien Fromage, who dealt with the period after Pentecost, completed the series (1878–1901), which was frequently reprinted, not only in the original but also in more than one of the languages into which it had been translated. A complete list of Gueranger's works is to be found in the *Bibliographie des bénédictins de la Congrégation de France,* 2nd ed., 55–71 and 167–168 (1906). Guéranger died on Jan. 30. 1875.

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GUERCINO, the name given to GIOVANNI FRANCESCO BARBIERI (1591–1666), Italian baroque painter, because of his squint. He was born on Feb. 8. 1591, at Cento, near Ferrara, and received his earliest training locally. But the formative influence on his style came from Bologna, especially from the work of Lodovico Carracci. His first pictures (*e.g.,* the "Madonna in Glory With Saints and a Donor:" at the Brussels museum) have large, rather uncouth forms, strong colour, unbalanced compositions and broad, vigorous brushwork. The lights are scattered over the surface in patches. leaving much of the picture in shadow *(cf.* Carracci's Cento "Madonna" of 1591). This method of using light and shadow was unrelated to the discoveries of Caravaggio and was derived from Bologna and Venice, which Guercino visited in 1618; the tendencies toward realism in his style were general in 17th-century Italy.

In 1621 Guercino went to Rome, and there, among many other commissions, decorated the Casino Ludovisi. The main fresco, "Aurora," on the *gran' salone* ceiling. is a spirited. romantic work; yet it already reveals something of the crucial experience of his stay in Rome, which was his contact with Pope Gregory XV's private secretary, Monsignor Agucchi, a propagandist for the classicism of Annibale Carracci's Roman style. Guercino seems to have tried to make his own style conform with Carraccesque principles, an effort reflected in his "Sta. Petronilla" (Vatican gallery).

On the death of Gregory in 1623, Guercino returned to northern Italy, continuing to smooth out the unclassical features of his style. The result was not entirely happy and Guido Reni's unassailable position in Bologna as heir to Annibale Carracci increased his difficulties. But Guercino was continually employed by ecclesiastical and private patrons. Some of the later works—*e.g.,* the "Death of Dido" (Spada gallery. Rome) and the "Hercules and Antaeus"

(Palazzo Zampieri, Bologna), both of 1631—are considerable achievements; others are weak and empty. In 1642 Guido died and Guercino settled in Bologna, where he died on Dec. 22, 1666.

See D. Mahon, *Studies in Seicento Art and Theory* (1947).

(M. W. L. K.)

GUÉRET, a town of central France, capital of the *département* of Creuse, situated 48 mi. N.E. of Limoges on the Orleans railway. Pop. (1954) 8,700. Guéret grew up around an abbey founded in the 7th century, and in later times became the capital of the district of Marche. The Hôtel des Monneyroux (used as a prefecture), a mansion of the 15th century, is the only building of importance.

It is the seat of a prefect and a court of assizes, and has a tribunal of first instance, and a chamber of commerce. The industries include leathermaking and the manufacture of basketwork, tiles, hosiery and wooden shoes, and there is trade in agricultural produce and cattle.

GUEREZA, a long-tailed black and white Ethiopian monkey, *Colobus abyssinicus,* often called bishop monkey from the attractive robelike mantle of fine, silky white hair; the name is sometimes extended to embrace all the darker thumbless monkeys of the genus *Colobur* They resemble the langurs (*q.v.*) with which they agree in their slender build. These gentle herbivores seldom leave the tops of tall trees.

GUERICKE, OTTO VON (1602–1686), German natural philosopher, notable for his studies of air pressure, was born at Magdeburg, in Prussian Saxony, on Nov. 20, 1602. Having studied law and mathematics in Germany and at Leyden, he visited France and England. and in 1636 became engineer-in-chief at Erfurt. In 1627 he was elected alderman of Magdeburg, and in 1646 mayor of that city and a magistrate of Brandenburg. His leisure was devoted to scientific pursuits. especially in pneumatics. Incited by the discoveries of Galileo, Pascal and Torricelli, he attempted the creation of a vacuum.

After a number of partially successful experiments he invented the air pump (1650). Besides investigating other phenomena connected with a vacuum, he constructed an electrical machine which depended on the electrification of a rotating ball of sulfur; he also made successful researches in astronomy, predicting the periodicity of the return of comets. In 1681 he gave up office, and retired to Hamburg, where he resided until his death on May 11, 1686.

His principal observations are given in his work, *Experimenta nova, ut vocant, Magdeburgica de vacuo spatio* (1672). He is also the author of a *Geschichte der Belagerung und Eroberung von Magdeburg. See* F. W Hoffmann, *Otto von Guericke* (1874).

GUÉRIDON, a small table to hold a lamp or vase, supported by a tall column or a human or mythological figure. This piece of furniture, often very graceful and elegant, originated in France toward the middle of the 17th century.

In the beginning the table was supported by a Negro or some exotic figure, and there is some reason to believe that it took its name from the generic appellation of the young African groom or "tiger," who was generally called "Guéridon," or, in English, "Sambo."

GUERILLA: *see* GUERRILLA WARFARE.

GUÉRIN, PIERRE NARCISSE, BARON (1774–1833), French painter, the teacher of both E. Delacroix and J. Géricault, was born at Paris on May 13, 1774. He had an early success with his topical "Marcus Sextus" (1799, Louvre). "Phèdre et Hippolyte" (1802, Louvre) and "Andromaque" (1810, Louvre) are melodramatic and highly calculated pieces. His best painting, the only one to show feeling for colour and atmosphere, is "Enée racontant à Didon les malheurs de Troie" (1817, Louvre). He died in Rome on July 16, 1833. (AA B.)

GUÉRIN DU CAYLA, GEORGES MAURICE DE (1810–1839), French poet. was born at the château of Le Cayla in Languedoc. He joined for a short time the group formed by Lamennais (*q v.)* at La Chênaie. Early in 1833 he went to Paris, where he taught at the Collège Stanislas. In Nov. 1838 he married a Creole lady of some fortune. He died on July 19, 1839. In the *Revue des deux mondes* for May 15, 1840, there appeared a notice of Maurice de Guérin by George Sand, to which she added two fragments of his writings—one a composition in prose entitled the *Centaur,* and the other a short poem. His *Reliquiae* (2 vols., 1861), including the *Centaur,* his journal, a number of his letters and several poems, was edited by G. S. Trébutien, and accompanied with a biograpical and critical notice by Sainte-Beuve. A new edition, with the title *Journal, lettres et poèmes,* followed in 1862; an English translation of it was published at New York in 1867.

Though Maurice de Guérin was essentially a poet, his prose is more striking and original than his poetry. Its peculiar and unique charm arises from his strong and absorbing passion for nature, a passion of pagan intensity.

The name of EUGÉNIE DE GUÉRIN (1805–48), sister of Maurice de Guérin, was closely associated with her brother's work. Her *Journals* (1861, Eng. trans., 1865) and her *Lettres* (1864, Eng. trans., 1865) indicated the possession of giits of as rare an order as his, though of a different kind. In her case mysticism assumed a form more strictly religious, and she continued to mourn her brother's loss of his early Catholic faith. She died on May 31, 1848.

See the notices by George Sand and Sainte-Beuve referred to above; Sainte-Beuve, *Causeries du lundi* (vol. xii) and *Nouveaux Lundis* (vol. iii); G. Merlet, *Causeries sur les femmes et lès livres* (1865); Selden, *L'Esprit des femmes de notre temps* (1864); Marelle, *Eugénie et Maurice de Guérin (1869)*; Harriet Parr, *M. and E. de Guérin, a monograph* (1870); and Matthew Arnold's essays on Maurice and Eugenie de Guérin, in his *Essays in Criticism.*

GUERNIERI or WERNER (fl. 1350), a celebrated mercenary captain, was a member of the family of the dukes of Urslingen. He served the Pisans (1340–43), but afterward collected a troop of adventurers which he called the Great Company, and with which he plundered Tuscany and Lombardy. He then entered the service of Louis I the Great, king of Hungary and Poland, whom he assisted to obtain possession of Naples. When dismissed from this service his ravages culminated in the sack of Anagni in 1358. He is said to have worn a breastplate with the inscription, "The enemy of God. of pity and of mercy."

GUERNSEY, the second largest of the Channel Islands, and the westernmost of the important members of the group, its chief town, St. Peter Port, on the east coast (in 2° 33' W., 49° 27′ N.) being 30 mi. from the nearest French coast to the east. The island, roughly triangular. is $9\frac{3}{4}$ mi. long from northeast to southwest and has an extreme breadth of $5\frac{1}{4}$ mi. and an area of 24.46 sq.mi. Pop. (1951 census) 43,547, excluding about 100,000 annual visitors. The island was occupied by German forces from June 30, 1940, to May 9, 1945.

The island is flat and low in the north, but rises gradually to a plateau (height more than 300 ft.) in the south. The fracturing of the granitic rocks resulted in steep-sided valleys and bays, separated from one another by rocky headlands. The scenery of the south coast, with the bays of Moulin Huet, Saints and Petit Bot, is notable. The west side of the island has a gradual slope and longer, wider valleys with a low rocky coast and open bays (Rocquaine, Perelle, Vazon, Cobo, etc.) exposed to the Atlantic. On the sheltered eastern side are the two ports, St. Peter Port and St. Sampson, the harbour of St. Sampson being the remnant of an arm of the sea, which formerly isolated the Vale and L'Ancresse in the northeast from the rest of the island.

Soil structure ranges from heavy loam in the south to pure sand in the north. Seaweed, or vraic, has been used for centuries as manure, and large quantities are still incorporated in the soil annually, the cutting and harvesting of vraic being regulated by law. The climate is mild and equable and the annual sunshine record is high, averaging 1,905 hr. In consequence, the island is popular as both a winter and summer resort.

The typical form of settlement in Guernsey is that of the smallholder, agriculture proper having largely given way to horticulture and domestic building. Initial permanent colonization of the island was by militant monks from the duchy of Xormandy prior to the conquest of England. It is a region rich in megalithic monuments of Armorican type and most of the churches are definitely on sites of prehistoric sanctity. Celtic saints have left their trace in legend and dedication; there is also a Norse element in the population. About the 11th century most of the land was apportioned to Norman manors, but the usual organization became modified because of absentee lords. Fishing supplemented cultivation, and in the 17th and 18th centuries Guernsey developed maritime adventure, including privateering for the English kings against the French during the frequent wars. The introduction of a root crop (parsnips) brought agricultural prosperity: but the end of privateering with the peace of 1815 meant a crisis for Guernsey in spite of its ships and shipyards and its use as a place for the storage and maturation of southern wines. In the middle of the 19th century a great local effort led to the building of harbours, a prelude to the development of rapid communications. There is also an excellent airport on the island. Because of its slope northward and its somewhat exposed position, Guernsey is not warm enough in summer to grow grapes and tomatoes intensively in the open. It therefore specializes in cultivation under glass, the area of which covers about 1,000 of its total 15,560 ac. Guernsey has a separate herd of dairy cattle of great value. 'In the middle of the 19th century granite was the island's main export and was quarried at its northern end, but this trade declined.

Guernsey is united with Alderney, Sark, Herm and the adjacent islets to form the bailiwick of Guernsey, separate from Jersey (*see* CHANNEL ISLANDS for constitution). Guernsey is divided into ten parishes, with St. Peter Port, its chief town, as one. The population of St. Peter Port in 1951 was 16,799. There is good Romanesque work in the church of St. Michael, Vale, and the church of St. Peter Port is a notable building. Remains of monastic buildings are seen at Yale and on Lihou Island, north of Rocquaine bay.

See C. P. Le Huray, *The Bailiwick of Guernsey* (1952); B. C. de Guerin, *The Norman Isles (1948)*. (B. C. DE G.)

GUERRAZZI, FRANCESCO DOMENICO (1804–1873), Italian patriot and writer of historical novels through which he expressed his political opinions. Born at Leghorn on Aug. 12, 1804, he was educated for a legal career at Pisa, where in 1821 he met Byron. In 1829, with Guiseppi Mazzini and Carlo Bini, he founded at Leghorn a political journal, the *Indicatore livornese*, which was soon suppressed. Several times imprisoned for his activity in the cause of Young Italy, he wrote his most famous novel, *dssedio di Firenze* (1836), in prison. He became a liberal leader at Leghorn, and in 1848 was made a minister. In 1849, on the proclamation of the republic of Tuscany and the flight of the grand duke, he was one of the triumvirate, with Mazzini and Guiseppi Montanelli, and then became dictator, but after the restoration he was arrested and imprisoned. and exiled to Corsica. He was later allowed to live at Genoa and, after 1862, became a deputy at Turin. He died near Cecina, Sept. 23, 1873. His many romantic novels, in which artistic and historical truth is sacrificed to political enthusiasm, reveal the fieriness of temperament which made him an effective political speaker.

See R. Guastalla, *La vita e le opere di F. D. Guerrazzi* (1903); P. Miniati, F. D. *Guerrazzi* (1927).

GUERRERO, FRANCISCO (c. 1528–1599), Spanish composer, was born at Seville about 1528. He became a pupil of Morales and was one of the most important of the Spanish group who came under Italian influence in the second half of the 16th century. At 18 he was made maestro de capilla at Jaen. His next appointment was at Malaga, and in 1554 he became maestro de capilla of Seville cathedral. He died on Nov. 8. 1599. Many of his works have been preserved, the most important being: a volume of *Sacrae cantiones* for four and five voices (1 j55); *Magnificats* (Louvain 1563); *Liber primus Missarum F. Guerrero Hispalensis Odei phonasco autore* (Paris, Du Chemin 1566), containing lour masses in five parts, five masses in four parts, motets and five and six parts and a *Pater noster* in eight parts (a copy of this is in the Imperial library. Vienna); motets. published in Vienna 1570, 1589; masses, published in Rome 1$82. Eslava's famous collection: *Lira sacrohispana* (1869) contains Guerrero's Passion according to St. Matthew for four voices and the Passion according to St. John for five voices, three motets for five voices and a four-part mass. For a complete list, *see* Robert Eitner's *Quellenlexikon. See* also the article *Guerrero* by J. R. Sterndale-Bennett in Grove's Dictionary.

GUERRERO, VICENTE (1783–1831), Mexican independence hero born at Tixtla, began his military career in 1810. José Maria Morelos commissioned him to promote the revolutionary movement in the south. By 1817 the movement was virtually suppressed, but Guerrero continued guerrilla warfare until he accepted (1821) Agustín de Iturbide's invitation to consummate Mexican independence.

When Iturbide had himself crowned emperor (1822), Guerrero participated in the military and political struggles which followed. In March 1829 he was chosen president but the tenacious soldier proved less adept at political administration. The troops of Antonio López de Santa Ana rebelled and Guerrero was betrayed, tried and executed in Chilapa on Feb. 14, 1831.

(S. R. R.)

GUERRERO, a Pacific coast state of Mexico, bounded northwest by Michoacán, north by México (state) and Morelos, northeast and east by Puebla and Oaxaca and south and west by the Pacific. Area 24,887 sq.mi. Pop. (1950) 919.386, largely composed of Indians and mestizos. The state is roughly broken by the Sierra Madre del Sur and its spurs, which cover its entire surface with the exception of the Pacific coastal plain. The valleys are usually narrow, fertile and heavily forested. but difficult of access. Guerrero is divided into two distinct zones—the *tierras calientes* of the coast and lower river courses where tropical conditions prevail, and the *tierras templadas* of the mountain region, celebrated for its agreeable, productive and healthy climate The principal river is the Balsas. Agricultural products include cotton, coffee, tobacco and cereals, and the forests produce rubber, vanilla and various textile fibres. Mineral resources include silver. gold, mercury, lead, iron. coal, sulfur and precious stones.

Guerrero became a state in 1849, and was named after Vicente Guerrero, a leader of Mexico's war for independence. Chilpancingo (pop. 12,662). the capital, is an agricultural centre. Two well-known cities are Taxco (pop. 10 025) and Acapulco (*q.v.*), a famous colonial port now a fashionable resort. Taxco's silver industry, which dates from the 1520s when Hernán Cortes established a mining community, has been revived, largely through the efforts of William Spratling. Taxco, because of its colonial character, has been declared a national monument, and is a great tourist and art centre. Its baroque church of Santa Prisca is one of the most famous in Mexico. (J. A. Cw.)

GUERRILLA WARFARE, a form of warfare carried on by independent. quasi-military groups in connection with a regular war. generally in the rear of or on the flanks of the enemy. The term guerrilla, of Spanish origin, means literally "small war"; in English, when used as a noun, it denotes a person engaged in the kind of warfare just described. The term partisan is synonymous with guerrilla, as is "irregular."

A guerrilla or partisan is, in the literal meaning of the word, an "irregular"; he is never a regular soldier and his irregularity is his trade-mark. In the Peninsular War of the early 1800s the Spanish guerrillas called themselves *partidos* or "partisans"; during World War II the Soviet irregulars called themselves partisans or "fighters for freedom." The Germans termed these same partisans *Banditen* or "bandits." In general, a regular war may be defined as the attempt to take terrain from an enemy and hold it or deny it to him; an irregular war. or warfare by guerrillas, partisans or nonregulars, may be defined as the attempt to prevent or avoid exploitation of terrain by an enemy. In its broadest sense, guerrilla warfare is the projection behind enemy lines of all elements of a war fought between regular armies.

Guerrilla warfare and guerrilla-type warfare are not the same thing. Tribal warfare, for example, consisting of operations carried out by relatively primitive groups not in connection with a regular war. cannot be considered guerrilla warfare. The campaigns waged by Iberian, Gallic and Germanic tribes against Rome were regular wars in that the tribes, no matter what their composition, strategy or tactics, represented the only striking forces opposing the legions. They were the armies of the tribes defending their land against invasion or occupation. Similarly, the long series of tribal wars fought by native groups against the British army and the Indian wars in America cannot be considered guerrilla warfare. The armies of the Russian Reds in the period 1917–21 and the Chinese Communists in the period 1927–40 have been called "guerrilla armies of movement" by their leaders because of their loosely knit constitution and type of operations. But these were not true guerrilla armies and the warfare they waged was not true guerrilla warfare, though it was the only warfare they were organizationally and logistically capable of waging.

Generally speaking. guerrilla warfare may take any one of several forms. It may be a rebellion of an indigenous populace synthetically instigated and supported from without; it may be a popular revolt against enemy occupation with some organization and central direction by a recognized authority; or it may be the activity of sizable groups of troops bypassed by an invader in a rapid offensive. The activity of the Spanish guerrillas against the Napoleonic armies in the Peninsular War was a combination of a popular rising against an invader and occupier and a revolt supported and sustained by the British from without. as was the French resistance to German occupation during World War II. The Arab revolt of 1916–18 against the Turks and Germans was synthetic both in conception and execution; it was bought of the Arabs with promises of national independence, arms and supplies, advice and leadership and several million British pounds sterling. The Soviet partisan movement against the Germans in World War II was a combination of a popular revolt and the activity of bypassed regular army groups brought into a cohesive effort by a central authority.

For guerrilla warfare to start and develop into an effective force, certain basic premises must be satisfied. If it is to have a chance of success it must take place in a broad expanse of terrain sufficiently broken and difficult to give security to its bases, cloak its operations and discourage continued pursuit. It must have at least the passive support of the population. It must have motivation. It must be waged by tough, independent people inured to hardship. It must have more than a modicum of organization and discipline. It must have logistical support and some professional leadership and advice from regular soldiers. And it must be conceived in combination with a war carried on by a regular army, and both waged according to a plan encompassing the operation of the whole.

Tactics.—The term guerrilla tactics is a misnomer. The tactics of the ambush, the hit-and-run, infiltration and attack from the rear or at night are neither new nor peculiar to irregular warfare. They mere evolved in early tribal warfare, and for many years have been standard elements of infantry tactics. They may be modified to suit the particular people or terrain involved or adapted to new weapons or means of communication, and refinements based on experience may be added, but basically they remain the same. *(See* TACTICS.)

Strategy.—Guerrilla units are by their very nature strategic rather than tactical forces. Being irregular, not part of a regular army, they are too loosely knit and widely spread for concentrated efforts. and too poorly organized and disciplined to be of value in formal combat with regular units. They can aid a regular force in winning a war, or perhaps prevent an enemy from winning it. but they can never win a war by themselves. They can undermine an enemy. but only a regular force can overthrow one. The value of guerrillas lies in the talents they inherently possess—speed, mobility, endurance, independence of arteries of supply and familiarity with the country—not in their hitting power, not in occupying and controlling territory, not in fighting battles. The guerrillas' only practical line is to wage a war of detachment, containing the enemy and modulating his action by their mere existence, forcing him to spread out in occupation and thus weakening him, then striking his flanks and rear. interrupting his lines of communication, destroying his matériel, turning the indigenous population against him and acting in conjunction with the regular force opposing him.

Guerrillas and International Law.—As early as the U.S. Civil War cognizance was taken of the status of guerrillas as legal or extralegal combatants. Following the doctrine formulated by Francis Lieber, pioneer in the codification of international law, the United States government set the policy that men or bands of men who committed hostilities without being part of the organized hostile army and who did so intermittently were not public enemies and were not entitled to the privileges of prisoners of war. The Hague conferences of 1899 and 1907 and later 20th-century thinking followed closely along this line. Guerrillas are considered lawful belligerents and are entitled to be treated as prisoners of war only if they meet the following requirements: they must be commanded by a person responsible for his subordinates; they must wear a fixed distinctive sign or uniform recognizable at a distance; they must carry arms openly; and they must conduct their operations in accordance with the laws and customs of war. If they fail to fulfill all these conditions, they may be tried and sentenced to imprisonment or execution. *(See* LAWS OF *WAR.)*

PRE-WORLD WAR II GUERRILLA ACTIVITY

American Revolution.—In the American Revolution the guerrilla bands operating in the southern colonies waged an irregular campaign that indirectly exercised a decisive effect on the course of the war. Following the British occupation of Charleston. S.C., in 1780, the threat of French aid to the colonies and the strategy of completely subduing the southern colonies and then pressing the war northward into Virginia necessitated the enlistment of active help from the loyalist elements of the populace and the elimination of all thought of resistance from the remainder. Consequently, Cornwallis, the British commander, immediately garrisoned the country at strategic points in an attempt to cow the rebels and draw the loyalists to him as a reservoir of replacements. This move, combined with the inept British policy of attempting to force the colonists into arms against their countrymen or lay open their property to confiscation, almost immediately sowed seeds of discontent.

The hardy, independent men of the back country, heretofore largely neutral, began openly to swing to the Continental cause. Under the able leadership of men like Francis Marion (*q.v.*), Thomas Sumter (*q.v.*) and others, they gathered into small bands and began striking sharply at Tory groups and British outposts. Defeating the Tories in several engagements and keeping the British garrisons under constant pressure, they forced Cornwallis to continue and even expand his garrisoning of the countryside, which weakened him and made the Tories aware of the guerrillas' striking power. This latter factor impeded Cornwallis' recruiting from Tory ranks.

Both Marion and Sumter understood the kind of warfare they were waging and the type of forces they had at their command. Knowing that men are influenced by action and that to hold an irregular group together it must be kept busy, they kept their bands almost constantly in motion. They also realized that their untrained men could not face the British regulars in battle. Thus they retreated swiftly in the face of odds and changed their bases regularly. harrying their enemy on the fringes and forcing him into fruitless miles of pursuit. This guerrilla action, combined with the sudden, one-time rising of the mountain men and their crushing defeat of the British and the Tories at King's Mountain, completed the loss of indigenous support for Cornwallis and thus frustrated his policy and hastened the end of the war. Although the British won almost every battle in the south, each victory resulted in losses which the Tory elements mould not replace for fear of the guerrillas, and Cornwallis was forced to withdraw. The irregulars did not win the war in the Carolinas, but certainly it is fair to say that they prevented the British from doing so.

Spain, 1808–14.—The Spanish rising against French invasion and occupation during the Napoleonic Wars was a popular revolt sustained by abundant native enthusiasm and a powerful foreign ally. It was an uprising born of shame of their country's weakness and hatred of a foreign invader. It was aided and abetted by Great Britain. It exercised a considerable influence on the outcome of the regular war being waged at the same time.

Both the Spaniards and their country were well suited for guerrilla warfare. The Spaniards were a rough. hardy people living in a hard land, inured to hardship and poverty, highly independent and inattentive to comforts beyond their reach. Much of their land was rugged, broken and relatively trackless, cut by barren mountain ranges and many rivers, with few roads. When Wellington was preparing his campaign against the French in Spain and Portugal, he saw the possibility of supplementing the strength of his small army by actively aiding, advising and supplying the guerrilla bands which had risen after the French had taken over the land. He saw that the French army had its limits; that the more ground it had to occupy the weaker it would be at any given point; that it could not control a thoroughly disaffected country and still provide a field army strong enough to defeat him. He therefore detailed an experienced officer to maintain close liaison with the bands, to supply them. to improve their organization and discipline and co-ordinate their actions with those of the British.

The guerrilleros, irregular as they were, became efficient in their o n cause only to the degree that they became organized and disciplined. With help and encouragement their bands grew in numbers and in boldness, and several outstanding leaders appeared. In the northern provinces, where terrain and the guerrillas' knowledge of it worked against the French, the country was soon completely out of hand. French garrisons were cut off from each other and from their headquarters at Madrid; supply convoys were regularly attacked and often destroyed; and couriers seldom got through unless heavily guarded. Heavy flying columns of French veterans continually struck at the bands, but found them difficult to locate and more difficult to maintain contact with.

During the five years of the war, half the French force was continually employed in the ceaseless and fruitless task of guerrilla hunting; others were forced into the idleness of passive occupation. As a result, with more than 300,000 men under arms, there were never more than 70,000 available to face the British. In the last analysis, it was the drain of French soldiers to the peninsula that made Napoleon too weak to fight the powers of central Europe successfully in 1813. For five years the hardiness of the Spanish guerrillas and the skill and drive of Wellington detained in the peninsula the French army with which Napoleon might have completely conquered Europe.

The American Civil War.—In the American Civil War the government of the Confederate States made a formal attempt to legislate a guerrilla resistance into existence. With one exception, the attempt failed because of the difficulty of centralized control and direction of the irregular groups that mere formed. Although authorized by the Confederate congress. so many of the bands became filled with men who merely desired to escape the rigours and dangers of regular campaigning and so often did more damage to friends than to enemies that they had to be absorbed into the regular army. The one exception was the band of John S. Mosby (*q.v.*), which operated in northern Viriginia. An officer of J. E. B. Stuart's cavalry, Mosby demonstrated considerable ability as an irregular leader. Starting early in 1863 with a small group, he almost immediately turned the fringes of the winter-quartered Federal army into a state of confusion with his raids. One of these carried several miles inside the Union lines and resulted in the capture of a general officer in his headquarters aithout casualty to the raiders. In addition to his guerrilla activity, Mosby proved himself highly valuable as an intelligence medium, sending regular reports to Confederate headquarters.

Although the discipline of his command was far better than that of most irregular units, his band was still irregular, loosely knit and spread over a wide area. Conscious of his own strengths and weaknesses, he stayed for the most part within his own limitations. He struck at no large bodies of enemy troops; he quickly withdrew when faced with too much pressure. He saw that by remaining on the aggressive he could compel his adversary to guard against him at a hundred points while he attacked where he chose. This constant threat impelled the Federals to detach large bodies of troops as guards for supply trains and depots. At one point the strategy forced a Union commander to ask for 5,000 additional men to replace soldiers placed on special duty to guard against his raids. After the war, Gen. Philip Sheridan stated that Mosby drained his line-of-battle strength with this strategy to the extent of possibly prolonging the war several months.

Finally, the Federal cavalry so laid waste his zone of operations that his bases and sources of supply mere destroyed and his raiding was brought to an end. Mosby was an excellent guerrilla leader. He was tough, resourceful, and had an excellent understanding of what he was about. Had he been many rather than one, the northern forces would have suffered far more than they did.

Lawrence and the Arab Revolt.—As noted above, the Arab revolt (1916–18) and the resultant guerrilla warfare were almost wholly synthetic in both conception and execution. The Arab people were a heterogeneous spread of tribes, politically frivolous and more prone to fight among themselves than to combine against a single enemy. Their revolt against the Turks and Germans during World War I was largely brought about through British leadership, support and open subsidy. The leading spirit of the revolt was T. E. Lawrence (*q.v.*), a former archaeologist who had acquired a unique knowledge and understanding of the near east and its peoples. How effective a leader he was has always been in some dispute, but the achievements of the revolutionary movement he virtually led are facts. Taking over as titular head soon after the first rising, Lawrence early demonstrated his understanding of guerrillas and their potentialities. Not a professional soldier but deeply read in military history, he saw that irregulars such as the Arabs, because of their lack of organization and discipline, would not and could not attack places held in strength and thus remained incapable of forcing a decision; that they were as unable to defend a point or line as they mere to attack it; that their military value lay in depth, not in front. His strategy was to dispose his force in such a manner as to impose on the enemy the widest possible passive defense, and thus weaken him the most. This Lawrence did by widespread attacks on lines of communication and constant pressure on outposts. Soon the British commander saw that there were more Turks and Germans facing the Arab irregulars than fighting the British army. In conjunction with the final British offensive against Damascus. Lawrence and his Arab bands were ordered to give the illusion that the bulk of Allied strength lay east of the Jordan river and that the attack would come from that direction. By artful maneuver and timely demolitions, they were able to create this effect. As a result the British regular army, as it had been enabled to do by the Spanish guerrillas in the peninsula a century earlier, was able to concentrate all its strength against only a part of the enemy and a relatively easy victory resulted. As irregular as they were, the Arab guerrillas were able to contain about 25,000 Turkish and German soldiers for a considerable period and at a critical time to draw off one entire Turkish army and some reserves from another, immediately prior to the final, all-out British offensive.

WORLD WAR II

During World War II guerrilla warfare became more prevalent and came into more prominence than in all previous history. In Europe the change from the positional warfare of World War I to the war of movement instituted by the Germans, in which large masses of fast-moving armoured and motorized units operated over great distances on loose and fluid fronts and with lengthened communication lines, gave guerrilla forces an opportunity to develop and effectively operate to a far greater extent than in the past. Improvements in, aircraft and radio contributed to this development. Similarly, the mountainous terrain of the Balkans, the jungles of the Pacific and the swamps and forests of the Soviet Union fostered the growth of guerrilla movements as never before. Yet throughout this conflict, guerrilla warfare remained essentially irregular, as in the past, with all the strengths and weaknesses that that implied.

The Philippines.—On the surrender of the Philippine Islands to the Japanese in 1942, many groups of U.S. and Philippine military personnel refused to obey the surrender order. They moved into the mountains and jungles of the interior of the islands to form guerrilla bands and continue the war. Although they had the support of a majority of the population and were generally familiar with the country, these bands at first were seriously hampered by a lack of supplies and matériel, especially communications equipment. and their effectiveness suffered for some time for the want of centralized control and a regular army with which to work. Within a few months several of these bands were able to establish radio contact with Gen. Douglas MacArthur's headquarters in Australia and gain recognition as bona fide units. This brought active American liaison and badly needed supplies. Many bands, however, were unable to establish such contact for some time, and as a result their development was seriously restricted.

Following abortive attempts by some groups to operate actively against the Japanese. MacArthur, fearing the loss of even this tenuous contact with the islands, ordered them to desist from such activity and confine themselves to gathering and transmitting information on Japanese movements and dispositions and organizing and training themselves so that they might actively aid in the eventual U.S. reinvasion. In some areas the bands were well led and made excellent progress in executing their assigned mission. The leadership of other groups was taken over by political opportunists. and in one case by active Communists. and results were correspondingly poor. In some cases the bands of rival leaders waged open narfare for control of an area or island. Other bands were little more than bandit groups and used their position to carry out systematic pillaging.

Gradually, in most areas, however, firmer hands prevailed, and before MacArthur's return in late 1944, most of the islands were under firm organizational control, with regiments. divisions and military districts established and operating. At the time of the U.S. landings and during succeeding operations against the Japanese defenders, many of these guerrilla units gave excellent accounts of themselves, operating alongside or in close conjunction with the regular army.

The Balkans. — When the Germans invaded and occupied the Balkans in 1941 they entered an area peculiarly suited to guerrilla warfare. The terrain of most of the peninsula was wild and mountainous. with few good roads and rail lines, and its people were hardy and independent. The divergent nature of several national groups there, however, had the effect of tempering these natural advantages somewhat.

To free German troops for operations in Russia, the occupation of the Balkans was planned primarily as a responsibility of the Italians. The Germans were to secure only the communication routes and certain areas of economic importance. The Italians were poorly suited to the task. Their policy was wavering and irresolute; troop units were slow to react to guerrilla raids; and individual soldiers showed a distinct reluctance to fight. Their poor showing in previous campaigns earned them the disdain of the population and encouraged the guerrillas. Before the Italian surrender in 1943 the Germans gradually were forced to take over their ally's responsibilities.

In Yugoslavia there were two principal guerrilla organizations betneen which there was sharp cleavage from the start: the Chetniks, organized and led by the pro-royalist and anti-Communist Drazamihajlovic ahose policy called for the organization of strong underground forces in Serbia for eventual co-operation with Allied landings; and the Partisans, organized by the Communist Tito who looked to the expulsion of the invaders as an opportunity to re-establish the nation as a Communist country. A fratricidal conflict within a conflict soon developed with these groups fighting one another as well as the enemy. The Partisans were the more aggressive of the tno, and it was to them that the Germans directed most of their attention. The Greek guerrillas were also divided along political lines between the pro-royalist E.D.E.S. (National Republican Greek league) and the Communist-led and Communist-backed E L.A.S. (National Popular Liberation army).

Guerrilla activity in Yugoslavia started in 1941 and in Greece early in 1942. Bridges were blown up, communication lines destroyed. military vehicles and convoys attacked and isolated garrisons assaulted. As a result. the Germans and Italians undertook positive corrective measures with a series of antiguerrilla actions. While most of these were tactical successes in that they inflicted many casualties on the irregulars and cost them heavily in equipment, they generally failed in a strategic sense in that the bulk of the bands almost always slipped through the attackers and escaped. This pattern continued generally throughout the war. By the end of 1942 the Partisans and Chetniks were well organized and were receiving quantities of supplies from the British. Allied efforts to induce the two groups to work together for a common cause. however, failed, and the fratricidal war continued. Even before the defection of Italy in Sept. 1943, it became evident to the Germans that they would have to cope with the irregulars in the Balkans themselves. and they prepared and executed a number of medium- and large-scale antiguerrilla actions. In Yugoslavia most of these actions were directed against the more aggressive Partisans, because the Chetniks were showing themselves to be increasingly ineffective as irregulars, in several cases openly collaborating with the Italians. As before, these antiguerrilla operations mere tactical successes and strategic failures. The Partisan organization remained unbroken and their actions required the withdrawal of large German troop units from other fronts. When Italy surrendered to the Allies, the Italian army in the Balkans literally fell apart, greatly to the benefit of the irregulars. Many Italian units went over to the guerrillas in *toto* with all of their arms and stores. The Germans were forced to bring in large additional bodies of troops to fill the vacuum thus created. During the last year and a half of the war. the Germans operated under increasing difficulties, but throughout they were able to dominate the situation and retain the initiative. They regularly struck at the guerrillas, inflicting heavy casualties on them and keeping them continually off balance. When the Germans were finally forced to withdraw from the peninsula by the pressure of Russian advances from the east, they were able to do so in good order. On the other hand, the guerrillas made a not inconsiderable contribution. With material assistance from the Allies, they were able to aid the breakup of German power by tying down large bodies of German troops in occupation and preventing their commitment on more active fronts.

French Resistance. — The French resistance movement cannot be viewed as a simple revolt against the enemy. Opposition to the Germans was the prime motive, but there were widely divergent political opinions including Communism in the resistance groups. There were those who saw that whoever controlled the underground would be in an excellent position to control the nation after liberation. This political rivalry between bands combined with the relatively flat and open terrain of the country, which was anything but conducive to large-scale guerrilla organization and activity, precluded resistance along nationally unified lines. An attempt under the aegis of Gen. Charles de Gaulle was completely broken by the Germans in 1943. As a result, under direction of a headquarters in London, the movement was fostered and supported as a formal weapon with only nominal national unity, operations being controlled and directed on regional or group bases through separate communications channels. Air drops of arms and demolition equipment a-ere stepped up and radio operators and liaison agents were sent in to the bands under the over-all concept of developing the resistance into a strategic weapon to be employed in conformity with the Allied master plan. Priority was given to railway sabotage, and rail demolitions were stepped up sharply in the months prior to the invasion. Rail demolitions in direct support of post-D-day operations were highly successful. During June 1944 rail cuts totaled 486, and on the day after D-day 26 trunk lines were unusable, all suffering multiple breaks. One German *Panzer* division was seriously delayed in reaching the beachhead at this critical time by road sabotage. Although the effectiveness of an irregular force can never be accurately assessed. the French resistance furnishes an excellent example of how intelligent organization and direction can achieve positive results in irregular narfare even with rival and divergent groups.

The Soviet Partisan Movement. — The Soviet partisan movement set up in the wake of the German armies invading the U.S.S.R. in 1941 was probably the largest and certainly the most elaborately organized guerrilla movement in the history of warfare. It combined all the classic elements of guerrilla movements of the past with modern means of communication and transportation and modern weapons. At its peak it probably included more than 150,000 men in organized units. The Russians had the more important requirements for waging guerrilla warfare: they were a hardy people living in a hard land; with the exception of the flat eastern and central Ukraine, the terrain of their land was either swampy or heavily forested or both, and was cut by numerous rivers; both the rail and road nets were sparse. making any interdiction of them doubly effective; and they had motivation beyond the fact of an invasion of their country by a foreign power.

The German leaders made a number of errors in their planning for the invasion which had very positive and direct effects on the rise and growth of the partisan movement. The military leaders, counting on a quick victory, made inadequate provision for control of their rear and for protection of their lines of communication. The political leaders planned an occupation of pure repression and exploitation in which no attempt was to be made to win the people over to collaboration. Force was to be used in its most brutal form, and extreme economic exploitation practised no matter how much the natives suffered.

The partisan movement was formed after the start of the German attack from the pro-Soviet elements of the populace and scattered Soviet army personnel bypassed in the invasion. Although soon brought under a desultory sort of control exercised from Moscow, these partisans accomplished little of a positive nature during the first year of the war. The organization of the bands was anything but good; their morale was poor; and their leadership, too often political, left much to be desired. Further, they seldom showed any aggressiveness. In large part igiiored by the Germans. the movement improved considerably during the next 18 months. It was reorganized along formal lines and brought under closer Moscow direction, and a system of controls for co-ordinating its actions with those of the Soviet army was set up. Trained leaders were sent to the bands and large quantities of arms and equipment were furnished them. Despite this aid, during 1942 their activity had little or no detrimental effect on German military operations. Considerable inroads were made on German economic activity, however, and by the end of 1942 much of the planned economic exploitation had been frustrated.

By the opening of the 1943 campaigning season, the reorganization of the movement was complete and the bands were in a good position to exercise a really decisive effect on the battles to come. In conjunction with the main Soviet army effort they were to wait until the Germans were forced to withdraw and then strike heavily at the rail lines in their rear, thus blocking them in the forward areas without prepared defenses where they might be destroyed. For this mission in the area of the main effort, there were about 62,000 partisans in units identified by the Germans and probably another 40,000 in unidentified units. On signal from Moscow the bands set off demolitions on the rail lines in more than 15,000 places during August and added nearly 5,000 more in September. Yet because the demolitions were poorly executed and too often did no damage, and the heaviest attacks were not followed up, the partisans failed to block the German lines of retreat; the withdrawals never became routs but were carried out on schedule and according to plan. Most partisan activity aimed at the German army followed this pattern.

German antipartisan strategy and countermeasures were well conceived and had much to do with the failure of the bands to carry out their missions. Wisely, the Germans, too short of troops to attempt to control all the country, pulled themselves in defensively on their major supply lines to guarantee the continued supply of the field armies and let the partisans take over the rest. When line troops were available and the situation demanded action, they launched large-scale attacks against the bands. In between times they sent a steady stream of small, mobile raiding parties after them to keep their concentration areas in a constant state of flux. Although the large-scale actions were generally tactical rather than strategic successes, when combined with the smaller actions they kept the bands continually moving, prevented them from getting set for raiding of their own and often completely dispersed them for weeks at a time.

The greatest weaknesses of the partisan movement were its basic irregularity and the problem of over-all control. The partisans were far from being regular soldiers, despite the great amount of energy spent on the movement by Moscow. and they were never able to stand up to the Germans even on ground and in circumstances of their own choosing. When the Germans saw the need to clear them from an area they were almost always able to do so. The problem of effectively controlling their large numbers far behind the German lines was insoluble.

POST-WORLD WAR II

In the decade following World War II there was no true guerrilla warfare with the exception of a halfhearted attempt by the North Koreans and Chinese Communists in the rear of the United Nations lines during the Korean war. The repeated and continuous Communist campaigns of subversion and ideological infiltration, principally in Greece and southeast Asia, were guerrilla in type but they cannot be considered as guerrilla warfare in the sense of the definition given at the start of this article. They had as their goals the subversion of the indigenous peoples to the extent that the governments of their countries might be seized by Communists and brought within the Soviet circle of influence, rather than the support of a regular army in formal warfare. In Greece there was actual open warfare, but it was fought between regular Greek forces and a loosely knit Communist army formed of dissident elements of the Greek populace. In Korea the attempt of the North Koreans and Chinese to establish an effective guerrilla force behind the United Nations lines mas never more than a desultory sort of effort. At one time there were estimated to be 10,000 to 15,000 Communist guerrillas in southeast Korea, but they accomplished little of note, pulled few United Nations troops from the front to guard against them and exercised no effect on the outcome of the struggle.

In conclusion, we may say that guerrilla warfare can be a valuable adjunct to the operations of a regular army, but too much should never be expected from it. Because guerrilla bands are loosely knit, poorly disciplined, and must remain so. they can never overthrow an enemy or win a war. But under wise direction by leaders who understand them and their limitations they can go far toward undermining an enemy and materially aid in his defeat. *See* also INSURGENCY.

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GUESDE, JULES (legal name, MATHIEU BASILE) (1845–1922), organizer and early leader of the Marxist wing of the French labour movement, was born in Paris, Nov. 11, 1845. Guesde began his career as a radical journalist, and in 1877 founded one of the first modern socialist weeklies, *Égalité*. Guesde consulted with Karl Marx and Paul Lafargue (a son-in-law of Marx) in 1880 on a socialistic program of French labour action. Adopted by a national labour congress in 1880, the program called on workers to elect representatives sworn to "conduct the class struggle in the halls of parliament"; *i.e.*, to stand uncompromisingly for the establishment of the socialist state. Guesde was opposed by labour opportunists — in French usage, the "possibilists"—who sought labour's gains by tactics of economic and political pressure-group action — aggressive collective bargaining. strikes and the promise of workingmens' votes to favourable political candidates regardless of their party affiliations. The split between "Guesdists" and "possibilists" is an early French manifestation of a fundamental line along which the labour movements of the western world continue to be divided. Guesde served in the chamber of deputies beginning in 1893 and as minister without portfolio in 1914 and 1915. A fertile author and powerful orator, he died July 28, 1922, at St. Mandé, Seine.

See Alexandre Zévaès, *Jules Guesde, 1845–1922* (1929), which contains a complete list of his writings; Suzanne Lacore, *Jules Guesde* (1945). (G. W. Z.)

GUEST, EDGAR ALBERT (1881–1959), U.S. writer of verse, was born in Birmingham, Eng., on Aug. 20, 1881. He was brought to the United States in 1891 and went to work for the *Detroit Free Press* four years later. After working as a police reporter, he began to write rhymes daily; they became so popular that his "poems" were syndicated in newspapers throughout the country. His first commercially published book. *A Heap o' Livin'* (1916), became a best seller. But he won no critical acclaim for his optimistic rhymes on subjects such as home, mother and the virtue of hard work. Guest, who became a U.S. citizen in 1902, published a number of other books and appeared on radio and television. He died Aug. 5, 1959, in Detroit, Mich.

GUEST, EDWIN (1800–1880), English antiquary. born in 1800, was educated at King Edward VI's grammar school, Birmingham, and at Gonville and Caius college, Cambridge. where he graduated as 11th wrangler, subsequently becoming a fellow of his college.

Called to the bar in 1828, he devoted himself, after several years of legal practice, to antiquarian and literary research. In 1838 he published his exhaustive *History of English Rhythms*. He also wrote a large number of papers on Roman-British history, which, together with a mass of fresh material for a history of early Britain, were published posthumously under the title *Origines Celticae* (1883).

In 1852 Guest was elected master of Caius college, becoming LL.D. in the following year: and in 1854–55 he was vice-chancellor of Cambridge university.

Guest was a fellow of the Royal society and an honorary member of the Society of Antiquaries.

He died on Nov. 23, 1880.

GUEST, one who receives hospitality in the house of another (Ger. *Gast,* cognate with Lat. *hostis,* originally a stranger; in Class. Lat. an enemy; *cf.* host). Guest is also applied in biology to a parasite.

GUETTARD, JACQUES ETIENNE (1715–1786), French naturalist and mineralogist, was born at Étampes, Fr.. on Sept. 22. 1715. In boyhood he gained a knowledge of plants from his grandfather, who was an apothecary, and he later qualified as a doctor in medicine.

Pursuing the study of botany in various parts of France and other countries, he began to take notice of the relation between the distribution of plants and the soils and subsoils. In this way his attention came to be directed to minerals and rocks. In 1746 he communicated to the Academy of Sciences in Paris a memoir on the distribution of minerals and rocks, and this was accompanied by a map on which he had recorded his observations. He therefore, as remarked by W. D. Conybeare. "first carried into execution the idea, proposed by [Martin] Lister years before, of geological maps."

In the course of his journeys he made a large collection of fossils, but he had no clear idea about the sequence of strata. He made observations on the degradation of mountains by rain, rivers and sea, and he was the first to ascertain the existence of former volcanoes in the district of Auvergne.

His publications include *Observations sur les plantes,* 2 vol. (1747); *Histoire de la de'couverte faite en France de matières semblables à celles dont la porcelaine de la Chine est composée* (1765); *Mémoires sur différentes parties des sciences et arts,* 5 vol. (1768–83); *Mémoire sur la minéralogie du Dauphine',* 2 vol. (1779).

He died in Paris on Jan. 7, 1786.

GUEUX, LES or "THE BEGGARS," a name assumed by the confederacy of nobles and other malcontents who in 1566 opposed Spanish tyranny in the Netherlands. The leaders of the nobles, who signed a solemn league known as "the Compromise," by which they bound themselves to assist in defending the rights and liberties of the Netherlands against the civil and religious despotism of Philip II, were Louis, count of Nassau, and Henry, count of Brederode. They drew up "the request." petitioning against Philip's religious edicts and the Inquisition, and on April 5, 1566, about 250 nobles marched to the palace to present it to the regent, Margaret, duchess of Parma. Seeing her alarm at such numbers. Charles, count of Berlaymont. one of her councillors, exclaimed. "What, madam, is your highness afraid of these beggars (*ces gueux)?"* At a great feast held by about 300 confederates at the Hôtel Culemburg three days later. Brederode in a speech declared that if need be they were all ready to become "beggars" in their country's cause. The words caught on. and the hall resounded with loud cries of *"Vivent les gueux!"* ("Long live the beggars!"). The name became thenceforward a party appellation. The patriot party adopted the emblems of beggarhood, the wallet and the bowl, as trinkets to be worn on their hats or their girdles.

The original league of Beggars was short-lived, crushed on land by the duke of Alva, but in the following years the name *Gueux de mer,* Sea Beggars. was given to malcontents who took to the sea and were joined by desperadoes of many nationalities. Granted letters of marque in 1569 by the prince of Orange, who was now openly the head of the party of revolt, and animated at once by a bitter hatred of Catholics and a love of plunder, these fierce corsairs preyed on shipping and raided monasteries and churches near the coasts, under the command of a succession of daring and reckless leaders, the best known of whom is William de la Marck, lord of Lumey. Until 1572 they were able to refit and dispose of their booty in English ports, but then Queen Elizabeth I suddenly refused to admit them to her harbours any longer. They therefore seized Brielle by surprise in the absence of the Spanish garrison on April 1, 1572, and Flushing was also taken by a *coup de main.* The capture of these two towns gave the signal for a general revolt, and is regarded as the real beginning of the War of Dutch Independence. In spite of their indiscipline and the cruelties and excesses in which they at first engaged, the Sea Beggars played an indispensable part in rousing Holland and Zeeland to revolt, and their command of the sea did much to thwart the Spaniards in the war itself. (K. H. D. H.)

GUEVARA, ANTONIO DE (*c.* 1480–1545), Spanish chronicler and moralist. He held successively the offices of court preacher, court historiographer, bishop of Guadix and bishop of Mondoiiedo.

His first authorized publication, *Libro llamado Relox de Principes, en el qual va encorporado el muy famoso libro de Marco Aurelio* (1529). a didactic novel after the manner of Xenophon's *Cyropaedia,* was often reprinted and before the close of the century had been translated into Latin, Italian. French and English, one English translation being by Lord Berners (1534) and another by T. North (1557). John Lyly was much indebted to it, but its thought now seems neither just nor profound. its style stiff and affected. It gave rise, however, to a literary controversy of great bitterness and violence, the author having ventured without warrant to claim for it a historical character, appealing to an imaginary "manuscript" in Florence.

Other works of Guevara (1539) are the *Década de las vidas de los diez Césares;* the *Epístolas familiares,* sometimes called *The Golden Letters;* the *Menosprecio de la corte y alabança de la aldea;* and the *Libro de los inventores del arte de marear.*

GUEVAWA, LUIS VÉLEZ DE: *see* VÉLEZ DE GUEVARA, LUIS.

GUGGENHEIM, the name of a family of U.S. industrialists founded by Meyer Guggenheim (1828–1905) who, together with his seven sons, developed world-wide mining interests. Meyer Guggenheim, born in Lengnau, Switz.. Feb. 1. 1828, emigrated to the U.S. when he was 19. settling in Philadelphia, Pa. In 1872 he established the firm of Guggenheim and Pulaski, importers of Swiss embroideries, later reorganized as Guggenheim and Sons, with the four oldest sons as partners. In 1888 the company sold its lace business and entered copper mining and smelting. forming the Philadelphia Smelting and Refining Co. in 1888. Smelters were built at Philadelphia and in Colorado and Mexico, and ore deposits were acquired throughout the world. Alliances with mine owners were established in an attempt to integrate and control both mining and processing operations. The Guggenheims defeated the American Smelting and Refining Co. in a struggle for control of the industry, and took control of that company in 1901. Meyer Guggenheim died March 15, 1905; his sons continued the management.

DANIEL GUGGENHEIM (1856–1930) was largely responsible for the smelting operations of the firm, and his operations were international in scope. He developed tin mines in Bolivia, gold mines in Alaska, diamond fields in Africa, copper mines in Utah, nitrate fields in Chile and rubber plantations in the Congo. The firm established smelting and refining plants all over the world. SIMON GUGGENHEIM (1867–1941) was United States senator from Colorado (1907–13). In 192; he and his wife established, as a memorial to their son, the John Simon Guggenheim Memorial foundation "to further the development of scholars and artists by assisting them to engage in research. . . under the freest possible conditions." HARRY F. GUGGENHEIM (1890–), industrialist and foundation executive, was horn Aug. 23, 1890, son of Daniel Guggenheim. He graduated at the University of Cambridge. He was associated with the company properties and headed the Daniel and Florence Guggenheim foundation for research in aeronautics and the Solomon Guggenheim foundation. In 1929–33 he was United States ambassador to Cuba. (J. R. LT.)

GUHAYNA: see ARABS.

GUIANA (probably "land of waters"), the region between the Amazon and the Orinoco, northeast South America. comprising the territories of British Guiana, Netherlands or Dutch Guiana (Surinam) and French Guiana (Guyane française) and also the adjacent parts of Brazil and Venezuela. This article deals uith the British. Dutch and French sections.

The region, once known as the Wild Coast, was unattractive to Spanish and Portuguese colonization because of swamp and forest, natural obstructions in the rivers and lack of gold. Its possession was contested by the French. Dutch and English for 200 years and the territories in their present form only took shape after the Napoleonic Wars. They remained unaffected by the Ibero-American liberation movements of the 19th century and have only moved away from a strictly colonial status by peaceful evolution in recent years.

This article is divided into the following sections:

I. PHYSICAL GEOGRAPHY

1. Geology and Structure. — The main structural features are similar to those of eastern Brazil. The central parts of the region consist of an ancient crystalline plateau, generally not rising more than 500 ft. above sea level. This platform supports an immense, almost horizontal mass of sandstones and conglomerates, of Mesozoic age, with a thickness of up to 1,500 ft. which is greatly exaggerated in many places by igneous intrusions. This formation is known as the Kaieteurean, from the great Kaieteur falls (*q.v.*) by which the Potaro river descends its eastern face. It occupies a relatively small part of the surface of the three territories.

The ancient crystalline platform reaches sea level for the most part at some distance inland from the existing coast line. It appears to have been depressed well below its present level in Late Tertiary and Early Quaternary times during which it was covered with great thicknesses of alluvium, while granite islands crumbled to form the white sands which overlie the platform inland of the coast alluvium. The platform was upraised and given a slight seaward tilt in geologically recent times. The coast series form an artesian system of great value to the agriculturalist. Important features of the ancient platform are veins of gold and diamonds and the bauxite deposits of British and Dutch Guiana derived from lateritic earths under conditions of intense weathering.

The sedimentary series of the coast areas show few unconformities. They consist of a fairly regular succession of clays, shales, silts, sands, lignites and semilignites. The principal modes of accumulation are clearly visible. Large quantities of liquid mud, brought there by the current setting along the coast from the Amazon. are moved in and out by the tides and much is caught and anchored by vegetation. Decayed vegetation in lagoons produces peaty deposits. Accumulations of shelly material break down and mix with clay and sand to form light soils.

2. Relief and Drainage. — The massive sandstones of the interior form typically savanna-covered plateaus, uniform over large areas. The most striking features are the steep. almost vertical faces which form the edges of blocks at different levels and down which streams plunge in immense falls, cutting deep canyons. The savanna is a region of light rainfall. Though a great number of streams rise there, none is large. The more prominent heights include the Serra Acarai (Akarai mountains) and Tumuc-Humac mountains of the southern frontiers at about 2.500 ft., but the series rises to much greater heights in the Serra Pacaraima (*q.v.;* Pakaraima mountains), which are outliers of the Guiana highlands (*q.v.*), on the western frontier of British Guiana, culminating in the great massif of Roraima at 9,432 ft. The ancient rock platform forming most of the territory was intensely folded. The general strike of the rocks is east-southeast–west-northwest. Hard elevated portions of the platform are sometimes sufficiently distinctive to have separate names, like the Makarapan and Kanuku ranges of British Guiana.

The crystalline platform is heavily forested, but there are exceptional areas of savanna in the southwest of British Guiana on either side of the western Kanuku mountains. There the flat surface is covered with heavy clays and boulders of conglomerate, with sandy hillocks. The drainage is poor, with the headstreams of Amazon and Essequibo tributaries often confused. The ill-defined Lake Amuku may be the site of Manoa, the city of Eldorado.

The rivers of the central forested area do not, with the exception of the Essequibo, form large basins but run seaward fairly directly and with few tributaries, separated from their neighbours only by low divides. Even the Essequibo has few right-bank tributaries. All rivers on the crystalline rocks have numerous rapids, often extending in great series, where they cross intrusive bars of igneous rock, but since the average gradient is one foot to one mile, the stretches between rapids are usable by canoes and motorboats and form'the only routes over most of the area. See COURANTYNE; MARONI; SURINAME; DEMERARA.

Except for remnants of sand dunes and shell ridges, the coast is exceptionally featureless. A large part is a few feet below sea level and subject to heavy rains, so its natural drainage is very poor. Many of the coast rivers, especially in the northwest districts of British Guiana and in Dutch Guiana, have long northwesterly courses because of marine deposition by currents. A narrow strip, 3 to 6 mi. deep, close to the sea and discontinuous, has been turned into valuable plantation land by damming back the swamp waters inland and erecting a dike against the sea. The superfluous water drains seaward through sluices in the sea dam, which can be opened only as the tide recedes. Parts of this elaborate and expensive system of artificial drainage have become ruinous in periods of decline of plantation agriculture. The main wealth of British and Dutch Guiana depends on the efficient exploitation of the relatively few miles of drained land remaining, In French Guiana there was never much and now there is almost none.

3. Climate.—Guiana as a whole is very close to the equator and has the characteristic rather high temperatures, heavy rainfall with only small seasonal breaks, high humidity and high average cloud cover of lowlands in these latitudes. Temperatures are remarkably uniform. At Georgetown, British Guiana, the average monthly temperature varies from 79.3° to 82.2° F. and from day to day the shade temperature varies from 75°–78° to 85°–88°. The unpleasant effects of continuous high temperature and high humidity are mitigated near the coast by the northeast trade winds but these have little direct effect on the interior.

Rainfall mainly arises from the movement of the intertropical front, though the reasons for its seasonal distribution are not alnays clear. It is heavy everywhere in the forested zone and on the coast, with a tendency to increase eastward. Thus the annual average at Georgetown is about 89 in. and at Cayenne, French Guiana, 130 in. Two net seasons are usual though their incidence differs somewhat in difierent parts of the Guianas. On the coast of British Guiana a long wet season from April to August and a short wet from December to early February are sufficiently well marked on the average. In the southern savannas, however, the short wet season is not experienced. Total annual rainfall is variable and years of drought occur at intervals when only 60–70 in. fall.

4. Vegetation.—Along the coast a diversity of plants maintain themselves in the shallow brackish sea water where tides and currents are not too strong, and they are valuable for coast protection. The black mangrove (*Avicennia nitida* and associated plants) has roots spreading widely and throwing up peglike breathing projections; salt-water grasses extend stolons rapidly underground, throw up new shoots and send deep roots downward; mangrove (*Rhizophora*), in the estuaries, sends strong roots downward through the air into the mud. The undrained coastal areas or wet savanna support coarse grasses (Andvopogon, *Pennisetum,* etc.) and a wide scattering of trees, notably the coconut, truli and manicole or assai palms.

The high forest or selva which covers most of the Guianas is magnificent in its size and luxuriance. Among its most prominent members are the greenheart (Ocotea rodioei) and the wallaba (*Eperua jalcata*), which are among the most gregarious of the forest trees and favour especially the sandy soils on the northern edge of the forest zone; the giant mora (*Mora* excelsa) and crabwood (Carapn *guianensis*), which favour swampy sites; the bulletwood tree (*Manilkara* bidentata), which produces balata latex, and a number of rubber-producing trees; and a great variety of trees producing handsome cabinet woods. The forest trees are draped with parasitic lianas or bushropes, epiphytes, fungi and orchids. The luxuriant vegetation extends to the still waters where the water lily Victoria regia with its beautiful flower and huge leaf is the most prominent of many aquatic plants.

In the interior savannas open grassland is interspersed with much bare rock, termite hills and clumps of the ita palm (*Mauritia flexuosa*). All the coast villages produce a great variety of tropical fruit and vegetables. Peppers, cassava (manioc) and maize, originally characteristic products of the forest and savanna Indians, are also widely grown on the coast.

5. Animal Life.—Although only the insects and birds are ordinarily visible, animal, reptile, fish and insect life is immensely varied and teeming. The fiercer mammals include the ocelot, the haka tiger or yaguarundi and the jaguar. The largest land animal is the tapir, which is fairly rare. The manatee is a herbivorous aquatic mammal. Other exotic creatures are the sloth, the great anteater! the capybara or bush pig and the armadillo. Monkeys and deer are among the commonest of the wild mammals.

The birds of the coast include vultures, some species of which are useful scavengers. the chicken hawk, finfoot (*Heliornis*), the muscovy duck, snipe, teal, plover, pigeon and heron. The kiskadee is the "sparrow of Guiana." The blue sacki and the hummingbird are very common. The kingfisher and the beautiful scarlet ibis are seen on the rivers. In the forests bird life is indescribably rich in variety and plumage. It includes the tinamou, the gorgeous cock of the rock, the marudi or bush turkey, the vividly coloured macaw and the bellhird with a note like a silver gong. Flocks of parrots are common in the savannas.

The alligator (cayman) is the most frequent of the larger water creatures. It infests the fresh waters of the coastlands, particularly the great rivers. There are many varieties of snake, of which the giant anaconda or water boa is the biggest and the bushmaster the most vicious. Lizards are extremely numerous; the larger types include the iguanas of the lower rivers; smaller ground and arboreal forms are found also.

Fish life abounds in the sea and rivers. Shark and sting rays are iound offshore. Snapper and grouper are the most esteemed of the sea fish commonly landed. River fish include the voracious predatory piranha (*Serrasalmo*) and the lukanani (*Cichla*) Invertebrate life is the most abundant of all. Especially obvious are mosquitoes. sand flies, grasshoppers. termites. ants and spiders.

II. NATURAL RESOURCES

1. Land Use.—The pattern of partly poldered coast. heavily forested and little-developed interior and savanna margins is continued through the three countries though only British Guiana has any considerable area of savanna.

Coastlands.—These were developed on a common pattern from the 17th century. Many parts of the coast were subject to changes of sovereignty but there was also much co-operation between settlers of the three competing nations Originally they preferred sites a little nay up the estuaries where they were less obvious to pirates and privateers. In the 18th century they began to polder the coasts and trade grew until ports were needed in the second half of the century. Some of the rivers, notably the Essequibo, nhich is the largest. had no suitable site for a port; nor was there ever sufficient trade to warrant many.

The drainage of the coast soils was initially achieved with slave labour and maintained later only under a heavy financial burden. The soil won from the snamp and the sea is very fertile though acid. and a great variety of crops has been tried on it. Of commercial crops, indigo, tobacco, cocoa, rice, cotton and sugar have been produced at different times. Sugar reigned supreme for well over a century and though its importance is much reduced in Dutch Guiana and it has vanished from French Guiana there are no immediate signs of its being displaced in British Guiana. The wetness of the climate reduces the sucrose content of the juice somewhat, and the maintenance of the drainage system is an expense from which most of these countries' competitors are free. The planters of Guiana one much to their readiness to adopt new methods. to their support of research in producing new varieties of cane and combating plant diseases, and to the rationalization of the industry into fewer and larger units. In the early 1960s, though there was more land abandoned than in cultivation the combined sugar industry produced more than ever before. Rice growing, relieved from Asiatic competition in the mid-20th century, is the second industry of the coast in British and the first in Dutch Guiana. It is mainly in peasant hands. The narrow coastal belt, incompletely drained and still offering the most obvious scope for settlement, amounts to only 10% of the total area of the whole region and directly supports about 90% of the population.

Forest *and* Savanna.—The forest areas have. on the whole, poor soils. Their magnificent timbers are mostly difficult to cut and transport economically because of their high density and the non-gregarious habit of growth of most species, while curing is difficult in the humid atmosphere. Nevertheless, the several forestry departments are striving with slowly increasing success to make better use of this great resource. The collection of balata is a minor but persisting occupation. The savanna regions also have generally poor soils. They are used for cattle rearing on the open-range system. Tobacco is grown for local consumption.

2. Minerals.—Within the forest area gold is obtained in relatively small quantities, mainly from river deposits. Diamonds are steadily produced on a small scale. A number of other minerals are known to exist, but only bauxite, manganese. kaolin, columbite and low-grade iron are present in workable quantities. In the late 1950s bauxite was the only one of these being worked, but in bauxite all three Guianas have a resource of world importance. The mining of manganese was also being undertaken in the northwest district of British Guiana.

III. THE PEOPLE

The indigenous peoples, collectively known as Amerindians, are only numerous in British Guiana. where their numbers were estimated at 20,830 in 1957, when they appeared to be on the increase after centuries of decline. They include the Warraus, Arawaks, Caribs. Wapisianas. Arekunas and Makusis, the mixed "Spanish Arawaks" of the Moruka river and many more. The Cariban and Arawakan languages are widely spoken. but neither group corresponds to a single distinctive culture. The Warrau language is distinct from these. The Warraus seem to have inhabited the northwest coast continuously since first met in 1595, and to have been responsible for the shell heaps of the Pomeroon.

The two main cultures correspond, though not absolutely, to savanna and forest environments, the latter characterized by pottery and a better developed agriculture. The earliest pottery, from Mabaruma in the northwest of British Guiana, is tentatively dated between A.D. 1200 and 1400 and no remains definitely earlier than this are known. The first explorers found Caribs and Arawaks alternating along the Guiana coasts. Caribs are now, in general, inland of Arawaks and Warraus but extend to the coast in French Guiana. The Makusi are the most prominent of the savanna peoples.

Until the 19th century the forest peoples had in common the manufacture of polished stone implements and coil pottery, weaving (including bead decoration and the manufacture of hammocks), cassava cultivation, the use of the blowpipe. vegetable poisons for hunting and fishing and fish traps. Throughout the interior of the Guianas are scattered rocks inscribed with hieroglyphics known as *timehri* which have not been deciphered. They may have some distant connection with the Andean civilizations.

The Amerindians are very rarely seen in the more populous parts of the coasts. In British Guiana they were after 1953 given important rights in reservations totaling over 6,000 sq.mi., but are not confined to them. They are useful workers in the cattle, logging and gold industries. The other permanent forest dwellers are the Djuka or Bush Negroes of Dutch Guiana. They are descendants of escaped slaves, organized into five groups, only two of which are large. Their common language is an extraordinary form of English compounded with Dutch and several African dialects. They appear to be on the increase, and are responsible for about 75% of an important logging industry. The other major elements in the population of the Guianas are all predominantly coast dwellers.

Descendants of African slaves form the principal single group in Dutch and French Guiana and the second group in British Guiana. Former slaves abandoned the plantations in large numbers after emancipation and became independent peasantry or town dwellers. They are strong and enterprising and make their mark in town and forest industries and the professions.

The "East Indians" of British Guiana and the "British Indians" of Surinam came predominantly as indentured labour from India to replace the Africans in plantation work. They now form the largest racial group in British Guiana and the second in Surinam and in both countries are increasing more rapidly in numbers than any other. They remain largely in agriculture, being the mainstay of plantation labour in British Guiana. They have done well in trade, and are well represented among the professions. The large majority speak Hindi or Urdu. The Chinese and the Portuguese also entered originally as agricultural labourers but are now rarely found outside the major towns. They have done well in business and the professions and their influence is disproportionate to their numbers, but they do not increase. In Surinam there is a noteworthy large group of Indonesians (almost all Javanese or their descendants) who were still arriving up to 1939. They have remained agriculturalists and are predominantly Moslem.

Europeans other than Portuguese in the Guianas are few and most are short-term inhabitants. While every kind of racial mixture may be found, the descendants of white and Negro crosses are much the commonest. The larger part are in the chief towns and a high proportion are in clerical and professional work. See also *Population* under each country, below, and the articles ARAWAK; CARIB; WARRAU; SOUTH AMERICA: Ethnology; SOUTH AMERICAN LANGUAGES; INDIAN, LATIN-AMERICAN. (G. LN.)

IV. HISTORY

In the 16th century "Guiana" meant the coast from the Orinoco to the Amazon, with an undefined extent of country behind it. Christopher Columbus had sighted it in 1498 but both Spaniards and Portuguese found other regions more attractive, and partly for this reason Guiana appealed to explorers and adventurers of other European nations who could hope for security among its intricate waterways and profit from its fertile coastlands. A still greater lure was the legendary Eldorado (*q.v.*), a man or town of gold in the interior, whose story was brought back by Sir Robert Dudley from his exploration of the mouth of the Orinoco in 1595. Sir Walter Raleigh who followed him heard of a great gold mine which appeared to confirm the tale. This led to Raleigh's last expedition of 1617–18, but before that settlements were established for trade and the cultivation of tobacco. In 1604–06 Charles Leigh made an abortive attempt to found a colony on the Wiapoco, now the Oyapock river of French Guiana. In 1609 Robert Harcourt annexed the whole Guiana coast in the name of King James I. but his patent was revoked in 1619 in favour of the Amazon company, the latter's patent in turn being canceled after Spanish protests. In 1627 the Guiana company was set up by a joint patent in favour of Harcourt and Roger North, but its main settlement on Tocujos Island was captured in 1629 and its activities ended by 1635.

Characteristic of this period was the considerable degree of co-operation between English, Dutch and French settlers on the one hand. and on the other the joint action of the Spanish and Portuguese which in 1623 swept away most of the foreign settlements in the lower estuary of the Amazon, including those of the Dutch on the Xingu, which may well have been founded before the end of the 16th century. The French established a small settlement on the Cayenne but the Dutch, with their colonies on the Essequibo (1616) and the Berbice (1627), constituted the only formidable challenge to the Hispanic powers in Guiana up to the mid-17th century.

The first English attempts in Guiana had been made by amateurs. but that of Lord Willoughby of Parham in Surinam in 1651 was made by experienced colonists. By now, however, the Dutch were rivals of the English and this thriving colony was captured by the Dutch in the spring of 1667. In October of that year it was recaptured by an English force, which had occupied Cayenne in September; but by the treaty of Breda (July 21, 1667) colonies in French possession on Jan. 1, 1665, were restored to France and Anglo-Dutch claims were settled on the basis of possession as on May 21, 1667, Surinam thus passing to the Netherlands.

In 1682 the Dutch West India company received the grant of Guiana from the states-general. It sold a third of its holdings to the city of Amsterdam and another third to Cornelis van Aessens, lord of Sommelsdijk, who governed the colony with rare energy and foresight until his death in 1688. The three partners also formed the Chartered Society of Surinam. Berbice was given the status of a separate colony in 1732 and Demerara enjoyed the same status from 1773 to 1784, when it was reunited with Essequibo with Stabroek (now Georgetown) as the capital. The basis of the prosperity of these Dutch colonies was the production of sugar in the coastal districts. depending upon an ingenious but expensive system of dikes and canals; but they were also centres of considerable importance for both legal and illicit trade in the Caribbean. In 1781, following Adm. Sir George (later Lord) Rodney's capture of St. Eustatius, they fell into British hands, only to be captured (by the French) in 1782 and restored to the Netherlands by the treaty of Paris in 1783.

In the course of the French Revolutionary Wars the Netherlands was overrun by the French and with its overseas possessions became from the British point of view "occupied territory." The Netherlands Guiana colonies were occupied by British troops and held from 1796 to 1814. save for the brief period (1802–03) of the peace of Amiens. After the peace settlement of the congress of Vienna (1814–15) the colonies of Essequibo, Demerara and Berbice passed by purchase to Great Britain and the Dutch were left with only Surinam on the mainland of South America.

For the rest of the 19th century Surinam, though not unprosperous, was overshadowed by the far more rapid development of the Dutch colonies in the East Indies and, later, by the prosperity of the oil-refining island of Curaçao.

French Guiana (Cayenne), though the scene of occasional attempts at large-scale development, remained the Cinderella of the French colonial empire, its use as a penal colony (until 1949) giving it an unenviable if not wholly justified notoriety.

The history of Guiana after World War II was marked by radical constitutional adjustments in all three European-controlled territories (see *History* under each country, below).

(W. L. BN.; X.)

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V. BRITISH GUIANA

British Guiana lies between latitude 0° 30' and 8° 30' N. and longitude 56° and 61° 30' W. Its area is 83,000 sq.mi., with a seaboard of about 270 mi.; the coastal plain has an area of 6,250 sq.mi. of which approximately 46j sq.mi are cultivated. The three colonies of Essequibo, Demerara and Berbice came finally under British government as part of the settlement at the end of the Napoleonic Wars, and were united under one governor and the name of British Guiana in 1831. The main geographical features of the country were surveyed by Sir Robert H. Schomburgk (*q.v.*) in 1835–44, but a large proportion of the forested area of the east and southeast is still virtually unknown. (*G.* LN.)

History.—At the time when the three settlements—Essequibo, Berbice and Demerara—were united as one colony in 1831, British Guiana had the highest productive potentiality in the British Caribbean but, far more than the older colonies, it lacked an adequate labour force. The abolition of the slave trade in 1807 and of slavery in 1833 were heavy blows to its economy and a further setback was the withdrawal of the preference granted to British colonial sugar. The situation seemed desperate by the mid-19th century but was relieved by the work of Sir Henry Barkly (governor 1848–53) and by the evolution of a system of immigration from India. The colony had its share in the modest revival of prosperity in the British West Indies from the mid-1850s to the mid-1870s. but its comparative lack of alternative crops made it particularly susceptible to the increasing and subsidized competition of European beet sugar and the situation was grave enough by 1897 to warrant the appointment of a royal commission. The principle of free trade was still strong in British domestic politics, and a preference granted to colonial sugar in 1919 was not fully realized before 1931 and was insufficient to meet the fall in world prices in 1929–34. As in most of the British Caribbean colonies a period of acute economic depression led to inevitable strikes and disturbances. The report of the Moyne commission (1938) provided the basis for the Colonial Development and Welfare acts of 1940, 1945 and 1949. By the end of 1950 grants of over £3,000,000 ($8,400,000), nearly two-thirds of which was for drainage and irrigation. had been approved for British Guiana. The refugee commission of 1939 suggested settling a large number of European refugees in the interior and the settlement commission of 1948 recommended extensive settlements for the surplus population of such colonies as Barbados. Neither of these reports was favourably received in British Guiana. where the natural increase of population in the 1940s and 1950s was rapid. Opinion in British Guiana also rejected participation in a British Caribbean federation. (See WEST INDIES (FEDERATION), THE.)

The British inherited from the Dutch, and did not greatly alter, a singularly complicated constitutional structure which, with one major change in 1891, lasted until 1928 when a single-chamber legislature with a minority of elected members was created. The crisis of 1953 which followed the electoral success of the extreme left-wing party led to rapid constitutional developments (see *Government* and *Administrution*, below). (*W.*L. EN.; X.)

Population. — At the census of April 9, 1946. the population totaled 375,701; the estimated figure on Dec. 31, 1958, was 539,-940, including 21,590 Amerindians. All but a small proportion of the people live east of the Pomeroon river on the coastal plain and the lower rivers. Georgetown has an estimated population (1958) of 92.808, and New Amsterdam of 14,150.

Medical and sanitary improvements have resulted in a rapid increase of the population since 1931, when there was a total of 311,000. By 1946 it increased by 21% and by 1946–58 by more than 30%. In 1931 East Indians formed 42% of the population; in 1946, 44%; in 1958, 48%; and they were considered likely to constitute more than half the population by 1963. In 1946, 221,-697 persons belonged to Christian denominations, including 85.329 Anglicans, 43.474 Roman Catholics, 25,210 Presbyterians, 19,658 Methodists and 18,827 Congregationalists; and there were 115,574 Hindus and 29,351 Moslems.

Government and Administration. — A revised constitution, providing for universal adult suffrage, a bicameral legislature and a ministerial system, was introduced in 1953. The elections of that year brought into power the extreme left-wing People's Progressive party led by Cheddi Jagan. The British government thought that the actions of the new government would lead to Communism and threaten the welfare of the country. The new constitution was therefore suspended in Oct. 1953 and military forces were sent to maintain order. A wholly nominated interim legislative council took office until June 1957. Meanwhile there was dissension in the People's Progressive party and the more moderate group seceded and became the People's National congress. At the general election of Aug. 12, 1957, the People's Progressive party secured nine seats, the People's National congress three seats and the United Democratic party and the National Labour front one each.

The new legislative council consists of a speaker. 3 official members (the chief secretary, the attorney general and the financial secretary). 6 nominated members and the 14 elected members. The governor presides over the executive council, which consists of the 3 official members and j members of the elected majority party each holding a portfolio.

The constitution as amended in 1956 allows for the nomination of not more than 11 members of the legislative council and the election of not fewer than 14 members. the total (excluding the speaker but including the 3 official members) not to exceed 28.

The country is divided into six coastal (East Berbice. West Berbice. East Demerara, West Demerara, Essequibo Islands and Essequibo) and three interior (North West. Mazaruni-Potaro and Rupununi) divisions, each under a district commissioner who provides advice and assistance to the local authorities and coordinates government action. The six coastal divisions are subdivided into 46 villages and 48 country districts for the purposes of local government. The central authority is the local government board, nominated by the governor. This body appoints one-third of the members of each village council, the remainder being elected, and appoints all the members of the country district councils. The local authorities are responsible for the maintenance of roads other than main roads, and of irrigation and drainage canals and dams not under the control of the drainage and irrigation board. They have functions relating to drinking water, lands, sanitation, abbatoirs and cemeteries.

The three interior divisions have a total area of about 70,000 sq.mi. and a population of only 28.500. They are directly administered by the department of the interior. Ten "Amerindian districts" have been demarcated for the sole occupation of the native Indians. In some of them local district councils have been formed.

Georgetown, the capital, and New Amsterdam form municipalities outside the above schemes. Each has a mayor and a council with an elected majority. On each sit three councilors nominated by the governor.

Taxation. — The principal sources of public revenue are income tax and customs and excise taxes. Much the larger part of the latter comes from import taxes. The rate of duty payable on most articles imported is 20% ad valorem (preferential tariff) and 36% ad valorem (general tariff).

Wages and Employment. — The official policy is to foster the principles of trade unionism. In the chief industries collective bargaining is the rule and machinery exists for the settlement of disputes and for arbitration if necessary. Government has powers to regulate wages in any employment but has reserved these powers for the regulation only of unorganized trades.

In the sugar industry wages are paid on a piece-rate basis to field workers. The rates vary greatly between plantations because of different conditions of soil and types of work. There are a number of incentive schemes aiming particularly at inducing regularity of work. The sugar industry is the largest employer of labour in the country. The amount of labour employed is being steadily diminished by increased mechanization and the policies pursued to produce a higher level of employment per individual worker. Factory labour (including field-equipment operators and field mechanics) is also substantial in the sugar industry. The workers have an 8-hour day and a 48-hour week. Rice cultivation is mainly in peasant hands. Rice milling is chiefly done at small. privately owned mills, though there are several large modern mills erected in connection with government irrigation schemes. The bauxite industry produces the second most valuable export but is a relatively small employer of labour. The timber industry is the only other large employer of labour besides the government.

As sugar and rice are seasonal occupations, there has always been a fair amount of unemployment, underemployment and casual labour. The rapid rise of population has aggravated the problem. Very strenuous efforts are being made to make more land available for rice growing and other forms of peasant farming, and to introduce new local industries.

Social Conditions. — Formerly, houses were universally built of wood. with galvanized iron roofs. and raised on piles, but concrete construction is becoming common. Before 1945 there was a great deal of urban and rural overcrowding, but after 1946 housing and town planning legislation was in force and was vigorously implemented. Concurrently, the sugar industry provided new homes or helped workers to build their own.

Government-promoted community services include youth work, women's work and a variety of self-help schemes in rural areas, and voluntary societies flourish in Georgetown. Experimental community projects also exist, nhich are attempting to bring about the unified development of particular areas through education and the encouragement of self-help. There is an old-age pension scheme and assistance is given to other aged persons, the infirm and destitute children.

Public Health. — There are five public general hospitals and a number of smaller private or specialized hospitals, many run by the sugar estates. Malarial control is very efficient and the disease has almost been eliminated. A similar campaign is being planned against the carrier of filaria, *Culex fatigans.* Pneumonia and bronchitis are the principal causes of death among adults. The standard of health is in general good. Low dietary standards are slowly being raised by education and economic improvement.

Justice. — The supreme court consists of a chief justice and five puisne judges. Two or more judges constitute a "full court," which is almost entirely a court of appeal. The supreme court has unlimited jurisdiction in civil matters, which are tried by a single judge without a jury. It has jurisdiction in criminal matters brought before it by indictment. and in these the judge is assisted by a jury. Appeals lie to the court of criminal appeal of the supreme court. Magistrates hold courts of summary jurisdiction throughout the country, and make preliminary inquiries into indictable cases. The rules of procedure in all courts are substantially the same as in their English counterparts.

Education. — Most schools are denominational and grant-aided. There are also many nondenominational government schools and others provided by sugar estates and mining companies and several private schools. Education is free and compulsory from j to 14 years and a few schools take pupils up to 16 years, but enrollment and attendance, especially in rural areas. are considerably below the maximum possible. The teachers' training college has an average output of 60 per annum. There is a well-organized schools' broadcasting service. The government maintains Queen's college, a boys' grammar school in Georgetown founded in 1844. and the Bishops' High School for Girls; and assists two other grammar schools. one in New Amsterdam. A technical institute has made much progress since 1945, and the Carnegie Trade school for women has a long and distinguished history. Many students pursue courses of higher education in the U.K.. Canada, Jamaica and the U.S. Adult education is also promoted by the British council.

Economy. — Domestic trade is mainly in foodstuffs. About half the milled rice produced is consumed locally. The cattle raised in the Rupununi savannas are slaughtered at Lethem or are driven along the Annai-Takama trail to be fattened on the coast pastures. Local production of a number of products for home consumption is encouraged, including meat and fish processing, furniture, sawmilling, brewing, milk pasteurization and the manufacture of cigarettes, soft drinks and tobacco. Coconuts, the third most important crop, occupy about 32,000 ac. but do not produce enough oil to cover local requirements. The oil is an important item in cooking, and is also processed in a modern soap and margarine factory. A considerable amount of gold is retained and worked by goldsmiths.

The principal exports are sugar. bauxite, rice, rum, timber and lumber, diamonds, medicinal, pharmaceutical and toilet preparations, gold and balata. The principal imports are machinery, food (especially cereals. dairy products and wheat flour). fuels and lubricants. About 40% of total trade is with Great Britain, 22% with Canada, 13% with other commonwealth countries (principally in the West Indies) and 12% with the U.S. Great Britain takes about 40% of exports and Canada 38%.

Finance. — The money of account is British West Indian dollars and cents, with the dollar exchangeable (1959) at $4.80 to the pound sterling or B.W.I. $1.70 to U.S. $1. United Kingdom coinage was replaced by a local coinage after 1955; notes issued by the government and the two commercial banks until 1952 were replaced by those issued by the currency hoard for the eastern Caribbean. Heavy investment in development and welfare projects normally produced unfavourable balances after the end of World War II. Apart from administrative costs, the main items of expenditure are on social services. public works and economic development.

Communications. — Trade is hampered by difficulties of internal communication. There are about 370 mi. of motor roads; of these about 75 mi. are asphalt surfaced and the remainder of burnt clay. The system radiating from Bartica on the Essequibo into the Mazaruni and Potaro areas has 244 mi. of earth road. There are about 400 mi. of trails in the interior, principally in the Rupununi savannas. Surveys were being made in the mid-20th century for roads from Parika to Bartica and from the Potaro to the Rupununi. The coast railways have been reconstructed. Internal airway services, using a number of landing strips and the quieter stretches of rivers, are run by the government. Some meat is flown from the Rupununi and diamonds from the Mazaruni. Passengers and equipment are the chief freight. Water transport still has by far the greatest mileage. It is used coastwise. on the canals of the sugar estates, on the government and private ferries and services of the lower rivers and by light craft in the forest areas. British Guiana is linked by radiotelephone with the British West Indies, Great Britain, the U.S.. Canada and other countries.

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VI. FRENCH GUIANA

French Guiana (Guyane française), an overseas *département* of the French republic, lies between 1° 30' and 5° 50' N. and 51° 40' and 54° 30' W. It is bounded on the north by the Atlantic, on the west by the Maroni river. on the south by the Tumuc-Humac mountains and on the east by the Oyapock river. Its area is approximately 35,135 sq.mi., with a seaboard of zoo mi. and a depth of 250 mi. Numerous small islands lie off the coast, notably the fles du Salut (Royale, St. Joseph and Devils islands). The frontiers, long the subject of disputes, were fixed along the Maroni (French Guiana-Dutch Guiana) by the arbitration of the emperor of Russia in 1891, and along the Oyapock (French Guiana-Brazil) by the arbitration of the Swiss confederation in 1900. The southern boundary with Brazil follows the line of the water divide.

Population. — The 1954 census showed a total of 27,863 inhabitants, the majority living in the coastal communes: 11,458 at the capital Cayenne, and 2.185 at St.-Laurent-du-Maroni. The vast majority are Creoles. In the forested interior (Inini) there are about 2,000 gold prospectors (particularly Creoles from the British West Indies), 2,000 Negroes and 1,000 Amerindians. The population was on the decline until 1948 but the fight against yellow fever and malaria has resulted in a slight increase since that date though there is still less than one person to the square mile.

The appellation Creole is given to all those, whether white. Negro or of mixed blood, who have preserved or adopted a more or less European mode of life. Their language is French, or the Guiana Creole dialect, and they are Roman Catholic. The "refugee Negroes," escaped from the plantations in the 18th century, form three tribes on the Maroni: Djuka, Paramaka and Boni. They live partly by farming and more especially by river transport, and they speak *taki-taki,* derived partly from English. The Galibi Indians live on the coast, mingled with the Creoles. In the interior the Roucouyenne or Ouayana (on the upper Maroni), the Palikour and the Oyampi (on the Oyapock) have preserved their tribal customs and live by cultivating burned forest land and hunting. The Palikour belong to the Aramak group, the Galibi and Roucouyenne to the Carib group and the others to the Tupi-Guarani group.

Administration and Social Conditions. — The *dkpartement* is governed by a prefect, assisted by an elected general council and represented by one deputy and one senator in the French parliament. The administrative services depend directly upon the metropolitan ministries. The coastal region forms one *arrondissement* divided into communes, each administered by an elected municipal council. The interior constitutes the *arrondissement* of Inini. In addition to courts of first instance there is a court of appeal. The budget and taxes have been merged into those of the parent country. The transformation of the colony, on March 19, 1946, into a *département* marked the beginning of a new era, the development of French Guiana being henceforward assured by the budget of France. French Guiana, in the constitution of 1958, remains an overseas *département* within the French republic,

Primary schools exist in all the communes and there is a secondary school at Cayenne (*q.v.*), the departmental capital. The Institut Pasteur at Cayenne carries on an effective war against yellow fever. malaria and leprosy; and a service for the protection of the Indians has been established.

Economy. — Cultivation occupies less than 3.000 ha. ($11\frac{1}{2}$ sq.mi.) and French Guiana has to import meat. The chief crops are cassava, bananas and sugar cane. Since 1948 the Institut Français d'Amérique Tropicale, the Bureau Agricole et Forestier Guyanais and the Bureau hlinier Guyanais, set up at Cayenne, have been engaged in a survey of the resources of the country, geological, agricultural, water and forest, and in soil research and experimentation. The lowlands, especially those lying east of Cayenne, could be used for the cultivation of rice. The raising of buffalo is successful in the coastal savannas, and sawmills have been established.

Alluvial gold is no longer a profitable enterprise, but discoveries have been made of tantalite, diamonds and above all of bauxite in the coastal region, especially the strata at Kaw, where the reserves represent 42,000,000 tons of ore with a yield of 41% of aluminum. The largest exports are gold and timber. The unit of currency is the metropolitan French franc.

Communications.—A road has been built from St. Laurent to Cayenne. Silting hampers the development of a port, but there are two monthly shipping services to France (Bordeaux and Havre). The airport at Cayenne is served by French and American airlines and some airfields have been constructed in the interior. The Maroni, Mana, Sinnamary, Mahoury, Approuague and the Oyapock rivers provide means of communication with the interior, interrupted though they are by rapids.

History. — In 1604 a French expedition under the command of Daniel de La Ravardière, sent on the quest for Eldorado, landed at the river where Cayenne now stands, and subsequently several companies tried to establish white and Negro colonies there. In 1686 the privateer Jean Baptiste Ducasse led the colonists in an expedition against Surinam. where they were decimated. Thereafter, peace and administrative continuity (one dynasty of governors, the Orvilliers, kept the title from 1700 to 1763) brought some progress. Sugar cane, roucou, coffee and indigo were cultivated and there were village colonies, totaling about 10,000 Indians, established by the Jesuits.

In 1763 the prime minister, the duc de Choiseul, tried to colonize Guiana, and 14,000 emigrants, recruited by false propaganda, were disembarked at Kourou without any preparation and without food supplies. Within two years 11,000 died from fever and 2,000 returned to France. To add to this, the Jesuits were driven out and their work abandoned. The administrator Pierre Victor Malouet then took over the task of saving Guiana. He brought back from Surinam a French engineer, who constructed polders, and spice cultivation was introduced. In 1788 the colony had about 1,300 whites, 400 free Negroes and 10,500 slaves. The Revolution brought the emancipation of the slaves and the government of the Directory deported to Guiana certain politicians including Charles Pichegru (*q.v.*). Under the consulate Victor Hugues re-established slavery but he had to yield in 1809 to an Anglo-Portuguese attack. In 1817 Guiana was restored to France. From 1827 to 1846 Mother Anne Marie Javouhey, superior of St. Joseph of Cluny, founded on the Mana a prosperous colony for freed slaves. The abolition of slavery in 1848 brought ruin to the plantations. Several thousand Hindus, introduced into the colony, were decimated by sickness, and in 1852 it was decided to send convicts to Guiana. In 1855 the discovery of gold stripped agriculture once more of labour; the Indians made off to Brazil and Dutch Guiana. The convict settlement, established at St. Laurent, brought no benefit to the colony. Its abolition, decided on in 1936, was effected in 1940.

The explorations of Jules Crevaux (1877–82) and Henri Coudreau (1884–96) covered not only French Guiana but a portion of the Amazon basin.

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VII. SURINAM

Surinam (Suriname), Dutch Guiana or Netherlands Guiana lies between latitude 1" 50′ and 6° 7 N. and longitude 53° 59' and 58° 2' W. Its area is 54,144 sq.mi. with a seaboard about 240 mi. long. The cultivated area is about 12 j sq.mi., perhaps 1% of the potential of cultivable land. Of the area cultivated, 20.25 sq.mi. are under plantations, the remainder under medium or small farms.

Surinam was the scene of the first effective colonization by English settlers in Guiana, when from 1651 to 1667 experienced colonists from Barbados were introduced by Lord Willoughby of Parham. Toward the end of this period it had about 500 plantations and 40 sugar works. It was captured by the Dutch under Crijnssen, and ceded by the British at the treaty of Breda as from May 21, 1667, in exchange for New Netherlands (now New York). By 1900, 90% of all agricultural products were grown on plantations and 10% on small farms, but these figures were completely reversed, and coffee, sugar, cocoa and cotton were replaced in importance by rice and fruit. The plantation system and the maintenance of the poldered land both declined during the 19th century, partly because of the difficulties of the sugar industry, partly because of the diversion of Dutch energies from the West to the East Indies. After 1945 there was a notable influx of financial and technical resources and though Surinam still depends excessively on its exports of bauxite, there are a number of movements afoot to revive the economy. (G. **LN.**)

History.—The political history is uneventful after the periods described in the general history of Guiana. In 1828 Surinam and the Dutch West Indian islands were placed under a single governor, who resided at Paramaribo, but were separated again in 1848. Slavery was abolished in 1863, and an arrangement with the British for control of the coolie traffic was drawn up in 1870. The interest of the home government, which had waned with the decline of sugar in the 19th century, was renewed. Expeditions for scientific study, laboratories and establishments for agricultural research and expositions of products from Surinam in the Netherlands were evidence of this interest. For post-World War II changes see *Administration and Government,* below. (X.)

Population.—The population in the 1950 census was 183,681 exclusive of about 26,000 Indians and Negroes living in tribes. The population of Paramaribo was 74,337. At least seven-eighths of the people live on the coast. The proportion of the whole in Paramaribo (43%) is remarkable; the next town in size is Nieuw Nickerie (3,400). About 70% of the inhabitants of Paramaribo are Creoles (Negro and mixed peoples).

As in other tropical areas, the increase of population has been very striking. In 1900 the total was under 70,000; it was expected to reach 260,000 by the early 1960s. Bush Negroes have tended to increase for many years. The Amerindians appear to be reviving; their number in 1942 was estimated at just over 2,000. As in British Guiana, Indians from Asia are the most rapidly increasing group, comprising in the late 1950s about 35% of the total population. In 1942 they formed about 30%. Religious affiliations (1953) were: Reformed and Lutheran, 18,000; Moravians, 41,000; Roman Catholics, 39,000; Jews, 400; Moslems, 59,000; Hindus, 52,000; Confucians, 3,000; others, 6,000.

Government and Administration.—Under the act of Sept. 3, 1948, Surinam became part of the kingdom of the Netherlands. By an interim order operative from Jan. 20, 1950, Surinam obtained self-government except in foreign affairs and defense. The present constitution was defined by the Realm statute, effective from Dec. 29, 1954, which confirmed the interim situation and added certain rights of choice regarding international commitments. The governor, representing the sovereign, is head of the government. He appoints a ministry of nine ministers and an advisory council of five. The ministers are responsible to the legislative council (*Staten*) of Surinam, which is a body of 21 members, elected for a term of four years by adult suffrage. The country is divided into seven districts, of which Paramaribo (*q.v.*), the capital, is one, each administered by a commissary.

The principal sources of public revenue are import and export taxes, royalties on mining production, taxes on houses and estates, and income taxes.

Social Conditions and Education.—Of a total labour force of about 80,000, more than half are engaged in agriculture. On the average, unskilled workers earn 3 guldens ($1.55 or 11*s.* 3*d.*) a day and skilled workers 6 guldens. The country was considered by U.S. observers to be remarkably healthy by the standards of underdeveloped countries. It has also a literacy rate of 70%, there having been compulsory education for children of 7–12 years since 1876. The government aids both denominational and nondenominational schools. In 1959 there were 203 schools for elementary education (135 denominational), including 36 bush schools; and a medical school, a law college, 2 technical schools, 2 teachers' training colleges, 11 agricultural courses, 2 domestic science schools and 2 special schools. Other forms of social welfare are mainly run by voluntary bodies, subsidized by the government.

Economy.—Domestic trade is preponderantly in foodstuffs. The principal exports in 1957 were bauxite, plywood and rice. The U.S. takes 75% of the exports by value. The larger of the two bauxite mining concerns is the American Alcoa company. Imports, chiefly machinery, fuel oil and foodstuffs, are mostly from the U.S. and the Netherlands. The principal advances in production have been in logging and rice and the organization of a modern clothing industry.

Communications.—These are still poor in spite of extensions of the road system; there are about 600 mi. of main road, mainly in and around Paramaribo. The sole railway is a semiderelict 83 mi. single-track construction from Paramaribo to Kabel Station and Dam, built 1905–11 in the abortive hope of serving a gold-mining area. The system of water communication on the coastal plain is singularly complete because of the numerous streams flowing east-west. Boats can travel from the French to the British border on natural waterways with the single artificial link of the Saramacca canal.

Currency and Finance.—The currency unit is the Surinam gulden (florin or guilder). One Netherlands gulden = 0.5013 Surinam gulden (1959). Notes of 1 and 2.5 guldens are issued by the government, and notes of 5 guldens and upward by the Central bank. The Central bank was established in Oct. 1956, with a capital of 3,000,000 guldens, to supervise banking and act as a clearinghouse and to promote stability of the monetary unit. There are seven commercial banks.

In 1955 a ten-year development plan was launched, envisaging the investment of 256,000,000 Netherlands guldens of which one-third was to be raised locally, one-third granted by the Netherlands and one-third loaned by the Netherlands. One-quarter of the outlay was to be on agricultural development and 23% on transport. The development fund of 1947–55 spent 40,000,000 Netherlands guldens, all from grants.

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GUIANA HIGHLANDS, are located mainly in the Guiana region of South America, north of the Amazon and south of the Orinoco river. Consisting of a heavily forested plateau, they cover the southern half of Venezuela, all of the Guianas except for the low coastal plain, the northern part of Brazil and a part of southeastern Colombia. These highlands are similar in geology and surface form to the Brazilian highlands, from which they are separated by the narrow eastern part of the Amazon lowland. The rocks are geologically ancient granites and gneisses, covered in places by more recent sandstones and lava flows. The terrain is made up of a mixture of three elements: a basement of rolling hilly upland, standing mostly less than 1,000 ft. above sea level; surmounted in places near the stream divides by low mountains that stand above the hilly upland between 2,000 and 3,000 ft. above sea level; and surmounted by tabular plateaus where the sandstones and lava flows cover the crystalline rocks. The highest elevations are formed by these tabular uplands, such as Mt. Roraima (9,432 ft.) where the boundaries of Brazil, Venezuela and British Guiana come together. The highlands extend westward across the upper Orinoco (and across the Casiquiare canal, a torrential stream that connects the Orinoco with the Amazon via the Negro river) and in southeastern Colombia reach the eastern front of the Andes, thus separating the Orinoco lowland from the Amazon lowland. The whole region receives an abundance of rainfall and no season is really dry. The vegetation is mostly tropical rain forest, but there are certain parts of the area with savanna. Much of southern Venezuela is a mixture of semideciduous forest and woodland savanna. From the forests come valuable cabinet woods, balata, chicle, vanilla, divi-divi, insecticides and medicinal plants. The crystalline rocks carry a wealth of minerals, but exploration is difficult due to the plant cover. Gold and diamonds are mined, and the Sierra Imataca of Venezuela is a major source of iron ore. *See* also GUIANA: *Physical Geography; Natural Resources;* VENEZUELA; BRAZIL; COLOMBIA; SOUTH AMERICA. (P. E. J.)

GUIART or GUIARD, **GUILLAUME** (d. *c.* 1316), French chronicler and poet, was probably born at Orléans, and served in the French army in Flanders in 1304. He lived at Arras and then in Paris, thus being able to consult the large store of manuscripts in the abbey of St. Denis, including the *Grandes chroniques de France.* Afterward he appears as a *ménestrel de bouche.* Guiart's poem *Branche des royaulx lignages* was written and then rewritten between 1304 and 1307, in honour of the French king Philip IV., and in answer to the aspersions of a Flemish poet. Its 21,000 verses deal with the history of the French kings from the time of Louis VIII.; but it is only really important for the period after 1296 and for the war in Flanders from 1301 to 1304, for which it is a high authority. It was first published by J. A. Buchon (Paris, 1828), and again in tome xxii. of the *Recueil des historiens des Gaules et de la France* (1865).

See A. Molinier, *Les Sources de l'histoire de France,* tome iii. (1903).

GUIBERT or **WIBERT** (c. 1030–1100), of Ravenna, antipope under the title of Clement III. from June 25, 1080 until September 1100, was born at Parma between 1020 and 1030 of the noble imperialist family, Corregio. He was appointed by the empress Agnes, chancellor and, after the death of Pope Victor II. (1057), imperial vicar of Italy. He strove to uphold the imperial authority during Henry IV.'s minority, and presided over the synod at Basel (1061). Guibert lost the chancellorship in 1062. In 1073, through the influence of Empress Agnes and the support of Cardinal Hildebrand, he obtained the archbishopric of Rsvenna and swore fealty to Alexander II. and his successors. He seems to have been at first on friendly terms with Gregory VII., but soon quarrelled with him over the possession of the city of Imola, and henceforth was recognized as the soul of the imperial faction in the investiture contest. He allied himself with Cencius, Cardinal Candidus and other opponents of Gregory at Rome, and, on his refusal to furnish troops or to attend the Lenten synod of 1075, he was ecclesiastically suspended by the pope. He was probably excommunicated at the synod of Worms (1076) with other Lombard bishops who sided with Henry IV., and at the Lenten synod of 1078 he was banned by name. The emperor, having been excommunicated for the second time in March 1080, convened 19 bishops of his party at Mainz on May 31, who pronounced the deposition of Gregory; and on June 25 he caused Guibert to be elected pope by 30 bishops assembled at Brixen. Guibert was installed in the Lateran and consecrated as Clement III. on March 24, 1084. One week later, on Easter Sunday, he crowned Henry IV. and Bertha in St. Peter's. Clement survived not only Gregory VII. but also Victor III. and Urban II., maintaining his title to the end and in great measure his power over Rome and the adjoining regions. Excommunication was pronounced against him by all his rivals. He was driven out of Rome finally by crusaders in 1097, and sought refuge in various fortresses on his own estates. St. Angelo, the last Guibertist stronghold in Rome, fell to Urban II. on Aug. 24, 1098. Clement, on the accession of Paschal II. in 1099, prepared to renew his struggle but was driven from Albano by Norman troops and died at Civita Castellana in September 1100.

See J. Langen, *Geschichte der romischen Kirche von Gregor VII. bis Innocenz* III. (Bonn, 1893); Jaffé-Wattenbach, *Regesta pontif. Roman* (2nd ed., 1885–88); K. J. von Hefele, *Conczliengeschichte,* vol. v. (2nd ed.); F. Gregorovius, *Rome in the Middle Ages,* vol. iv., trans. by Mrs. G. W. Hamilton (London, 1900–02); and O. Kohncke, *Wibert von Ravenna* (Leipzig, 1888). (C. H. H.)

GUIBERT, JACQUES ANTOINE HIPPOLYTE, COMTE DE (1743–1790), French general and military writer, was born at Montauban, and at the age of 13 accompanied his father, Charles Bénoit, comte de Guibert (1715–1786), chief of staff to Marshal de Broglie, throughout the war in Germany, and won the cross of St. Louis and the rank of colonel in the expedition to Corsica (1767). His *Essai général de tactique* (1770) appeared in numerous subsequent editions and in English, German and even Persian translations (extracts also in Liskenne and Sauvan, *Bibl. historique et militaire,* 1845). His *Défense du système de guerre moderne,* a reply to his many critics (Neuchâtel, 1779) is a reasoned and scientific defence of the Prussian method of tactics, which formed the basis of his work when in 177j he began to co-operate with the count de St. Germain in a series of much-needed and successful reforms in the French army. In 1777, however, St. Germain fell into disgrace, and his fall involved that of Guibert, who was promoted to the rank of *maréchal de camp* and relegated to a provincial staff appointment. In his semi-retirement he vigorously defended his old chief St. Germain against his detractors. On the eve of the Revolution he was recalled to the War Office, but in his turn he became the object of attack and he died, practically of disappointment, on May 6, 1790.

See Toulongeon, *Eloge véridique de Guibert* (1790); Madame de Stäel, *Eloge de Guibert;* Bardin, *Notice historique du général Guibert* (1836); Flavian d'Aldeguier, *Discours sur la vie et les écrits du comte de Guibert* (Toulouse, 1855); Count Forestie, *Biographie du comte de Guibert* (Montauban, 1855); Count zur Lippe, "Friedr. der Grosse und Oberst Guibert" (*Militär-Wochenblatt,* 1873, 9 and 10).

GUIBERT OF NOGENT (1053–1124), historian and theologian, was born of noble parents at Clermont-en-Beauvoisis, and studied at the Benedictine abbey of Flavigny (Flaviacum) or St. Germer, where he devoted himself at first to the secular poets, and later changed to theology, through the influence of Anselm of Bec, afterwards of Canterbury. In 1104, he became head of the abbey of Notre Dame de Nogent. Of his works which appeared at Paris in 1651 and in Migne's *Patrol. Lat.,* vols. 156 and 184, the chief are his interesting autobiography, *De vita sua, sive monodiarum,* and his history of the first crusade, *Gesta Dei per Francos.* The former was translated into English by C. C. Swinton Bland (1926).

See H. von Sybel, *Geschichte des ersten Kreuzzuges* (Leipzig, *1881);* B. Monod, *Le Moine Guibert et son temps* (1905); and *Guibert de Nogent; histoire de sa vie* (ed. G. Bourgin, 1907).

GUICCIARDINI, FRANCESCO (1483–1540), Italian historian and statesman, was born at Florence on Mar. 6, 1483. He studied at the universities of Ferrara and Padua, and at that time contemplated a career in the church. Owing, however, to the opposition of his father, he turned his attention to law, and at the age of 23 was appointed by the Signoria of Florence to read the *Institutes* in public. He advanced his political prospects by his marriage with Maria Salviati. In 1512 the Signoria sent him on a mission to the court of Ferdinand of Spain, and Guicciardini issued from this first trial of his skill with an assured reputation for diplomacy, which in the Italy of that time implied an ability to meet plot with counterplot, and parry force with sleight of hand.

In 1515 Leo. X. took him into service, and made him governor of Reggio and Modena. In 1521 Parma was added to his rule, and in 1523 he was appointed viceregent of Romagna by Clement VII. Guicciardini was thus virtual master of the papal States beyond the Apennines, during a period of great difficulty. In 1526 Clement made him lieutenant-general of the papal army. In this capacity he witnessed from a distance the sack of Rome and the imprisonment of Clement, without being able to rouse the duke of Urbino into activity. Clement did not withdraw his confidence, and in 1531 Guicciardini was advanced to the governorship of Bologna, the most important of all the papal lord-lieutenancies. This post he resigned in 1534 on the election of Paul III., preferring to follow the fortunes of the Medicean princes.

It may here be noticed that though Guicciardini served three popes through a period of 20 years, he hated the papacy with a deep bitterness, attributing the woes of Italy to the ambition of the church. The same discord between his private opinions and his public actions may be traced in his later conduct. Guicciardini believed that the best form of government was a commonwealth administered upon the type of the Venetian constitution; and we have ample evidence to prove that he had judged the tyranny of the Medici at its true worth. Yet he did not hesitate to place his powers at the disposal of the most vicious members of that house for the enslavement of Florence. In 1527 he had been declared a rebel by the Signoria on account of his well-known Medicean prejudices; and in 1530, deputed by Clement to punish the citizens after their revolt, he revenged himself with a cruelty and an avarice that were long and bitterly remembered. When he returned to Florence in 1534, he did so as the creature of the dissolute Alessandro de' Medici, and he pushed his servility so far as to defend this infamous despot at Naples in 153j, before the bar of Charles V., from the accusations brought against him by the Florentine exiles (*Op. ined.* vol. ix.). He won his cause; but he justified the reproaches of his contemporaries, who describe him as a cruel, venal, grasping seeker after power, eager to support a despotism for the sake of honours, offices and emoluments secured for himself by a bargain with the oppressors of his country. Varchi, Nardi, Jacopo Pitti and Bernardo Segni are unanimous upon this point; but it is only the publication of Guicciardini's private mss. that has made us understand the force of their invectives. After the murder of Duke Alessandro in 1537, Guicciardini espoused the cause of Cosimo de' Medici, a boy unused to the game of statecraft, hoping to rule Florence as grand vizier under this inexperienced princeling. But Cosimo displayed the genius of his family for politics, and dismissed him. Guicciardini spent his last years in the composition of the *Storia d'Italia.* He died at Florence on May 23, 1540.

The Storia d'Italia (1561–64) dealt with the period 1494–1532; it was translated into most European languages. It is a masterpiece of scientific history, and is remarkable for treating the history of Italy for the first time as a national whole, and not as the accumulation of separate principalities and republics. The whole tangled skein of Italian politics, in that involved and stormy period, is unravelled with a patience and insight that are above praise. The *Storia d'Italia* was undoubtedly the greatest historical work that had appeared since the beginning of the modern era, though it owes its greatness in part to the importance of the period with which it deals. It remains the most solid monument of Italian reason in the 16th century, the final triumph of that Florentine school of philosophical historians which included Machiavelli, Segni, Pitti, Nardi, Varchi, Francesco Vettori and Donato Giannotti.

Though Guicciardini Iived through that agony of the Italian people, he does not seem to be aware that he is writing a great historical tragedy, and never ceases to be an impartial spectator—a cold and curious critic. He maintained that the explanation of historical events could only be traced in the detailed study of human character and motive. His writing is therefore overburdened with detail which, although it tends to destroy the proper perspective of his work, very accurately portrays the principles underlying his method.

Up to the year 1857 the fame of Guicciardini as a writer, and the estimation of him as a man, depended almost entirely upon the *Storia d'Italia,* and on a few ill-edited extracts from his aphorisms. At that date the Guicciardini family entrusted to Giuseppe Canestrini the publication of his hitherto inedited mss. The works thus brought to light include (1) the *Ricordi politici,* consisting of about 400 aphorisms on political and social topics, which illustrate Guicciardini's conviction that man is naturally actuated by the basest motives; (2) the observations on Machiavelli's *Discorsi,* which very clearly show his lack of political idealism; (3) the *Storia Fiorentina,* an early work; (4) the *Dialogo del reggimento di Firenze*, also probably an early work, in which the forms of government suited to an Italian commonwealth are discussed, and illustrated by the vicissitudes of Florence up to the year 1494; and (j) *Discorsi politici,* composed during his Spanish Iegation. Taken in combination with Machiavelli's treatises, the *Opere inedite* furnish a comprehensive body of Italian political philosophy anterior to the date of Fra Paolo Sarpi.

GUICHARD, KARL GOTTLIEB (1724–1775), soldier and military writer, known as QUINTUS ICILIUS, was born at Magdeburg in 1724, of a family of French refugees. He was educated for the church, but sought and obtained a commission in the Dutch army, making the campaigns of 1747–48 in the Low Countries. In 1757 his *Mémoires militaires sur les Grecs et les Romnins* appeared at The Hague; and in Jan. 1758 he entered the service of Frederick the Great, remaining for nearly 18 months in the royal suite. Guichard's Prussian official name of Quintus Icilius was the outcome of a friendly dispute with the king. He was appointed to the command of a free battalion. This corps he commanded throughout the later stages of the Seven Years' War. his battalion, as time went on, becoming a regiment of three battalions, and Quintus himself recruited seven more battalions of the same kind of troops. His command was almost always with the king's own army in these campaigns, but for a short time it fought in the western theatre under Prince Henry. When not on the march he was always at the royal headquarters, and it was he who brought about the famous interview between the king and Gellert on the subject of national German literature. He was made lieutenant colonel in 1765, and in 1773, in recognition of his work *Mémoires critiques et historiques sur plusieurs points d'antiquités militaires,* dealing mainly with Caesar's campaigns in Spain (1773), was promoted colonel. He died at Berlin on May 13, 1775.

GUICHEN, LUC URBAIN DE BOUEXIC, COMTE DE (1712–1790), French admiral, was born at Fougeres on June 21, 1712, and entered the navy in 1730. When France had become the ally of the Americans in the War of Independence, he hoisted his flag as rear admiral in the channel fleet, and was present at the battle of Ushant (July 27, 1779).

In March of the following year he was sent to the West Indies to fight Rodney. In the action to Ieeward of Martinique (April 17), Guichen narrowly escaped disaster. He gave no further opportunity of bringing him to close action, and brought his fleet back to Brest for repairs. In Dec. 1781 Guichen was sent to the West Indies with stores and reinforcements. On the 12th Admiral Kernpenfelt, who had been sent out by the British government to intercept him, sighted the French admiral in the Bay of Biscay through a temporary clearance in a fog, and attacked the transports, 20 of which were captured and the rest put to flight. Guichen died on Jan. 13, 1790.

GUIDI, CARLO ALESSANDRO (1650–1712), Italian lyric poet, was bom at Pavia on June 14, 1650. As chief founder of the well-known Roman academy called L'Arcadia, he had a share in the reform of Italian poetry, which had been corrupted by the extravagances of the poets Marini and Achillini and their school. Guidi's most celebrated song is that entitled *Alla Fortuna* ("To Fortune").

In 1681 he published at Parma his poems, his lyric tragedy *Amalasunta* in *Italy,* and two pastoral dramas, *Daphne* and *Endymion.*

His poetical version of the six homilies of Pope Clement XI proved to be the indirect cause of the author's death. Guidi was on his way to present a copy to the pope when he found a serious typographical error; he took it so much to heart that he was seized with an apoplectic fit at Frascati and died (June 12, 1712).

GUIDICCIONI, GIOVANNI (1500–1541), Italian diplomat and poet of the school of Petrarch, was born at Lucca, Feb. 25, 1500. His *Lettere* afford valuable observations on the political life of his time. His best work is a set of 14 sonnets contrasting ancient and Renaissance Rome. He died at Macerata, July 26, 1541.

Guidiccioni's works were published in 2 vol. (1867). *See* also E. Chiorboli, *Giovanni Guidiccioni* (1907).

GUIDO DA SIENA (active *c.* 1250–1275), Italian painter, who, if certain assumptions regarding him may be accepted as true, is the earliest representative of a new school of neo-Byzantine art that flourished in Siena in the 13th century. A large painting of the "Virgin and Child Enthroned," once in the church of S. Domenico at Siena and later moved to the Palazzo Pubblico, bears a rhymed Latin inscription, giving the painter's name as "Gu . . . o de Senis," with the date 1221. Milanesi alleged that the inscription had been tampered with and should read 1281, while Wickhoff maintained that the date 1221 was genuine. Later art criticism inclined toward the latter view. Milanesi thought that the work in S. Domenico was due to Guido Graziani, of whom no other record remains earlier than 1278, when he is mentioned as the painter of a banner.

GUIDO OF AREZZO (c. 990), a musician who lived in the 11th century, is also known as Guido Aretinus, Fra Guittone and Guy of Arezzo. He has been called the father of modem music, and a portrait of him in the refectory of the monastery of Avellana bears the inscription *Beatus Guido, inventor musicae.* Of his life little is known, and that little is chiefly derived from the dedicatory letters prefixed to two of his treatises and addressed respectively to Bishop Theodald of Arezzo and Michael, a monk of Pomposa and Guido's pupil and friend. At his first appearance in history Guido was a monk in the Benkdictine monastery of Pomposa, where he taught singing and invented his educational method, by means of which, according to his own statement, a pupil might learn in five months what formerly it would have taken him ten years to acquire. Envy and jealousy, however, drove him from the monastery and he went to live at Arezzo, where, about 1030, he received an invitation to Rome from Pope John XIX. He obeyed the summons, and the pope himself became his first and apparently one of his most proficient pupils. In Rome he met again his former superior, the abbot of Pomposa, who seems to have induced him to return to Pomposa. Thenceforward the particulars of his life are scanty but it is known that at one period he worked in the Benedictine monastery of St. Maur des Fosses where he invented his novel system of notation and taught the brothers to sing by it. In codex 763 of the British museum the composer of the "Micrologus," which gives an account of his method and other works by him, is always described as Guido de Sancto Mauro.

But whatever the details of his life there is no room for question as to the importance of his musical reforms and innovations. He it was who for the first time systematically used the lines of the staff, and the intervals or *spatia* between them. There is also little doubt that the names of the first six notes of the scale, *ut, re, mi, fa, sol, la,* still in use in France and Italy. were introduced by him. They were derived from the first syllables of six lines of a hymn addressed to St. John the Baptist, the initial notes of each line of which happened to form the scale, C, D, E, F, G, A, the lines in question being as follows:

Ut queant laxis *re*sonare fibris
*Mi*ra gestorum *fa*muli tuorum,
*Sol*ve polluti labii reatum,
Sancte Joannes.

Further, Guido is generally credited with the introduction of the F clef and with writings on music which are amply sufficient to account for the high esteem in which he was ultimately held by his contemporaries. The precise year of his death is unknown.

The most important of Guido's treatises, and those which are generally acknowledged to be authentic, are *Micrologus Guidonis de disciplina artis musicae,* dedicated to Bishop Theodald of Arezzo, and comprising a complete theory of music: in 20 chapters; *Musicae Guidonis regulae rhythmicae in antiphonarii sui prologum prolatae,* written in trochaic decasyllabics of anything but classical structure; *Aliae Guidonis regulae de ignoto cantu, identidem in antiphonarii sui prologum prolatae;* and the *Epistola Guidonis Michaeli monacho de ignoto cantu,* already referred to. These are published in the second volume of Gerbert's *Scriptores ecclesiastici de musica sacra.* A very important manuscript unknown to Gerbert (the *Codex bibliothecae Uticensis,* in the Paris library) contains an antiphonarium and gradual undoubtedly belonging to Guido. *See* TONIC SOL-FA.

See L. Angeloni, *G. d'Arezzo* (1811); Kiesewetter, *Guido von Arezzo* (1840); Kornmüller, "Leben und Werken Guidos von Arezzo," in Habert's *Jahrb.* (1876); Antonio Brandi, *G. Aretino* (1882); G. B. Ristori, *Biografia di Guido monaco d'Arezzo* (1868); and a life by Gastoué in the *Dict. d'archéologie* (1924). *See* also HEXACHORD; MUSIC; and MUSICAL NOTATION.

GUIDO RENI: *see* RENI, GUIDO.

GUIENNE, an old French province which corresponded roughly to the Aquitania Secunda of the Roman period. In the 12th century it formed, with Gascony, the duchy of Aquitaine (*q.v.*), which passed under the dominion of the kings of England by the marriage of Eleanor of Aquitaine to Henry II. But. in the 13th century, through the conquests of Philip Augustus, Louis VIII and Louis IX, it was confined within the narrower limits fixed by the treaty of Paris (1259). It was at this point that "Guienne," a vulgar form of "Aquitaine," was substituted as the name of the whole territory which, in southwestern France, belonged to the Plantagenets under the suzerainty of the French king. These territories formed a duchy which included not only the Bordelais, the Bazadais, part of Périgord, Limousin, Quercy and Rouergue but also Gascony (*q.v.*) properly so called, between the lower Garonne and the Pyrenees, and, later on, the Agenais. ceded by Philip III the Bold to Edward I in 1279. In 1296, 1324 and 1337 this duchy was confiscated by the kings of France on the ground that there had been a failure in the feudal duties. At the treaty of Brétigny (1360) Edward III acquired the full sovereignty of the duchy of Guienne, enlarged by the territories which formed the principality of Aquitaine. Some years later the treaty was broken on the initiative of Charles V of France, and French troops reconquered a large part of the country (1369–79). After alternating successes and defeats during the first half of the 15th century, the English troops were compelled to leave the whole country, first in 1451, then finally in 1453. It was then united to the French crown by Charles VII. In 1469 Louis XI gave it in exchange for Champagne and Brie to his brother Charles, duke of Berry, after whose death in 1472 it was again united to the royal dominion. Guienne then formed a government which from the 17th century onward was united with Gascony. The government of Guienne and Gascony, with its capital at Bordeaux, lasted until the end of the *ancien régime.* Under the Revolution the *départements* formed from Guienne proper were those of Gironde, Lot-et-Garonne, Dordogne, Lot, Aveyron and the chief part of Tarn-et-Garonne.

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GUILBERT, YVETTE (1868?–1944), French *diseuse,* born in Paris. won an immense vogue by her rendering of songs drawn from Parisian lower-class life and from the humours of the Latin Quarter. Her adoption of an habitual yellow dress and long black gloves, her studied simplicity of diction and her ingenuous delivery of songs charged with risqué meaning made her famous. She owed something to Xanrof (Léon Fourneau), who for a long time composed songs especially for her, and perhaps still more to Aristide Bruant, who wrote many of her argot songs. She is also remembered as the subject of a famous poster by H. Toulouse-Lautrec.

Her publications include *La Vedette* and *Les Demi-vieilles,* both novels (1902), and *Song of My Life: My Memories* (1927; Eng. trans., 1929).

GUILDFORD, municipal borough and county town of Surrey, Eng., in the Guildford parliamentary division, 28 mi. S.W. of London by road. Pop. (1951) 47,496. Area 11.2 sq.mi. It is situated on the river Wey in a gap in the North Downs through which pass also the London-Portsmouth road and the railway. A possession of King Alfred, it was a royal borough throughout the middle ages. It is first mentioned as a borough in 1130. Charters of Henry III (1257) granted among other privileges that Guildford should be the seat of the county court and the Surrey assizes "for ever." After the spring assizes in 1930 they were, however, moved to Kingston-upon-Thames. Of 12 other charters before 1686 the most important were those of Edward III in 1366 (fee farm), Henry VII in 1488 (incorporation) and James I in 1603 (commission of the peace). A fair at Trinity, almost immediately moved to Whitsun, was granted by Edward III. It was superseded under Henry VII by two, held on the feasts of St. Martin and St. George. Fairs. in May for the sale of sheep and in November for cattle, are still held; there is a cattle market on Tuesdays and a fruit and vegetable market on Fridays and Saturdays. St. Mary's church has a Saxon tower; there are the ruins of a Norman castle; Tudor buildings include the Royal Grammar school, founded in 1507 and refounded by Edward VI in 1553; among 17th–18th century buildings are Trinity hospital, founded by Archbishop Abbot in 1619, and the front of the Guildhall (1683). The staple industry during the middle ages was the cloth trade: it is now extinct. Later the town's prosperity was based on its markets, which, with a motor works and other industries, still contribute largely to its wealth. Guildford was constituted a diocese in 1927, and in 1936 the foundation stone of the cathedral church of the Holy Spirit, designed by Edward Maufe. was laid on Stag hill. The Rev. C. L. Dodgson (Lewis Carroll) died in Guildford in 1898 and is buried in the cemetery on the Mount.

GUILDS. (The spelling *guild* is now the common English spelling, but there are many reasons for preferring the older spelling *gild).* Mediaeval gilds were voluntary associations formed for the mutual aid and protection of their members. Among the gildsmen there was a strong spirit of fraternal co-operation or Christian brotherhood, with a mixture of worldly and religious ideals—the support of the body and the salvation of the soul. Early meanings out of the root *gild* or *geld* were expiation. penalty, sacrifice or worship, feast or banquet, and contribution or payment; it is difficult to determine which is the earliest meaning, and it is not certain whether the gildsmen were originally those who contributed to a common fund or those who worshipped or feasted together. Their fraternities or societies may be divided into three classes: religious or benevolent, merchant and craft gilds. The last two categories, which do not become prominent anywhere in Europe until the 12th century, had, like all gilds, a religious tinge, but their aims were primarily worldly, and their functions were mainly of an economic character.

Origin.—Various theories have been advanced concerning the origin of gilds. Some writers regard them as a continuation of the Roman *collegia* and *sodalitates,* but there is little evidence to prove the unbroken continuity of existence of the Roman and Germanic fraternities. A more widely accepted theory derives gilds wholly or in part from the early Germanic or Scandinavian sacrificial banquets. This view does not seem to be tenable, for the old sacrificial carousals lack two of the essential elements of the gilds, namely, corporative solidarity or permanent association and the spirit of Christian brotherhood. Max Pappenheim ascribed the origin of Germanic gilds to the northern "foster-brotherhood" or "sworn-brotherhood," which was an artificial bond of union between two or more persons. After intermingling their blood in the earth and performing other peculiar ceremonies, the two contracting parties with grasped hands swore to avenge any injury done to either of them. The foster-brotherhood seems to have been unknown to the Franks and the Anglo-Saxons, the nations in which mediaeval gilds first appear; and hence Pappenheim's conclusions, if tenable at all, apply only to Denmark or Scandinavia.

No theory on this subject can be satisfactory which wholly ignores the influence of the Christian Church. Imbued with the idea of the brotherhood of man, the church naturally fostered the early growth of gilds and tried to make them displace the old heathen banquets. The work of the Church was, however, directive rather than creative. Gilds were a natural manifestation of the associative spirit which is inherent in mankind. The same needs produce in different ages associations which have striking resemblances, but those of each age have peculiarities which indicate a spontaneous growth. It is not necessary to seek the germ of gilds in any antecedent age or institution. When the old kin-bond or *maegth* was beginning to weaken or dissolve, and the state did not yet afford adequate protection to its citizens, individuals naturally united for mutual help.

Gilds are first mentioned in the Carolingian capitularies of 779 and 789, and in the enactments made by the Synod of Nantes early in the 9th century, the text of which was preserved in the ecclesiastical ordinances of Hincmar of Reims (A.D. 852). The capitularies of 805 and 821 also contain vague references to sworn unions of some sort, and a capitulary of 884 prohibits villeins from forming associations "vulgarly called gilds" against those who have despoiled them. The Carolingians evidently regarded such "conjurations" as "conspirations" dangerous to the State. The gilds of Norway, Denmark and Sweden are first mentioned in the 11th, 12th and 14th centuries respectively; those of France and the Netherlands in the 11th.

Many writers believe that the earliest references to gilds come from England. The laws of Ine speak of *gegildan* who helped one another pay the *wergeld,* but it is not quite certain that they were members of gild fraternities in the later sense. These are more clearly referred to in England in the second half of the 9th century, though we have little information concerning them before the 11th century. To the first half of that century belong the statutes of the fraternities of Cambridge, Abbotsbury and Exeter. They are important because they form the oldest body of gild ordinances extant in Europe. The thanes' gild at Cambridge afforded help in blood-feuds, and provided for the payment of the *wergeld* in case a member killed anyone. The religious element was more prominent in Orcy's gild at Abbotsbury and in the fraternity at Exeter; their ordinances exhibit much solicitude for the salvation of the brethren's souls. The Exeter gild also gave assistance when property was destroyed by fire. Prayers for the dead, attendance at funerals of gildsmen, periodical banquets, the solemn entrance oath, fines for neglect of duty and for improper conduct, contributions to a common purse, mutual assistance in distress, periodical meetings in the gildhall—in short, all the characteristic features of the later gilds already appear in the statutes of these Anglo-Saxon fraternities. Some Continental writers, in dealing with the origin of municipal government throughout western Europe, have, however, ascribed too much importance to the Anglo-Saxon gilds, exaggerating their prevalence and contending that they form the germ of mediaeval municipal government. This view rests almost entirely on conjecture; there is no good evidence to show that there was any organic connection between gilds and municipal government in England before the coming of the Normans. It should also be noted that there is no trace of the existence of either craft or merchant gilds in England before the Norman Conquest. Commerce and industry were not yet sufficiently developed to call for the creation of such associations.

Religious Gilds after the Norman Conquest.—Though we have not much information concerning the religious gilds in the 12th century, they doubtless flourished under the Anglo-Norman kings, and we know that they were numerous, especially in the boroughs, from the 13th century onward. In 1388 parliament ordered that every sheriff in England should call upon the masters and wardens of all gilds and brotherhoods to send to the king's council in Chancery, before Feb. 2, 1389, full returns regarding their foundation, ordinances and property. They throw much light on the functions of the gilds. Their ordinances are similar to those of the above-mentioned Anglo-Saxon fraternities. Each member took an oath of admission, paid an entrance fee, and made a small annual contribution to the common fund. The brethren were aided in old age, sickness and poverty, often also in cases of loss by robbery, shipwreck and conflagration; for example, any member of the gild of St. Catherine, Aldersgate, was to be assisted if he "fall into poverty or be injured through age, or through fire or water, thieves or sickness." Alms were often given even to non-gildsmen; lights were supported at certain altars; feasts and processions were held periodically; the funerals of brethren were attended; and masses for the dead were provided from the common purse or from special contributions made by the gildsmen. Some of the religious gilds supported schools, or helped to maintsin roads, bridges and town-walls, or even came, in course of time, to be closely connected with the government of the borough; but, as a rule, they were simply private societies with a limited sphere of activity. They are important because they played a prominent rôle in the social life of England, especially as eleemosynary institutions, down to the time of their suppression in 1547. Religious gilds, closely resembling those of England, also flourished on the Continent during the middle ages.

The Gild Merchant.—The merchant and craft fraternities are particularly interesting to students of economic and municipal history. The gild merchant came into existence in England soon after the Norman Conquest, as a result of the increasing importance of trade, and it may have been transplanted from Normandy. Until clearer evidence of foreign influence is found, it may, however, be safer to regard it simply as a new application of the old gild principle, though this new application may have been stimulated by Continental example. The evidence seems to indicate the pre-existence of the gild merchant in Normandy, but it is not mentioned anywhere on the Continent before the 11th century. It spread rapidly in England, and from the reign of John onward we have evidence of its existence in many English boroughs. But in some prominent towns, notably London, Colchester, Norwich and the Cinque Ports, it seems never to have been adopted. In fact it played a more conspicuous rôle in the small boroughs than in the large ones. It was regarded by the townsmen as one of their most important privileges. Its chief function was to regulate the trade monopoly conveyed to the borough by the royal grant of *gilda mercatoria.* A grant of this sort implied that the gildsmen had the right to trade freely in the town, and to impose payments and restrictions upon others who desired to exercise that privilege. The ordinances of a gild merchant thus aim to protect the brethren from the commercial competition of strangers or non-gildsmen. More freedom of trade was allowed at all times in the selling of wares by wholesale, and also in retail dealings during the time of markets and fairs. The ordinances were enforced by an alderman with the assistance of two or more deputies, or by one or two masters, wardens or keepers. The *Morwenspeches* were periodical meetings at which the brethren feasted, revised their ordinances, admitted new members, elected officers and transacted other business.

Historians have expressed divergent views regarding the early relations of the craftsmen and their fraternities to the gild merchant. One of the main questions in dispute is whether artisans were excluded from the gild merchant. Many of them seem to have been admitted to membership. They were regarded as merchants, for they bought raw material and sold the manufactured commodity; no sharp line of demarcation was drawn between the two classes in the 12th and 13th centuries. Separate societies of craftsmen were formed in England soon after the gild merchant came into existence; but at first they were few in number. The gild merchant did not give birth to craft fraternities or have anything to do with their origin; nor did it delegate its authority to them. In fact, there seems to have been little or no organic connection between the two classes of gilds. As has already been intimated, however, many artisans probably belonged both to their own craft fraternity and to the gild merchant, and the latter, owing to its great power in the town, may have exercised some sort of supervision over the craftsmen and their societies. When the king bestowed upon the tanners or weavers or any other body of artisans the right to have a gild, they secured the monopoly of working and trading in their branch of industry. Thus with every creation of a craft fraternity the gild merchant was weakened and its sphere of activity was diminished, though the new bodies were subsidiary to the older and larger fraternity. The greater the commercial and industrial prosperity of a town, the more rapid was the multiplication of craft gilds, which was a natural result of the ever-increasing division of labour. The old gild merchant remained longest intact and powerful in the smaller boroughs, in which, owing to the predominance of agriculture, few or no craft gilds were formed. In some of the larger towns rhe crafts were prominent already in the 13th century, but they became much more prominent in the first half of the 14th century. Their increase in number and power was particularly rapid in the time of Edward III., whose reign marks an era of industrial progress. Many master craftsmen now became wealthy employers of labour, dealing extensively in the wares which they produced. The class of dealers or merchants, as distinguished from trading artisans, also greatly increased and established separate fraternities. When these various unions of dealers and of craftsmen embraced all the trades and branches of production in the town, little or no vitality remained in the old gild merchant; it ceased to have an independent sphere of activity. The tendency was for the single organization, with a general monopoly of trade, to be replaced by a number of separate organizations representing the various trades and handicrafts. In short, the function of guarding and supervising the trade monopoly split up into various fragments, the aggregate of the crafts superseding the old general gild merchant. This transference of the authority of the latter to a number of distinct bodies and the consequent disintegration of the old organization was a gradual spontaneous movement—a process of slow displacement, or natural growth and decay, due to the play of economic forces—which, generally speaking, may be assigned to the 14th and 15th centuries, the very period in which the craft gilds attained the zenith of their power. While in most towns the name and the old organization of the gild merchant thus disappeared and the institution was displaced by the aggregate of the crafts towards the close of the middle ages, in some places it survived long after the 15th century either as a religious fraternity, shorn of its old functions, or as a periodical feast, or as a vague term applied to the whole municipal corporation.

On the Continent of Europe the mediaeval gild merchant played a less important rôle than in England. In Germany, France and the Netherlands it occupies a less prominent place in the town charters and in the municipal polity, and often corresponds to the later fraternities of English dealers established either to carry on foreign commerce or to regulate a particular part of the local trade monopoly.

Craft Gilds.—A craft gild usually comprised all the artisans in a single branch of industry in a particular town. Such a fraternity was commonly called a "mistery" or "company" in the 15th and 16th centuries, though the old term "gild" was not yet obsolete. "Gild" was also a common designation in north Germany, while the corresponding term in south Germany was *Zunft,* and in France *métier*. These societies are not clearly visible in England or on the Continent before the early part of the 12th century. With the expansion of trade and industry the number of artisans increased, and they banded together for mutual protection. Some German writers have maintained that these craft organizations emanated from manorial groups of workmen, but strong arguments have been advanced against the validity of this theory (notably by F. Keutgen). It is unnecessary to elaborate any profound theory regarding the origin of the craft gilds. The union of men of the same occupation was a natural tendency of the age. In the 13th century the trade of England continued to expand and the number of craft gilds increased. In the 14th century they were fully developed and in a flourishing condition; by that time each branch of industry in every large town had its gild. The development of these societies was even more rapid on the Continent than in England.

Their organization and aims were in general the same throughout western Europe. Officers, commonly called wardens in England, were elected by the members, and their chief function was to supervise the quality of the wares produced so as to secure good and honest workmanship. Therefore, ordinances were made regulating the hours of labour and the terms of admission to the gild, including apprenticeship. Other ordinances required members to make periodical payments to a common fund, and to participate in certain common religious observances, festivities and pageants. But the regulation of industry was always paramount to social and religious aims; the chief object of the craft gild was to supervise the processes of manufacture and to control the monopoly of working and dealing in a particular branch of industry.

We have already called attention to the gradual displacement of the gild merchant by the craft organizations. The relations of the former to the latter must now be considered more in detail. There was at no time a general struggle in England between the gild merchant and the craft gilds, though in a few towns there seems to have been some friction between merchants and artisans. There is no exact parallel in England to the conflict between these two classes in Scotland in the 16th century, or to the great Continental revolution of the 13th and 14th centuries, by which the crafts threw off the yoke of patrician government and secured more independence in the management of their own affairs and more participation in the civic administration. The main causes of these conflicts on the Continent were the monopoly of power by the patricians, acts of violence committed by them, their bad management of the finances and their partisan administration of justice. In some towns the victory of the artisans in the 14th century was so complete that the whole civic constitution was remodelled with the craft fraternities as a basis. A widespread movement of this sort would scarcely be found in England, where trade and industry were less developed than on the Continent, and where the motives of a class conflict between merchants and craftsmen were less potent. Moreover, borough government in England seems to have been mainly democratic until the 14th or 15th century; there was no oligarchy to be depressed or suppressed. Even if there had been motives for uprisings of artisans such as took place in Germany and the Netherlands, the English kings would probably have intervened. True, there were popular uprisings in England, but they were usually conflicts between the poor and the rich; the crafts as such seldom took part in these tumults. While many Continental municipalities were becoming more democratic in the 14th century, those of England were drifting towards oligarchy, towards government by a close "select body." As a rule the craft gilds secured no dominant influence in the boroughs of England, but remained subordinate to the town government. Whatever power they did secure, whether as potent subsidiary organs of the municipal polity for the regulation of trade, or as the chief or sole medium for the acquisition of citizenship, or as integral parts of the common council, was, generally speaking, the logical sequence of a gradual economic development, and not the outgrowth of a revolutionary movement by which oppressed craftsmen endeavoured to throw off the yoke of an arrogant patrician gild merchant.

Two new kinds of craft fraternities appear in the 14th century and become more prominent in the 15th, namely, the merchants' and the journeymen's companies. The misteries or companies of merchants traded in one or more kinds of wares. They were preeminently dealers, who sold what others produced. Hence they should not be confused with the old gild merchant, which originally comprised both merchants and artisans, and had the whole monopoly of the trade of the town. In most cases, the company of merchants was merely one of the craft organizations which superseded the gild merchant.

In the 14th century the journeymen or yeomen began to set up fraternities in defence of their rights. The formation of these societies marks a cleft within the ranks of some particular class of artisans—a conflict between employers, or master artisans, and workmen. The journeymen combined to protect their special interests, notably as regards hours of work and rates of wages, and they fought with the masters over the labour question in all its aspects. The resulting struggle of organized bodies of masters and journeymen was widespread throughout western Europe, but it was more prominent in Germany than in France or England. This conflict was indeed one of the main features of German industrial life in the 15th century. In England the fraternities of journeymen, after struggling a while for complete independence, seem to have fallen under the supervision and control of the masters' gilds; in other words, they became subsidiary or affiliated organs of the older craft fraternities.

An interesting phenomenon in connection with the organization of crafts is their tendency to amalgamate, which is occasionally visible in England in the 15th century, and more frequently in the 16th and 17th. A similar tendency is visible in the Netherlands and in some other parts of the Continent already in the 14th century. Several fraternities—old gilds or new companies, with their respective cognate or heterogeneous branches of industry and trade—were fused into one body. In some towns all the crafts were thus consolidated into a single fraternity; in this case a body was reproduced which regulated the whole trade monopoly of the borough, and hence bore some resemblance to the old gild merchant.

In dealing briefly with the modern history of craft gilds we may confine our attention to England. In the Tudor period the policy of the Crown was to bring them under public or national control. Laws were passed, for example in 1503, requiring that new ordinances of "fellowships of crafts or misteries" should be approved by the royal justices or by other Crown officers; and the authority of the companies to fix the price of wares was thus restricted. The statute of 5 Elizabeth c. 4 also curtailed their jurisdiction over journeymen and apprentices (*see* APPRENTICESHIP).

The craft fraternities were not suppressed by the statute of 1547 (1 Edward VI.). They were indeed expressly exempted from its general operation. Such portions of their revenues as were devoted to definite religious observances were, however, appropriated by the Crown. The revenues confiscated were those used for "the finding, maintaining or sustentation of any priest or of any anniversary, or obit, lamp, light or other such things." This has been aptly called "the disendowment of the religion of the misteries." Edward VI.'s statute marks no break of continuity in the life of the craft organizations. Even before the Reformation, however, signs of decay had already begun to appear, and these multiplied in the 16th and 17th centuries. The old gild system was breaking down under the action of new economic forces. Its dissolution was due especially to the introduction of new industries, organized on a more modern basis, and to the extension of the domestic system of manufacture. Thus the companies gradually lost control over the regulation of industry, though they still retained their old monopoly in the 17th century, and in many cases even in the 18th. In fact, many craft fraternities still survived in the second half of the 18th century, but their usefulness had disappeared. The mediaeval form of association was incompatible with the new ideas of individual liberty and free competition, with the greater separation of capital and industry, employers and workmen, and with the introduction of the factory system. Intent only on promoting their own interests and disregarding the welfare of the community, the old companies had become an unmitigated evil. Attempts have been made to find in them the progenitors of the trade unions, but there seems to be no immediate connection between the latter and the craft gilds. The privileges of the old fraternities were not formally abolished until 1835; and the substantial remains or spectral forms of some are still visible in other towns besides London.

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GUILD SOCIALISM, the name of a school of socialist thought which became prominent in Great Britain in the early 20th century (*see* SOCIALISM). Its governing idea was that of self-government in industry—the application of democratic principles to industrial as well as to political affairs—and the organization of the economic life of the community on a "functional" basis. As the name implies, guild socialism had, in the minds of its founders, a relation to the forms of industrial organization which existed throughout the medieval world, and was based on an attempt, in some measure, to apply medieval ideas to the solution of modern problems. This does not mean that guild socialists wished to restore the medieval guild system, or to revive handicraft in place of machine production. This element was indeed present in the early stages, but had dropped away before it acquired any wide influence.

Origin.—The origin of the movement is to be found in the work of an architect, Arthur J. Penty, who published *The Restoration of the Guild System* in 1906, and of A. R. Orage, for many years editor of the *New Age*, in which journal the new doctrine gradually developed in the next few years. The fruit of this development was the book *National Guilds*, written by S. G. Hobson and edited by A. R. Orage, first published in the *New Age* in 1912. In this work, guild socialism first assumed its distinctive form as an attempt to convert the trade unions to the idea of "workers' control" in industry, and to create, with their aid, self-governing functional organizations for the government of industry in conjunction with the state.

So far the guild movement had not spread beyond a small circle of theoretical adherents. But in the years before 1914 a great wave of labour unrest spread over Great Britain. There were many strikes, and a new spirit of economic revolt entered into the trade-union movement. At the same time the doctrines of industrial unionism were imported from America (*see* INDUSTRIAL

WORKERS OF THE WORLD, THE), and those of syndicalism (*q.v.*) from France; and both these doctrines found numerous adherents among the younger trade unionists and excited vigorous controversy. Guild socialism was influenced by these movements and was more and more presented as a reconciliation of syndicalist and socialist doctrines. Like the syndicalists it denounced bureaucracy and state control. Unlike them. it repudiated anarchism, and recognized the necessity of the state as an instrument of political organization and control. It was not, however, until a group of the younger men began, in 1913, regularly to advocate guild socialism in the newly founded *Daily Herald* that the movement attained any widespread influence. And it was not until 1915 that it assumed, with the foundation of the National Guilds league by G D. H. Cole, W. Mellor, M. B. Reckitt and others, an organized form.

World War I and After.—The industrial situation during World War I undoubtedly helped the growth of the new movement. For the war, by making necessary large and frequent changes in industrial organization, profoundly stirred the trade unions, and created in the minds of trade unionists a keen desire for control and self-government in industry. During the war the influence of guild socialism was nidely felt in the shop stewards' movement and in the redrafting of many trade-union programs so as to include the demand for "workers' control." Thus, the Miners' federation, which before the war had demanded nationalization and state administration of the mines, changed its program in 1918 to a demand for national ownership and democratic control by the workers, and put forward its new guild socialist claim before the famous Sankey commission of 1919. The socialist bodies, such as the Independent Labour party and the Labour party itself, also altered their programs so as to include the demand for some measure of workers' control in industry.

Immediately after the war guild socialism spread still more rapidly, and entered on a new phase with the formation of actual working guilds, under trade-union auspices. in the building and other industries. The National Building guild and its local centres executed, between 1920 and 1922, a number of important housing contracts and were generally agreed to have done excellent work. But the guild had no capital, and the abandonment of the Addison housing scheme in 1921 was fatal to it. Driven to depend on bank and commercial credits. it overtraded and got into financial difficulties which in 1922 led to its collapse. Certain of its local centres survived and were still active for several years longer, as were the tailoring guilds in Glasgow and Leeds, the piano workers' guild in London and certain others.

Guild Socialism and Collectivism.—These practical ventures, however, were, from the standpoint of the main body of guild socialists, only of minor importance. For the guild was for them essentially a part of the mechanism of a socialist community, and "guilds" formed in a capitalist society could be guilds only in a quite incomplete sense. Guild socialism involves the ownership of industries by the whole community, as well as their administration by the "workers by hand and brain" (a phrase originally coined by the guild socialists) engaged in them. It is essentially a socialist doctrine, accepting the socialist idea of public ownership, and differing from the collectivist or state socialist school of thought only in its insistence on the idea of industrial self-government and its hostility to bureaucracy and political control of industrial affairs. Guild socialists differed, indeed, in their views about the form and structure of the state in a guild society. Some believed in the continued supremacy of the state as the political organ of government, while others held that the state in its present form is destined to disappear and to be replaced by a sort of federal authority representing the community in its various functional aspects. This latter view has been associated with the philosophical ideas of political pluralism. It must not be confused with proposals for "industrial self-government" under capitalist control.

Industrial self-government was, for the guild socialists, the application to economics of a general principle that is of far wider significance. They believed that democracy can be real only if it is "functional"—that is, if it is specifically related to each of the main activities of society. It is absurd, they held, to speak of political democracy where industry is organized on autocratic lines, for the conditions of a man's daily work will inevitably affect his attitude and status as a citizen. Moreover, the existing economic system fails because it does not call out what is best in men. Instead of a co-operative fellowship of service we have contending groups of masters and men, alike wasted by "the sickness of an acquisitive society" (R. H. Tawney). It is necessary so to organize the economic and social system as to make each service a responsible fellowship, whose members are "on their honour" to do their best in the interest of all. (G. D. H. C.)

Appraisal.—Guild socialism as such lost appeal in Great Britsin, and elsewhere had no theoretical or practical impact. The reasons became manifest as critical thought was brought to bear on the ideas of guild socialism in the decade after 1919.

It became clear that the division of economic power, political power and representation in sovereign legislatures is not as distinct as guild socialists had implied. Legislatures that represent territorial divisions in which each voter has one vote tend, indeed, to be overly general in their representation, but the consultation, formal and informal, by both legislatures and administrative bodies with various interest groups steadily remedied this weakness; and the suggestions of guild socialists had nothing to do with the remedy. In Germany. France and Italy native and traditional needs and ideas produced special formal "corporative" advisory bodies. (See CORPORATE STATE.) If political representation of the voters was not everywhere as incessantly active as guild socialists thought it ought to be in a guild organization, political parties. the mediums of democratic representation, improved themselves in the techniques of continuous operative linkage between people, groups, legislatures and the executive. Workers' control of industry was contrived in part through trade unions which brought direct pressure on employers, or through the establishment of some form of workers' elected councils in the workshops with some rights of joint determination of business policy. It became apparent that the vesting of sovereign power in numerous guilds must lead to insoluble disputes over the xi-eight of representation to be accorded to each guild. Also, the number of guilds (each a segment of the national economy) must be so large as virtually to substitute a multiplicity of parties, each based on an economic interest, for a usually much smaller number of conventional political parties (in some nations, only two), with a consequent grave divisive effect on society. The belief that workers would more actively share in guild operation than in the activities of political parties could not be proved; but their demonstrated passivity in their own trade unions and consumers' co-operative societies engendered skepticism of the faith of guild socialists.

The essence of guild socialist doctrine, that political representation in great societies is a gross wholesale process that needs remedies, however, remained valuable. French syndicalism, German *Standestaat* ("estate") or "corporative" theories and Latin state "corporativism" and institutions contained this germ and were variant answers to the anxieties which guild socialism expressed. (H. Fi.)

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GUILFORD, BARONS AND EARLS OF. FRANCIS NORTH, 1st Baron Guilford (1637–85), was the third son of the 4th Baron North (*see* NORTH, BARONS), and was created Baron Guilford in 1683, after becoming lord keeper in succession to Lord Nottingham. He had been an eminent lawyer. solicitor general (1671), attorney general (1673) and chief justice of the common pleas (1675), and in 1679 was made a member of the council of 30 and. on its dissolution. of the cabinet. He was a man of wide culture and a staunch royalist. In 1672 he married Lady Frances Pope, daughter and co-heiress of the earl of Downe, who inherited the Wroxton estate; and he was succeeded as 2nd baron by his son Francis (1673–1729), whose eldest son Francis (1704–90), after inheriting first his father's title as 3rd baron, and then (in 1734) the barony of North from his kinsman the 6th Baron North, was in 1752 created 1st earl of Guilford. His first wife was a daughter of the earl of Halifax, and his son and successor Frederick was the English prime minister, commonly known as Lord North, his courtesy title while the 1st earl was alive.

FREDERICK NORTH, 2nd earl of Guilford, but better known by his courtesy title of Lord North (1732–92), prime minister of England during the important years of the American War, was born on April 13, 1732, and was educated at Eton and Christ Church, Oxford. At 22 years of age he was elected M.P. for Banbury, of which town his father was high steward, and he sat for the same town in parliament for nearly 40 years. In 1759 the duke of Newcastle made him a lord of the treasury, and he held this office under Lord Bute and George Grenville till 1765. On the fall of the first Rockingham ministry in 1766 he was sworn of the privy council, and made paymaster general by the duke of Grafton. In Dec. 1767, on the death of the brilliant Charles Townshend, he was made chancellor of the exchequer. North succeeded Grafton as premier in March 1770, and continued in office for 12 of the most eventful years in English history. George III had at last overthrown the ascendancy of the great Whig families, and found in North a pliant instrument. The path of the minister in parliament was a hard one; he had to defend measures which he had not designed and of which he had not approved, and this too in a house of commons in which all the oratorical ability of Burke and Fox was against him, and when he had only the purchased help of Thurlow and Wedderburne to aid him. The most important events of his ministry were those of the American War of Independence. He cannot be accused of causing it, but one of his first acts was the retention of the tea duty, and he introduced the Boston Port bill in 1774. When war had broken out he earnestly counseled peace, and it was only the earnest solicitations of the king not to leave his sovereign again at the mercy of the Whigs that induced him to defend a war which from 1779 he knew to be both hopeless and impolitic. In March 1782 he insisted on resigning after the news of Cornwallis' surrender at Yorktown. He had been rewarded for his assistance to the king by honours for himself and sinecures for his relatives, but in April 1783 North formed a famous coalition with C. J. Fox (*q.v.*), and became secretary of state with him under the nominal premiership of the duke of Portland. The coalition ministry went out of office on Fox's India bill in Dec. 1783, and North, who was losing his sight, gave up politics.

He succeeded to his father's earldom in 1790 and died on Aug. 5, 1792.

GUILLAUMAT, MARIE LOUIS ADOLPHE (1863–1940), French soldier, was born at Bourgneuf, Charente Maritime, Jan. 4. 1863. He left the military school of St. Cyr in 1884, and became a captain in 1893. He served for three years in Tongking with the foreign legion, and during the Boxer rising in 1900 was in Tientsin. In 1903 he was appointed professor of military history at St. Cyr and in 1908 lecturer on infantry tactics. After being director of infantry at the ministry of war from 1911, he became *chef de cabinet* to the minister of war in 1914. At the outset of World War I Guillaumat, who had already taken part in 12 campaigns, commanded a division at the battle of the Marne and later in the Argonne. Subsequently, in command of the 1st army corps, he took a notable part in the battles of Verdun and the Somme. In Dec. 1916 he was given the command of the 2nd army in front of Verdun and directed the attack of Aug. 20, 1917, which succeeded in freeing the position.

In Dec. 1917 he was sent to Salonika as commander in chief of the armies in the east (*see* SALONIKA CAMPAIGNS, 1915–18) but was recalled in July 1918 to take command of the entrenched camp at Paris in face of the enemy advance. He urged the launching of an offensive in Macedonia both at the inter-Allied war council at Versailles and before the British war cabinet; on Sept. 4, 1918, at the London conference, his advice was adopted. In Oct. 1918 Guillaumat was given the command of the 5th army on the Aisne for the final advance. After the war he was president of the commission of inquiry into the surrender of the frontier fortresses and later a member of the *conseil supérieur da la guerre.* After being entrusted with a mission to Athens. where he drew up a plan for the reorganization of the Greek army, he took command of the army of occupation in the Rhineland at the end of 1924. He was minister of war in June 1926.

GUILLAUME, CHARLES ÉDOUARD (1861–1938), French physicist. awarded the Nobel prize in physics in 1920 for his discovery of the anomalies of nickel-steel alloys. He was born at Fleurier, Switz., Feb. 15, 1861. Educated at Neuchâtel. he became a *docteur-ds-sciences* and devoted himself to the study of practical physics. He is principally known for his invention of the metal Invar, an alloy of nickel and steel which, having a coefficient of linear expansion of only .0000008 for 1° C., is in general use as a material for standard measures and instruments of precision. In 1920 he became director of the international bureau of weights and measures.

GUILLAUME, JEAN BAPTISTE CLAUDE EUGÈNE (1822–1905), French sculptor. was born at Montbard on July 4, 1822, and studied at the École des Beaux-Arts, Paris, which he entered in 1841. and where he gained the *prix de Rome* in 1845 with "Theseus Finding on a Rock His Father's Sword." He became director of the École des Beaux-Arts in 1864, and director general of fine arts from 1878 to 1879, when the office was suppressed.

Guillaume died in Rome on March 1, 190j.

His monuments are to be found in the public squares of the chief cities of France.

GUILLAUME D'ORANGE, also known as Fierabrace, St. Guillaume de Gellone, and the Marquis au court nez, was the central figure of the southern cycle of French romance, called by the *trouvères* the *geste* of Garin de Monglane. This cycle has a measure of unity. the poems being episodic rather than independent. Ms. Royal 20 D xi. (British Museum) contains 18 *chansons* of the cycle. Guillaume, son of Thierry and Alde, daughter of Charles Martel, was born in the north of France about the middle of the 8th century. He became one of the best soldiers of Charlemagne, and in 790 Charles's son Louis the Pious was put under his charge. He subdued the Gascons, and defended Narbonne against the infidels. In 793 Hescham, the successor of Abd-al-Rahman II., proclaimed a holy war against the Christians, and collected an army of 100.000 men. half of it against the Asturias, half against France. Guillaume met him at Villedaigne, and was defeated, but only after a resistance which so far exhausted the Saracens that they were compelled to retreat to Spain. He took Barcelona from the Saracens in 803, and in the next year founded the monastery of Gellone (now Saint Guilhem-le-Desert), of which he became a member in 806. He died there in the odour of sanctity in 812.

No less than 13 historical personages bearing the name of William have been thought to have their share in the formation of the legend. William. count of Provence, son of Boso II., delivered southern France from a Saracen invasion by his victory at Fraxinet in 973, and ended his life in a cloister. William Towhead (*Tête d'étoupe*), duke of Aquitaine (d. 983), showed a fidelity to Louis IV. paralleled by Guillaume d'Orange's service to Louis the Pious. The cycle of *chansons* which form the *geste* of Guillaume reposes on the traditions of the Arab invasions, from the battle of Poitiers (732) onwards, and on the French conquest of Catalonia from the Saracens. In the Norse version Guillaume appears in his historical environment, as a chief under Charlemagne; but plays a leading part in the *Couronnement Looys*, describing the formal association of Louis in the empire at Aix (813. the year after Guillaume's death), and after the battle of Aliscans it is from the emperor Louis that he seeks reinforcements. This anachronism arises from the fusion of the epic Guillaume with the champion of Louis IV.. and from the fact that he was a general of Louis the Pious. who was titular king of Aquitaine under his father. The inconsistencies between the real and epic Guillaume are often left standing in the poems. The personages associated with Guillaume in his Spanish wars belong to Provence, and have names common in the south. The most famous are Beuves de Comarchis, Ernaud de Girone, Aïmer le chétif, so called from his long captivity with the Saracens. The separate existence of Aïmer, who refused to sleep under a roof, and spent his life in warring against the infidel, is proved. He was Hadhemar, count of Narbonne, who in 809 was one of the leaders sent by Louis against Tortosa. No doubt the others had historical prototypes. In the hands of the *trouvères* they became all brothers of Guillaume, and sons of Aymeri de Narbonne, grandson of Garin de Monglane. Nevertheless when Guillaume seeks help from Louis he finds all his relations in Laon, in accordance with his historic Frankish origin.

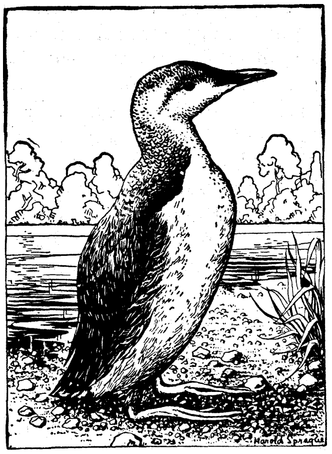
The central fact of the geste is the battle of the Archant or Aliscans, in which perished Guillaume's heroic nephew, Vezian or Vivien. At the eleventh hour he summoned Guillaume to his help against the Saracens. Guillaume arrived too late, was himself defeated, and returned alone to his wife Guibourc. This event is related in a Norman-French transcript of an old French *chanson* de geste, the *Chançun* de *Willame*—brought to light in 1901 at the sale of the books of Sir Henry Hope Edwardes—and in the *Covenant* Vivien, a recension of an older French chanson. *Aliscans* continues the story, telling how Guillaume obtained reinforcements from Laon, and how, with the help of the comic hero, the scullion Rainouart, he avenged his nephew's death. Rainouart turns out to be the brother of Guillaume's wife Guibourc, who was before her marriage the Saracen princess and enchantress Orable. Two other poems are consecrated to his later exploits, La Bafaille Loquifer, the work of a French Sicilian poet, Jendeu de Brie (*fl.* 1170), and Le *Moniage Rainouart*. The starting-point of Herbert of Dammartin (*fl.* 1170) in *Foucon* de *Candie* (Candie = Gandia in Spain?) is the return of Guillaume from the battle; and the Italian compilation I Nerbonesi seems in some cases to represent an earlier tradition than the later of the French chansons, although its author Andrea di Barberino wrote towards the end of the 14th century. The minnesinger Wolfram von Eschenbach based his *Willehalm* on a French original which must have differed from our versions. The variations in the story of the defeat of Aliscans, and the numerous inconsistencies of the narratives have occupied many critics. Aliscans (Aleschans, Elysii Campi) was, however, generally taken to represent the battle of Villedaigne, and to take its name from the cemetery outside Arles. Wolfram von Eschenbach even mentions the tombs which studded the field of battle. Indications that this tradition was not unassailable were not lacking before the discovery of the *Chançun de Willame,* which, although preserved in a very corrupt form, represents the earliest recension of the story, dating at least from the beginning of the 12th century. It seems probable that the Archant was situated in Spain near Tortosa, and that Guillaume started from Barcelona, not from Orange, to his nephew's help. The account was modified by successive trouvkres, and the uncertainty of their methods may be judged by the fact that in the *Chançun* de Wil-*lame* two accounts (II. 450–1326 and II. 1326–2420) of the fight appear to be set side by side. Le *Couronnement* Looys, Le *Charroi* de *Nîmes* (12th century) in which Guillaume enumerates his services to the terrified Louis, and *Aliscans* (12th century), with the earlier *Chançun,* are among the finest of the French epic pcems. The figure of Vivien is among the most heroic elaborated by the *trouvères,* and the giant Rainouart has a touch of Rabelaisian humour.

The *chansons de geste* of the cycle are: *Enfances Garin de Monglane* (15th century) and *Garin de Monglane* (13th century), on which is founded the prose romance of *Guérin de Monglane,* printed in the 15th century by Jehan Trepperei and often later; *Girars de Viane* (13th century, by Bertrand de Bar-sur-Aube), ed. P. Tarbé (Reims, 1850); *Hernaut de Beaulande* (fragment 14th century); *Renier de Gennes,* which only survives in its prose form; *Aymeri de Narbonne* (*c.* 1210) by Bertrand de Bar-sur-Aube, ed. L. Demaison (Soc. des anc. testes fr., 2 vols., 1887); *Les Enfances Guillaume* (13th century); *Les Narbonnais,* ed. H. Suchier (Soc. des anc. textes fr., 2 vols., 1898), with a Latin fragment dating from the 11th century, preserved at The Hague; *Le Couronnement Looys* (ed. E. Langlois, 1888), *Le Charroi de Nîmes, La Prise d'Orange, Le Covenant Vivien, Aliscans,* which were edited by W. J. A. Jonckbloet in vol. i. of his *Guillaume d'Orange* (The Hague, 1854); a critical teat of *Aliscans* (Halle, 1903, vol. i.) is edited by E. Wienbeck, W. Hartnacke and P. Rasch; *Loquifer* and *Le Moniage Rainouart* (12th century); *Bovon de Commarchis* (13th century), recension of the earlier *Siège de Barbastre,* by Adenes li Rois, ed. A. Scheler (Brussels, 1874); *Guibert d'Andrenas* (13th century); *La Prise de Cordres* (13th century); La *Mort Aimeri de Narbonne,* ed. J. Couraye de Parc (Soc. des Anciens Textes fr. 1884); *Foulque de Candie* (ed. P. Tarbé, Reims, 1860); *Le Moniage Guillaume* (12th century); *Les Enfances Vivien* (ed. C. Wahlund and H. v. Feilitzen, Uppsala and Paris, 1895); *Chançun de Willame* (Chiswick Press, 1903), described by P. Meyer in *Romania* (xxxiii. 597–618). The ninth branch of the *Karlamagnus Saga* (ed. C. R. Unger, 1860) deals with the *geste* of Guillaume. *I. Nerbonesi* is edited by J. G. Isola (Bologna, 1877, etc.).

See C. Révillout, *Etude hist. et litt. sur la vita sancti Willelmi* (Montpellier, 1876); W. J. A. Jonckbloet, *Guillaume d'Orange* (2 vols., 1854, The Hague); L. Clarus (ps. for W. Volk), *Herzog Wilhelm von Aquitanien* (Münster, 1865); P. Paris, in *Hist. litt. de la France* (vol. xxii., 1852); L. Gautier, *Epopées françaises* (vol. iv., 2nd ed., 1882); R. Weeks, *The Newly discovered Chançun de Willame* (Chicago, 1904); A. Thomas, *Etudes romanes* (1891), on Vivien; L. Saltet, "S. Vidian de Martres-Tolosanes" in *Bull. de litt. ecclés.* (Toulouse, 1902); P. Becker, *Die altfrz. Wilhelmsage u. ihre Beziehung zu Wilhelm dem Heiligen* (Halle, 1896), and *Der südfranzösische Sagenkreis und seine Probleme* (Halle, 1898); A. Jeanroy, "Etudes sur le cycle de Guillaume au court nez" (in *Romania,* vols. 25 and 26, 1896–97); H. Suchier, "Recherches sur . . . Guillaume d'Orange" (in *Romania,* vol. 32, 1903); *La légende de Guillaume d'Orange* (1920).

GUILLAUMIN, JEAN BAPTISTE ARMAND (1841–1927), French landscape painter and engraver, an important member of the Impressionist movement, was born in Paris, Feb. 16, 1841. He spent his boyhood at Moulins-sur-Allier and at the age of 17 went to Paris, there earning his living as an employee in the administration of the city. In his spare time he studied drawing under the sculptor Caillouette, and he painted views in the neighbourhood of Montmartre and Meudon and on the banks of the Seine. He also worked on portraiture and still life. In 1874 Guillaumin took part in an exhibition of Impressionist paintings with C. Pissarro, C. Monet and Sisley. By 1892 he was in a position to give up his post and to concentrate entirely on his art. After that date, he painted many seascapes on both the Atlantic and Mediterranean coasts. His execution is direct, bold and sometimes vehement, his colour harmonious. He is represented in the Boston Museum of Fine Arts, the National Gallery of Arts (Washington, D.C.), the Luxembourg and Petit Palais in Paris and at galleries in Rouen, Limoges, Brussels, Munich and Moscow.

GUILLEMOT, or, as it is usually called in U.S.A., MURRE, a sea-bird breeding on the rocky coasts of the North Atlantic in vast numbers. This bird, *Uria* aalge, is a member of the auk family and, like the rest of the Alcidae, it winters in the open sea. A second species, Briinnich's guillemot (U. lomvia), inhabits the Atlantic coasts of North America with *U.* aalge. Each has a race in the cold North Pacific and the west coast of Korth America and elsewhere. The black guillemot, *Cepphus grylle,* known to sailors as the dovekie, is almost entirely black in summer plumage. Unlike the common form. which lays a single egg, the black guillemot produces two or three in a clutch. The so-called bridled or ringed guillemot is a variety of *U. aalge* with a white mark resembling a bridle round its eye. It is worth mention as a good example of a quite distinct variation found in considerable numbers in nature, but not intergrading with the normal. It is probably due to a Mendelian mutation.



GUILLEMOT. A SEA-BIRD THAT BREEDS ON THE BRITISH COAST AND FLIES SEAWARD FOR THE WINTER MONTHS

GUILLOTINE, the instrument for inflicting capital punishment by decapitation, introduced into France at the period of the Revolution. It consists of two upright posts surmounted by a cross beam, and grooved so as to guide an oblique-edged knife, the back of which is heavily weighted to make it fall swiftly and with force when the cord by which it is held aloft is let go. Previous to the period when it obtained notoriety under its present name it had been in use in Scotland, England and various parts of the continent. There is still preserved in the antiquarian museum of Edinburgh the rude guillotine called the "maiden" by which the regent Morton was decapitated in 1581. The last persons decapitated by the Scottish "maiden" were the marquis of Argyll in 1661 and his son the earl of Argyll in 1685. It would appear that no similar machine was ever in general use in England; but until 1650 there existed in the forest of Hardwick, which was coextensive with the parish of Halifax, West Riding, Yorkshire, a mode of trial and execution called the gibbet law, by which a felon convicted of theft within the liberty was sentenced to be decapitated by a machine called the Halifax gibbet. A print of it is contained in a small book called *Halifax and its Gibbet Law* (1708), and in Gibson's edition of Camden's *Britannia* (1722). In Germany the machine was in general use during the middle ages, under the name of the *Diele*, the *Hobel* or the *Dolabra*. Two old German engravings, the one by George Penez, who died in 1550, and the other by Heinrich Aldegrever, with the date 1553, represent the death of a son of Titus Manlius by a similar instrument, and its employment for the execution of a Spartan is the subject of the engraving of the 18th symbol in the volume entitled *Synzbolicae quaestiones de universo genere*, by Achilles Bocchi (1555). From the 13th century it was used in Italy under the name of *Mannaia* for the execution of criminals of noble birth. The *Chronique de Jean d'Anton*, first published in 1835, gives minute details of an execution in which it was employed at Genoa in 1507; and it is elaborately described by Père Jean Baptiste Labat in his *Voyage en Espagne et en Italie en 1730*. It is mentioned by Jacques, viscomte de Puységur, in his *Mémoires* as in use in the south of France, and he describes the execution by it of Marshal Montmorency at Toulouse in 1632. For about a century it had, however, fallen into general disuse on the continent; and Dr. Guillotin, who first suggested its use in modern times, is said to have obtained his information regarding it from the description of an execution that took place at Milan in 1702, contained in an anonymous work entitled Voyage *historique et politique de Suisse, d'Italie, et d'Allemagne*.

Guillotin, who was born at Saintes, May 28, 1738, and elected to the constituent assembly in 1789, brought forward on Dec. 1 of that year two propositions regarding capital punishment, the second of which was that "in all cases of capital punishment it shall be of the same kind—that is, decapitation—and it shall be executed by means of a machine." The reasons urged in support of this proposition were that in cases of capital punishment the privilege of execution by decapitation should no longer be confined to the nobles, and that it was desirable to render the process of execution as swift and painless as possible. After satisfactory experiments had been made with the machine on several dead bodies in the hospital of Bicêtre, it was erected on the Place de Grève for the execution of the highwayman Pelletier on April 25, 1792. While the experiments regarding the machine were being carried on, it received the name *Louisette* or *La Petite Louison*, but the mind of the nation seems soon to have reverted to Guillotin, who first suggested its use; and in the *Journal des révolutions de Paris* for April 28, 1792, it is mentioned as *la guillotine*, a name which it thenceforth bore both popularly and officially.

GUIMARÃES, a town of northern Portugal, 36 mi. N.E. of Oporto by the Trofa-Guimarães branch of the Oporto-Corunna railway. Pop. (1950) 18,294. Guimarães is a very ancient town with Moorish fortifications. It occupies a low hill, skirted on the northwest by a small tributary of the river Ave. The citadel founded in the 11th century by Count Henry of Burgundy, was in 1094 the birthplace of his son Alphonso, the first king of Portugal. The font in which Alphonso was baptized is preserved, among other interesting relics, in the collegiate church of Santa Maria da Oliveira, "St. Mary of the Olive," a Romanesque building of the 14th century, which occupies the site of an older foundation. The convent of São Domingos, now a museum of antiquities, has a fine 12th–13th century cloister; the town hall is built in the blend of Moorish and Gothic architecture known as Manueline. Guimarães has trade in wine and farm produce; it also is engaged in the manufacture of cutlery, linen, leather and preserved fruits. Near the town are Citania, the ruins of a prehistoric Iberian city, and the hot sulphurous springs of Taipas.

GUIMARD, MARIE MADELEINE (1743–1816), French dancer, was born in Paris on Oct. 10, 1743. For 25 years she was the star of the Paris Opéra, and became even more famous by her love affairs, especially by her long liaison with the prince de Soubise. Her magnificent house at Pantin had a private theatre, where Collé's *Partie de chasse de Henri IV* which was prohibited in public, and most of the *Proverbes* of Carmontelle (Louis Carrogis, 1717–1806), and similar licentious performances were given to the delight of high society. In 1772, in defiance of the archbishop of Paris, she opened a gorgeous house with a theatre seating 500 spectators in the Chaussée d'Antin. In this Temple of Terpsichore, as she named it, the wildest orgies took place. In 1786 her property was sold by lottery for her benefit for 300,000 francs. After her retirement in 1789 she married Jean Etienne Despréaux (1748–1820), dancer, song writer and playwright.

GUINEA is the coastal region of West Africa and also the name of the gulf formed by the great bend of this coast eastward and then southward. The term has often been loosely used and may cover any part of the coast between Cape Verde (15° N.), near Dakar, and Mossâmedes, Angola (15° S.). There is a general distinction between Upper and Lower Guinea, westward and southward respectively of the line of volcanic peaks marked by Mt. Cameroon (13,350 ft.) and the islands of Fernando Po, Principe, São Tomé and Annobon. In a restricted sense Guinea most commonly refers to the coast between Cape Palmas and the Gabon (Gabun) estuary, though until the time of Gomes Eanes de Zurara (*q.v.*), a 15th-century Portuguese historian, the term appears to have applied only to coastal areas north of Cape Verde.

The name did not come into general use in Europe until the late 15th century, although it occurs on maps from about 1350 onward. It may be derived from the important trading town and kingdom of the upper Niger basin known variously as Ghinea, Genni, Jenné or Djenné and dating from the 8th century, or from Ghana (or Ghanata), the oldest known state of the western Sudan. Ghana, "the land of gold," was first mentioned by the astronomer Al Fazari, writing shortly before A.D. 800 Between 1914 and 1951 there were important excavations at Koumbi Saleh, the most probable site of Ghana's capital.

Much controversy surrounds the first European contacts with Guinea. The French claim that ships from Dieppe reached this coast in 1364–65 and that their merchants established trading posts as far south as São Jorge da Mina (Elmina in the Gold Coast) until their withdrawal in 1410; but there is no documentary evidence to prove this With the encouragement of Prince Henry the Navigator the Portuguese seaman Gil Eannes rounded Cape Bojador in 1434. Several years later Antam Gonçalves brought back to Lisbon the first cargo of slaves and gold. and a papal bull reserved to the Portuguese exclusive rights of dominion on the west coast of Africa. Further voyages were made by Nuno Tristam, Diniz Diaz, Cadamosto and others. In 1469 Fernão Gomes was granted a monopoly of traffic on this coast for five years provided that in each year he explored 300 mi, of new coast. The equator was reached in 1471 and the Congo estuary by Diogo Cam (*q.v.*) in 1482 or 1483.

For another half-century the Portuguese enjoyed the monopoly of trade, but after 1530 the English, Dutch, French, Danish and Brandenburgers showed interest in the Guinea coast and established companies and trading posts or forts. Sections of the coast were named according to their chief products. The Grain coast from Sierra Leone to Cape Palmas took its name from the peppery seeds known as grains of paradise, Guinea pepper or malagueta. Beyond Cape Palmas stretched the Ivory Coast where the natives traded elephants' tusks. The Gold Coast, mainly east of Cape Three Points, was often referred to as "Mina," and a great castle was built at São Jorge da Mina. Beyond the Volta river lay the Slave coast, the least known of all these areas and extending as far as the Niger delta, for long known as the Oil rivers.

European contact with, and penetration of, Guinea was greatly influenced by the nature of the relief and climate. The whole area is constantly hot and receives very heavy rainfall at certain seasons. Europeans could trade only during the dry so-called "Guinea season" (October–April). There were special navigational problems along the surf-bound coast which has few natural harbours. Access inland was difficult because of the dense natural vegetation (equatorial rain forest) and because the rivers were seldom navigable very far inland.

See West Africa; Dahomey; Ivory Coast; Liberia; etc.

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GUINEA, a gold coin at one time current in the United Kingdom. It was first coined in 1663. in the reign of Charles II, from gold imported from the Guinea coast of West Africa by a company of merchants trading under charter from the British crown — hence the name. Many of the first guineas bore an elephant on one side, this being the stamp of the company; in 1675 a castle was added. Issued at the same time as the guinea were five-guinea, two-guinea and half-guinea pieces. The current value of the guinea on its first issue was 20 shillings. It was subsidiary to the silver coinage, but this latter was in such an unsatisfactory state that the guinea in course of time became over-valued in relation to silver, so much so that in 1694 it had risen in value to 30 shillings. The rehabilitation of the silver coinage in William III's reign brought down the value of the guinea to 21s. 6d. in 1698, at which it stood until 1717, when its value was fixed at 21 shillings. This value the guinea retained until its disappearance from the coinage. It was last coined in 1813. and was superseded in 1817 by the sovereign. In 1718 the quarter-guinea was first coined. The third-guinea was first struck in George III's reign (1787). To George III's reign also belongs the "spade guinea," a guinea having the shield on the reverse pointed at the base or spade-shaped. The guinea is now chiefly used in reckoning professional fees: and subscriptions to a society or institution; the prices obtained for works of art, racehorses and sometimes landed property are also stated in guineas in the United Kingdom. *(See* also NUMISMATICS.)

GUINEA, REPUBLIC OF: see FRENCH GUINEA.

GUINEA FOWL, a well-known gallinaceous bird, so called from the country whence it was brought to Europe. It was known to the Romans but was probably reintroduced by the Portuguese in the 16th century.

The ordinary guinea fowl of the poultry yard *(see* also POULTRY AND POULTRY FARMING) is *Numida meleagris.* Under domestication few varieties have arisen. We may mention total and partial albinism and forms with legs bright orange instead of grayish brown. The sexes are alike. The West African race (*N. m. galeata),* from Senegal and Aïr to. Cameroon, is probably the ancestor of the domestic bird; it occurs in the Cape Verde Islands, and has been introduced into the West Indies. Some 20 other races over Africa include, in South Africa, *N. m. coronata* which is numerous from the Cape Colony to Ovampoland, and *N. m. papillosa* which replaces it in the west as far as the Zambesi. Madagascar has N. *m. mitrata,* distinguishable by its red crown and extending to East Africa. This bird has been introduced to Rodriguez. Abyssinia is inhabited by N. *m. meleagris,* which differs from the foregoing by the absence of red about the head. Darwin (*Anim. and Pl. under Domestication,* i, 294), gives this as the original stock of the modern domestic birds, but obviously by an accidental error. The finest species known is *Acryllium vulturinum* of East Africa, conspicuous by the bright blue in its plumage, the hackles in the lower part of its neck, and its long tail. All these guinea fowls except the last are characterized by having the crown bare of feathers and elevated into a bony "helmet," but there is another group in which a thick tuft of feathers ornaments the top of the head. This contains three species, the best known being *Guttera edouardi* from Guinea and Tanganyika to Natal. This bird is remarkable for the structure of its *furcula,* or merry thought, where the head is a hollow cup opening upwards, into which the trachea dips, and then emerges on its may to the lungs. Allied to the genus *Numida,* but distinguished therefrom by the possession of spurs and the absence of a helmet are *Agelastes* and *Phasidus,* from western Africa. Guinea fowls constitute the family Numididae. Polygamous and gregarious, guinea fowls lay many eggs on the ground. The flocks are noisy. The birds feed on the ground but normally roost in the trees. (G. F. Ss.)

GUINEA PIG (*Cavia porcellus*), the domestic form of a species of cavy (*q.v.*). This rodent was domesticated by the Indians of Peru, Ecuador and Colombia. long before the arrival of the Spaniards. Guinea pigs were kept for their meat, which was prized as a delicacy, and were first introduced into Europe for the same purpose soon after the discovery of America. Now these animals are rarely eaten but are kept as pets or used as valuable experimental subjects in medical and biological research.

The two sexes are much alike, about 10 in. long and weighing about 2 lb. There is no external tail, although internally there are seven caudal vertebrae. The ears are naked, rounded and relatively small. The fore feet have four toes, the hind feet only three; all toes are armed with broad claws, although guinea pigs are not fossorial in habit. They walk on the entire sole and palm. The legs are short, the body stout, and the head larne The several varieties differ nreatly in colour: black. tan, cream, chocolate, reddish, and white animals are common, as well as tortoise-shell, Dutch belted and Himalayan types. Some are "agouti," that is, they have banded hairs, black and ochraceous or buff, like the wild cavies. Size also varies somewhat in the different breeds. Long-haired cavies with silky pelage are called Peruvians. The so-called Abyssinian cavies have no connection with the East African country but have coarse hair forming odd whorls or rosettes. Short-haired varieties are usually called English or Bolivian cavies. Guinea pigs feed largely on grass and other green vegetation. If plenty of this is supplied, they can get along without water. In captivity they may be kept on rabbit or rat iood, but then they need water.

Wild cavies breed only once a year and only one or two young are born at a time, but guinea pigs have litters of 2 to 8 or more, twice or three times a year. The young are born after 63 to 75 days' gestation and are highly developed even at birth, furry, with their eyes open, and able to eat solid iood. In a few hours they can run with the mother; they are weaned at about two weeks. Females may reproduce at the age of 4 or 5 months, but it is better to wait until they are fully grown, at about 9 months. The life span may be as much as 6 or 7 years. (J. E. HL.)

GUINEA-WORM INFECTION (DRACONTIASIS, DRACUNCULOSIS) involves the viscera, with subsequent manifestations in the subcutaneous tissues and the skin. The causative agent is *Dracunculus medinensis,* a distant relative of the filaria worms *(see* FILARIASIS). The disease is endemic in India, the middle east and tropical Africa. The adult worms. minute males and cordlike females which attain the length of a metre, mature in the viscera and deeper tissues. The pregnant female then migrates through the subcutaneous tissues to the skin, usually of an extremity. where a small blister is produced. On contact with fresh water the blister bursts. discharging a swarm of larvae into the water. If these are ingested by the water flea *(Cyclops)* they migrate into the body cavity of the *Cyclops* and become infective for man when the water flea is accidentally swallowed in raw drinking water. The disease may become epidemic following annual holy pilgrimages of Hindus and Moslems, who wade into sacred streams and rinse out their mouths with the polluted water, accidentally swallowing some of the infected *Cyclops* and simultaneously contributing a new supply of larvae for the *Cyclops.*

Clinical manifestations, including hypersensitization, which develop as the females migrate from the deeper tissues to the skin, are readily controlled by the administration of epinephrine. The long, patent sinuous tunnel in which the worm resides becomes readily infected with bacteria. The worm resists attempts to pull it out intact. and if too much traction is produced it breaks off. Since the days of Moses natives have contented themselves with winding a small length of the worm each day on a stick at the site of the open blister. until finally the entire worm has been withdrawn. Introduction of phenothiazine ointment into the tissues immediately around the tunnel stupefies the worm and allows it to be removed intact.

Plankton-feeding fish, when stocked in infested waters, will eat the *Cyclops* and thus break the vicious cycle.

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GUINGAMP, a town of northwestern France, capital of an *arrondissement* in the *département* of Côtes-du-Nord. on the right bank of the Trieux, 20 mi. W.N.W. of St. Brieuc on the railway to Brest. Pop. (1954) 6.51j. Guingamp was the chief tonn of the countship (subsequently the duchy) of Penthièvre. The Gothic chapel of Grbces is near Guingamp. Its chief church, Notre-Dame de Bon-Secours, dates from the 14th to the 16th centuries; two towers rise on each side of the richly sculptured western portal and a third surmounts the crossing. A famous statue of the Virgin, the object of one of the most important "pardons" or religious pilgrimages in Brittany, stands in one of the two northern porches. The central square is decorated by a graceful fountain in the Renaissance style, restored in 1743. Remains of the ramparts and of the Château of the dukes of Penthièvre, which belong to the 15th century, still survive. Guingamp is the seat of a sub-prefect and of a tribunal of first importance. It is an important market for dairy cattle, and its industries include flour-milling, tanning, leather-dressing, furniture making and the manufacture of wool, wax, hosiery, wooden-shoes and sheet iron. Guingamp is a tourist centre.

GUINNESS, the name of a family of Irish brewers. The firm was founded by ARTHUR GUINNESS, who about the middle of the 18th century owned a modest brewing-plant at Leixlip, a village on the river Liffey. In or about 1759 Arthur Guinness (d. 1855), purchased a small porter brewery at St. James's Gate, Dublin. By careful attention to the purity of his product, coupled with a shrewd perception of the public taste, he built up a considerable business. But his third son, BENJAMIN LEE GUINNESS (1798–1868), may be regarded as the real maker of the firm, of which about 1825 he was given sole control. The trade in Guinness's porter and stout had been confined hitherto to Ireland, but Guinness established agencies in the United Kingdom, on the continent, in the British colonies and in America. The export trade soon assumed huge proportions; the brewery was continually enlarged, and Guinness, who in 1851 was elected first lord mayor of Dublin, became the richest man in Ireland. He spent some of his wealth on the restoration of St. Patrick's cathedral, Dublin. He represented Dublin city in parliament as a Conservative from 1865 till his death, and in 1867 was created a baronet. He was succeeded in the control of the business by Sir Arthur Edward Guinness (b. 1840), his eldest, and Edward Cecil Guinness (b. 1847), his third, son. Sir ARTHUR EDWARD GUINNESS was in 1880 raised to the peerage as Baron Ardilaun, and disposed of his share in the brewery to his brother Edward Cecil Guinness. In 1886 EDWARD CECIL GUINNESS disposed of the brewery, the products of which were then being sent all over the world, to a limited company, in which he remained the largest shareholder. Edward Cecil Guinness was raised to the peerage in 1891 as Baron Iveagh, created Earl of Iveagh (*q.v.*) in 1919 and died in 1927, was succeeded by his son, Rupert, Viscount Elvedon.

GUIPUZCOA, a maritime Basque province of northern Spain bounded north by the bay of Biscay, west by the province of Vizcaya (Biscay), south and south-east by Alava and Navarre and north-east by the river Bidassoa, here the frontier of France. The area is 728 sq.mi.; population in the 1950 census was 371,024 or 509.6 per sq.mi. Situated on the northern side of the Cantabrian mountains at their junction with the Pyrenees the province has a deeply dissected and highly picturesque surface with a much indented coastline and numerous harbours none of which are of the first importance, the chief are San Sebastian, Pasajes, Guetaria, Deva and Fuenterrabia. The rivers, Deva, Urola, Oria, Urumea, Bidassoa are all short, rapid and unnavigable. The climate is mild and moist and the soil is mostly rather infertile clay in the valleys; in spite of this cultivation is careful, but the province has to import grain. Gorse and heath occur on the windswept areas and there are forests of oak, chestnut, pine, with a good deal of holly and arbutus. Apple orchards are numerous and much cider is made. The province is rich in minerals such as iron, lignite, lead, copper, zinc and cement, zinc being important. Fisheries are important; cod, tunny, sardines and oysters being procured. There are ferruginous and sulphurous springs in many places, and these and the mild climate attract summer visitors. The province is concerned with international trade *via* the French frontier and its custom house on the Bidassoa is the most important in Spain, but it is chiefly remarkable for its development of local industries. Cotton and linen stuffs are made at Irun, Renteria, Villabona, Vergara and Azpéitia, baskets at Zumarraga, arms and gold work at Eibar, Plasencia and Elgoibar, chemicals at San Sebastian, Onati and Irun. Paper and timber-work are developed at San Sebastian, Irun, Onati and Tolosa. The Pasajes district is famed for its wines and liqueurs and large numbers are employed in this industry. The main railway line from Madrid northward to the French frontier runs through the province and it has loops to most of the important industrial centres. In consonance with the development of industries, roads are numerous and on the whole good in this province which, after Madrid, Barcelona and Vizcaya, is the most densely peopled in Spain. On the steep Cantabrian slopes roads are difficult and in rural areas there the ox cart is still widely used. The capital is San Sebastian (officially Guipúzcoa), with a pop. (1950) of 90,846. There is much emigration but the birth rate is high, and there is also immigration from other parts of Spain. The province is fairly prosperous industrially. Basque Nationalists (not the Nationalists under Franco) were strongly Loyalist in 1936, but were subdued in April and May 1937, by an enemy column under Gen. Emilio Mola. Many escaped to France. *See* Th. Lefebvre, *Les modes de vie dans les Pyrénées atlantiques* (1933).

GÜIRALDES, RICARDO (1886–1927), Argentine novelist and poet, famous for his poetic interpretation of the Argentinian gaucho, was born in Buenos Aires on Feb. 13, 1886, the son of a wealthy landowner. He died in Paris on Oct. 8, 1927. His masterpiece. *Don Segundo Sombra* (1926; English trans. by Harriet de Onís, 1935), is a poematic novel recreating the mythical gaucho that all Argentinians worship as a national symbol. This book combines the objectivity of country life and the subtlety of a poetic vision; it shows Guiraldes' twofold personality—the cosmopolitan spirit of an insatiable traveler well acquainted with French literary circles and the devoted admirer of his native land. A double view of the gaucho is presented, one through Don Segundo, the mature centaur, who is a model of manliness, and the other through the emerging personality of a young man, who follows undauntedly the footsteps of his friend and mentor.

Guiraldes was also a forerunner of post-World War I literary innovations in Argentina. Imbued with an audacious spirit, he found little receptiveness for his first volume of verses. El *cencerro de cristal* (1915). Two early novels, *Raucho* (1917) and *Xaimaca* (1923), are important as records of his literary convictions. *Rosaura* (1922), a poignant love story, shows the author's dramatic power and insight into human motives. (E. N.-S.)

GUISBOROUGH, a market town and urban district in the Cleveland parliamentary division of the North Riding of Yorkshire, Eng., 9 mi. E.S.E. of Middlesbrough by road. Pop. (1951) 8,611. Area 29.6 sq.mi. It lies in a fertile valley at the foot of the Cleveland hills. $4\frac{1}{2}$ mi. from the sea. Robert de Bruce, an ancestor of Bruce the Scottish king, founded a rich Augustinian priory there in 1119. Dissolved at the Reformation. all that now remains is the gateway and a finely carved east window. The parish church of St. Nicholas occupies the site of a church built before the priory and contains some ancient stained glass from the priory. Henry III granted a charter to hold markets, and Tuesdays and Saturdays are market days. On Tuesdays a cattle market is also held. In the town centre is a market cross, restored in the 19th century. Guisborough urban district includes the parishes of Kirkleatham (where are 17th-century almshouses), Hutton Lowcross, Morton, Pinchinthorpe, Newton, Upleatham. Tocketts and Wilton. Although much agriculture is carried on, there are also chemical works, steelworks and a clothing factory.

GUISE, a town of northern France, in the *département* of Aisne, on the Oise, 31 mi. N. of Laon by rail. Pop. (1954) 5,846. The scene of the German stand of Oct. 1918 is near Guise, which suffered much damage during World War I. The town was formerly the capital of the district of Thiérache and afterward of a countship. There is a château dating in part from the middle of the 16th century, which was converted into barracks during World War I. Camille Desmoulins was born in the town in 1762. The chief industry is the manufacture of iron stoves and heating apparatus, carried on on the co-operative system advocated by Fourier. in works founded by J. B. A. Godin.

(For an account of the battle of Guise *see* **FRONTIER.** BATTLES OF THE.)

GUISE, HOUSE OF, a cadet branch of the house of Lorraine. René II, duke of Lorraine (d. 1508). united the two branches of the house of Lorraine. From his paternal grandmother. Marie d'Harcourt, René inherited the countships of

Aumale, Mayenne, Elbeuf, Lillebonne, Brionne and other French fiefs, in addition to the honours of the elder branch, which included the countship of Guise, the dowry of Marie of Blois on her marriage in 1333 with Rudolph or Raoul of Lorraine. René's eldest surviving son by his marriage with Philippa, daughter of Adolphus of Egmont, duke of Gelderland, was Anthony, who succeeded his father as duke of Lorraine (d. 1544), while the second, Claude, count and afterwards duke of Guise, received the French fiefs. The Guises, though naturalized in France, continued to interest themselves in the fortunes of Lorraine, and their enemies were always ready to designate them as foreigners. The partition between the brothers Anthony and Claude was ratified by a further agreement in 1530, reserving the lapsed honours of the kingdoms of Jerusalem, Sicily, Aragon, the duchy of Anjou and the countships of Provence and Maine to the duke of Lorraine. Of the other sons of René II., John (1498–1550) became the first cardinal of Lorraine, while Ferri, Louis and Francis fell fighting in the French armies at Marignano (1515), Naples (1528) and Pavia (152j), respectively.

Claude of Lorraine, count and afterwards 1st duke of Guise (1496–1550), was born on Oct. 20, 1496. He was educated at the French court, and at 17 allied himself to the royal house of France by a marriage with Antoinette de Bourbon (1493–1583) daughter of François, count of Vendôme. Guise distinguished himself at Marignano (1515), and was long in recovering from the 22 wounds he received in the battle; in 1521 he fought at Fuenterrabia, when Louise of Savoy ascribed the capture of the place to his efforts; in 1522 he defended northern France, and forced the English to raise the siege of Hesdin; and in 1523 he obtained the government of Champagne and Burgundy; defeating at Neufchâteau the imperial troops who had invaded his province. In 1525 he destroyed the Anabaptist peasant army, which was overrunning Lorraine, at Lupstein, near Saverne (Zabern). On the return of Francis I. from captivity, Guise was erected into a duchy in the peerage of France, though up to this time only princes of the royal house had held the title of duke and peer of France. The Guises, as cadets of the sovereign house of Lorraine and descendants of the house of Anjou, claimed precedence of the Bourbon princes. Their pretensions and ambitions inspired distrust in Francis I., although he rewarded Guise's services by substantial gifts in land and money. The duke distinguished himself in the Luxemburg campaign in 1542, but for some years before his death he effaced himself before the growing fortunes of his sons. He died on April 12, 1550.

He had been supported in all his undertakings and intrigues by his brother John, cardinal of Lorraine (1498–1550), who had been made coadjutor of Metz at the age of three. The cardinal was archbishop of Reims, Lyons and Narbonne, bishop of Metz, Toul, Verdun, Thérouanne, Luçon, Albi, Valence, Nantes and Agen, and before he died had squandered most of the wealth which he had derived from these and other benefices. Part of his ecclesiastical preferments he gave up in favour of his nephews. He became a member of the royal council in 1530, and in 1536 was entrusted with an embassy to Charles V. Although a complaisant helper in Francis I.'s pleasures, he was disgraced in 1542, and retired to Rome. He died at Nogent-sur-Yonne on May 18, 1550. He was extremely dissolute, but as an open-handed patron of art and learning, as the protector and friend of Erasmus, Marot and Rabelais he did something to counter-balance the general unpopularity of his calculating and avaricious brother.

Claude of Guise had 12 children, among them Francis, 2nd duke of Guise; Charles, 2nd cardinal of Lorraine (1524–74), who became archbishop of Reims in 1538 and cardinal in 1547; Claude, marquis of Mayenne, duke of Aumale (1526–73), governor of Burgundy, who married Louise de Brézé, daughter of Diane de Poitiers, thus securing a powerful ally for the family; Louis (1527–78), bishop of Troyes, archbishop of Sens and cardinal of Guise; René, marquis of Elbeuf (1536–66), from whom descended the families of Harcourt, Armagnac, Marsan and Lillebonne; Mary of Lorraine (*q.v.*), generally known as Mary of Guise, who after the death of her second husband, James V. of Scotland, acted as regent of Scotland for her daughter Mary, queen of Scots; and Francis (1534–63), grand prior of the order of the Knights of Malta. The solidarity of this family, all the members of which through three generations cheerfully submitted to the authority of the head of the house, made it a formidable factor in French politics.

Francis of Lorraine, 2nd duke of Guise (1519–1563), "le grand Guise," was born at Bar on Feb. 17, 1519. As count of Aumale he served in the French army, and was nearly killed at the siege of Boulogne in 1545 by a wound which brought him the name of "Balafrit." Aumale was made (1547) a peerage-duchy in his favour, and on the accession of Henry II. the young duke, who had paid assiduous court to Diane de Poitiers, shared the chief honours of the kingdom with the constable Anne de Montmorency. Both cherished ambitions for their families, but the Guises were more unscrupulous in subordinating the interests of France to their own. Montmorency's brutal manners, however, made enemies where Guise's grace and courtesy won him friends. Guise was a suitor for the hand of Jeanne d'Albret, princess of Navarre, who refused, however, to become a sister-in-law of a daughter of Diane de Poitiers and remained one of the most dangerous and persistent enemies of the Guises. He married in Dec. 1548 Anne of Este, daughter of Ercole II., duke of Ferrara, and through her mother Renée, a granddaughter of Louis XII., of France. In the same year he had put down a peasant rising in Saintonge with a humanity that compared very favourably with the cruelty shown by Montmorency to the town of Bordeaux. He made preparations in Lorraine for the king's German campaign of 1551–52. He was already governor of Dauphin&, and now became grand chamberlain, prince of Joinville, and hereditary seneschal of Champagne, with large additions to his already considerable revenues. He was charged with the defence of hletz, which Henry II. had entered in 1551. He reached the city in Aug. 1552, and rapidly gave proof of his great powers as a soldier and organizer by the skill with which the place, badly fortified and unprovided with artillery, was put in a state of defence. Metz was invested by the duke of Alva in October with an army of 60.000 men, and the emperor joined his forces in November. An army of brigands commanded by Albert of Brandenburg had also to be reckoned with. Charles was obliged to raise the siege or, Jan. 2, 1553, having lost, it is said, 30,000 men before the walls. Guise used his victory with rare moderation and humanity, providing medical care for the sick and wounded left behind in the besiegers' camp. The subsequent operations were paralysed by the king's suspicion and carelessness, and the constable's inactivity, and a year later Guise was removed from the command. He followed the constable's army as a volunteer, and routed the army of Charles V. at the siege of Renty on Aug. 12, 1554. Montmorency's inaction rendered the victory fruitless, and a bitter controversy followed betneen Guise and the constable's nephew Coligny, admiral of France, which widened a breach already existing.

The conclusion of a six years' truce at Vaucelles (1jj6) disappointed Guise's ambitions. and he was the main mover in the breach of the treaty in 1558, when he was sent at the head of a French army to Italy to the assistance of Pope Paul IV. against Spain. Guise, who perhaps had in view the restoration to his family of the Angevin dominion of Naples and Sicily, crossed the Alps early in 1557, and after a month's delay in Rome. where he failed to receive the promised support. marched on the kingdom of Naples, then occupied by the Spanish troops under Alva He seized and sacked Campli (April 17), but was compelled to raise the siege of Civitella. Meanwhile the pope had veered round to a Spanish alliance, and Guise, seeing that no honour was to be gained in the campaign, wisely spared his troops, so that his army was almost intact when, in August, he was hastily summoned home to repel the Spanish army which had invaded France from the north, and had taken St. Quentin. On reaching Paris in October Guise was made lieutenant-general of the kingdom, and proceeded to prepare for the siege of Calais. The town was taken after six days' fighting, on Jan 6, 1558, and this success was followed up by the capture of Guines, Thionville and Arlon, when the war was ended by the treaty of Câteau Cambritsis (1559)

Although his brother, the cardinal of Lorraine, was one of the negotiators, this peace was concluded against the wishes of Guise, and was regarded as a triumph of the constable's party. The Guises were provided with a weapon against Montmorency by the bishop of Arras (afterwards Cardinal Granvella), who gave to the cardinal of Lorraine at an interview at Péronne in 1558 an intercepted letter proving the Huguenot leanings of the constable's nephews.

On the accession in 1559 of Francis II., their nephew by marriage with Mary Stuart, the royal authority was practically delegated to Guise and the cardinal, who found themselves beyond rivalry for the time being. They had, however, to cope with a new and dangerous force in Catherine de' Medici, who was now for the first time free to use her political ability. The incapacity, suspicion and cruelty of the cardinal, who controlled the internal administration, roused the smaller nobility against the Lorraine princes. A conspiracy to overturn their government was formed at Nantes, with a needy Périgord nobleman named La Renaudie as its nominal head, though the agitation had in the first instance been fostered by the agents of Louis I., prince of Condé. The Guises were warned of the conspiracy while the court was at Blois, and for greater security removed the king to Amboise. La Renaudie, nothing daunted, merely postponed his plans; and the conspirators assembled in small parties in the woods round Amboise. They had, however, been again betrayed and many of them were surrounded and taken before the coup could be delivered; one party, which had seized the château of Noizay, surrendered on a promise of amnesty given "on his faith as a prince" by James of Savoy, duke of Nemours, a promise which, in spite of the duke's protest, was disregarded. On March 19, 1560, La Renaudie and the rest of the conspirators openly attacked the chbteau of Amboise. They were repelled; their leader was killed; and a large number were taken prisoners. The merciless vengeance of the Guises was the measure of their previous fears. For a whole week the torturings, quarterings and hangings went on, the bodies being cast into the Loire, the young king and queen witnessing the bloody spectacle day by day from a balcony of the chbteau.

The cruel repression of this "conspiracy of Amboise" inspired bitter hatred of the Guises, since they were avenging a rising rather against their own than the royal authority. They now entrenched themselves with the king at Orleans, and the Bourbon princes, Anthony, king of Navarre, and his brother Condé, were summoned to court. The Guises convened a special commission to try Condé, who was condemned to death; but the affair was postponed by the chancellor, and the death of Francis II. in December saved Condé. Guise then made common cause with his old rival hfontmorency and with the Marshal de Saint André against Catherine, the Bourbons and Coligny. This alliance, constituted on April 6, 1561, and known as the triumvirate, aimed at the annulment of the concessions made by Catherine to the Huguenots. The cardinal of Lorraine fomented the discord which appeared between the clergy of the two religions when they met at the colloquy of Poissy in 1561, but in spite of the extreme Catholic views he there professed, he was at the time in communication with the Lutheran princes of Germany, and in Feb. 1562 met the duke of Württemberg at Zabern to discuss the possibility of a religious compromise.

The signal for civil war was given by an attack of Guise's escort on a Huguenot congregation at Vassy (March 1, 1562). Although Guise did not initiate the massacre, and although, when he learned what was going on, he even tried to restrain his soldiers, he did not disavow their action. When Catherine de' Medici forbade his entry into Paris, he accepted the challenge, and on March 16, he entered the city, where he was a popular hero, at the head of 2,000 armed nobles. The provost of the merchants offered to put 20,000 men and two million livres at his disposal. In September he joined Montmorency in besieging Rouen, which was sacked as if it had been a foreign city, in spite Guise's efforts to save it from the worst horrors. At the battle of Dreux (Dec. 19, 1562) he commanded a reserve army, with which he saved Montmorency's forces from destruction and inflicted a crushing defeat on the Huguenots. The prince of Condé was his prisoner, while the capture of Montmorency by the Huguenots and the assassination of the Marshal de Saint-André after the battle left Guise the undisputed head of the Catholic party. He was appointed lieutenant-general of the kingdom, and on Feb. 5, 1563, he appeared with his army before Orleans. On the 19th, however, he was shot by the Huguenot Jean Poltrot de Méré as he was returning to his quarters, and died on the 24th of the effects of the wound. Guise's splendid presence, his generosity and humanity and his almost unvarying success on the battlefield made him the idol of his soldiers. He attended personally to the minutest details, and Monluc complains that he even wrote out his own orders. The mistakes and cruelties associated with his name were partly due to the evil counsels of his brother Charles, the cardinal, whose cowardice and insincerity were the scorn of his contemporaries. The negotiations of the Guises with Spain dated from the interview with Granvella at Péronne, in 1558, and after the death of his brother the cardinal of Lorraine was constantly in communication with the Spanish court, offering, in the event of the failure of direct heirs to the Valois kings, to deliver up the frontier fortresses and to acknowledge Philip II. as king of France. His death in 1574 temporarily weakened the extreme Catholic party.

Of the children of Francis "le Balafré" five survived him: Henry, 3rd duke of Guise; Charles, duke of Mayenne (1554–1611) (*q.v.*), who consolidated the League; Catherine (1552–96), who married Louis of Bourbon, duke of Montpensier, and encouraged the fanaticism of the Parisian leaguers; Louis, second cardinal of Guise, afterwards of Lorraine (1555–88), who was assassinated with his brother Henry; and Francis (1558–73).

Henry of Lorraine, 3rd duke of Guise (1550–1588), born on Dec. 31, 1550, was 13 years old at the time of his father's death, and grew up under the domination of a passionate desire for revenge. Catherine de' Medici refused to take steps against Coligny, who was formally accused by the duchess of Guise and her brothers-in-law of having incited the murder. In 1566 she insisted on a formal reconciliation at Moulins between the Guises and Coligny, at which, however, none of the sons of the murdered man was present. Henry and his brothers were, however, compelled in 1572 to sign an ambiguous assent to this agreement. Guise's widow married James of Savoy, duke of Nemours, and the young duke at 16 went to fight against the Turks in Hungary. On the fresh outbreak of civil war in 1567 he returned to France and served under his uncle Aumale. In the autumn of 1568 he received a considerable command, and speedily came into rivalry with Henry of Valois, duke of Anjou. He had not inherited his father's generalship, and his rashness and headstrong valour more than once brought disaster on his troops, but the showy quality of his fighting brought him great popularity in the army. In the defence of Poitiers in 1569 with his brother, the duke of Mayenne, he showed more solid abilities as a soldier. On the conclusion of peace in 1 j70 he returned to court, where he made no secret of his attachment to Margaret of Valois. His pretensions were violently resented by her brothers, who threatened his life, and he saved himself by a precipitate marriage with Catherine of Cleves (daughter of Francis of Cleves, duke of Nevers, and Margaret of Bourbon), the widow of a Huguenot nobleman, Antoine de Crog, prince of Porcien. Presently he ended his disgrace by an apparent reconciliation with Henry of Valois and an alliance with Catherine de' Medici. He was an accomplice in the first attack on Coligny's life, and when permission for the massacre of Saint Bartholomew had been extorted from Charles IX he roused Paris against the Huguenots, and satisfied his personal vengeance by superintending the murder of Coligny.

Henry was now the acknowledged chief of the Catholic party, and the power of his family was further increased by the marriage (1575) of Henry III. with Louise of Vaudémont, who belonged to the elder branch of the house of Lorraine. In a fight at Dormans (Oct. 10, 1575), the only Catholic victory in a disastrous campaign, Guise received a face wound which won for him his father's name of Balafré and helped to secure the passionate attachment of the Parisians. He refused to acquiesce in the treaty of Beaulieu (May 5, 1576), and with the support of the

René II. (who united the two branches of the house of Lorraine), duke of Lorraine, and Philippa of Geldcrland, had (besides two older boys who died in childhood. and four unmarried daughters)

- Antoine, duke of Lorraine, †1544, ancestor of the dukes of Lorraine and the house of Mercoeur.
- Claude, 1st duke of Guise, †1550, =Antoinette of Bourbon.
  - Francis, 2nd duke of Guise, †1563, =Anne of Este.
    - Henry, 3rd duke, †1588 = Catherine of Cleves (and had 14 children),
      - Charles, 4th duke of Guise, †1640.
        - Henry, archbishop of Reims, and 5th duke, †1664.
        - Marie, called Mlle. de Guise, succeeded to the duchy in 1675 and sold her rights to Louis Augustus, duke of Maine.
        - Louis, chevalier of Guise and duke of Joyeuse, †1654.
          - Louis-Joseph, 6th duke of Guise, †1671.
            - Francis-Joseph, 7th and last duke of Guise, †1675.
        - And 8 more.
      - Claude, duke of Chevreuse, =Marie de Kohan, widow of the duke of Luynes.
      - Louis, 3rd cardinal of Guise, †1621.
      - And 11 more.
    - Charles, duke of Mayenne, †1611.
      - Henry, duke of Mayenne, †1621.
    - Louis, 2nd cardinal of Guise, †1588.
    - Catherine = Louis de Bourbon, duke of Montpensier.
    - And 5 others.
  - Charles, 2nd cardinal of Lorraine, †1574.
  - Claude, marquis of Mayenne and duke of Aumale, †1573, =Louise de Brézé
    - Charles, duke of Aumale, †1631.
  - Louis, 1st cardinal of Guise, †1578
  - Francis, grand prior.
  - René, marquis of Elbeuf, †1566.
    - Charles, duke of Elbeuf, †1605.
  - Marie= (1) duke of Longueville, (2) James V, of Scotland.
    - Mary Stuart, queen of Scots.
  - And 5 others.
- John, 1st cardinal of Lorraine.
- Ferri, killed at Marignano.
- Louis, killed at Naples.
- Francis, killed at Pavia.

†Date of death

Jesuits proceeded to form a "holy league" for the defence of the Roman Catholic Church. The terms of enrolment enjoined offensive action against all who refused to join. This association had been preceded by various provincial leagues among the Catholics, notably one at Péronne. Condé had been imposed on this town as governor by the terms of the peace, and the local nobility banded together to resist him. This, like the Holy League itself, was political as well as religious in its aims, and was partly inspired by revolt against the royal authority. In the direction of the League Guise was hampered by Philip of Spain, who subsidized the movement, while he also had to submit to the dictation of the Parisian democracy. Ulterior ambitions were freely ascribed to him. It was asserted that papers seized from his envoy to Rome, Jean David, revealed a definite design of substituting the Lorraines, who represented themselves as the successors of Charlemagne, for the Valois; but these papers were probably a Huguenot forgery. Henry III. eventually placed himself at the head of the League, and resumed the war against the Huguenots; but on the conclusion of peace (Sept. 1577) he seized the opportunity of disbanding the Catholic associations. The king's jealousy of Guise increased with the duke's popularity, but he did not venture on an open attack, nor did he dare to avenge the murder by Guise's partisans of one of his personal favourites, Saint-Mégrin, who had been set on by the court to compromise the reputation of the duchess of Guise. This incident supplied Alexandre Dumas *père* with the subject of his *Henri III. et sa cour* (1829).

Meanwhile the duke had entered on an equivocal alliance with Don John of Austria. He was also in constant correspondence with Mary of Lorraine, and meditated a descent on Scotland in support of the Catholic cause. But the great riches of the Guises were being rapidly dissipated, and in 1578 the duke became a pensioner of Philip II. When in 1584 the death of the duke of Anjou made Henry of Navarre the next heir to the throne, the prospect of a Huguenot dynasty roused the Catholics to forget their differences, and led to the formation of a new league of the Catholic nobles. At the end of the same year Guise and his brother, the duke of Mayenne, with the assent of other Catholic nobles, signed a treaty at Joinville with Philip II., fixing the succession to the crown on Charles, cardinal of Bourbon, to the exclusion of the Protestant princes of his house. In March 1585 the chiefs of the League issued the Declaration of Péronne, exposing their grievances against the Government and announcing their intention to restore the dignity of religion by force of arms. On the refusal of Henry III. to accept Spanish help against his Huguenot subjects, war broke out. The chief cities of France declared for the League, and Guise, who had recruited his forces in Germany and Switzerland, took up his headquarters at Châlons, while Mayenne occupied Dijon, and his relatives, the dukes of Elbeuf, Aumale and Mercoeur, roused Normandy and Brittany. Henry III. accepted, or feigned to accept, the terms imposed by the Guises at Nemours (July 7, 1585). The edicts in favour of the Huguenots were immediately revoked.

Guise added to his reputation as the Catholic champion by defeating the German auxiliaries of the Huguenots at Vimory (Oct. 1587) and Auneau (Nov. 1587). The protestations of loyalty to Henry III. which had marked the earlier manifestoes of the League were modified. Obedience to the king was now stated to depend on his giving proof of Catholic zeal and showing no favour to heresy. In April 1588 Guise arrived in Paris, where he put himself at the head of the Parisian mob, and on May 12, known as the Day of the Barricades, he actually had the crown within his grasp. He refused to treat with Catherine de' Medici, who was prepared to make peace at any cost, but restrained the populace from revolution and permitted Henry to escape from Paris. Henry came to terms with the League in May, and made Guise lieutenant-general of the royal armies. The estates-general, which were assembled at Blois, were devoted to the Guise interest, and alarmed the king by giving voice to the political as well as the religious aspirations of the League. Guise remained at the court of Blois after receiving repeated warnings that Henry meditated treason. On Dec. 25 he was summoned to the king's chamber during a sitting of the royal council, and was murdered by assassins carefully posted by Henry III. himself. The cardinal of Lorraine was murdered in prison on the next day. The history of the Guises thenceforward centres in the duke of Mayenne (*q.v.*).

By his wife, Catherine of Cleves, the third duke had 14 children: among them Charles, 4th duke of Guise (1571–1640); Claude, duke of Chevreuse (1578–1657), whose wife, Marie de Rohan, duchess of Chevreuse, became famous for her intrigues; Louis (1585–1621), 3rd cardinal of Guise, archbishop of Reims, remembered for his liaison with Charlotte des Essarts, mistress of Henry IV.

CHARLES, 4th duke of Guise (1571–1640), was imprisoned for three years after his father's death. He married Henriette Catherine de Joyeuse, widow of the duke of Montpensier. His eldest son predeceased him, and he was succeeded by his second son HENRY (1614–64), who had been archbishop of Reims, but renounced the ecclesiastical estate and became 5th duke. He made an attempt (1647) on the crown of Naples, and was a prisoner in Spain from 1648 to 1652. A second expedition to Naples in 1654 was a fiasco. He was succeeded by his nephew, LOUIS JOSEPH (1650–1671), as 6th duke. With his son, FRANCIS JOSEPH (1670–75), the line failed; and the title and estates passed to his great-aunt, Marie of Lorraine, duchess of Guise (1615–88), daughter of the 4th duke, and with her the title became extinct. The title is now vested in the family of the Bourbon-Orleans princes.

BIBLIOGRAPHY.—A number of contemporary documents relating to the Guises are included by L. Cimber and F. Danjou in their *Archives curieuses de l'histoire de France* (1834, etc.). Vol. iii. contains a soldier's diary of the siege of Metz, first published in Italian (Lyons, 1553), accounts of the sieges of Calais (Tours, 1558), of Thionville (1558); vol. iv. an account of the tumult of Amboise from the *Mémoires* of Condé, and four accounts of the affair of Vassy; vol. v. four accounts of the battle of Dreux, one dictated by Guise, and accounts of the murder of Guise; vol. xi. accounts of the Parisian revolution of 1558; and vol. xii. numerous pamphlets and pieces dealing with the murder of Henry of Guise and his brother. An account of the murder of Guise and of the subsequent measures taken by Mayenne, which was supplied by the Venetian ambassador, G. Mocenigo to his Government, is printed by H. Brown in the *Eng. Hist. Rev.* (April 1895). For the foreign policy of the Guises, and especially their relations with Scotland, there is abundant material in the English *Calendar of State Papers* of Queen Elizabeth (Foreign Series) and in the correspondence of Cardinal Granvella. The memoirs of Francis, duke of Guise, covering the years 1547 to 1563, were published by Michel and Poujoulat in series 1, vol. iv. of their *Coll. de mémoires*. Among contemporary memoirs *see* especially those of the prince of Condé, of Blaise de Monluc and of Gaspard de Saulx-Tavannes. *See* also J. B. H. du Trousset de Valincourt, *La Vie de F. de Lorraine, duc de Guise* (1681); A. de Ruble, *L'Assassinat de F. de Lorraine, duc de Guise* (1897), where there is a list of the ms. sources available for a history of the house; R. de Bouillé *Hist. des ducs de Guise* (4 vols., 1849); H. Forneron, *Les Guise et leur époque* (2 vols., 1887); H. M. Williams, *The Brood of False Lorraine: the History of the Ducs de Guise, 1496–1588* (2 vols., 1918).

GUITAR (Fr. guitarre, Ger. *Guitarre,* Ital. *chitarra*), a musical instrument strung with gut strings twanged by the fingers, having a body with a flat back and graceful incurvations in complete contrast to the members of the family of the lute (*q.v.*), whose back is vaulted.

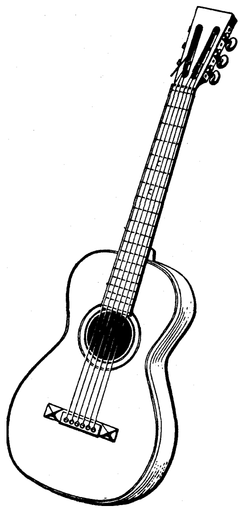
The construction of the instrument is of paramount importance in assigning to the guitar its true position in the history of musical instruments, midway between the cithara (see LYRE) and the violin. The mediaeval stringed instruments with neck fall into two classes, characterized mainly by the construction of the body: (1) those which, like their archetype the cithara, had a body composed of a flat or delicately arched back and soundboard joined by ribs; (2) those which, like the lyre, had a body consisting of a vaulted back over which was glued a flat soundboard without the intermediary of ribs.

The latter method of construction predominates among oriental instruments and is greatly inferior to the first. A striking proof of this inferiority is afforded by the fact that instruments with vaulted backs, such as the rebab or rebec, although extensively represented during the middle ages in all parts of Europe by numerous types, have shown but little or no development during the course of about 12 centuries, and have dropped out one by one from the realm of practical music, leaving only the mandolin as survivor.

The guitar must be referred to the first of these classes, having been derived from the cithara.

One of the earliest representations of a guitar in western Europe occurs in a Passionale from Zwifalten, A.D. 1180, acquired by the Royal Library at Stuttgart. St. Pelagia, seated on an ass, holds a rotta or cithara in transition! while one of the menservants leading her ass holds her guitar. Both instruments have three strings and the characteristic guitar outline with incurvations, the rotta differing in having no neck.

GUITAR FIDDLE (TROUBADOUR FIDDLE): a modern name bestowed retrospectively upon certain precursors of the violin, possessing characteristics of both guitar and fiddle. The name "guitar fiddle" is intended to emphasize the fact that the instrument, in the shape of the guitar, which during the middles ages represented the most perfect principle of construction for stringed instruments with necks, adopted at a certain period the use of the bow from instruments of a less perfect type, the rebab and its hybrids.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A MODERN SIX-STRINGED GUITAR

The use of the bow with the guitar entailed certain structural changes in the instrument. The large central rose sound hole was replaced by lateral holes of various shapes; the flat bridge, suitable for instruments whose strings were plucked, gave place to the arched bridge required in order to enable the bow to vibrate each string separately. The arched bridge, by raising the strings higher above the sound board! made the stopping of strings on the neck extremely difficult if not impossible — a matter which was adjusted by the addition of a finger-board of suitable shape and dimensions. At this stage the guitar fiddle possesses the essential features of the violin, and may justly claim to be its immediate predecessor. not so much through the viols (which were the outcome of the Minnesinger fiddle with sloping shoulders) as through the intermediary of the Italian *lyra*, a guitar-shaped bowed instrument with from 7 to 12 strings. From such evidence as is now possessed, it would seem that the evolution of the early guitar with a neck from the Greek cithara took place under Greek influence in the Christian East. *See* GUITAR.

GUITRY, the name of two French actors, father and son, the latter being also a producer and playwright.

LUCIEN GERMAIN GUITRY (1860–1925) was born in Paris on Dec. 13, 1860. Immediately after leaving the Conservatoire he first appeared at the Gymnase in *La Dame aux Camélias* (1878). His style of acting, sparing in gesture and theatrical effects, at first surprised rather than pleased the public and the critics. Sarah Bernhardt asked him to play at the Théâtre de la Renaissance, and it was there that he achieved his first successes.

He appeared in plays of the most varied character, from Charles Maurice Donnay's *Amants* (1895) to Anatole France's *Crainquebille.* He succeeded in representing the utmost frenzy of passion with the greatest economy of method. From 1918 onward he frequently acted in the plays of his son Sacha Guitry; he was remarkably successful in creating the principal parts in *Pasteur* and *Mon Père avait raison.*

He died in Paris, June 1, 1925.

SACHA GUITRY (1885–1957), dramatist, actor and producer, was born at St. Petersburg, Russia! on Feb. 21, 1885, the son of the foregoing. He was only 21 when he achieved success with his first play *Nono.* This was followed by *Chez les Zoaques* (1906), *Petite Hollande* (1908), *Le Scandale de Monte Carlo* (1908), *Le Veilleur de nuit* (1911) — one of his best plays — and *Un Beau mariage* (1911).

Sacha Guitry generally acted in his own plays; it is difficult to draw an absolute distinction between his work as an actor and as a playwright, for his art was always to some extent in the nature of brilliant improvisation. His output was enormous; he had over 90 plays produced out of 130 that he wrote. Special mention is given to those more serious pieces which he wrote for his father to act in: *Debureau* (1918). *Pasteur* (1919) and *Béranger* (1920). He wrote, directed and acted in many motion pictures of which the best known was perhaps *Roman d'un tricheur* ("The Cheat"). His autobiography *Mémoires d'un tricheur* (translated into English as *If I Remember Right)*, appeared in 1935. He was promoted commander of the Legion of Honour in 1936 and elected to the Académie Goncourt in 1939.

Five times married, he taught all his wives. of whom Yvonne Printemps was the most celebrated, to act. He died in Paris on July 24, 1957.

See S. Guitry, *Lucien Guitry, sa carrière et sa vie* (1930); A. Madis, *Sacha* (1950). (*W. A.* **Ds.**)

GUITTONE D'AREZZO (*c.* 1230–1294), Italian poet. Fra Guittone, who belonged to the religious and military order of the Cavalieri di Santa Maria, wrote sonnets and love poems, which can be studied in a good modern edition, *Le rime di Fra Guittone* (1901), by Pelligrini. He is more famous as the writer of the earliest extant letters written in the Italian language.

END OF VOLUME TEN

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